

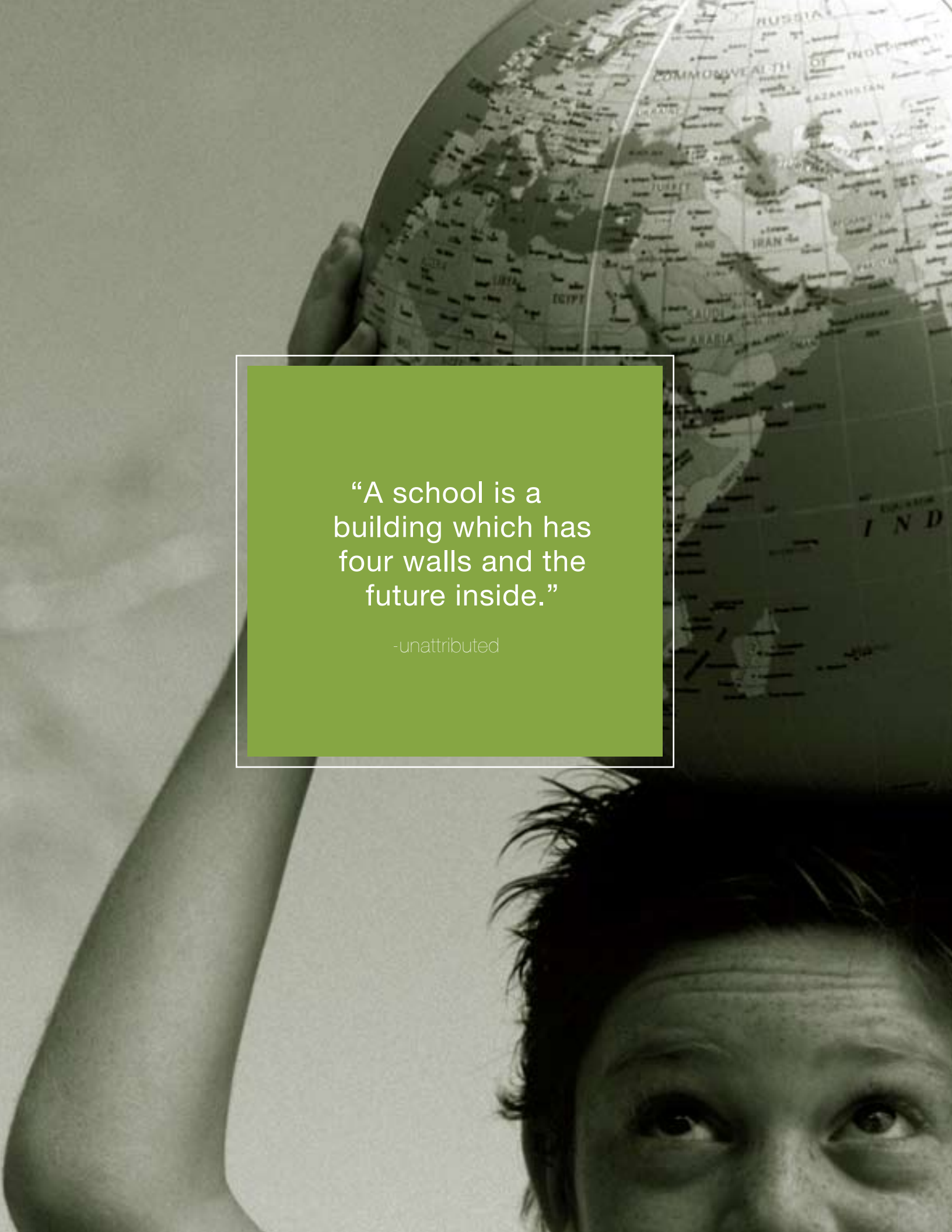
# GREEN SCHOOLS

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## RESOURCE GUIDE

A Practical Resource for Planning and Building Green Schools in Ontario

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“A school is a building which has four walls and the future inside.”

-unattributed



# GREEN SCHOOLS

RESOURCE GUIDE

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## INTRODUCTION

A “green school” is an energy efficient, higher-performing school that can be environmentally beneficial, economical to build and operate, and offer improved learning environments. The topic of green schools is increasing in importance, driven by greater environmental awareness and rising energy and operation costs.

The guide has been developed specifically for Ontario school boards, based on a review of over 250 articles, papers and websites on green schools from Canada, North America and worldwide. The authors also conducted original research on the performance of green measures incorporated in Ontario green schools, completed a web-based survey of 53 Ontario school boards, and gathered first-hand accounts of implementing green schools from over 20 Ontario school boards.

The goal of this resource is to provide initial guidance to school boards and their consultants who are considering building a green school. This guide focuses on green school strategies that are proven, practical, reliable, cost-effective, and beneficial to the environment.

This guide does not establish a set of “green school” requirements, evaluation criteria, or prescriptive solutions. This document is meant to provide guidance for school boards, and their professional consultants, along the path to developing greener school. It recognizes the great diversity of Ontario school boards, and that there is no “one-size-fits-all” solution. It provides school boards with a common range of information and

background on some key green development questions and resources. Thus allowing individual boards to set their own green course.

To ensure usability for a wide cross-section of readers, this resource guide includes an executive summary, and separate sections on green school benefits, planning, design and construction, occupancy and operation, and reference materials.

Some readers may choose to read this manual from cover to cover, while others will choose to zero in on the areas most relevant to their needs and interest. For example, a teacher may read over the executive summary and then skip to the topics listed under “Occupancy” for ideas on implementing green action plans.

**“Hot links” are embedded throughout the PDF version of the document. These will direct the reader to a related section in the document or to external websites for additional information. Given the constantly evolving nature of websites, these links are provided for convenience only, and the authors cannot vouch for the accuracy or currency of the information contained on any external website.**



# OVERVIEW & EXECUTIVE SUMMARY

A “Green School” is an opportunity to build an energy efficient, higher-performing school - that can be environmentally beneficial, offer improved learning environments, and can be economical to build today and operate for years to come.

## EXECUTIVE SUMMARY

Ontario school boards are facing new expectations, as students, staff and parents demand more from our school buildings. Schools must be wired for technology, more secure, accessible, and “greener” than ever before. School board staff are expected to respond to all of these demands, while they face restricted budgets, limited resources, and greater pressure to deliver new schools faster. In this challenge, however, lies opportunity.

A Green School is an opportunity for boards to address issues of energy efficiency, environmental sustainability, student achievement, and long-term costs, in a complete and considered way. It is a means for boards to build higher-performing schools that are energy efficient, environmentally beneficial, and economical to build and operate, while offering improved learning environments.

### **Some Ontario school boards have already embraced the challenge and are building green and energy-efficient schools:**

- More than 100 Ontario schools from over 16 school boards have qualified under Natural Resources Canada’s Commercial Building Incentive Program (CBIP), achieving an average 39% energy savings (over Code compliance), and 11 have surpassed the 50% energy-saving mark.
- Ontario schools have also been recognized under the Leadership in Energy and Environmental Design (LEED) program.

If Green Schools are to become main stream, however, the knowledge and lessons learned by boards which have built them must be disseminated more widely. In a survey completed by ZAS Architects Inc. and Halsall Associates for this guide, half of Ontario boards scored their own familiarity with “green”, “sustainable” or “high-performance” schools as moderate or low. By presenting a practical approach to greening, based on case studies, best practices and benchmarks from Ontario and other jurisdictions, this manual will begin to address this knowledge gap.

### **What is a “green” school?**

This is often the first question asked, and one for which there is no simple answer. There is no commonly held Green School standard or definition. To confuse things further, the terms “green”, “healthy”, “sustainable,” and “high performance” are often used interchangeably.

However, there are several principles that frequently reoccur in Green School definitions: protecting the environment, lowering operating costs, improving the health and quality of the learning environment, and integrating learning opportunities with the built environment.

Ultimately, school boards and their school communities are in the position to define “Green School” for themselves. A process can be an important early step in developing a successful, lasting, and locally responsive Green School. More can be found on defining “green schools” in Section 2.2.

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## Why green our schools?

Some benefits will address unique issues faced by each board or school community. Other benefits are more universal:

### 1. Energy Efficiency

With demonstrable operational cost savings and reduction of environmental impact, energy efficiency should be the first consideration for any Green School. Significant cost savings can be achieved from available and relatively low-cost, efficient technologies. Emissions from energy use also represent one of the largest impacts any school will have on the environment.

### 2. Financial Sustainability

Building a Green School (depending on the green features pursued) can add 5% to 10% to the initial cost. This scale of incremental cost can be quickly recovered from lower operating costs that will continue over the life of the building.

### 3. Promoting Environmental Stewardship

By engaging and inspiring students, the building itself can educate the next generation of Ontarians about their role in conserving resources and reducing waste. Ontario's Green Schools will also support the emerging green building industry, and enhance awareness of sustainable design in all sectors of the economy.

### 4. Demonstrating Environmental Sustainability

Ontarians now expect their public institutions to act responsibly with regard to climate change and other factors affecting the environment. The building of Green Schools is a tangible way for the Ontario education sector to show what can and is being done with respect to:

- Energy conservation
- Reducing greenhouse-gas and smog emissions
- Reducing water use and improving water quality
- Diverting material from landfill
- Saving topsoil and native-species habitat
- Promoting active transportation

### 5. Supporting Student Achievement

Green Schools support student achievement in three ways. They can save money from operations that can be redirected to the classroom. They can provide teaching environments that are more conducive to learning - through improvements in acoustics, lighting, temperature and air quality. They can engage and inspire students by demonstrating both simple and complex ways to bring about innovation and change.





# 11 STEPS

## TO A GREEN SCHOOL STRATEGY

The following eleven steps are a road map to guide a school board from inception to completion of a green school project. With the great diversity of Ontario's schools, a board may choose to follow all or none of the steps. In any case, these eleven steps will assist boards in forming the right questions to support their greening efforts.

### 1. Draft the Green Team

Developing a green school starts with the team. It may begin as a committee of school board staff, and grow to include other stakeholders and consultants. Many kinds of expertise are needed in building the green school: school board staff from all departments; building users; specialized green consultants; energy modelers; commissioning agents. Start by assessing the available in-house resources, and augment the team with outside resources that can include consultants and staff from government agencies or non-profits. See Section 2.1 for more information.

### 2. Define Green Objectives

Once the team is assembled, define what a "green" school is for this board and for this project. Then draft green objectives, with input from key stakeholders based on the green

school definition. The draft objectives and definition will be used throughout the design and construction phases for guidance, decision-making, and evaluation of the project. Agreement on clear objectives early in the process limits the need for costly corrective actions, gives the multidisciplinary design team a clear direction, and reduces the likelihood of any surprises for occupants on opening day.

There may be a temptation to focus on implementing individual highly-visible green "features" or technologies. Generally, however, a more comprehensive approach based on multiple green objectives is a more successful strategy. One that balances experimentation with a more measured approach. An environmental improvement of 10% over 20 schools results in a greater net benefit for the environment than an improvement of 90% in a single school. An improvement of 10% in 20 schools is also more likely to be achievable than a single 90% improvement. Setting initially low, achievable objectives that increase over time (as skills and experience are gained) is generally a lower risk strategy than implementing a number of one-off far reaching green features.

Most successful green design approaches build upon school board initiatives that are already underway, and use skills currently available to the board. Any green initiative should answer real challenges the board is facing in an effective and achievable way. Refer to "Defining Green Objectives" Section 2.2.

### 3. Set a Whole Life Building Budget

With a definition of “green” and draft green objectives in place, the next task is to set a whole life budget. Budgets should consider costs over the entire life of the building. A board that saves on construction costs, only to incur higher long-term operation and maintenance costs, has not realized any savings at all. School boards should consider a reasonable payback period for any premium over the base construction budget. For example, the construction budget could be set at the provincial benchmark with a maximum payback of 10 years on any premium items. Budgeting may also include non-monetary items, such as carbon-emission reduction and water conservation. Section 2.3 discusses Whole Life Budgets further.

### 4. Refine the Green Objectives

Once the whole life budget has been determined, the green objectives should be reviewed and specific green strategies discussed. A method of tracking and monitoring adherence to the green objectives should also be established at this point. The board may want to consider the use of one of the many green building rating tools or develop its own tracking method. Regardless of the method, what is important is that the green progress can be tracked and that any changes can be explained and understood by all the stakeholders while remaining flexible enough to take advantage of unexpected green synergies that may emerge through design and construction. Refer to Section 2.4

### 5. Gather Support

Any green school program will require some degree of change. Change will need support from stakeholders, support, that is ideally, secured as early in the process as possible. A collaborative process that gives stakeholders (trustees, board administrators, school staff and the broader community) an opportunity to provide input into the green objectives and become “champions” is critical to a project’s success. External supporters may also bring additional funding, experience or assistance with approvals. More on gathering support for a Green School can be found in Section 2.5.

### 6. Select a Green Site

Often a school site is simply designated by the developer, and the board may not have much influence over the location. Boards should still seek to engage developers and municipal officials early in the process to identify the best location for a new school site. When a board does have a choice, it should select a site which will support defined green objectives. Criteria can include a site that is within walking distance of a majority of students, supports compact urban form, is located on or near public transit routes, is connected to a walking or bike path system, is adjacent to a public park, etc. More can be found in Section 2.6

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## 7. Green Design Approach

After site selection, the green design approach is the first opportunity to implement the green design objectives. Green design requires broader thinking. Consider the impact a design decision will have today and in the future, on the architecture, the cost of construction and operation. To facilitate this expanded thinking, the Integrated Design Process (IDP) was developed by the Department of Natural Resources in the early 1990s. The IDP creates a structure to allow building planners, users, operators, and all consultant disciplines to provide input into the design. The goal is to optimize the building's performance and operational efficiencies at the lowest building cost, by identifying "win/win" cost trade-offs through the design process. To ensure none of the green objectives refined in step 4 are lost.

Green projects most often get into financial difficulties when the drivers of green costs and methods to control those costs are not fully understood. When costs and environmental goals are understood by all of the stakeholders through the IDP, the investment can be optimized to deliver a fiscally responsible project that provides real environmental and operational benefits. Any proposed measures should be evaluated for their return on investment in both financial and environmental terms. Are the proposed measures the right ones for this school, on this site, in this environment, for this investment? Refer to Section 3.1 for more detail.

## 8. Green Design and Construction Methods

There are a broad range of green design elements that can be incorporated into a school, starting with energy efficient strategies. Energy efficiency provides predictable operation cost savings with relatively short payback periods for small initial investments. This list of six measures that combined will typically yield a 30% energy savings:

- high-efficiency boilers
- ventilation heat recovery
- improved building envelope
- high-efficiency water heaters
- high-efficiency lighting design
- variable speed drives

In addition to energy efficiency, a green school should consider ways to green the school site, reduce water use, divert waste from landfill, and improve the learning environment. Section 3.2 covers numerous ways to "green" school design and construction.

## 9. Commissioning/Handover and Training

The design sets the stage but environmental performance of a school is equally related to occupant behavior and its operation. Proper commissioning, handover procedures, and operator training ensure that the environmental performance promised by the design is realized.

Commissioning provides a second set of eyes to review the design, installation, and operation of the mechanical systems of the building. This role can be filled by a specialized board staff or an outside commission agent. A commissioning agent could be valuable as an advocate through design and construction and to assist with a smooth handover, especially for smaller boards.

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The handover of the building and operator training should also be carefully considered. Consultants should prepare design/intent documents and expected performance results, and contractors need to complete full Operation and Maintenance (O&M) and hold start-up and training sessions. Any training sessions should be recorded for future reference. More on this can be found in Section 3.3.

## 10. Ownership and Operation of a Green School

Green schools generally require active ownership. This may mean monitoring of building systems to optimize performance and compliance with design targets, and active user involvement in waste or energy reduction programs. The Canadian Green Building Council notes that design, operation, and behavior each share a one-third responsibility for long-term energy performance. Green schools require building operators and users to understand their particular role in supporting the green design and building objectives. Users must become educated, active occupants, and operators must understand the green intent behind the design. Since active ownership must be considered in the design phase, a green process requires much more overlap among planning, design, construction and occupancy. Section 4.1 related more information on the Ownership and Operation of a Green School.

## 11. Learn for Continuous Improvement

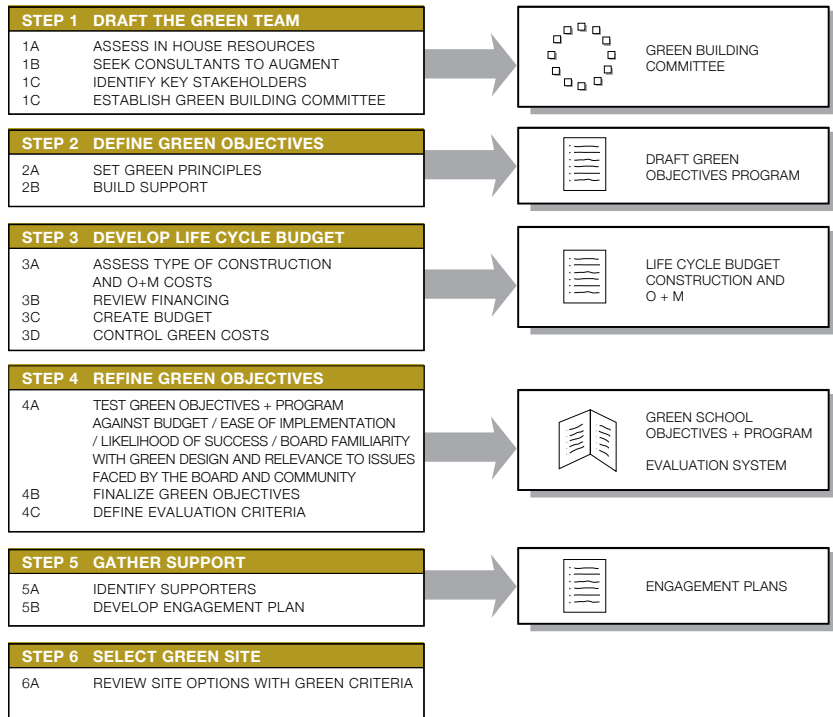
A green school is not a static concept. The environmental performance of green schools will improve over time. The lessons learned with each new green school will contribute to our overall understanding and improve the design and performance of tomorrow's schools. More on how to learn from today's schools to apply towards future designs can be found in Section 4.2.

# Green Design Process

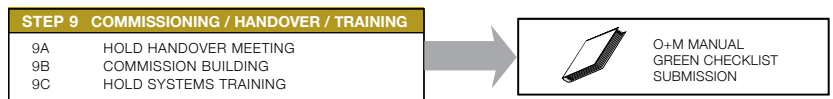
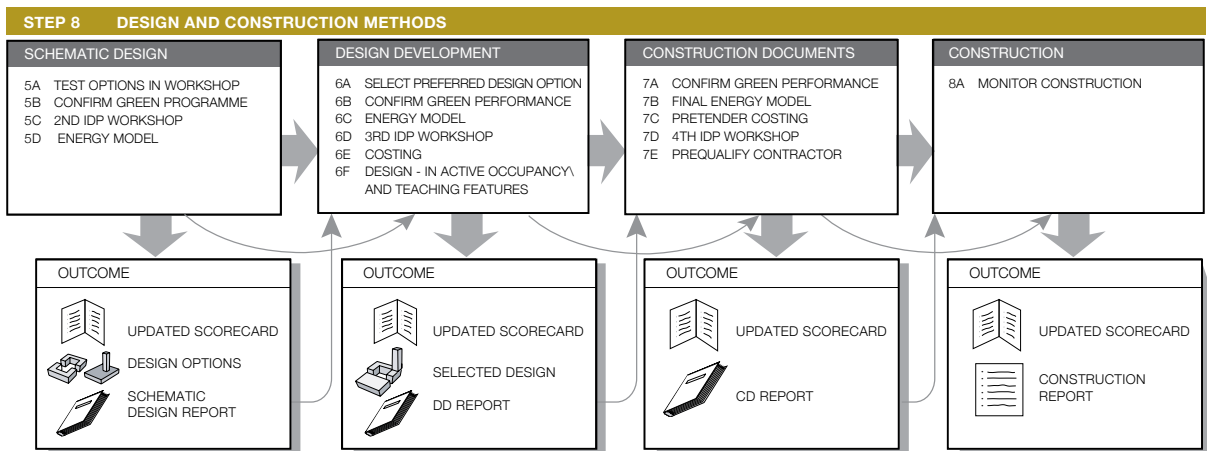
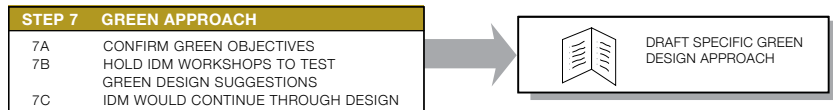
## SECTION 2 Planning

### STEPS

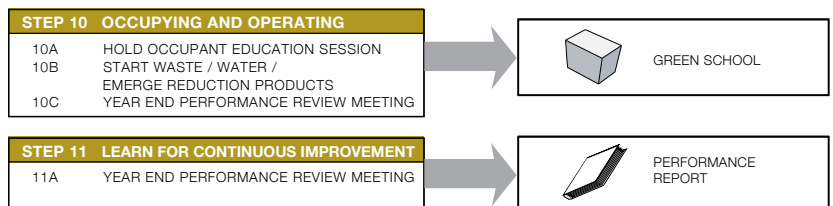
### OUTCOMES



## SECTION 3 Design Construction



## SECTION 4 Occupying and Operating



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# 5 GREEN APPROACHES

## ANY SCHOOL BOARD SHOULD CONSIDER

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# Quick Start Guide

These five steps on the road to green include low-cost, low-risk, easy-to-implement measures. Every board may not be able to implement all of these approaches but even one is a step to a greener future.

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**1** SAVE MONEY AND THE ENVIRONMENT THROUGH CONSERVATION

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**2** ENGAGE STUDENTS AND STAFF AND ENCOURAGE POSITIVE OCCUPANCY BEHAVIOR

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**3** REDUCE, REUSE, RECYCLE

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**4** GREEN THE SITE

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**5** ENHANCE LEARNING OPPORTUNITIES

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# 1

## SAVE MONEY AND THE ENVIRONMENT THROUGH CONSERVATION

Energy and water use represent the bulk of potential green school environmental and operational savings. A 30% reduction target (from code compliance) for new builds and major renovations is usually achievable, with minimal investment and with short paybacks.

## Six energy efficiency measures can save 30%

- High efficiency boilers;
- High efficiency water heaters;
- Ventilation energy recovery;
- Improved insulation;
- Variable speed drives;
- High efficiency lighting systems

Other energy and water saving features could include: building automation system, automatic controls, low-flow plumbing fixtures, and materials that require less energy to manufacture and to ship (e.g. local and highly recycled materials).

Designing for efficiency is only the first step. The Canadian Green Building Council notes that design, operation, and behavior each share a one-third responsibility for long-term energy performance. To optimize the operation, the school should be commissioned and monitored for actual energy use to ensure the building systems were built and operate as designed. Monitoring energy and water use allows for improvement to the school's performance and that of future designs. Green schools should also encourage occupant awareness and saving behavior by displaying energy use and implementing student action programs.

Once all of the conservation options have been considered, a board may want to explore renewable generation options such as; ground source heat pumps, solar domestic hot water heating, and wind or solar electrical generation. In almost all cases, **it is a preferable green and economic policy to save a watt rather than to generate a watt, even if that watt was generated using renewable technology.**

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## 2 ENGAGE STUDENTS AND STAFF AND ENCOURAGE POSITIVE OCCUPANT BEHAVIOR

Green schools offer a great opportunity to engage students with an issue that is important to them.

By using concrete examples, we can provide students with an opportunity to actively participate in programs that can improve our environment. Engaged occupants can provide significant energy and water savings simply by adopting more efficient behaviours. Good habits such as turning off lights, walking to school, double sided copying, reducing and recycling waste, and lowering thermostats all save energy, operational costs, and the environment.

For these reasons it is important to engage the staff and students by creating green schools that demonstrate creative approaches to environmental issues. Designing a green school will provide a school board with an opportunity to use the building as a learning tool that could be included in the curriculum. Monitoring the school's environmental performance will provide opportunities to celebrate success and reinforce the lesson that something can be done.

## 3 REDUCE REUSE RECYCLE

The three Rs start with design. Investigate reducing building size by “right-sizing” room areas to reduce the volume of new materials required. Reusing existing components or entire buildings will also reduce environmental impacts. New building materials should be specified as high recycled content materials to encourage recycling. In addition, target for a high diversion of construction waste during the school's construction. The design should also include for at-source waste separation to support recycling and composting of school generated waste.

When the school is occupied, consider implementing a litterless lunch, recycling, composting and other user-driven waste management programs.

# 4

## GREEN THE SITE

A green school site can encourage the use of active forms of transportation, support the native habitat and conserve water and energy. Revisit standard programs to find savings in building and hard surface areas. Right-size classrooms, support spaces and parking lots to limit the building's footprint.

Ask civil and landscape consultants to investigate bio-swales and retention ponds to manage storm water. Work with landscape consultants to provide low maintenance native and shade planting.

Encourage staff and students to take greener transportation to school: locate schools close to student populations, bike lanes, and transit routes. Provide safe walking routes that connect to adjoining park paths or sidewalks. Install secure bike parking, and limit car parking and drop-off to only what is required by zoning by-law. Consider starting a walking school bus program.

Consider blacking out the site after hours for security, energy savings and bird migration.

# 5

## ENHANCE LEARNING ENVIRONMENTS

Positive learning environments lead to positive learning outcomes. The importance of providing quality learning environments is highlighted by the fact that the school building is one of the few student performance variables that is wholly within the control of the board. Therefore, along with efficient design, the quality of the learning space should be carefully considered. Boards should consider linking their green school with the curriculum to concretely demonstrate the concepts of energy efficiency and environmental stewardship within the classroom.

### Lighting

Lighting systems should provide even and consistent lighting and be augmented with task-specific lighting where needed. A well designed direct ceiling mounted T-8 system with electronic ballasts will generally provide quality lighting levels. However, a direct/indirect T-8 or T-5 system with electronic ballasts can provide even more consistent lighting, with the potential of greater energy savings. Use daylighting - but carefully locate windows and provide shading screens or blinds to avoid glare. Also consider the use of daylight sensors to turn off lights when daylight is sufficient.

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## Comfort

Access to views, natural daylight in classrooms and thermal controls have all been shown to have some positive impact on student performance, and should be considered in green school design.

## Acoustics

Classrooms should be designed to improve audibility. Reduce reverberation times in classrooms by installing sound absorbing ceiling tiles, and lower ambient noise by acoustically isolating teaching spaces from mechanical equipment and other noise generators. Provide sound isolating features in the building envelope if the school site is near exterior noise generators such as busy roads, rail lines, industrial facilities and airports. Commissioning an acoustic study should be considered for any questionable site.

## Health

Indoor Environmental Quality (IEQ) is impacted by the school's design, construction, and maintenance. Boards should strive to design for good IEQ by designing effective ventilation systems, specifying low VOC materials (especially paint and adhesives), and detailing a durable, moisture-repelling building envelope. Build "clean" by requiring contractors to protect interior materials and ductwork from contamination and water damage during construction. Apply rigorous maintenance schedules for housekeeping and building systems. Green cleaning products also have a role to play in keeping a green school a healthy school.

# GREEN SCHOOL BENEFITS

- 1.1 Energy Efficiency
- 1.2 Financial Sustainability
- 1.3 Promote Environmental Stewardship
- 1.4 Demonstrate Environmental Sustainability
- 1.5 Support Student Achievement

**Some possible benefits of building a green school will arise from each board's particular definitions of a green school. Potential benefits will address unique issues faced by the board or individual school community. Other potential benefits are universal:**

- ENERGY EFFICIENCY
- FINANCIAL SUSTAINABILITY
- PROMOTING ENVIRONMENTAL STEWARDSHIP
- DEMONSTRATING ENVIRONMENTAL SUSTAINABILITY
- SUPPORTING STUDENT ACHIEVEMENT

## 1.1 Energy Efficiency

Water and energy use reductions represent the greatest demonstrable environmental and cost benefits of building a green school. Reduction of energy and water consumption delivers real environmental benefits, predictable and measurable results, and the monetary savings to offset additional capital costs.

Energy and water use directly relate to three important ecological issues: air quality, climate change and safe drinking water. According to Environment Canada, the heating and cooling of our buildings is responsible for 17% of greenhouse gas emissions. Environment Canada

also identifies nitrogen oxides (NO<sub>x</sub>) and volatile organic compounds (VOCs) as the two leading contributors to smog and demonstrates that heating and power generation account for 15.6% of NO<sub>x</sub> production in Ontario and 13.4% of VOC production in Ontario. Growing limitations on sources of clean drinking water have also been recognized by Environment Canada. The International Joint Commission reports only 1 % of the water in the Great Lakes system is renewable. Therefore reduction in energy and water use can have significant impact on important environmental issues. There are also substantial monetary returns on investments in efficiency, including reducing the risk of exposure to volatile energy prices.

## 1.2 Financial Sustainability

Ontario school boards typically design school buildings to last over 50 years. Over that time, operational and maintenance costs can outstrip the entire original construction cost. In most cases, green schools not only cost less to operate, but they have been shown to recoup their extra building costs several times over the operational life of the building. The initial cost of greening schools might best be seen as an investment, one that is supported through operational savings over the short term and long term.

Staffing, energy, water, sewage, waste disposal, cleaning and material replacement costs are all on



the rise, and if not considered in the design stage the board can be left with these volatile costs over the entire life of the building.

Primarily, cost savings will come from investments in energy and water efficient systems and long-life building materials. The energy savings can be accurately predicted during the building's design. Using computer energy models, potential energy use can be calculated and various options for return on investment can be explored.

Through life-cycle cost analysis, major building components such as roofs, flooring and cladding materials can be evaluated over the life of the project. Future maintenance and replacement costs can be predicted. Boards should evaluate cost-saving options, and plan and budget for operating and maintenance savings before the school is even built.

### 1.3 Promote Environmental Stewardship

A green school's influence on students and the school community is likely its greatest environmental impact.

Building a green school displays a tangible example of environmental stewardship and demonstrates that something can be done. Green schools teach students environmental practices that can be implemented today, and will inspire a generation of future environmental leaders. By linking the school design and construction to the

environmental education curriculum, the lessons in the classroom can be reinforced by the walls and roof of that very classroom.

Building green also represents an opportunity to engage students on subjects they are very passionate about. Schools that have implemented student education and action programs have seen energy savings of more than 10% and waste reduction of over 15%. These schools also report high rates of student engagement with the program, which can spread to other areas of school life.

The green school project also has the potential to make social change on a broad scale. One in five Ontarians learns or works in a publicly funded school every day. Instilling positive environmental habits in students and staff could play a significant role in "greening" Ontario, as environmental habits learned at school by 20% of the population come home. A green school also demonstrates to the school community how much can be achieved by building green, and inspires others in the community to follow the board's lead.

Green school building can also lead to market transformation. The building of K to 12 schools is the second largest sector in the Ontario construction market according to Statistics Canada. In 2007-08, Ontario District School Boards spent \$1.3B on building schools as documented by the Ministry of Education. Such a large volume of expenditure in a single market sector provides leverage and opportunity. Greening this segment will set an example for the construction industry and may establish Ontario as a leader in green construction technology.

## Can Ontario schools make a difference?

An example of school construction as a lever to create green industry is provided by the Lakehead District School board. The board insisted on specifying a high performance polyiso spray insulation system to reduce heating loads, even though there were no qualified installers in the Thunder Bay area. Three different contractors saw the opportunity presented by this improved insulation system. They have been trained and are now making the green technology available to the whole community.

## 1.4 Demonstrate Environmental Sustainability

Ontarians have embarked on an important shift in their outlook on the environment, and expect public institutions to act on this priority issue. As holders of large tracts of land and real estate and as educators of our future citizens, Ontario school boards have the power to act to improve this province's environmental health.

### Reduce Greenhouse Gases and Smog Emissions

Green schools lower overall greenhouse-gas emissions by using strategies such as energy-efficient design and construction with low-embodied energy materials. These same features will also limit emission of key ingredients in smog, such as nitrous oxides, ozone and volatile organic

compounds. Green school design and operations have been shown to reduce emissions. The average 39% energy reductions seen by over 100 Ontario schools in NRCan's CBIP program would translate into a similar reduction in emissions.

### Reduce Water Use

Green schools, through water efficiency measures, can address the issue of water conservation, making a positive contribution to the environment as a whole. A green school could realistically cut water use by 30%.

### Reduce Waste

School lunches generate an average of 8,500 kilograms of waste per school per year, according to the Recycling Council of Ontario. Industry Canada reports construction activities are responsible for 1.2 million tonnes of waste annually in Ontario. Green schools in Ontario have consistently reported construction recycling rates of in excess of 70%. User-led initiatives such as waste-free lunch programs dramatically lower school waste production.

### Practice Smart Growth

Smart growth is the wise use of green lands in conjunction with broader municipal and provincial plans. School boards should consider the environment of the location, the community infrastructure, and its viability for environmental transportation. The design process should consider options such as a multi-storey building, modest parking lots and drop-off loops to minimize the building's transportation carbon footprint.

## Support Indigenous Habitats

One hundred and eighty one Ontario species are listed as “at risk” by the Committee on the Status of Endangered Wildlife. Ontario schools occupy some 145 square kilometres, much of which lies within urban areas that are under-served by green space. By practicing good stewardship over this territory, school boards have a unique opportunity to add native habitat and support native species survival for future generations at little or no extra cost. Green schools will also serve as showplaces within the community where efficient, economical and effective new technologies, materials and products can be demonstrated to the broader community.

## 1.5 Support Student Achievement

### Transfer Resources

A key principle of green design is to achieve maximum efficiency from the resources used over the life of the building. The operation and maintenance savings realized through efficiency in the design may then be reallocated to other needs – essentially putting money back into the classroom.

For example, energy can be a substantial cost. Focusing on efficiency and low life-cycle costs can result in operational cost savings which can be utilized elsewhere. A more detailed discussion on costs included in the section 2.3 Whole Life Budget.

## Supportive Learning Spaces

Evidence suggests that indoor environments that are well ventilated, dry, well lit, have good acoustics, and that limit pollution sources and potential infections may improve student comfort and performance. Research to date offers little consensus on what quantifiable improvement in learning can be expected from any specific green measure. Improvements in the learning environment can and should be expected, but investment in these features for the sake of this expected improvement cannot be supported through empirical research at this time. Few studies definitively document a direct correlation between specific healthy buildings measures and student outcomes.

The school building is, however, one of the variables in student performance that is wholly within the control of the school board. Even without definitive proof, it seems reasonable to recommend low-cost measures that appear to improve student performance, especially in such areas as air quality, acoustics, lighting, infection control and supporting a healthy active lifestyle.

### Engage and Inspire Students

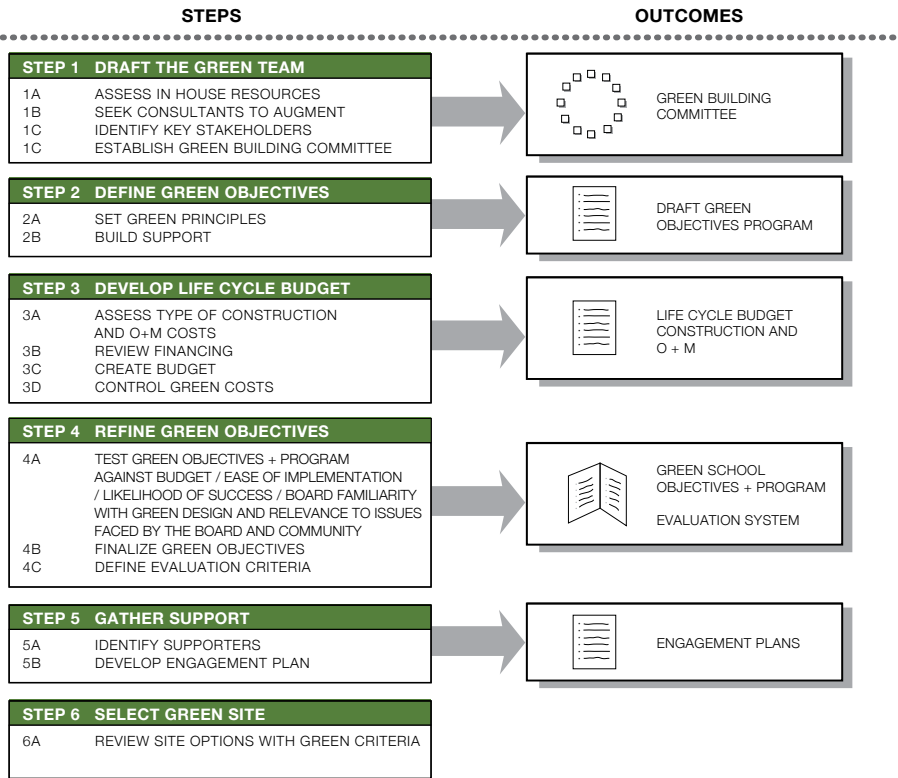
A school and its systems can engage students through active energy management and waste reduction programs. It can inspire them through conscientious design, creative solutions to environmental issues, and can become a teaching opportunity in itself, showing students that something can be done and challenging them to do more.

# GREEN SCHOOL PLANNING

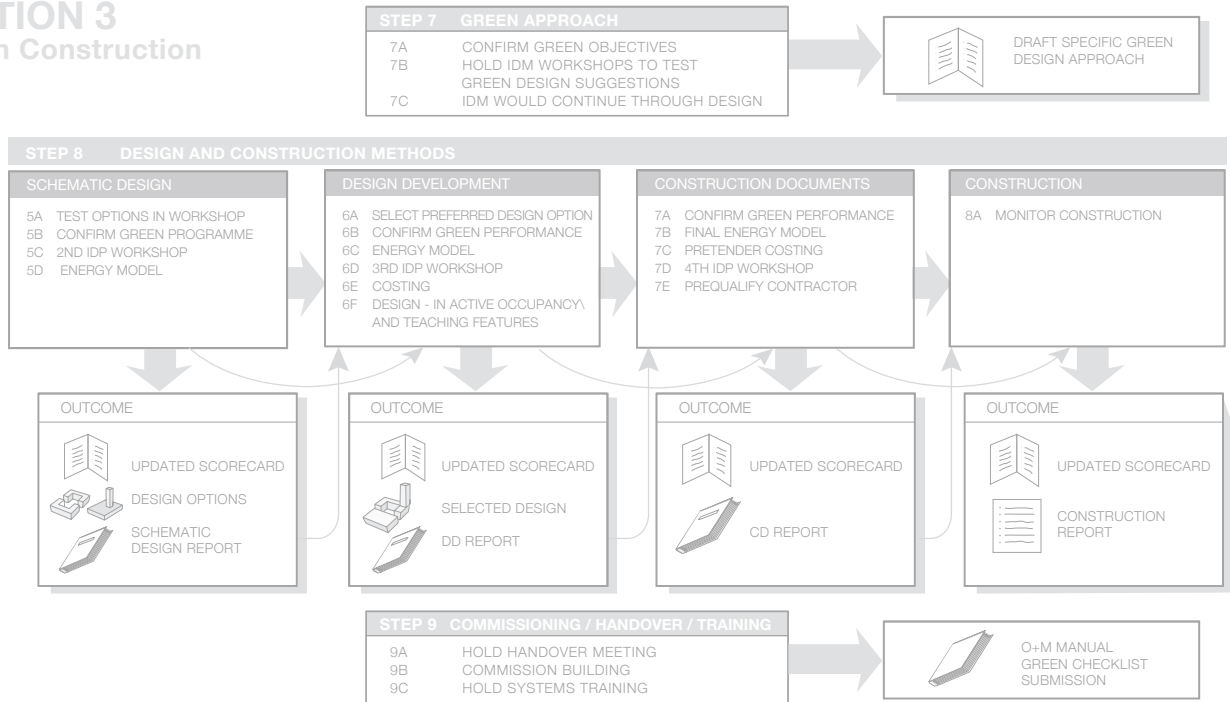
- 2.0 Ontario Green School Planning Checklist
- 2.1 Step 1: Drafting the Green Team
- 2.2 Step 2: Define Green Objectives
- 2.3 Step 3: Whole Life Budget
- 2.4 Step 4: Redefine Green Objectives
- 2.5 Step 5: Gather Support
- 2.6 Step 6: Site Selection

# Green Design Process

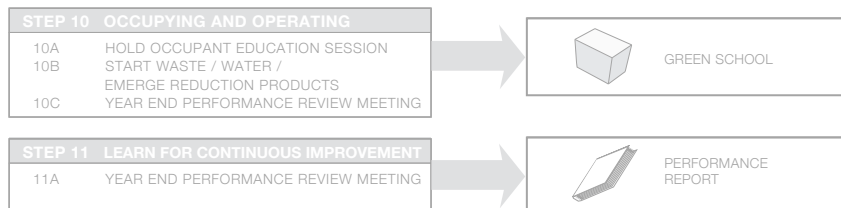
## SECTION 2 Planning



## SECTION 3 Design Construction



## SECTION 4 Occupying and Operating



## 2.0 Green School Planning

This section covers the planning phase for a green school - discussing topics of:

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### Assembling a Green Team

SECTION 2.1

### Defining Green Objectives

SECTION 2.2

### Setting a Whole Life Budget

SECTION 2.3

### Refining the Green Objectives

SECTION 2.4

### Gathering Support

SECTION 2.5

### Selecting A Green Site

SECTION 2.6

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### Green School Planning

#### Self-Evaluation Checklist

Directly following this page is the green school Planning Self-Evaluation Checklist intended for board staff, consultants and contractors.

#### How to Use:

The checklist is a compendium of the most common green questions. It is anticipated that school boards could use the checklist as a template to refine and add green questions relevant to their own school communities.

This checklist is a starting point, not a defined standard. It is not meant as an assessment tool for green performance as there are a number of green performance and assessment tools available from other sources.

The checklist consists of eight columns. The column for Proposed Project Measures is meant for internal project team tracking. This column is to be filled in by the school board or consultant, and explains how a particular project intends to address the question. A thorough description of each of the columns and a basis for typical project impact assumptions is contained in a section following the checklist.



## Ontario Green School Planning Checklist

Board:  
 School Name:  
 Project Address:

Green Questions	Question Rational	Possible Measures	Typical Project Impacts			Target	Proposed Project Measures	Typical Project Milestone	Team Member/ Responsibility
			Costs	Payback	Implementation				
<b>2.1 Step 1 - Drafting the Green Team</b>									
What resources are available from the stakeholder group or within the board?	Establish internally available resources, thereby identifying outside consultants that maybe needed to fill knowledge gaps.	Survey stakeholders and board staff for green experience. Establish a green building committee comprised of stakeholders and staff.	\$ (staff time or for a consultant to assist with this process)	n/a	May add some time to the pre-design phase of the project			Pre-Design School Board Planning	
Can the right green consultants be retained?	A critical aspect to the success of any green school will be getting the right advice from experienced consultants.	Issue a "green" RFP and evaluate respondents on experience, a track record of reviewing previous projects performance and bring "best practices" knowledge from other boards and sectors. Additional consultants such as sustainable specialist or energy modellers may also be considered.	n/a	n/a	n/a			Pre-Design School Board Planning	
<b>2.2 Step 2 - Define Green Objectives</b>									
Has the board adopted a Green Schools Resolution?	Provide board-wide guidance on Green Schools.	Adopt a Green School Development Policy on the school board.	n/a	n/a	Will require a policy review process at the board level			Pre-Design School Board	
How is "green" school defined for this Board or this School Building Project?	Create a common Green School Definition.	With key stakeholders, review existing "green" school definitions and create a board or project-specific definition. Green objectives should build on programs the boards is already undertaking or address real green issues faced by the board or local community.	\$ (staff time or for a consultant to assist with this process)	n/a	May add some time to the pre-design phase of the project			Pre-Design School Board Planning	
Are there current green programs or issues in the Board or the community?	To identify sources of strength in the board or community upon which to build.	Survey current green programs active within the board or in the community. Ask for input from stakeholders on current green issues and programs.	\$ (staff time or for a consultant to assist with this process)	n/a	May add some time to the pre-design phase of the project			Pre-Design School Board Planning	
What are the Board's key objectives for a "green" school?	To create a common set of objectives to assist in decision making and tracking of green targets throughout the project.	With key stakeholders, identify specific green objectives. These could include energy or operational savings, reducing waste routed to landfill, improved learning environments, providing outdoor learning environments, etc.	\$ (staff time or for a consultant to assist with this process)	n/a	May add some time to the pre-design phase of the project			Pre-Design School Board Planning	
<b>2.3 Step 3 - Whole Life Budget</b>									
What are the project's cost of constructing, operating and maintaining the school building over it's expected life?	Identify costs over the entire expected life of the Project.	Establish a life cycle budget using the amount budgeted for construction and for operation and maintained for the building over it's useful life.	\$ (staff time or for a consultant to assist with this process)	n/a	May add some time to the pre-design phase of the project			Pre-Design School Board Planning	
How can the split between capital and operating budgets be optimized?	Establishing the right capital budget to allow for long-term O & M savings leading to cost savings over the life of the project.	Consider small capital investments (as little as 5 to 10%) into improved building systems that would return that investment over a short-time period.	\$ (staff time or for a consultant to assist with this process)	n/a	May add some time to the pre-design phase of the project			Pre-Design School Board Planning	
Are there financing options available to pay for capital investment?	Small investments can provide reasonable returns on investment and insulate the Board from volatile commodity prices.	Consider options to provide additional funds for capital improvements.	\$ (staff time or for a consultant to assist with this process)	n/a	May add some time to the pre-design phase of the project			Contract Documents Architect/ Civil Consultant	

Green Questions	Question Rationale	Possible Measures	Typical Project Impacts			Target		Proposed Project Measures		Typical Project Milestone	Team Member/Responsibility
			Costs	Payback	Implementation	Y	N	?			
How can the investment in green features be optimized?	Similar levels of environmental performance can be achieved with widely varying amounts of investment. Therefore it is important the greatest benefits are derived for a set amount invested.	Flatten the green learning curve by retaining an experienced team, establish realistic green goals early and use the Integrated Design Process effectively.	\$ (staff time or for a consultant to assist with this process)	n/a	May add some time to the pre-design phase of the project					Pre-Design School Board Planning	
<b>2.4 Step 4 - Redefine Green Objectives</b>											
Do the Objectives defined above appear feasible when reviewed against budget?	Without tracking, a project might stray from the green objectives and without evaluation at the end of the project there is no way to measure success.	Establish regular review milestones with reports back to stakeholder group. These milestones could be at the end of Schematic Design, end of Design Development, Pre Tender, at completion of construction and one year after construction completion.	\$ (staff time or for a consultant to assist with this process)	n/a	May add some staff and consultant time over the project					Pre-Design School Board Planning	
How can objectives be tracked through the project?	Without tracking, a project might stray from the green objectives and without evaluation at the end of the project there is no way to measure success.	Establish regular review milestones with reports back to stakeholder group. These milestones could be at the end of Schematic Design, Design Development, Pre Tender, at completion of construction, and on one year after construction completion.	\$ (staff time or for a consultant to assist with this process)	n/a	May add some staff and consultant time over the project					Pre-Design School Board Planning	
Is a green building rating system to be considered? Although there is no need to use a green building system, some boards may choose this option.	If a green rating system is being considered, it should be early in the process to prevent redesign costs.	Review green building rating systems (a summary of rating systems is provided in Section 3.5).	\$ (could range dramatically depending on which rating system is selected)	n/a	May add some time to the pre-design phase of the project					Pre-Design School Board Planning	
<b>2.5 Step 5 - Gather Support</b>											
Are there any key stakeholders or supporters that need to be consulted?	Identifying stakeholders and potential supporters early in the process, can ensure critical input on the design is provided and leverage resources to assist with the Project.	Approach a wide range of potential stakeholders that could include: operation and maintenance staff, teaching staff, parents and students, municipal officials, local utilities and energy and environment ministers of Provincial and Federal governments	\$ (staff time or for a consultant to assist with this process)	n/a	May add some time to the pre-design phase of the project					Pre-Design School Board Planning	
How can stakeholders be kept involved in the process?	To ensure stakeholders are actively engaged and can provide input and support when appropriate.	Create a communication plan with stakeholders which could include: regular e-mail up-dates on the project and milestone meetings to review process. There may also need to be an educational component that would engage and inform stakeholders.	\$ (staff time or for a consultant to assist with this process)	n/a	May add some time to the pre-design phase of the project					Pre-Design School Board Planning	
<b>2.6 Step 6 - Site Selection</b>											
Is the Proposed School Site on Environmentally Sensitive Land?	To preserve farm land and native habitat.	Select a site that is below regional flood plain; ecologically sensitive land; provides habitat of a rare or endangered species; is near or adjacent a wetland	\$ (site dependent)	n/a	Site Dependent					Pre-Design School Board Planning - Site Selection Review	
Will the Proposed School Site Support Compact Development a Previously Developed Lands?	To promote compact development thus limiting urban sprawl and loss of farmland.	Develop new school on a site within an established community (older than 20 years) or with a minimum density that meets the smart growth guidelines	\$ (site dependent)	n/a	Site Dependent					Pre-Design School Board Planning - Site Selection Review	
Is the Proposed Site in a Walkable Location?	To promote the use of walking, biking, rollerblading, etc. to school by keeping the travel distances short. Greater use of active transportation will improve levels of physical fitness, air quality and overall energy efficiency by reducing car trips.	Select school site so that the majority of students will not be expected to meet Provincial Guidelines for Busing	\$ (site dependent)	n/a	Site Dependent					Pre-Design School Board Planning - Site Selection Review	
Is the Site Accessible by Public Transportation?	To promote the use of public transit to school and thus improve air quality and overall energy efficiency by reducing car trips.	Select site within a close proximity of a transit station or within a 5 min walk of a surface transit routes.	\$ (site dependent)	n/a	Site Dependent					Pre-Design School Board Planning - Site Selection Review	

## Planning Checklist Notes:

### Green Question

These are typical questions a board may confront in developing a green school. Questions should be gathered from a number of sources including: green school rating systems (e.g. LEED, Green Globes, and CHPS); input from stakeholders, and other Ontario school boards .

### Question Rational

This column lists the environmental, economic or student success benefits associated with the green question.

### Possible Measures

Listed under possible measures are typical strategies employed to address the environmental, economic or student success issues raised by the stated question.

### Typical Project Impacts

\$	Less than 5% over conventional school development measure
\$\$	5 to 15%
\$\$\$	15% +

Incremental Costs and Typical Paybacks are based on typical case (described below) - as actual project costs will vary widely based on site and other project factors. All proposed target costs should be reviewed and confirmed with a professional design team and a certified cost consultant before proceeding

The “Typical Project Impacts” were based on comparison to a hypothetical two storey 4,150 m<sup>2</sup> (45,000 sq.ft.) elementary school; for 450 students; on a 2 ha (5 acre) site; load bearing masonry construction and steel roof structure; brick exterior cladding with ASHRAE 90.1 (2004)

compliant insulation and air barrier system; double glazed low-e insulated windows in aluminum frames; painted block interiors with NCR 0.55 acoustic ceiling tile; vinyl composite tile (VCT) flooring, except carpet in front office and library. Mechanical System: centralized mid-efficiency boiler, roof top air handling units, local air condition to office and library, basic building automation system and low flow plumbing fixtures. Building wide T-8 lighting fixtures with electronic ballasts except high intensity discharge (HID) fixtures for the gym.

### Targets

Under this column the board official or consultant would record either a Yes (to be pursued) , No (not pursued) or ? (more information required).

### Proposed Project Specific Measures

Board staff or consultant records the specific measures their green school is proposing to implement.

### Typical Project Milestone

Listed as either Planning, Pre-design; Schematic Design; Design Development, Contract Documents, Construction, Post-Construction or Occupancy. This column lists the project milestones at which a proposed measure would typically need to be incorporated to avoid unnecessary costs.

### Team Member Responsibility

All team members must work cooperatively to successfully execute a green design. It is useful to assign a point person or a team member with primary responsibility. This column suggests those members with primary responsibility.

## 2.1 Step 1: Drafting the Green Team

A green school team begins within the board itself and the formation of an internal green development team. The importance of having the right board staff at the table cannot be overstressed. Experienced building operators and users and top-level “buy-in” will greatly increase the likelihood of success. Intensive staff input may not be needed on every green project – in fact, many green measures may become standard fare over time – but when it comes to early green projects, it is crucial that staff from engineering, operations, maintenance and academics are all represented on the committee.

### Assess Internal Strengths and Resources

It is important to review the strengths and resources available within the board. For instance, the board may have staff who are well versed in energy efficiency or waste management. If the board lacks expertise in some areas of key concern, outside experts may be needed. These experts may also fall outside the usual range of consultants hired by the board, and may include acousticians, water management consultants or energy modelers.

**The hiring of consultants may also be phased in over time. A specialized green consultant may be hired early on to assist the board in the planning phases and write the architectural RFP. That consultant may or may not continue on through the rest of the project. Conversely, a general call for consultants led by an**

**architect could be placed in the early stages, with a requirement for an expanded pre-design phase to assist with forming the green objectives. If the board has the resources, it could take on the planning phase and issue an architectural RFP after the planning phase is complete. In any event, realizable green objectives must be set through the planning phases. Like the building itself, a strong green design process requires a strong foundation. A green foundation clearly describes a well thought-out set of green objectives, a whole life budget, and selection of a green site.**

### Retain Green Building Professionals

- **Green Consultants:** An experienced consultant team can bring lessons learned from other boards or building types, which can be crucial ingredients in delivering maximum value and green benefits. These consultants must translate the board’s objectives into a design and a set of contract documents for the contractor. Much of the project’s success will depend on the skills, knowledge and experience of the consultant team to balance the green, financial, and operational requirements. *(Refer to Section 5.2 The Green Consultant RFP.)*

In some parts of Ontario, it may be difficult to assemble a team of consultants and builders that is knowledgeable in local and green issues. In these cases, a board may consider hiring key green consultants, (sustainability consultant, energy use consultant, specialized architect, mechanical or electrical consultant) to work with and mentor local consultants on green issues.

- **Green Builders:** The field of green building in general and green schools in particular is still fairly new and dynamic. Best practices are still in the developmental stages. The contractor, therefore, is a very important team partner in building green. No matter how carefully objectives are set or systems specified, if the contractor fails to exercise care, diligence and skill, any green measure can be negated. To ensure the credentials of the builder, the use of a pre-qualification process to create a list of qualified contractors is advised.

- **Green Building Specialists:** Expertise in both energy modeling and commissioning have been shown to be very good investments, since they have the potential to reap returns in operational savings many times above the original consultant fee. Some other key areas of specialty are daylight modeling, life-cycle costing and acoustics. Not every type of consultant is required for every project. Some may be retained to develop “board standards” that may be applied to other schools, thus distributing costs over several projects.

## 2.2 Step 2: Define Green Objectives

# What does 'green school' mean?

There is no commonly held green school standard or definition. The terms green, healthy, sustainable and high performance are often used interchangeably, leaving school boards in the position of defining “green schools” for themselves.

The advantage of creating a definition is that it is unique to the board’s particular circumstances, concerns and priorities. Also, the very act of creating a definition requires a board to come to a consensus internally as to what is meant by a green school.

The disadvantage is that definitions may vary from board to board, making comparisons and benchmarking difficult. Another approach may be simply to adopt or adapt an existing green school definition. In any approach, the board will need to take a position and create or choose a green definition.

The following contains some example definitions of green schools and key questions to ask when creating a definition or statement of principles. Putting some real meaning behind the term green school is an important first step in the development of a green school strategy. It offers a chance to test assumptions and build support for setting new priorities and measures of success for building programs.

## Commonly accepted green school principles

The first step in creating a green school definition is to survey what commonality exists between other widely accepted definitions. Although there is no universally accepted definition of green schools, we have some common principles emerging from a survey of international green school definitions. Principles include protecting the environment, lowering operating costs, improving the health and quality of the learning environment, and integrating learning opportunities with the built environment. Listed below are four examples:

### Council of Educational Facility Planners (GEFPI)

*“A healthy school cares for and looks after the overall well-being of its occupants. This school is an environment-friendly school, saves energy and is passionate about the health of its occupants.”*

### Collaborative for High Performance Schools (CHPS)

*“A high performance green school has three distinct attributes: it is less costly to operate than a conventional school; it is designed to enhance the learning and working environment; it conserves important resources such as energy and water.”*

### United Kingdom’s Department for Children, Schools and Families

*“A sustainable school prepares young people for a lifetime of sustainable living, through its teaching, fabric, and day-to-day practices. It is guided by a commitment to care:*

- *for oneself (our health and well-being);*
- *for each other (across cultures, distances and generations);*
- *for the environment (both locally and globally).”*

### COSBO’S E&E Green Schools Working Committee has suggested that a green school is one that:

- *is energy efficient*
- *is financially sustainable*
- *promotes environmental stewardship*
- *demonstrates environmental sustainability and*
- *supports student achievements*

## Ask Key Questions

In the context of these definitions, the next step is to build on these basic principles by asking more specific questions.

- What are the important outcomes expected or required of a green school?
- How can developing a green school dovetail with other challenges the board is facing?
- What green objectives match existing board objectives?
- What are “green” issues in our community?
- How would any green premium be funded? (reserves, financing, energy service agreement (ESAs), grants, gifts)
- What return on investment would green features need to achieve?
- What is flexible, what is not?

Ultimately, any successful green school or measure must address relevant issues faced by the board and community. The goal is to create a green school agenda that meets real local needs, while adhering to generally accepted principles.

## Green school objectives

The green school objectives will be used to guide and support the design and construction phases, the decision-making process, and ultimately to evaluate the success of the project. The objectives should define broad project targets, yet be specific enough to be measured and verified. In developing the objectives, the following items should be considered:

- any board-wide green school objectives or policies
- willing partners
- available financial resources
- broadly-held school and community environmental concerns.

The objectives can be developed through a school-specific workshop process, a board-wide green school policy, or as part of the Integrated Design Process. Objectives must be meaningful, address real concerns, be technically and financially feasible, and be supported by stakeholders.

Objectives can include achieving a specific green building rating system target, or they could be tailored to achieve some or all of the following types of goals:

- **Specific green school outcomes (for example: a 30% reduction in energy use)**
- **Financial requirements (for example: cost no more than 5% than a conventional building)**
- **Environmental considerations (for example: a 10% reduction in CO<sub>2</sub>)**
- **Educational goals (for example: ability to use exposed building systems for a curriculum on energy efficiency)**

Boards may face pressure to deliver the greenest school possible, which may lead to the addition of numerous “bells and whistles” without benefit of a unified plan. In too many cases, green school targets are defined far from the point of implementation, and often end up placing unrealistic expectations on under-resourced staff working with limited construction budgets.



## 2.3 Step 3: Whole Life Budget

On average, operational costs may be up to 10 times the building's construction costs when considered over its entire life. The challenge is to find ways to transfer the potential future cost savings to today's capital budgets.

The most important question is not whether a board can afford a green school, but how much a board can afford to invest.

The life-cycle budget should consider not only soft and hard construction cost, but also ownership costs, to create a budget that is viable today and sustainable into the future.

In most cases, even small strategic investments can result in significant savings over the life of the building. This represents a fundamental shift in the way school boards should consider approaching capital funding and budgeting, from merely controlling costs to maximizing returns. Using this approach, every cost should be considered in relation to its investment potential over the life of the building or system. Budgeting for a green school can be calculated using a two-step process. The first step is to determine an acceptable capital expenditure; the second is to determine an acceptable additional investment with an expected rate of return.

Currently, energy and water savings and life-cycle costing of major building elements (e.g. roofs and HVAC) are the items that produce reliable, predictable and quantifiable values for budgeting purposes.

### Up-front Savings

In some cases, green measures actually cost less than the "non-green" alternatives. The principle of design efficiency (building only what is necessary and avoiding duplication) is an example of a green approach that can save money. Efficient internal planning can decrease the overall building area, reducing ongoing environmental impacts and as expenses such as heat and light. Keeping the building area compact also reduces up-front construction capital.

As related in the École secondaire Jeunes sans frontières Case Study (found in Section 3), waste reduction is another opportunity to do the right thing for both the environment and the bottom line. Similarly, reducing hard-surface site areas by planning for minimal parking and drop-off areas reduces the cost of asphalt and storm water storage, discourages car use, and saves on other site development costs.

### Operation and Maintenance Savings

Green school designs offer a real opportunity to reduce operating costs. In the survey of school boards, ongoing energy costs and O & M costs, were identified as two of the top three drivers increasing demand for green schools. According to Ministry of Education statistics, in 2006/07 Ontario school boards spent \$417M on utility costs.

When the American Society of Heating, Refrigeration and Air-Conditioning Engineers (ASHRAE) carried out an extensive study in preparation for the publication of its Advanced Energy Design Guide for K-12 School Buildings in the U.S., they found that 30% energy saving in K-12 schools should be “easy”.

Energy savings of 30% (compared to code compliance) should be achievable with a 5% to 10% investment over conventional construction costs. Refer to Section 3.2 for more specific energy and water saving strategies.

Specific energy and water savings can be accurately predicted using existing modeling software. Some lending institutions now provide green loans at preferred interest rates based on predicted savings.

### Low Maintenance and Replacement Costs

Durability is a key environmental principal. Greening often means building for the long term, using robust materials and detailing to resist wear. A related principle is reuse. It makes sense to build from materials that can be taken apart and resold or reused rather than materials that have no value in a second life. Choosing sustainable building materials and fixtures can not only keep more waste out of landfills, but can actually help to offset building maintenance, repair and replacement costs. Analyze life-cycle cost for major building components, particularly roofing, flooring, cladding, lighting and HVAC systems.

### Green School Financing Options

Many Ontario boards have already found creative ways of financing green school investments that have returned good value to the board over time. In financing a green school, the challenge for a board becomes determining the value of the investment to calculate the expected return and managing the investment to achieve the best rate of return. To determine the value of the investment, the board will have to review sources of capital available for the project, including provincial funding, incentive programs, board reserves, capital from lending institutions and capital from the open market.

A number of Ontario boards have looked to Energy Service Agreements (ESA) to fund energy savings initiatives. These types of agreements usually see a private energy service organization funding the up-front cost of an energy upgrade, and guaranteeing the board savings over the period of the agreement. The board pays a portion of the savings back to the energy service organization. The advantages of an ESA are that they require little or no up-front capital or staff time investment by the board.

However, ESA's are focused on financial return from energy savings and thus may not encompass larger operational and maintenance issues. Boards should also consider the cost of an ESA over the advantages. ESA charges can exceed the cost of more conventional borrowing.

## Control Green Costs

Green or LEED-rated projects do not necessarily have to cost more than conventional buildings.

A comprehensive 2004 review of 138 U.S. buildings by Langdon Davis (a U.S. cost consultancy) concluded:

“Many projects are achieving LEED within their budgets, and in the same cost range as non-LEED projects.”

In 2007 Langdon Davis revisited the study using the same methodology with a further 221 buildings, with the same findings. A key finding of both studies was that green building costs relate more to the cost of a specific green feature than to overall environmental performance.

A Massachusetts study of green pilot schools came to the same conclusion: “The study team did not find a close correlation between overall incremental cost and the greenness of the project.” These findings are also borne out by school projects in Ontario, where the 2007 LEED Canada Cost Survey estimated that the costs of a LEED Silver school ranged from \$130 per square foot for a secondary school to \$160-165 per square foot for an elementary school.

The investments that will be required to achieve green school benefits should be targeted to a strategy that will provide an optimized rate of return and support. No single approach will suit all programs and all sites. Direct investment in green features should be rooted in an understanding of the return, such as reduced utility costs. In this way the investment can be measured against a return. Each board must establish its own priorities and expected returns.

To optimize the investment it is important to understand ways to control green costs by reducing the green learning curve, establishing green goals early and using the integrated design process.

## Green Learning Curve

Many organizations that initiate green building projects have noted that they require a significant learning curve. Between 2000 and 2003, the City of Seattle commissioned \$600 million in LEED projects. The LEED premium over conventional construction methods fell 150% between 2000 and 2003. (City of Seattle, 2004).

The reason for the reduction in costs was simple: as the city's project managers, consultants and contractors got to know the process and optimized their approach, the cost of building green fell.

School boards should train staff and hire experienced consultants and contractors to flatten the learning curve. The Appendices in this manual provide practical tools to help in this process. Other ways to take this critical step include educating your board on environmental issues and green buildings, attending conferences, sharing experiences with other boards and staffing the project with informed professionals (See Section 5.2 The Green Consultant RFP).

### Establish Green Goals Early

Green goals must be identified at the very beginning of a project. Whether a green objective is to achieve a rating system target such as LEED Gold or a building performance goal (for example, a five-to-ten-year payback period), the objectives must be clearly stated and followed consistently.

Adding green objectives late in the design or construction process adds costs. One of the key methods of controlling the cost of green features is to use the Integrated Design Process. As the design phase progresses and the direction of the project becomes fixed, changes become more expensive as fewer trade-off opportunities are open to the team. Adding green objectives after construction has commenced can have even a greater cost impact, since it may force the consultant to rework the design or the contractor to modify or rebuild completed work.

## CASE STUDY:

# Keewatin-Patricia District School Board

In August 1998, the Keewatin-Patricia DSB proposed a pilot retrofit incentive project. The plan was to undertake a complete energy retrofit of Ignace School in the town of Ignace, near Dryden, Ontario. This 7,060 square-metre (76 thousand square-foot) facility was heated entirely by electricity and consumed 1,594,000 kWh of electricity annually at a cost of nearly \$147,000.

The KPDSB also decided to retrofit a large secondary school, Queen Elizabeth District High School in Sioux Lookout, Ontario. Two heating options were considered for the Queen Elizabeth project: an oil-fired boiler and a combined solar/ground-source heat pump system. The two sources of energy would incur similar operating costs. The other option was natural gas, at a capital cost of approximately \$1 million.

Although the capital cost of the heat pump was \$1.5 million, the board decided to install it due to its qualitative, environmental and energy consumption benefits for both projects.

Once the retrofit was complete, energy costs at Ignace School were projected to drop by approximately \$39,000 - a savings of almost \$108,000 a year, or 73%.

## CASE STUDY: Keewatin-Patricia District School Board PAGE 2

However, the actual energy cost savings were not quite as dramatic as anticipated due to the board's decision to provide new air-conditioning throughout. A large portion of the projected operational savings were eaten up as a result of the additional energy load, but with the improved air exchange rate they provided better overall thermal comfort and indoor air quality for staff and students.

NRCan's Energy Innovators Initiative subsidized the Ignace School retrofit with a grant of \$331,700. This agreement was based on the board implementing similar energy-saving measures in seven of its other schools.

Based on the success of the earlier program, the board has undertaken a 12-year, \$2.3 million project that includes solar domestic hot water heating, additional ground source units, solar pre-heating, and solar and wind electric generation demonstration projects. In total, this latest program is expected to save the district more than \$186,000 in annual utility and operational costs. Energy savings from the upgrades fund the program. An added benefit is the positive impact on the environment.

To further promote energy efficiency, the board has promoted environmental sensitivity among students and staff through a poster contest promoting recycling and the development of related board policy. The Facility Management staff's knowledge of energy-efficient equipment and practices are continually assessed in order to provide appropriate training. In addition, school principals report on the energy efficiency initiatives so that building occupants are aware of decreased energy consumption.

By improving energy management and reducing energy consumption at several of its schools, the KPDSB is saving energy, saving money and reducing its greenhouse gas emissions. Students also benefit from more comfortable and improved learning facilities, more financial resources for educational programs and, of course, a healthier environment.

## CASE STUDY:

# York Region District School Board

York Region DSB has essentially been able to flatline its energy costs despite adding approximately 80 new schools since 1997, while maintaining budgets in line with the funding formula.

The board has become an informed client and developed its own comprehensive mechanical and electrical guidelines. These guidelines inform and direct the efforts of a select team of experienced consultants.

The board has also developed a network of community partners that provide resources and financial support. Among the board's initiatives:

## CASE STUDY: York Region District School Board PAGE 2

### Lighting

The YRDSB focuses on optimizing lighting loads through targeting wattage, types of lights used in classrooms and, most recently, light harvesting. Light harvesting technology maintains proper lighting levels at all times, signaling for some artificial lights in classrooms to be turned off when outdoor natural light is available.

### Reduced Night Loads

The YRDSB has focused extensively on achieving an 80% reduction of power at nighttime in our facilities – this is done through advanced building automation controls and blackout lighting in the school – both interior and exterior lighting. Through training, staff are able to easily adjust schedules to accommodate extra-curricular permits, with most facilities completely shutting down by 10:30 - 11:00 pm. The building's level of energy consumption ends up being between 10 – 20% of its daytime peak loads.

### Heating

The YRDSB has invested in high-quality “Eutectic” cast-iron boiler systems that allow the YRDSB to utilize low temperature heating in the shoulder months, as well as achieve more than 85% boiler efficiency and still maintain a capital life expectancy of over 30 years. Most recently, the use of variable water flow technology has allowed the electrical and natural gas consumption to be further optimized.

### Metering

In over 100 schools the YRDSB has the ability to view “real time live” electrical consumption within their facilities. The data achieved through this metering allows the YRDSB to target specific electrical loads in the building to determine where further savings can be achieved. This also provides them with information to locate problems when and where they occur and to ensure the buildings performance is optimized. The “real time live” metering infrastructure allows for the students to verify their actions and see their results through an interactive web site. For more information on ECO Schools, visit <http://ontarioecoschools.org>

### “ECO SCHOOLS” Curriculum

The students and staff of each school have embraced the “Ontario ECO Schools” program. This program brings environmental literacy into the classroom with the primary focuses on energy, waste diversion, school grounds greening and environmental stewardship. Students are able to reduce lighting levels through a “lights out” program that significantly effects the day time energy consumption in the schools.

### Staff Training

Every lead caretaker has received at least four hours of intensive training on the operation of their specific facility systems, with ongoing courses continually being scheduled. Trainees understand how their efforts fit into the big picture and how they contribute to the board's conservation goals.



## 2.4 Step 4: Refine Green Objectives

Once the green objectives for the project have been established, it is important that the progress on these objectives is monitored, evaluated and communicated to stakeholders. Any green building process is dynamic, and many variables are unknown at the outset. Challenges and opportunities will emerge throughout the project. The hallmark of many successful green projects is that they are able to turn a challenge into an opportunity by applying a green approach. Site conditions, advances in technology, and approvals can all have an impact on the viability of particular options.

Without evaluation, objectives can become meaningless, and the critical data needed to improve future projects will not be collected. Without communication throughout the process, stakeholders can lose a feeling of investment in the success of the project and may withdraw support or develop unrealistic expectations.

### Green School Building Program

The green school building program follows the form of a traditional design brief and program, but would include specific items to realize the green objectives developed in the previous steps. Like the conventional building program used by the design consultants, a green school building program should reflect the physical space requirements and design elements required to meet the established green objective. For example, a green school building program may include:

- An environmental science room
- An outdoor classroom
- Integration of the interior with exterior space to support environmental learning opportunities
- Larger mechanical space to accommodate heat recovery
- Minimum parking requirements

## Green Building Rating Systems

Some school boards may want to consider using one of the more widely available green building rating systems for evaluation, monitoring and even third party certification. These tools can be used simply as a self-evaluation tool. If third-party certification is required, then application can be made to a certification body to verify green claims. There are two primary advantages to using one of the widely recognized green building rating tools. First, these tools have gained significant profile in the building industry. Simply stating a performance level for a recognized green building tool can be useful shorthand in developing an RFP.

Second, requiring certification by a third party reduces the onus on the board to set and enforce a green building standard. This “outsourcing” of some of the responsibility could be a real benefit, especially for boards that are new to green schools and those with limited in-house resources. The drawbacks to following or certifying under a green building rating system are cost and a current lack of school-specific standards in Canada. Although certification fees can be relatively low, the cost of additional consultant time to prepare the documentation may be significant.

Many view costs for items such as energy modeling and commissioning as good investments. Some of the cost, however, simply goes into documentation.

Rating systems are passive tools and do not specifically recommend a program of green features. Thus two very similar buildings, achieving the same level of green performance, can vary widely in the type of green features employed, costs, maintenance requirements and suitability for purpose. Green building tools only rate the relative green performance of buildings based on a selected group of criteria. These are important issues to consider when deciding whether to use a green building rating system. A comparison table of the various rating systems is included in Section 5.5 of the manual.

## 2.5 Step 5: Gather Support

Although a green school need not look any different from a conventional school, achievement of its green objectives at a reasonable cost may require some change to “business as usual”. It is useful if support for the overall project is built with those who may be asked to change.

Any green strategy should identify potential supporters of the green approach, both internal and external, and those who may be most affected by it. To both engage supporters and allay fears, the potential benefits of a green school must be fully explained and understood. Through the Integrated Design Process (IDP), stakeholders can offer valuable insight to suggest or refine measures that will result in both greater environmental and financial returns. The IDP is described in more detail in Section 5.1.

Eliciting input and involving stakeholders in the process fosters the feeling of ownership and provides opportunities to champion green measures. Engaged and invested stakeholders, particularly end users, will often become key supporters of the projects and can be important allies in explaining trade-offs to peers.

### Internal Support

The board trustees can be included at the strategic level to help develop a clear statement of principles, expected outcomes, or targets. Specifying green technologies or products is better left to professionals in consultation with board staff who can balance technical, specific site and building program issues with cost and environmental benefits.

Other internal partners can include relevant support staff, teaching staff, school environmental clubs, current and future students and parents. Without this kind of understanding of end users’ needs and the opportunity to test design alternatives, a design team may overlook or eliminate a feature of great importance to the end user. End users’ involvement throughout the project is especially important in ensuring that expectations remain consistent with what can feasibly be delivered.

## External Support

External partners tend to fall into four groups, providing:

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1. **Financial incentives**
  2. **Knowledge and resources**
  3. **Assistance with approval processes or requirements**
  4. **Political or community support**
- 

## Financial Incentives

Financial incentives are available from numerous sources. Government bodies are moving away from large-scale incentive or granting programs even for energy savings, arguing that since most energy-efficiency measures pay for themselves, building owners shouldn't need capital incentives to go green. The trend of government funding has turned towards "enabling" green projects by supporting design and feasibility studies and other narrowly targeted initiatives. A current list of available funding sources is included in Section 5.4

External partners have their own priorities, responsibilities and accountabilities. It is important that a clear understanding of how the partnership will work is established at the outset. Issues such as decision-making processes, recognition, copyright, contribution schedules and payment amounts should all be discussed and written into an agreement before the project starts.

## Knowledge and Resources

Numerous governmental and non-governmental organizations provide knowledge and resource support. Resources range from information about everything from energy efficiency to greening of school grounds. Some groups such as Evergreen may even assist with design and fundraising for green schoolyards. (A list of resources is included in Section 5.8.)

## Assistance with Approval Processes

Green building measures usually do not require special approvals. However, green construction is by definition not completely conventional. It is important to consult with relevant approval authorities early in the design process so that occupancy, building permit and other approvals are not held up due to unfamiliarity with the type of project under construction.

In particular:

- Electrical distribution tie-in for electrical solar cells will require ESA and Local Utility Review.
- Grey water reuse systems often require careful inspection by plumbing inspectors to ensure no possibility of contamination of the potable water system.
- Storm water management systems may come under special scrutiny if the municipality is unfamiliar with alternative systems (e.g. bio-swales or infiltration galleries).
- Any type of alternative water treatment method will require municipal and Ministry of Environment approval

## Political or community support

The broader school community can have a major impact on a green school: as champions, potential fundraisers and as the eventual occupants. As champions, the school community can build political support to help with approvals or overcome bureaucratic barriers. An engaged school community can also be very useful in fundraising, and may have access to other further support resources.

## 2.6 Step 6: Select a Green Site

When a board has the option to select a school site, selecting a green site can result in a number of benefits. A green site would support smart growth policies, promote active transportation, provide outdoor learning opportunities, and allow for optimal building and outdoor amenity orientation. Selecting a green site can be a low-cost way of realizing substantial green benefits.

### Smart Growth

Potential school sites in previously developed communities or within designated growth areas should be given preference. These sites that will support the compact urban form that produces vibrant, walkable communities on the local scale. At the macro scale, selecting sites that support smart growth will reduce road congestion, transportation-related smog and carbon emissions, and preserve farmland.

### Promote Active Transportation

Anecdotal evidence collected from GTA schools suggests upwards of 60% of students are driven to school daily. Active routes to school should be encouraged by selecting school sites that are walkable, bikeable and close to public transit. Sites that are within walking distance to the majority of students, within a five minute of convenient public transit, and connect to walking and cycling paths should be given priority.

### Outdoor Learning Opportunities

Sites that link to parkland or natural features allow for joint use of outdoor facilities or large native planting areas that could provide enhanced outdoor learning opportunities.

### Optimal Building and Outdoor Amenity Orientation

Priority should be given to sites with primarily southern exposure and shelter (from either existing trees or topography) from prevailing and storm winds. A site with southern exposure allows the school to also have a primarily southern exposure and avoid low east and west sun angles (which can result in glare and excessive heat gain). South facing and sheltered outdoor spaces will also be comfortable longer into the winter and summer seasons, encouraging outdoor play and learning.

# DESIGNING AND BUILDING A GREEN SCHOOL

- 3.0 Ontario Green School Design and Construction Process Checklist
- 3.1 Step 7: Green Design Approach
- 3.2 Step 8: Green Design and Construction
  - 3.2.1 Greening School Sites
  - 3.2.2 Water Use Reductions
  - 3.2.3 Energy Saving
  - 3.2.4 Materials and Waste
  - 3.2.5 Learning Environments
- 3.3. Step 9: Commissioning / Handover and Training

## 3.0 Green School Design and Construction

This section covers the design and construction phase for a green school discussing topics of:

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### Green Design Approach

SECTION 3.1

### Green Design and Construction Methods

SECTION 3.2

### Commissioning

SECTION 3.3

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The following pages are intended to provide an open, yet structured, system to assist boards in the planning of green schools consisting of a Self-Evaluation Checklist and more detailed step-by-step discussion in the individual sections 3.1 through 3.3. It is recognized that each board - and in fact each school site - faces unique challenges, thus the measures listed here are meant to help boards determine their own green path and are not meant to be prescriptive.

### Green School Planning Self-Evaluation Checklist

Directly following this page is the green school Planning Self-Evaluation Checklist.

#### How to Use:

The checklist is by no means exhaustive and is only a compendium of the most common green questions. It is hoped that school boards could use the check list as a template to refine and add green questions relevant to their own school communities. This checklist is a starting point, not a defined standard. It is not meant as an assessment tool for green performance, as there are a number of green performance and assessment tools available from other sources.

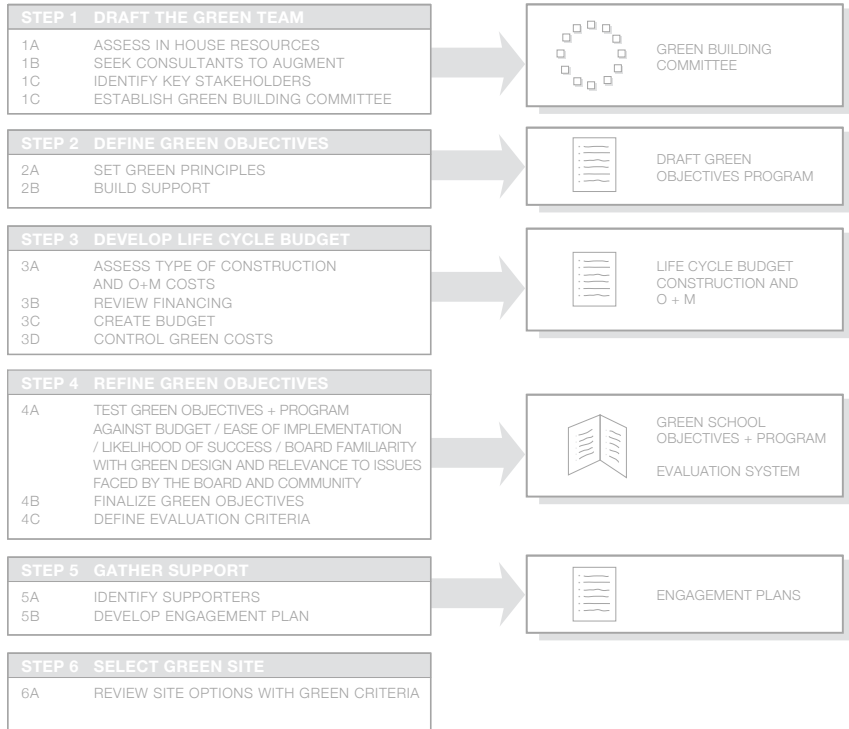


# Green Design Process

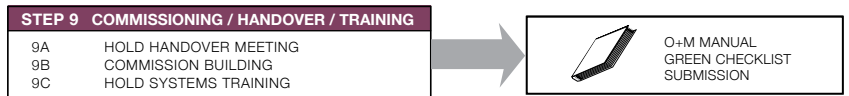
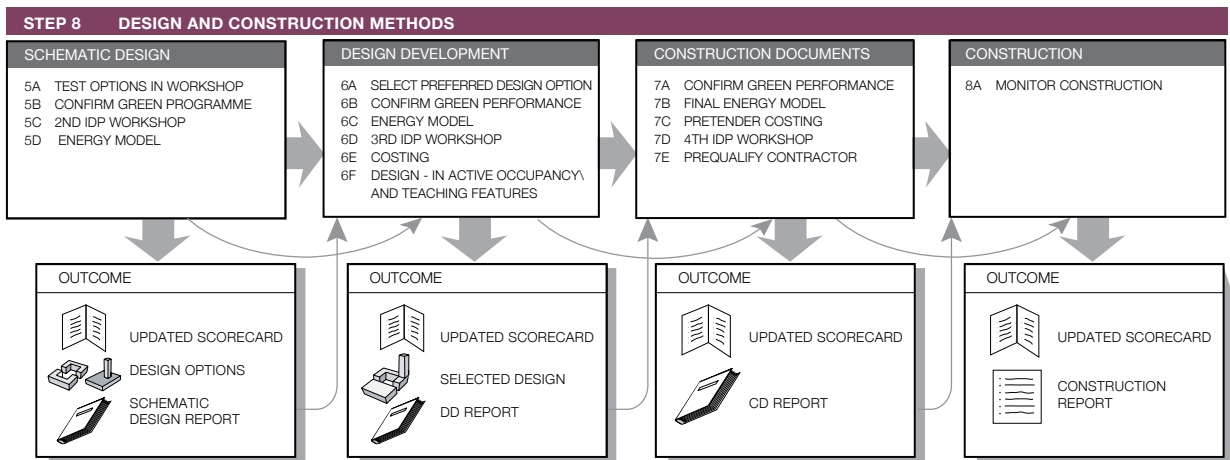
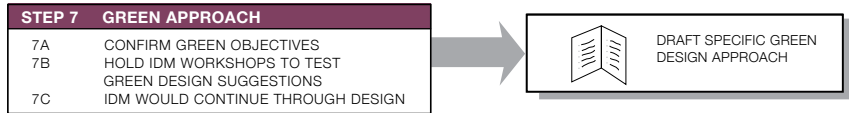
## SECTION 2 Planning

### STEPS

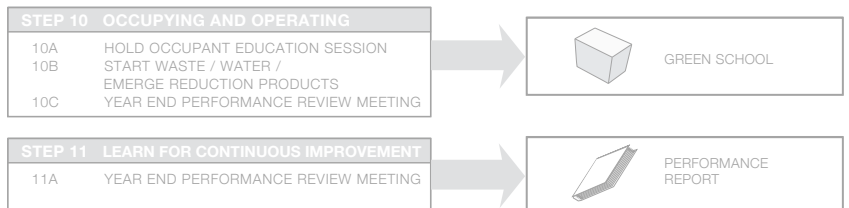
### OUTCOMES



## SECTION 3 Design Construction



## SECTION 4 Occupying and Operating



## Design and Construction Checklist Notes:

### Green Question

These are typical questions a board may confront in developing a green school. Questions have to be gathered from a number of sources including green school rating systems (e.g. LEED, Green Globes, and CHPS), input from the steering committee, as well as Ontario school boards.

### Question Rationale

In this column, list the environmental, economic or student success benefits associated with the green question.

### Possible Measures

Listed under possible measures are typical strategies employed to address the environmental, economic or student success issues raised by the stated question.

### Typical Project Impacts

\$	Less than 5% over conventional school development measure
\$\$	5 to 15%
\$\$\$	15% +

Incremental Costs and Typical Paybacks are based on a typical case (described below) as actual project costs will vary widely based on site and other project factors. All proposed target costs should be reviewed and confirmed with a professional design team and a certified cost consultant before proceeding.

The “Typical Project Impacts” were based on comparison to a hypothetical 2-storey 4,150 m<sup>2</sup> (45,000 sq.ft.) elementary school; for 450 students; on a 2 ha (5 acre) site; using load bearing masonry construction and steel roof structure; brick exterior

cladding with ASHRAE 90.1 (2004) compliant insulation and air barrier system; double glazed low-e insulated windows in aluminum frames; painted block interiors with NCR 0.55 acoustic ceiling tile; VCT flooring, except for carpet in front office and library. The baseline Mechanical System includes a centralized mid-efficiency boiler, roof top air-handling units, local air-conditioning to office and library, basic building automation system and low-flow plumbing fixtures. The base building lighting is assumed to be T-8 lighting fixtures with electronic ballasts throughout, with the exception of HID fixtures in the gymnasium.

### Targets

Under this column the board official or consultant would record either a Yes (to be pursued), No (not pursued) or ? (if more information is required).

### Proposed Project Specific Measures

Board staff or consultant record the specific measures their green school is proposing to implement.

### Typical Project Milestone

Listed as either Planning, Pre-design, Schematic Design, Design Development, Contract Documents, Construction, Post-Construction or Occupancy. This column lists the project milestones at which a proposed measure would typically need to be incorporated to avoid unnecessary costs.

### Team Member Responsibility

All team members must work cooperatively to successfully execute a green design. It is useful to assign a point person or a team member with primary responsibility. This column suggests those allocated members.

**Ontario Green School Design and Construction Checklist**

Board:  
 School Name:  
 Project Address:

Green Questions	Question Rational	Possible Measures	Typical Project Impacts			Target	Proposed Project Measures		Typical Project Milestone	Team Member Responsibility
			Costs	Payback	Implementation		Y	N		
<b>3.1 Step 7 - Green Design Approach</b>										
Can green design and building approach be used to provide the greatest environmental benefits cost effectively?	Using a green design and approach that places a priority on working with the site, right siting, efficiency, waste reduction and learning environments, high performance and at a low cost.	Work from the principle of life cycle costing considering how design decisions will effect the cost and utility of the school over it's entire useful life.	\$	n/a	May add some time to the design phase of the project				Pre-Design School Board Planning	
Can using the Integrated Design Process (IDP) optimize the school's environmental performance at the most effective cost?	Using an IDP will break down silos allowing cost trade-off to be identified and keep all stakeholders informed and involved.	Establish a green school working group, schedule regular meetings for working sessions and to monitor project progress.	\$	n/a	May add some time to the project process				Pre-Design School Board Planning	
<b>3.2 Step 8 - Green Design and Construction Methods</b>										
<b>3.2.1 Greening School Sites</b>										
Can the way the school site is developed protect or restore habitat?	Prevent wind and waterborne removal of earth from the site causing air pollution in the form of fine particulates and siltation of water courses.	On undeveloped sites limit site disturbance to a minimum around the building perimeter OR On previously developed sites restore habitat by planting native plants.	\$	n/a	Site Dependent				Schematic Design Architect/ Landscape Architect	
Is erosion & sedimentation control methods written into contract documents and reviewed throughout construction?	Require and review installation of perimeter silt fences, low slope 1:3 stockpiles, mud mats and other methods to control erosion and sedimentation on site.		\$	n/a	Site Dependent				Contract Architect/ Civil Documents Consultant	
Does the site design support green outdoor learning?	To promote link between school design and occupant use and to maintain environmental benefits over time.	Design for outdoor classrooms, environmental science stations and/or organic weed and pest control demonstrations.	\$	n/a	Site Dependent				Schematic Design School Board - Architect/ Landscape Architect	
Does the site design support green maintenance?	To promote link between school design and occupant use and to maintain environmental benefits over time.	Design landscape elements for low intensity maintenance, no pesticide use and no irrigation.	\$	n/a	Site Dependent				Schematic Design School Board - Architect/ Landscape Architect	
<b>Transportation</b>										
How can walking and bicycle use be promoted by the site design?	To promote walking and cycling as a way to school and thus improve levels of physical fitness, air quality and overall energy efficiency by reducing car trips.	Provide safe routes to school that cross as few vehicle entrances as possible, secure bicycle parking, staff shower facility for staff, select a school site on a bike lane or bike path that is linked to network.	\$	n/a	Easy				Schematic Design School Board - Architect/ Landscape Architect	
Can car use and emissions be reduced?	To reduce number of cars being used and promote use of low emissions and energy efficiency vehicles and thus improve air quality and overall energy efficiency.	Provide designated preferred location parking for car pools, low emitting and fuel efficient private vehicles.	\$	n/a	Easy				Schematic Design School Board - Architect/ Landscape Architect	
Can parking capacity be reduced?	To promote the use of active transportation and public transit by limiting availability of parking. Greater use of active transportation will improve levels of physical fitness, air quality and overall energy efficiency by reducing car trips.	Provide no more than the required parking by local zoning bylaw, lobby municipality to reduce parking and drop-off requirements, and design a green multi-use parking spaces that can be used for other activities when not need for parking.	Saving	Immediate savings on construction cost	Easy				Pre-Design School Board - Architect/ Landscape Architect	
Can site design be used to reduce exposure to exhaust?	Reduce possibility of vehicle exhaust being drawn into the school.	Locate vehicle drop-off loops so that exhaust is unlikely to enter the building through doors or air intakes.	\$	n/a	Moderate				Schematic Design Architect/ Landscape Architect	

Green Questions	Question Rationale	Possible Measures	Typical Project Impacts	Target	Proposed Project Measures	Typical Project Milestone	Team Member/Responsibility		
			Costs	Payback	Implementation	Y	N	?	
Could a walking school bus programme be implemented at the school?	To promote walking to school by providing a safe way for students. Greater use of active transportation will improve levels of physical fitness, air quality and overall energy efficiency by reducing car trips	Implement walking School Bus Programme	\$	n/a	Moderate				Occupancy School Operations
<b>Micro Climates</b>									
Can the building be orientated to maximize south light and site features?	To reduce energy costs and promote the use of daylighting	Orient building so that the majority of the school's classrooms faces within 15 degrees of true north or south, and use hills or mature site trees to provide natural wind blocks and shade.	Saving (site dependant)	Depends on overall energy savings	Site Dependent				Schematic Design Architect/ Landscape Architect
Is the site designed to minimize heat island effect?	To prevent localized heating during the summer commonly referred to as the heat island effect.	Consider high-reflective paving material, open grid paving surface, shade trees, providing underground parking to free ground area for landscaping.	\$	n/a	Easy				Schematic Design School Board - School Program/ Architect/ Landscape Architect
Can the building roof material be used to reduce heat island effect?	To prevent localized heating during the summer commonly referred to as the heat island effect.	Install high reflective (white) Energy Star roofing or consider a (green) vegetative roof system.	\$\$ (white roof) \$\$\$ (green roof)	20 to 30 yrs 40 to 50 yrs	Easy				Design School Board - Development School Program/ Architect
Could landscape design shade of play area?	To limit student exposure to harmful solar rays	Shade by planting or built structures a majority of designated outdoor play areas	\$	n/a	Easy				Schematic Design School Board - School Program/ Architect/ Landscape Architect
<b>Storm water</b>									
Will storm water management design control quantity to pre-development limits?	To limit pollution of natural water flows by managing stormwater runoff.	Limit area of site of impervious materials, install bio-swales, control flow roof drains or stormwater management (SWM) ponds.	\$	Immediate savings on construction cost	Easy				Schematic Design Architect/ Civil Consultant
Can the storm water management design improve water quality by capturing suspended soils and oil ?	To limit disruption of natural water flows by eliminating stormwater runoff, increasing on-site infiltration and eliminating contaminants.	Construct site storm water systems with oil/grit separators, bio-swales, or polishing ponds.	\$		Moderate				Schematic Design Architect/ Civil Consultant
Light Pollution	Could light pollution reduction fixtures be used?	To eliminate light trespass from the building and site, improve light sky access and reduce development impact on nocturnal environment.	\$	n/a	Easy				Design Architect/ Development Electrical Consultant
<b>3.2.2 Water Use Reductions</b>									
<b>Innovative Waste Water</b>									
Consider innovative wastewater technologies?	To reduce generation of wastewater and potable water demand.	Consider filtration of grey water for reuse in toilets OR installing alternative treatment system that would treat black water to tertiary standard.	\$\$\$	10 to 30 yrs	Moderate to Difficult				Schematic Design Architect/ Civil/ Mechanical Consultant
<b>Indoor Water Use</b>									
Could water use be reduced?	Maximize water efficiency within building to reduce the damage on municipal water supply and wastewater systems.	Low-flow Plumbing fixtures Toilets Urinals Showerhead Faucets Replacement Aerator Metering Faucets	\$	1 to 3 yrs	Easy				Schematic Design Architect/ Civil/ Mechanical Consultant
Could water use be further reduced?	Maximize water efficiency within building to reduce the damage on municipal water supply and wastewater systems.	Low-flow fixtures as above but also dual flush toilets and waterless urinals	\$	3 to 5 yrs	Moderate				Schematic Design Architect/ Civil/ Mechanical Consultant

Green Questions	Question Rational	Possible Measures	Typical Project Impacts	Target	Proposed Project Measures	Typical Project Milestone	Team Member/Responsibility
		Costs	Payback	Implementation	Y	N	?
<b>3.2.3 Energy Saving</b>							
<b>Energy Efficiency</b>							
How can energy expenditure be minimized?	Reduction in energy use not only saves on operation costs but also reduces one of the major sources of school carbon emissions and smog producing gases.	School should target a minimum of 30% energy use reduction (compared to MNEBC). At least six key measures should be considered: 25% increase in insulation levels (above OBC), insulated low-e glazing, energy recovery ventilation, 85% plus efficiency boilers, variable speed pumps and fans, 85% plus efficient domestic hot water heaters, T-8 lighting system, lighting occupancy sensors and building automation system.	3 to 5 yrs (depending on measures implemented)	Easy to Moderate			Schematic Architect/ Mechanical/ Electrical Consultant
How can energy expenditure be further minimized?	Reduction in energy use not only saves on operation cost but also reduces one of the major sources of school carbon emissions and smog producing gases.	Target 40% to 60% energy savings (compared to MNEBC) are achievable by implementing efficiency measures. Measures could include: 40% increase in insulation levels (above OBC), demand ventilation, high efficiency condensing boilers and chillers (or no air conditioning), daylight controls on lighting.	\$\$ to \$\$\$ (depending on efficiency targeted)	5 to 15 yrs (depending on measures implemented)	Moderate		Schematic Architect/ Design Mechanical/ Electrical Consultant
<b>Renewable Energy</b>							
How much energy can come from an on-site renewable source?	Offsetting grid supplied power with site produced renewable power. Will reduce overall fossil fuel energy use and one of the major sources of school carbon emissions and smog producing gases.	Consider renewable energy system. Renewables include active systems (solar, wind, or mini-hydro electrical generation, solar hot water heating, solar intake air preheating, and geothermal and biomass thermal generation and passive systems (passive solar heating and natural ventilation). Generally, active renewable systems are still relatively expensive per unit of energy produced. Overall it is more economical and beneficial to the environment to save a watt than to generate a watt by any measure.	\$\$\$	20+ yrs	Moderate		Schematic Architect/ Design Mechanical/ Electrical Consultant
Can energy come from a green power source?	As with producing renewable power on site, buying green power will offset the use of non-renewable grid power. Thus reducing overall fossil fuel energy use and thus one of the major sources of school carbon emissions and smog producing gases.	Enact an agreement to purchase power from a Green Power supplier.	\$\$	n/a	Easy		Occupancy Architect/ Mechanical/ Electrical Consultant
<b>3.2.4 Materials and Waste</b>							
<b>Reduce</b>							
Will recyclables and organics be collected and stored?	To limit waste production at the school.	Provide an accessible area for separate waste collection that serves the entire building.	\$	n/a	Moderate		Schematic School Board - Design School Operations
Can the school implement a waste reduction program?	To limit waste production at the school.	Implement a waste reduction plans.	\$	n/a	Moderate		Schematic School Board - Design School Operations
Can 50% or more of construction waste be diverted from landfill?	To reduce amount of construction waste sent to landfill.	Develop a waste management plan based on provincial regulations that target at least 50% diversion, even a 75% target should be achievable.	\$	n/a	Easy		Contract Architect/ Documents Contractor
Is the buildings design, detailing and construction durable?	To reduce the likelihood for the need for premature extensive renovations or building replacement.	Design and detail with long-life materials that will resist water penetration. Engage an inspection and testing specialist to review details and inspect installation during construction.	\$	n/a	Moderate		Design Architect/ Development Contractor
Has the life-cycle of key building material been Analyzed?	To reduce the likelihood for the need for premature extensive renovations or building replacement.	Select roofing, flooring and building cladding material based on life-cycle costing	\$	n/a	Moderate		Design Architect Development
How flexible is the design?	To reduce the likelihood for the need for premature extensive renovations or building replacement.	Design for future expansion by allowing for an addition of 25% more classrooms OR use of open bay non-load bearing structural system	\$	n/a	Moderate		Schematic Architect Design

Green Questions	Question Rational	Possible Measures	Typical Project Impacts	Target	Proposed Project Measures	Typical Project Milestone	Team Member/Responsibility		
			Costs	Payback	Implementation	Y	N	?	
<b>Re-use</b>									
Can parts of the existing building be re-used or maintained?	Reusing existing materials reduce the energy needed to manufacture, ship and install new materials. Reusing also prevents existing materials from being sent to landfill.	Maintain parts of the existing building structure and shell for reuse into the new school.	\$	n/a	Difficult				Schematic Architect Design
Can existing materials be re-used on another location?	Reusing existing materials reduce the energy needed to manufacture, ship and install new materials. Reusing also prevents existing materials from being sent to landfill.	Use refurbished materials, products and furnishings.	\$	n/a	Moderate				Schematic Architect Design
Can the new materials be re-used at the end of building useful life?	Reusing existing materials reduces the energy need to manufacture, ship and install new materials. Reusing also prevents existing materials from being sent to landfill.	Specify materials that can be disassembled and reused at the end of the building's useful life (e.g. steel or wood structural beams, windows, etc.) OR enter lease agreements with material manufactures.	\$	n/a	Moderate				Design Architect Development
<b>Recycle</b>									
Can highly recycled materials be used for the new construction?	Recycling materials reduce the energy need to manufacture new materials. Recycling also prevents materials from being sent to landfill.	Specify materials with high recycled content for example certain types of: structural steel, fly ash and slag concrete, drywall, ceiling tile, lockers, carpet.	\$	n/a	Easy				Design Architect Development
Can materials be recycled at the end of life?	Recycling materials reduce the energy need to manufacture new materials. Recycling also prevents materials from being sent to landfill.	Specify materials that can be disassembled and recycled at the end of the building's useful life OR enter agreements with material manufactures for materials to be returned for recycling.	\$	n/a	Moderate				Design Architect Development
<b>Local and Renewable</b>									
Can locally extracted, processed & manufactured materials be specified?	Local materials reduce the energy need to ship materials.	Specify local materials, most Ontario locations should be able to target a significant amount of local content material.	\$	n/a	Easy				Design Architect Development
Are the materials from rapidly renewable sources?	Use of renewable materials reduces the demand on material from non-renewable sources	Specify renewable materials such as bamboo flooring or millwork.	\$	n/a	Moderate				Design Architect Development
Is the wood certified?	Use of wood from certified sources ensures the forested are well managed and sustainable	Specify wood items to be FSC certified.	\$	n/a	Moderate				Design Architect Development
<b>3.2.5 Learning Environments</b>									
<b>Indoor Environmental Quality</b>									
Can carbon dioxide levels be monitored?	CO <sup>2</sup> is a key indicator of quality of indoor air.	Install CO <sup>2</sup> detectors on return air ducts.	\$	n/a	Easy				Design Architect/ Development/Mechanical Consultant
Can IAQ be managed during construction?	IAQ must be protected right from the start of construction.	Implement SMANNA requirements for HVAC systems and ensure all absorptive materials are protected from water and dust during construction	\$	n/a	Easy				Construction Architect/ Mechanical Consultant/ Contractor
How can IAQ be managed before occupancy?	Just after installation is usually the peak period for material off-gassing.	Follow a building flush out protocol	\$	n/a	Easy				Construction Architect/ Documents Mechanical Consultant
Consider effectiveness of proposed ventilation system at managing IAQ?	Fresh air needs to be getting to the occupant zone to be effective.	Implement a displacement ventilation system	\$\$\$	n/a	Moderate				Schematic Architect/ Design Mechanical Consultant
Are the adhesives & sealants made of low-emitting materials?	These are materials that tend to have high VOC emissions.	Specify materials that are low in VOC emissions and at a minimum meet South Coast Air Quality Management District Rule 1168 or are listed by CHPS as safe for schools	\$	n/a	Easy				Design Architect Development
Are the paints and coatings made of low-emitting materials?	These are materials that tend to have high VOC emissions	Specify materials that are low in VOC emissions and at a minimum meet South Coast Air Quality Management District Rule 1168 or are listed by CHPS as safe for schools	\$	n/a	Easy				Design Architect Development
Is the carpet made of low-emitting materials?	These are materials that tend to have high VOC emissions	Specify materials that are low in VOC emissions and at a minimum meet CRI Green Label or are listed by CHPS as safe for schools	\$\$	n/a	Easy				Design Architect Development

Green Questions	Question Rational	Possible Measures	Typical Project Impacts			Target	Proposed Project Measures		Typical Project Milestone	Team Member/Responsibility
			Costs	Payback	Implementation	Y	N	?		
Are the composite wood and laminate adhesives made of low-emitting materials?	These are materials that tend to have high VOC emissions.	Specify materials that are low in VOC emissions and at a minimum meet South Coast Air Quality Management District Rule 1168 or are listed by CHPS as safe for schools.		n/a	Difficult				Design Development	Architect
Can indoor chemical & pollutant source control be provided?	Control pollution at the source.	Provide entryway systems at all main entrances and seal and provide separate ventilation of all room used to store volatile chemicals (e.g. caretaker's and science rooms).	\$	n/a	Moderate				Schematic Design	Architect
How can infection be controlled?	To reduce the spread of infections.	Provide touch-free main washrooms and anti-bacterial house keeping plan.	\$	n/a	Moderate				Schematic Design	Architect
<b>Occupant Comfort and Control</b>										
Can spaces be individually controlled and monitored ?	Studies have shown that local control of light levels and temperature results in higher occupant satisfaction.	Provide limited individual classroom control over lighting and temperature.	\$	n/a	Easy				Schematic Design	Architect/ Mechanical Consultant
Can daylight be provided for all classrooms (excluding computer or presentation rooms)?	There has been a link shown between health and sense of well being and an individual's access to natural daylight.	Provide a minimum of 250 lux of natural daylight and glare control devices to all classrooms (excluding computer and presentation rooms).	\$	n/a	Moderate				Schematic Design	Architect
Can outdoor views be provided for all classrooms (excluding computer or presentation rooms)?	There has been a link shown between health and sense of well being and an individual's access to views.	Provide a line of sight to the outdoors for all classrooms (excluding computer and presentation rooms).	\$	n/a	Moderate				Schematic Design	Architect
<b>Acoustics</b>										
How can acoustic interference be minimized in the classroom?	There is strong evidence to show that background noise has a detrimental effect on learning.	Measures should include: acoustically separating mechanical equipment from classroom, install sound absorption materials on ceilings or walls, avoid sites in close proximity to noise generators (e.g. roads, airports, industrial facilities) or consult acoustic consultant and province recommended acoustical measures.	\$	n/a	Easy				Schematic Design	Architect/ Mechanical Consultant
<b>3.3 Step 9 - Commissioning/ Handover and Training</b>										
Consider building commissioning?	Building system commissioning has been consistently shown to save energy and maintenance issues by identifying system design, manufacturing and installation issues.	Engage commissioning authority that does not include individuals directly responsible for design or construction to: review the design intent and the design documentation; incorporate the commissioning requirements into the construction documents; develop a commissioning plan; verify installation, functional performance, training and operation and maintenance documentation; complete a commissioning report; provide the board with the information for re-commissioning building systems and review building operation with the O&M staff during first year of operation.	\$	n/a	Easy				Design Development	School Board - Development School Operations
Should building systems be measured & verified?	Given the investment required to make a building more efficient, it only make sense to track that performance and verify systems are delivering efficiencies expected. Boards have found significant savings can be found when buildings are centrally monitored variances tracked and corrected. M&V data is also critical to identify areas that have worked well and those that should be targeted for improvement.	Install sensors on critical components of building systems that feed data back to a centralized building automation system. Sensors should allow for independent reading of items such as heating, cooling, lighting, fans and drives, and equipment loads.	\$	5 to 10 yrs	Moderate				Design Development	School Board - Development School Operations
Should enhanced systems training be provided?	An energy efficient system is only as good as its operator, therefore to fully realize energy savings, operators need to have a full understanding of the building systems and how to run them.	Third party or designated board staff to complete O&M manuals, create classroom user guide and energy using tips for students and teachers and conduct hands-on training workshop for operation staff.	\$	Immediate	Moderate				Post-Construction	School Board - School Operations



Green Questions	Question Rationale	Possible Measures	Typical Project Impacts			Target	Proposed Project Measures	Typical Project Milestone	Team Member/ Responsibility
			Costs	Payback	Implementation				
Will there be a board energy manager involved?	Having a energy manager available allows for board-wide comparisons and action to improve energy efficiency.	Designated board staff as an Energy Manager responsible for on-going monitoring of energy performance and cost of the school over time.	\$	Immediate	Moderate			Post-Construction School Operations	School Board - Operations
How can occupants behaviour be modified?	Studies suggest occupant behaviour can account for 30% of a buildings energy use.	Implement measures that make resource use visible (e.g. a school energy odometer), tie an environmental science unit to green features at the school.	\$	Immediate	Moderate			Design School Board - Development	School Board - Operations

**Notes**

This checklist is meant as a guide to green school design, construction and operation for School Boards and Design Team and is not meant to verify environmental performance.

**Incremental Costs** are based on a typical case as actual project costs of any of the measures in the checklist can vary widely based on site and other project factors. Therefore all proposed target costs should be reviewed and confirmed with the design team and a certified cost consultant before proceeding.

- \$ < 5% over conventional school development measure
  - \$\$ 5 to 10%
  - \$\$\$ 15% +
- Saving May even result in a net project saving

**Typical Payback** is based on energy and water savings for a typical case as actual project costs of any of the measures in the checklist will vary widely and so will savings based on site and other project factors. Therefore all proposed target paybacks should be reviewed and confirmed with the design team and an energy and water saving modeling consultant before proceeding.



## 3.1 Step 7: Green Design Approach

Green design approaches will be specific to each project. The managers of each project must find the optimal balance between green performance, initial costs and long-term costs, considering the particular site, budget and green objectives.

This challenges designers to consider the function, green goals, occupant health and cost over the entire useful life of the school by using life-cycle analysis, computer modeling, previous experience and end-user input.

### 1 Work with the Site

Incorporate site conditions into the design to take advantage of solar orientation, natural features and topography. Design to include safe routes to school, positive micro-climates, shading, and native habitat.

### 2 Right-sizing

Build only what is required for aesthetic, operational or user requirements by right-sizing spaces, and design to reduce circulation space. Design out the need for mechanical and electrical systems where possible.

### 3 Efficiency First

Design to reduce resource demand to the minimum (high-performance water fixtures, building envelope, mechanical and electrical systems) then consider generation (ground source heat pumps, solar and wind power, and so on.)

### 4 Reduce, Reuse, Recycle

Consider waste-reduction strategies during construction and occupancy. Consider reusing existing buildings and components, and design flexibly so the new school can be reused in the future. Specify high recycled-content materials and design for building deconstruction at the end of its useful life.

### 5 Design for Learning

By first creating optimal learning environments that are well lit, acoustically excellent, comfortable, healthy and inspiring. Create learning opportunities through green building features.

While each board will develop its own particular green school design and construction approach, in most cases the design and construction of a green school can be very similar to the traditional process. The main differences arise in such areas as depth of stakeholder involvement, integration and overlap between design, construction and occupancy phases, and of course the additional requirements and verifications required by the green objectives.

### Green Design

To design green and cost-effective schools requires creative trade-offs that transfer cost from one area to another. To facilitate a productive design process, green school design requires high level input at the early design stages of the project. This means involving stakeholders sooner in the process than usual. Mechanical engineers may be asked for input on the first thoughts about orienting the building. Operators may be involved in the actual design and selection of the HVAC system. This early involvement is usually achieved through the Integrated Design Process (IDP).

The front-loading of the design process extends to individuals' involvement as well. Green school design requires a break from "rule-of-thumb" or "it-worked-last-time" approaches. Instead, each decision is examined and optimized to deliver a higher performing product in the end. This process requires a more intense design phase and greater communication with end users.

Decision-making must consider the green objectives determined in the pre-design phase. This would typically include setting objectives

that relate to environmental impacts, occupant health and productivity, and life-cycle costing – opening up the decision-making process to broader environmental and scheduling criteria. Most traditional projects focus solely on first-time costs, at the expense of long term operational and maintenance costs.

How do these changes to the design process affect green school delivery? Ontario and U.S. school boards report that the design process of a green school generally takes longer than that of the traditional method. Depending on the complexity of the project, however, most also reported fewer errors in construction documents. Some boards reported that they incurred additional consultant costs, but boards in more competitive areas saw no increase in fees. In almost all cases, operational savings greatly outweighed any design fee increase. The cost of certification will depend on the rating system, the certification level, the project's demographics and characteristics, your Green Team's LEED experience, and when in the design process the board decides to seek certification (the earlier the better). Ontario school boards reported that applying for and certifying a green building typically added \$75,000-\$100,000 to consultant fees.

### Green Building

The impact on construction should be carefully considered throughout the design phase. Regardless of which green approaches are selected, there are key areas to watch through construction.

Green projects will tend to be more exacting and detailed in regard to construction methods and materials. Contractors must be aware of different lead times and supply sources for the exact products specified. For instance, it may be tempting for a sub-trade to substitute the specified low-VOC caulking with a non-green alternative from the local building supply store. Contractors must build in planning, preparation and quality control to ensure that subcontracted trades use only the specified products.

For green projects, consultants will also require more extensive product data from contractors to verify the green credentials of a proposed product. This adds time and effort to the shop drawing process. Commissioning and flush-out requirements are also likely to be more onerous on a green project and thus will require greater contractor co-ordination and close-out time.

### The Integrated Design Process

A Canadian innovation known as the Integrated Design Process (IDP) is the key to reducing initial capital costs while optimizing long-term building performance. The IDP is used to identify potential cost trade-offs through the early design stage. This is achieved by close collaboration among all the project stakeholders. The goal is to start the design with all key players involved to identify potential cost trade-offs, and avoid commitment to a design direction that may have negative and costly impacts.

The IDP concept breaks down “silo” thinking and optimizes the design not just for one system but of the entire building. This is achieved by using a prescribed communication method.

For example, in the traditional design process, building orientation is often considered without input from mechanical consultants, even though it may have a significant impact on the design of mechanical systems as well as on the comfort of end users. Orienting the school so that large areas of the building face west will greatly increase cooling loads, may lead to overheating and may create a problem of glare from the low afternoon sun.

Through the IDP, however, other options could be explored; the building could be relocated to a north-south orientation, or exterior shading or high-performance glass could be considered on the west façade. While the changes may cost more on a line-item basis, the cost of the exterior shading may be offset by the savings from a reduced mechanical system. The result is a lower bottom-line cost. This creates a “win-win” solution that combines lower capital costs, lower operating costs and improved occupant comfort.

The IDP is not only required between consultants but also within the board’s departments (for example, between construction, plant and academics). The more communication between the various stakeholders, the greater the chance that high-performance, low-cost solutions will be found.

Every project will have its own potential win-win conditions that can be identified through an IDP, thus delivering a higher performing building at a lower cost. Refer to Section 5.1 for further information on IDP.

## 3.2 Step 8: Green Design and Construction

### 3.2.1 Greening School Sites

#### Benefits:

##### Demonstrates Environmental Sustainability

##### Supports Student Achievement

- Students using active forms of transportation to school are likely to be healthier
- Providing a physical connection to native species habitat and the night sky on school sites should stimulate natural curiosity and learning

##### Controls Ownership Costs

- Reducing on-site car infrastructure will reduce both capital and maintenance costs
- Generally native species planting requires less maintenance

##### Promotes Environmental Stewardship

- Greening school sites is one of the most visible green measures a school can take
- Green site elements are a clear demonstration that the board is doing its part for the environment

##### Green Strategies

Site selection and planning that considers land use and transportation options, preservation of native habitat and farm land, control of erosion, on-site storm water management, and light pollution will help preserve land resources. Most of the site selection and planning goals can be achieved at little or no cost. They do require different decision making priorities, and are dependent on outside factors such as the housing market, zoning by-laws and municipal standards.

## Design Options:

### A. Site Selection

Incremental Cost: None (site dependent)

Ease of Implementation: Easy (site dependent)

Payback: not applicable

Realizable Targets:

Select a site that is not: designated under Agricultural or ecologically sensitive land; below regional flood plain; on habitat for rare or endangered species, and develop new school on a site within an established community (older than 20 years) or with a minimum density of 0.8 times coverage.

Implementation Considerations:

- Site selection is often beyond the control of the school board, and is dependent on land designated by developers or mandated under municipal official plans
- Boards should lobby for more input on municipal policies that determine school sites

Cost Considerations:

- Usually cost neutral, although sites in higher density locations may be more costly

### B. Support Native-Species Habitat

Incremental Cost: Low (site dependent)

Ease of Implementation: Easy (site dependent)

Payback: not applicable

Realizable Targets:

- Maximizing green space on site
- Implementing site erosion control during construction: perimeter silt fences, low slope 1:3 stockpiles, and mud mats
- Limiting light pollution that impacts migratory birds and obscures the night sky
- Planting native species

Implementation Considerations:

- Usually the erosion control measures are required by local building standards, however, they should be noted in the contract documents
- Areas of native plant restoration may have an unconventional appearance to some people

Cost Considerations:

- Usually cost neutral, however native plants tend to require less maintenance and be more drought resistant.

## CASE STUDY:

# Bill Crothers Secondary School

### York Region District School Board

Through a series of internal and external partnerships, the York Region DSB was able to achieve a unique facility within a restrictive budget. The project started with a vision for a secondary school with a focus on healthy, active living located in what will become a dense urban core for one of Ontario's fast growing communities. This vision presented a number of challenges. It required a large building program that would include three athletic fields, three double gyms and other specialized athletic facilities, married to all the usual spaces needed for a 1,800-student secondary school. This entire program was proposed to be located in an area of relatively expensive and scarce land supply, using only limited funds.

The solution lay in adopting a collaborative approach that allowed a former golf course located partly on the flood plain to be redeveloped as a new school. Throughout the project, the York Region DSB worked closely with the local Conservation Authority and the Town of Markham to redevelop the golf course as the site for a Green School, one that was to target LEED Silver certification. An important riverbank habitat was restored and the new school was built using LEED design principles. An agreement between the Town of Markham and York Region DSB has resulted in use of the fields not only for the school program but also for public use. This is a prime example of how an Integrated Design Process and a collaborative approach can achieve sustainability goals.



## C. Transportation

Incremental Cost: None (typically, less car infrastructure results in savings)

Ease of Implementation: Easy to Difficult (depending on measure)

Payback: not applicable

### Realizable Targets:

- Selecting school sites that are walkable, bikeable and close to public transit
- Providing secure bicycle parking for students and staff as well as staff showers
- Providing safe routes to schools that prioritize walking and biking over driving
- Implementing a “walking school bus” program
- Limiting parking lot size and lobbying municipalities to reduce school parking and drop-off requirements

### Implementation Considerations:

- Many transportation issues are mandated by local authorities (land use, location of school sites, parking requirements, drop-off, etc).
- Municipalities may need to be lobbied to change car-oriented planning requirements

### Cost Considerations:

- Usually less expensive to build for other forms of transportation than the private car





## D. Micro Climates

Incremental Cost: None to Moderate

(depending on measure and site)

Ease of Implementation: Easy

(depending on measure and site)

Payback: Immediate to long term

(depending on measure and site)

Realizable Targets:

Using building orientation and site features to create a more moderate climate immediately surrounding the building. Measures could include: orienting the building to the south, use of “white” roof / paving to reduce heat island effect, and introducing landscape elements to shade and shelter the building and play areas.

Implementation Considerations:

- Smaller sites typically allow less freedom in building and landscape element locations

Cost Considerations:

- Additional planting and “white” surface materials could increase costs moderately

## E. Storm Water

Incremental Cost: None to Moderate

(depending on measure and site)

Ease of Implementation: Easy to Moderate

(depending on measure and site)

Payback: Immediate

Realizable Targets:

Collect rain water for slow release to municipal system or filtration and reuse. Rain water can be collected in a storage medium for reuse, slow release, or it can be absorbed into the ground through permeable surface treatments. Measures could include bio-swales to collect storm water from hard surfaces, infiltration or storage galleries, retention ponds, control-flow roof drains and vegetated roofs.

Implementation Considerations:

- Smaller sites typically allow less freedom in rain water collection and filtering
- There may be snow clearing and maintenance issues with permeable paving in parking lots
- Above ground holding ponds may present a safety risk and aesthetic issues
- Roof structure needs to be designed for any water retention proposed on the roof
- Vegetated roofs can present structural, cost and maintenance issues

Cost Considerations:

- In many cases on-site rain water management is more cost effective than a traditional pipe system
- Vegetated roofs and rain water use can have a significant cost premium



## F. Light Pollution

Incremental Cost: Low

Ease of Implementation: Easy

Payback: n/a

Realizable Targets:

- Install light fixtures with cuts-offs, limit outdoor lighting levels, and apply a “lights out” policy outside school operational hours

Implementation Considerations:

- Despite evidence to the contrary, many members of the public still equate high light levels with increased safety
- Lower light levels with targeted lighting could be perceived as less safe

Cost Considerations:

- No significant cost implication



## 3.2.2 Water Use Reductions

### Benefits:

#### Demonstrates Environmental Sustainability

- Our use of potable water is exceeding the sustainable supply

#### Supports Student Achievement

- Availability of clean drinking water is a key health determinant

#### Controls Ownership Costs

- Municipalities need to recoup costs through water fees. Even at today's rates, water and sewage fees are a significant cost for most school boards

#### Promotes Environmental Stewardship

- Demonstration that the board is moving on this important issue will provide a lesson that can be brought home

#### Green Strategies

Municipal water use can be reduced in two ways: first through conservation and second by collection. As storm water is increasingly regulated and more expensive to contain and store, it should be seen as a resource. The cost of managing storm water can be offset by reducing the amount of treated water purchased from the municipality.

### Design Options:

#### A. Conservation

Incremental Cost: Low

Ease of Implementation: Easy

Payback: 1 to 3 years

Realizable Targets:

A realizable target that could be incorporated into a green school plan would be an overall reduction of water use by 20% (30% should be considered in areas with more acute water shortages) by a combination of the following features:

- Installation of low-flow fixtures with automatic control
- Some boards have also had success with waterless urinals, while others have found the water savings did not justify the additional maintenance required

Implementation Considerations:

- Low-flow devices have generally matured to the point where there are few if any maintenance or installation issues
- Automatic controls run the gambit from well proven foot controls on "Bradley" type lavatories to more recent infrared (IR) sensors.
- IR sensors are now available as "hard wired", eliminating the need for battery replacement. Users have become more familiar with IR sensors in airports and shopping malls.
- Waterless urinals need careful consideration of maintenance requirements, drain material, and slope before installation. Refer to the tech data sheet in section 5.3 for a more detailed discussion.

Cost Considerations:

- No significant cost implication

## CASE STUDY:

# Hastings and Prince Edward District School Board

The Hastings and Prince Edward DSB has undergone a dramatic energy- and water-saving retrofit program. In particular, water efficiency strategies included switching to infrared sensors for sink and toilet control, as well as to waterless urinals. 12 schools and one administration building have been retrofitted so far, with over 50 units being installed. Each school moved from fixtures that were typically connected to high volume flush valves, which have now been eliminated through waterless technology, so the overall water-savings is significant.

Based on the success of the program, the board has made these measures the standard for all future retrofits. They plan to continue with an additional 20 buildings being upgraded over the next year alone, but only where the fixtures are ready to be replaced as part of the scope of the project.

The urinals came with excellent instructions on how to install and maintain them. However, the board did admit to a learning curve with the new technology, particularly on the maintenance side. One lesson learned is to ensure all drainage pipes are in reasonable condition prior to installation to allow proper flow. Daily maintenance is essential; blue sealing liquid needs to be topped up

occasionally, and cartridges need to be replaced annually. The staff has found that if maintenance is not performed on a regular basis, odours accumulate, but that this is no different than any washroom that isn't maintained properly.

The cost of each waterless fixture is competitive to a conventional fixture and requires less plumbing to install. The cost of cartridges is decreasing as they become more common and stocked in local supply chains and the board has also sourced a low cost solution to the blue sealing liquid. There is no hesitation to install waterless fixtures as part of each retrofit regardless of the length of the payback period - the operational savings have proven to be worthwhile.



## B. Rainwater or Grey Water Collection for Irrigation and/or Toilet Flushing

Incremental Cost: Moderate to High

Ease of Implementation: Moderate to Difficult

Payback: 10 to 30 years

Realizable Targets:

- Storm water retention for irrigation, if irrigation is required
- Some school boards are experimenting with grey water re-use (water from sinks and showers) or storm water use for toilet flushing which may be an expensive option, with filtration systems requiring maintenance

Implementation Considerations:

- Use of collected rain water for irrigation is the most straightforward use of any collected water, however, may be a cause of concern for the municipality. It is important to understand the approval procedure before completing detailed design of any system. The location of the large storage tanks required for collection need to be carefully considered for natural fall, maintenance and any future repairs or removal. Filters required for grey water reuse require regular maintenance and flushing.

Cost Considerations:

- Significant cost implications; a grey water/rain water collection system for toilet flushing can cost in the range of \$100,000 to \$300,000 in a typical elementary school



### 3.2.3 Energy Saving

#### Benefits:

##### Demonstrates Environmental Sustainability

- As reported in Natural Resources Canada (NRCan) published data, educational services account for 14% of the total energy consumption, by sector, in Ontario, which makes it the third most energy-intensive sector of all 10 sectors
- Lower energy use will slow climate change and reduce smog

##### Supports Student Achievement

- Reducing energy costs frees up resources which can be reallocated to the classroom

##### Controls Ownership Costs

- Energy efficient schools cost less to operate

##### Promotes Environmental Stewardship

- Innovative design and technologies provides unique learning and behavioral change opportunities for students and staff

##### Green Strategies

The energy used to heat, cool, light and power the building and its equipment can be reduced by an efficient system design, and even further reduced by smart operation and positive user behavior.

It is an important point that design only takes energy saving so far. Building operation will have a

significant impact on the realized energy savings. Commissioning, training and staff involvement and support are important elements in any energy saving strategy.

Some realizable targets that could be incorporated into a green school plan are:

- Better building envelopes (increase insulation by 25% over the Ontario Building Code (OBC), target 40/60 window to wall ratio, high performance windows, orientate the building to maximize southern exposure)
- Efficient mechanical and electrical systems (centralized efficient boiler plant, heat-recovery ventilators, demand or timer control ventilation, heating and lighting, and Energy Star-compliant appliances and equipment)
- Smarter buildings (building automation system, commissioning, extensive training and monitoring)
- Reduced cooling (limit or eliminating cooling within the building)
- Consider following recommendations of American Society of Heating, Refrigeration and Air Conditioning Engineers (ASHRAE) Advance Energy Design Guide for K-12 Schools (refer to [www.ashrae.org](http://www.ashrae.org))

The strategies discussed below are those which should be considered for achieving what is today considered “good practice” in Ontario. In terms of energy performance, this is roughly 30% to 35% better than the Model National Energy Code for Buildings (MNECB).

In addition to this, we have added a discussion titled “Net Zero Energy” in order to begin a discussion on where green design can begin to eliminate carbon emissions.

## Design Options

### A. Building Design

An overall design target to reduce building energy use by 30% to 40% is achievable by most typical schools, with a 5% to 10% investment resulting in a five to ten year payback period. Through analyzing case studies and energy modeling a “typical” elementary school, six key low-cost and low-risk measures emerged. Combined, these six proven measures (improved building envelope, high-efficiency boilers, high-efficiency water heaters, ventilation heat recovery, variable speed drives, and high-efficiency lighting design) were demonstrated to deliver 30% energy reductions over a code compliant reference building, at the least initial cost, and were applicable to most situations. These six measures are not a complete list of the energy measures boards should investigate, but they are a solid starting point. In addition to these six measures, boards should also consider green design strategies such as building orientation, high efficiency cooling and premium efficiency motors.

### A.1 Building Envelope Improvements

#### (R values >25% better than code)

The thermal performance of the building envelope has a direct impact on the amount of energy required to keep a building comfortable. Increasing the R-values of the envelope assemblies by 25% above code is a typical, cost-effective measure to improve energy consumption. For the Southern Ontario climate, this means approximately:

- Roof: 4.45 RSI (R-25), 100 mm of polyiso roof insulation
- Walls: 2.22 RSI (R-12.5), 65 mm of extruded polystyrene insulation
- Windows: U= 2.38 W/m<sup>2</sup>C (U 0.42), SHGC of 0.4, 40% window-to-wall ratio

From the case studies analyzed, the following represents the effect of the improvement on the building envelope on the energy performance and the budget of the building:

- Energy savings: 14% of the total average savings
- Cost premium: \$0.2/sq.ft.
- Net Present Value: \$0.55/sq.ft.

To Achieve Net Zero Energy:

The simplest way to reduce energy consumption is to not let it pass through the building enclosure uncontrolled. Very simple energy modeling can be used to predict the value and payback of increased insulation levels. Net Zero schools will likely have 35% more insulation in addition to the values above.



## A.2 Boilers

Conventional boilers can reach efficiencies of up to 85% by incorporating measures to improve combustion and minimizing heat losses. New boilers commonly incorporate these new technologies, which also can be implemented through retrofits. Some of these measures are:

- Fan-assisted combustion: fan-assisted burners optimize the mix of fuel and air and as a result, excess air is reduced. This type of burner also reduces losses by minimizing the amount of hot air going up the chimney, and optimizes the heat transfer inside the boiler by improving combustion gas flow through the heat exchanger.
- Motorized dampers: Motorized dampers reduce heat loss through the chimney by closing the flue when the boiler is idle.
- Electric ignition: instantaneous electric ignition or other intermittent ignition devices eliminate the need for pilot flames, thus reducing this waste of fuel.
- Sealed combustion: controls the combustion process by preventing boilers from inducing infiltration into the building and thus reducing heating loads. With this type of system, air is drawn directly from outside through a sealed vent, avoiding heated indoor air being mixed with the outside air during the combustion process.
- Pulse combustion: Instead of a continuous flame, pulse systems create discrete, rapid combustion pulses in a sealed chamber. The turbulent nature of this process results in a highly efficient heat transfer to the heat exchanger.

High efficiency condensing boilers reach efficiencies between 90% and 96% when operating at the correct temperatures. They include advanced heat exchanger designs that maximize heat extraction from the flue gases before they are exhausted. The temperature of the flue gas is reduced to the point where the water vapour produced during combustion condenses back into liquid form, releasing the latent heat, and thus improving energy efficiency. Since approximately 2% of the energy of a gas-fired boiler is latent heat, this represents a significant energy-savings potential. Careful attention must be paid to the condensate, which is acidic and must be piped to a drain.

For peak efficiency, the water vapor in the flue gases must condense. This is achieved by running the flue gases across a heat exchanger to feed the heating “return water” and cooling them to below the water dew point. To achieve this, return water temperature to the boiler must be below 60°C. This can be challenging with some heating systems, such as hydronic radiant panels, but if condensation does not occur, the efficiency of the boiler will be reduced.

In retrofits, boiler efficiency can be improved by adding an economizer, which is a heat exchanger that utilizes the waste heat from the flue gas to preheat the boiler feed water. A condensing economizer improves the effectiveness of reclaiming flue gas heat by cooling the flue gas below the dewpoint. The condensing economizer recovers both the sensible heat from the flue

gas and the latent heat from the moisture that condenses. It must be ensured that the condensate does not enter the boiler, as it is highly corrosive.

### A.3 Heat Recovery Ventilation

A heat recovery ventilator (HRV) consists of two parallel air-handling systems. One collects and exhausts indoor air and the other draws in outdoor air and distributes it throughout the school. The exhaust and outdoor air flows pass through the heat exchanger case, and the heat from the exhaust air is used to pre-heat the outdoor air flow. The two streams of air are physically separated, allowing just the heat to transfer from one to the other. A conventional HRV system is able to recover 70% to 80% of the heat from the exhaust, significantly reducing the heating needs for the outdoor ventilation air drawn into the building.

### A.4 Variable Speed Drivers

Common motors are designed according to peak loads, leading to energy inefficiency caused by continuous operation at reduced capacity during off peak periods. Variable Speed Drives (VSD) are devices which have the potential to provide energy savings in systems where loads vary with time. The VSD adjusts motor speed to the required motor load by varying the frequency of the motor supply voltage. This allows continuous process speed control.

### A.5 HVAC System Totals

From the case studies analyzed, the following values represent the effect of the above strategies on the energy performance and the budget of the building.

Heating, cooling and ventilation:

- Energy savings: 50% of the total energy savings is attributable to condensing boilers, high efficiency cooling systems, and HRV.
- Cost premium: \$23.3/sq.ft.
- Net Present Value: \$2.66/sq.ft.

Variable Speed Drivers and High Efficiency

Motors:

- Energy savings: 8%
- Cost premium: \$0.25/sq.ft.
- Net Present Value: \$1.25/sq.ft.

To Achieve Net Zero Energy:

Net Zero energy buildings utilize renewable energy sources such as:

- Earth tubes – buried air intake tunnels that pre-cool summer air and pre-heat winter air for ventilation, because the soil around the tubes (at a depth greater than 2m) remains at or near 10 degrees C the entire year.
- Active solar energy – such as photovoltaic or solar thermal panels that convert the sun's energy into electricity or heat
- Ground Source Heat Pumps
- Wind Electrical Generation



## A.6 Lighting

A lighting strategy consisting of luminaries with high-efficiency fluorescent lamps, switching controls, occupancy sensors or continuous dimming controls and daylight harvesting can significantly reduce electricity costs.

In classrooms, T-8 electronic ballast lighting (direct or indirect) systems will provide high quality even illumination with low energy use. T-5 electronic ballast lighting systems will provide even greater energy savings, however, a direct/indirect installation is recommended to avoid possible hot spots. LED lighting is a quickly emerging technology that has significant potential to provide very low cost, high quality light.

For high ceiling areas (e.g. gyms or libraries) fluorescent lamps can be either T-8 (typically for mounting heights up to 25 feet) or newer, even more energy efficient T-5 HO (high output) lamps (up to 50 feet). Four super T-8 lamps plus ballast at 154 W produce as much light as a standard 250-W metal halide lamp (286-297W with ballast). For T5 HO, similar savings relative to metal halide are possible.

To take advantage of natural daylight, controls can be used to dim or turn off electric lights in response to levels of natural daylight. There are two types of controls – dimming systems and switching systems. The switching system is often preferred because of ease of maintenance and installation. The switch system can be achieved using a 3 tube fixture switching between one or two tubes depending on available daylight. Typically at least one photo sensor is required for each building orientation.

From the case studies analyzed, the effect of implementing these strategies (high efficiency lamps, controls, sensors and daylighting) on the energy performance and budget are:

- Energy savings: 13%
- Cost premium: \$0.16 /sq.ft.
- Net Present Value: \$2.57 /sq.ft.

Integrating daylight and improving lighting efficiency are the most economically efficient strategies in schools given:

- the low capital cost required
- the large energy savings
- the relative weight of lighting in the total average school energy consumption

To Achieve Zero Net Energy:

Net zero energy buildings maximize the use of daylight to offset electrical lighting loads and reduce cooling load. Strategies to optimize daylight in the design are:

- Early integration in design process (Consider the school's architecture, landscape, engineering aspects and use of each space to determine optimal levels of daylight.)
- Light shelves, high ceilings, clerestories and light interior finishes selection, will improve daylight penetration and distribution while reducing the required glazing area for optimal daylight
- Maximize outdoor surface reflectance in front of glazed areas, (incorporating glare control measures)

- Use of Solar Tubes - Solar Tubes are aluminum pipes laminated with a mirrored surface on the inside, designed to bring exterior daylight from the roof to interior spaces without access to daylight. The light is distributed through a diffuser which maximizes daylight distribution into the spaces even on cloudy days.

### A.7 Optimization of Building Orientation

When designing an energy efficient building, building orientation should be the first point of discussion. How can a proposed building best take advantage of the microclimate within which it will be built? This is a process of reaping the benefits of the sun and wind when they are valuable, and controlling them passively when they are not.

The impact of the sun is most easily managed in narrow buildings with the long axis within 15° of an east/west line, and with mostly south-facing windows. Sun control devices, such as light shelves and shades on south windows, optimize daylight penetration and allow solar energy into the building during winter, while shielding it in the summer. Interior design decisions, such as open concept offices, glazed interior partitions, and dark colored, high thermal mass floor finishes further improve performance.

An optimal percentage of openings to maximize daylight penetration as well as minimize heat loss during the winter is 40% combined with 3m high ceilings to maximize daylight.

Variables including site constraints and building program make it impossible to predict both the cost premium for optimizing orientation or the resultant energy savings. However, the costs can be negligible, as this is more about organizing building elements rather than adding systems or increasing their quality. Given that the strategy results in “free” energy, the impact on energy consumption can be significant.

Net Zero Energy:

Creating net zero energy buildings requires a greater understanding and better response to micro-climate conditions. Controlling and harvesting passive energy flows is the main strategy for offsetting the use of fossil fuels. This can be best achieved through:

- Collecting data – installing a weather station at the site prior to design
- Predicting performance – sophisticated computer simulations tools can predict the impacts of daylighting strategies, thermal mass impacts, and natural ventilation.

### A.8 High Efficiency Cooling

High efficiency systems are available depending on the cooling system and capacity required in the building. For cooling capacities up to 20 tons, cooling efficiencies range from 8.9 EER to 13.4 EER. Energy Star Air Conditioning Units have efficiencies up to 11 EER.

### A.9 Economizer

An Economizer is a damper which controls the amount of outdoor air brought into the building through the HVAC system. This allows free outside cool air to be maximized to reduce the cooling load. Low-leak dampers are important to keep out unwanted air when the dampers are closed.

### A.10 Premium Efficiency Motors

Premium efficiency motors fall within the new set of efficiency levels developed by the U.S. National Electrical Manufacturers Association (NEMA). The NEMA Premium™ designation refers to motors able to reduce electrical power consumption and costs, improve reliability (since they are manufactured with superior quality materials), offer higher service factors and reduce the waste heat output. Premium efficiency motors display efficiencies between 3.5 and 1% better than common motors, ranging from 85% to 95% (depending on the power required). Due to the reliability of this technology, manufacturers normally provide long guarantee periods for them.

## B. Operations

Significant energy savings can be achieved by implementing:

### B.1 Commissioning

To verify that the focus on performance is maintained from design to building operation so that the systems perform as intended. Implementation of building commissioning normally results in optimized electrical and mechanical performance, thus generating significant energy savings.

### B.2 Scheduling of Building Operations

Implementing an operations schedule provides energy savings by reducing the time in which systems are unnecessarily operating (i.e., after hours, in unoccupied spaces). Scheduling operations typically include allowances for local systems, operations scheduled by zones, and an “after-hours” systems schedule.

### C. Staff/Student Education

The intent of the environmental educational programs is to develop a tie between the schools' design, technology and operations and what students learn. These programs are developed by school boards to incorporate environmental education as well as environmentally responsible action into the school setting, and to improve physical building performance. Student achievement and environmental stewardship is promoted by teaching, inspiring and exposing children to technology and practices which have a positive impact on the environment.

#### Education Programs:

- Provide teachers with environmental educational resources
- Engage students and teachers in the task of improving the energy efficiency of the building through active participation.

Schools which have implemented education programs have reduced their energy consumption by an average of 10%.



## CASE STUDY:

# Commerical Building Incentive Program (2002-2006)

(OVER 100 ONTARIO SCHOOLS)

More than 100 Ontario schools from over 16 school boards have achieved an average 39% energy saving (over and above Code compliance), and 11 have surpassed the 50% energy-saving mark under Natural Resources Canada's Commercial Building Incentive Program (CBIP). Most of the boards reported CBIP schools were completed at between 0 -10% premium over conventional school construction cost. Even at a 10% premium, payback was expected in less than 15 years.

over 100  
Ontario School  
achieved an  
average 39%  
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## CASE STUDY:

# Valley View Public School

(RAINBOW DISTRICT SCHOOL BOARD)

Valley View Public School is a 56,000 square-foot, 600-student, K-to-Grade 8 school located in Sudbury. Its new school building is a consolidation of several older schools, and was the first new school the Rainbow District School board has built in 40 years. As such, the board wanted a school that would be cutting-edge and stand the test of time. One of the early decisions was that the school should be as resource-efficient as possible, and promote a productive and healthy learning environment.

The board had already been successful at implementing energy-saving retrofits and occupant awareness programs, and for this new school operating costs were to be considered from the start. A number of measures designed to reduce environmental impact and operational costs and to improve the learning environment were included in the design. Green measures were installed, such as a geothermal heat pump, displacement ventilation, building automation, heat recovery, waterless urinals, low-flush toilets, a water reuse system, a polished concrete floor finish and solar electric panels.

Even in its first year of operation these investments were already paying off. The new school uses less energy than the old one despite being twice the size. Water savings have also been dramatic. The green investment along with additional cost incurred from building in the north forced the capital budget up to \$209 per square foot. However, from the board's experience with the increasing costs of operating an older school, the option of saving now only to pay later was not considered. Based on the operational savings, the board has been able to finance the additional capital cost, resulting in a high quality learning environment for students today and savings over the long term.

## 3.2.4 Materials and Waste

### Benefits:

#### Demonstrates Environmental Sustainability

- With ever increasing pressure on landfills waste diversion is an important pillar to building towards a more sustainable society
- Besides consuming land, waste consumes energy since it must be transported, often for many kilometers, and waste processing itself consumes energy

#### Supports Student Achievement

- Waste diversion and reduction programs are an important point of student engagement

#### Controls Ownership Costs

- Reducing or reusing materials can reduce capital costs
- Specifying long-life low maintenance materials will lower operation costs
- With ever increasing garbage costs waste diversion could save significant costs over the long term

#### Promotes Environmental Stewardship

- By following the reduce, reuse, recycle mantra the board is demonstrating practical ways students can reduce their environmental foot print

### Green Strategies:

Design the principles of reduce, reuse and recycle into the building's construction and operation. Specify low-energy construction techniques and low embodied energy materials. These include recycled materials, local materials, and those that require minimal processing. Embodied energy is typically considered to be the energy used to build the school, including energy used for construction tools and cranes and the energy needed to extract, manufacture, and transport materials to the school site. Areas should also be set aside within the building for separate waste stream storage and at-source waste separation.





## Design Options:

### A. Operation Waste Diversion

Incremental Cost: Low to None

Ease of Implementation: Easy to Moderate

Payback: not applicable

Realizable Targets:

Divert waste from landfill by point of source separation. This requires specialized waste receptacles for deposit of organic and recyclable waste and collection of all the buildings waste for centralized collection.

Implementation Considerations:

- Design of two or three bin waste receptacles located where the waste is being generated (e.g. organic waste receptacle in lunch room)
- Provide a pest resistant location for centralized waste collection

Cost Considerations:

- Usually cost neutral

### B. Construction Waste Diversion

Incremental Cost: Low to None

Ease of Implementation: Easy

Payback: not applicable

Realizable Targets:

Requiring 50% waste diversion from landfill during construction. This requires on-site waste separation for recycling and/or reuse.

Implementation Considerations:

- Contractor must provide on-site bins for recyclable materials

Cost Considerations:

- Usually cost neutral as recycling saves contractor on landfill charges

### C. Long life Building Design

Incremental Cost: Low to Moderate

Ease of Implementation: Moderate

Payback: not applicable

System Description:

Design building for long service life by allowing for flexibility to meet future needs and specifying durable materials. Designing for flexibility may include designing corridor and mechanical system for future additions, or use of an open bay structural system to allow for reconfiguration of interior partitions. Specification of durable materials should include a review of life cycle costing of roofing material, exterior cladding, mechanical systems, air/vapor barrier system and flooring material.



**Realizable Targets:**

- Generally designing for long life will increase capital costs but save on maintenance and operational cost over the life of the building. Therefore, budget tools to transfer funds from O & M to capital are required

**Cost Considerations:**

- Should reduce overall building costs

**D. Reuse**

Incremental Cost: Low to Moderate

Ease of Implementation: Moderate to Difficult

Payback: not applicable

**Realizable Targets:**

Design for the reuse of building components or materials. Reuse strategies could include renovation of an existing building on site, reuse of building materials from a building on-site or from another location (e.g. structural steel, windows, furniture, etc).

**Implementation Considerations:**

- The renovation of an existing building would need to be carefully studied for cost, schedule and appropriateness of the renovation.
- Reuse of materials needs to be reviewed for soundness of the reused elements and scheduling

**Cost Considerations:**

- Can vary widely depending on the individual situation

**E. Materials with High Recycled Content**

Incremental Cost: Low to Moderate

Ease of Implementation: Easy to Moderate

Payback: not applicable

**Realizable Targets:**

- Specify materials with high recycled content. These materials include steel, aluminum, drywall, ceiling tiles

**Implementation Considerations:**

- Designers must source high-recycled materials for inclusion in contract documents

**Cost Considerations:**

- Usually cost neutral

**F. Materials that can be Recycled**

Incremental Cost: Low to Moderate

Ease of Implementation: Easy to Moderate

Payback: not applicable

**Realizable Targets:**

- Specify materials that are recyclable or can be returned to a manufacturer. These materials include some types of carpet, steel, aluminum, drywall, and ceiling tiles.

**Implementation Considerations:**

- Designers must source recyclable materials for inclusion in contract documents

**Cost Considerations:**

- Usually cost neutral

## G. Locally Extracted and Manufactured Materials

Incremental Cost: Low to Moderate

Ease of Implementation: Easy to Moderate

Payback: not applicable

Realizable Targets:

- Specify materials that are locally extracted or manufactured (In Ontario, a high percentage of materials are available from a local manufacturer.)

Implementation Considerations:

- Designers must source local materials for inclusion in contract documents

Cost Considerations:

- Usually cost neutral because of Ontario manufacturing base

## H. Rapidly Renewable Materials

Incremental Cost: Low to Moderate

Ease of Implementation: Moderate to Difficult

Payback: not applicable

Realizable Targets:

Specify materials that are composed of rapidly renewable materials (can be renewed in less than a generation or 20 years). These materials include: linoleum (linseed and jute), bamboo, popular wood, agro-fibre (wheat, straw, coconut), etc.

Implementation Considerations:

- Designers must source renewable materials for inclusion in contract documents

Cost Considerations:

- Usually add to cost moderately to cost

## I. Certified Wood

Incremental Cost: Low to Moderate

Ease of Implementation: Moderate

Payback: not applicable

Realizable Targets:

Specify Forest Stewardship Council (FSC) certified wood. This is wood that has been grown in a sustainable manner.

Implementation Considerations:

- Designers must source FSC certified wood for inclusion in contract documents
- FSC certified wood is not available from all suppliers

Cost Considerations:

- Usually adds moderately to cost. Additional costs may be quite minor depending on the amount of wood used on the job

## CASE STUDY:

# École secondaire Jeunes sans frontières

(Conseil scolaire de district du Centre-Sud-Ouest)

Completed in 2007, this 8,463m<sup>2</sup> project in Brampton combines a traditional secondary school with an occupational training facility. It was the first LEED Silver designation for a secondary school within Ontario, and the second within Canada. The CSDCSO's mandate for environmental stewardship resulted in a 42% energy cost savings and 31% potable water savings as compared with a conventional building.

Materials used on the project, as well as material waste being generated were also a key focus for the board. As a result, they achieved a 91% construction waste diversion rate from landfill,

with over 300 tonnes of material being sent for reuse or recycling. In addition, 24% of the building materials were sourced from recycled content – all this with no additional construction cost. Considering tipping fees are in the range of \$100 / tonne in the Greater Toronto area, a 300-tonne reduction would save approximately \$30,000. This savings could then easily cover any additional administration and onsite separation costs that may apply.

These and other successfully applied LEED strategies, including radiant heating and cooling, a green roof garden, and locally-sourced materials, have encouraged the board to an even greater commitment to 'greening' its schools in future.



## 3.2.5 Learning Environments

### Benefits:

#### Demonstrates Environmental Sustainability

- Healthy indoor environments often result from the use of low emission materials that means fewer emissions into the general environment
- Use of facility as a learning tool

#### Control Ownership Costs

- An improved indoor environment will lead to few complaints and thus maintenance call backs

#### Promote Environmental Stewardship

- By demonstrating a commitment to the environment, the board is providing an example

#### Green Strategies:

Throughout design, construction and operation, consider the learning environment quality. Specify low VOC emitting materials, positive construction methods, a building flush-out, effective ventilation systems and limited individual classroom control. Design for access to views and natural light for each of the classroom and infection control. Implement Indoor Air Quality procedures and green cleaning programs.

### Design Options:

#### A. Design for Good Air Quality

Incremental Cost: Low to Moderate

Ease of Implementation: Easy to Moderate

Payback: not applicable

Description:

Design high quality exterior envelopes that resist moisture penetration and separate indoor pollution sources

Implementation Considerations:

- Most Ontario schools are designed with high quality moisture repelling exterior materials
- Pollutant separation systems such as entryway systems (to capture exterior dust and particulates) and separate ventilation of rooms with pollution sources or chemical storage (e.g. caretaker rooms, arts and science rooms, and rooms with high volume photocopiers) are unusual in Ontario schools and will add to cost and maintenance

Cost Considerations:

- Costs vary but will add moderately to the project cost

## B. Effective Ventilation

Incremental Cost: Moderate to High

Ease of Implementation: Easy to Moderate

Payback: not applicable

Description:

Design ventilation systems to ensure contaminants are effectively removed from the room, demand sensors to control ventilation by need, and separately ventilate areas of high emissions (e.g. chemical storage areas and vestibules)

Implementation Considerations:

- Displacement ventilation is the most effective form of ventilation but is also the most costly and requires floor spaces for low-level supply grilles
- A common demand control sensor is the CO<sub>2</sub> detector, which increases ventilation rates when high CO<sub>2</sub> concentrations are dictated (often an indicator of poor ventilation)

Cost Considerations:

- Costs vary but will add moderately to the project cost

## C. Indoor Air Quality During Construction

Incremental Cost: Low

Ease of Implementation: Easy

Payback: not applicable

Description:

Require contractor to store absorptive materials in a dry space until installed. The mechanical trade is to follow SMACNA requirements

Implementation Considerations:

- These measures are simply good construction practice

Cost Considerations:

- N/A

## D. Indoor Air Quality Immediately Following Construction

Incremental Cost: Low

Ease of Implementation: Easy to Moderate

Payback: not applicable

Description:

Run ventilation systems at 100% air and at standard operation temperatures and humidity to flush emissions out of the building

Implementation Considerations:

- Requires an extended period of time between completion by contractor and occupancy for building flush-out

Cost Considerations:

- The only cost is for the energy required to run the system at 100%

## E. Low Emitting Materials

Incremental Cost: Low

Ease of Implementation: Easy to Moderate

Payback: not applicable

Description:

Specify adhesives, sealants, paints, coatings, carpets and composite wood products that emit low levels of Volatile Organic Compounds (VOC). Low emission products are listed on the Ecologo website ([www.ecologo.org/en/abouttheprogram/](http://www.ecologo.org/en/abouttheprogram/)) or Green Seal web site [www.greenseal.org](http://www.greenseal.org) and on the Collaborative for High Performance Schools web site [www.chps.net](http://www.chps.net) Carpets are also listed under the Green Guard program.

Implementation Considerations:

- Low emitting materials are limited to materials within the internal air barrier. Materials outside the air barrier will off-gas to the exterior and not affect indoor air quality.
- Most sealants, adhesives and paints typically used in schools can be found in low emitting forms that are widely available in Ontario, cost competitive and offer similar performance quality. In most cases the low VOC version is water based, as opposed to solvent based. Due to the growing demand for low VOC products, most manufacturers are no longer developing new solvent based products. As a result the water based products are constantly improving versus their solvent based

counterparts.

- Since typical school carpets are not generally low emission products, a low emitting carpet would be an upgrade. A better approach may be to forgo the carpet completely. Carpets, if not subjected to a rigorous cleaning program, harbor contaminants, mould and allergens, generally reducing air quality.
- Where available, low VOC composite wood products tend to be comparable in price and superior in quality to typical composite core material

Cost Considerations:

- Low VOC adhesives, sealants and paints have only a minimal incremental cost. Wood floor finishes are a notable exception, where cost of the low VOC water based product can be 50% higher than the oil based product. Green carpets are coming down in cost, but will still range around \$30/ m<sup>2</sup>. Use of low VOC wood products is more limited by availability than price.

## F. Indoor Air Quality Management

Incremental Cost: Low

Ease of Implementation: Moderate

Payback: not applicable

Description:

Implement indoor air quality management programme to maintain high air quality over the life of the project. Health Canada's IAQ Tool for Schools Action Kit is one example of such a system.

Implementation Considerations:

- A comprehensive indoor air quality management system should be considered the during design phase, not added at occupancy
- Staff training may be required as part of the implementation of a management system

Cost Considerations:

- Low capital costs, but may require additional staff time on an ongoing basis to implement

## G. Limited Individual Classroom Control of Temperature and Ventilation and Lighting

Incremental Cost: Low

Ease of Implementation: Moderate

Payback: not applicable

Description:

Provide limited individual classroom control over HVAC and lighting systems

Operable windows may be considered based on internal analysis and consultant recommendations

Implementation Considerations:

- Additional control points may be required
- Staff training may be required. Implementing an occupant energy management strategy would be a good idea

Cost Considerations:

- Low capital costs

## H. Access to Views and Daylight

Incremental Cost: Moderate to Expensive

Ease of Implementation: Moderate

Payback: not applicable

### Description:

Provide access to views and daylighting to every classroom. Evidence suggests student performance is enhanced by access to views and daylight. During the design, building orientation, the size and location of glazing must be carefully considered to allow views and daylight to classrooms.

### Implementation Considerations:

- Daylight must be balanced against glare, as uncontrolled daylight may have a negative impact of students to the point where benefits of daylighting are negated. Therefore any daylighting strategy must account for glare control by considering the orientation of glazing, high performance window films, defusing window cores and exterior shading.
- Large areas of glazing will also increase cooling and heating loads and thus should be coordinated with mechanical systems to balance daylighting, views and energy efficiency
- When coupled with daylight sensors that will dim or turn off electrical lights when natural light is sufficient, the sun light can be “harvested” to save on electrical costs
- Interior blinds or shades will need to be provided for rooms where projectors are used

### Cost Considerations:

- Daylighting strategies can vary from simply well placed and sized north facing windows to narrow single loaded floor plates with exterior shading and interior light shelves. The cost thus is reliant on the strategy pursued. Generally the best moderate cost option is to locate windows on primarily the north and south façades (east and west façades have major glare and heat gain issues) with light defusing glazing on high level windows (2100 a.f.f) and interior blinds on lower windows (below 2100 a.f.f.) to provide glare control.



## I. Acoustic Quality in Classrooms

Incremental Cost: Low

Ease of Implementation: Moderate

Payback: not applicable

### Description:

According to researcher John Erdreich (1999), “Teaching in a room with poor acoustics is analogous to reading in the dark; inappropriate acoustical design exacerbates the difficulty of communication between teacher and student.” An independent study by the American Speech-Language Hearing Association states that “The deleterious effect of poor acoustics on student comprehension and learning, especially students under age 15 and those with hearing and/or learning problems, is well documented.”

These findings emphasize the need to practice good acoustical design by reducing noise from heating, ventilation and air-conditioning systems and limiting other types of background noise to improve the learning environment for students. Boards considering new buildings should avoid sites in close proximity to noise generators like roads, airports and industrial facilities. When the site cannot be relocated, an acoustic engineer can offer advice about the possibility of installing sound absorption materials on ceilings or walls.

Unoccupied classrooms should target not exceeding a noise level of 45 dbA with a maximum reverberation time of 0.6 sec. Measures should include:

- acoustically separating mechanical equipment from the classroom
- avoiding sites in close proximity to noise generators (e.g. roads, airports, industrial facilities)
- consulting acoustic engineer when site cannot be relocated
- installing sound absorption materials on ceilings or walls

### Implementation Considerations:

- Locate mechanical equipment and other noise generating equipment outside the acoustical envelope of the classroom
- Completely acoustically seal each classroom from all other spaces
- Provide an acoustic ceiling tile with a NRC of at least 0.65
- Follow recommendation of an acoustical consultant on school sites in close proximity to noise generators

### Cost Considerations:

- Generally incremental costs are minor over typical school design. However, cost can be significantly higher if the site in close proximity to a noise generator

## J. Lighting

Effective lighting is obviously a key requirement for student performance, and one that should be considered carefully in green school design. Students must be able to read without harsh glare or shadows on books, boards and posters. There is also some evidence to suggest that access to daylight is important to maintain circadian rhythms and to improve moods. This is possibly a significant area for consideration given that Ontario students study through the darkest seasons of the year.

Some realizable targets that could be incorporated into a green school plan would be:

- High quality T-8 florescent lighting systems and task-specific lighting in specialized areas and more even indirect/direct lighting designs
- Access to views and daylight
- A target 250 lux of natural daylight (excluding computer and presentation rooms) and glare control devices in all classrooms
- Provide a line of sight to the outdoors for all classrooms (excluding computer and presentation rooms)

## K. Infection Control

We know infectious diseases are transmitted on building surfaces or through re-circulated indoor air. Applying green design principles can reduce illness and discomfort for those students, teachers, staff and other building users who are sensitive to allergens or at risk of respiratory problems. They will

also safeguard the entire extended school population, including families of the building users, from the spread of bacterial and viral infections.

Some targets that could be incorporated into a green school plan would be:

- Follow effective ventilation design guidelines and instal high quality filters in HVAC systems
- Designing “no-touch” washrooms with labyrinth entrances and automatic control fixtures
- Undertaking diligent maintenance programs to clean and disinfect all surfaces

## L. Supporting Healthy Active Lifestyles

Beyond providing a healthy building, a green school should also support students to lead a healthy and active lifestyle.

Some targets that could be incorporated into a green school plan would be:

- Encouraging active transportation to school by providing safe walking and biking routes on school sites, providing bike lock-up areas and showers for staff, and limiting parking and drop-off areas
- Linking education units on healthy lifestyles and nutrition with the presence of edible landscapes on school grounds or “active ways to school” challenges

## 3.3 Step 9: Commissioning

Commissioning is a critical step in building green and achieving energy-efficiency targets. A commissioning agent is typically hired directly by the board to act on the owner's behalf. The scope of the commissioning agent's work usually includes review of the heating, ventilation and cooling design intent, and verification that the installed system functions and operates as intended in the design. Items such as peer mechanical design review and system balancing are also often part of the scope of this work. Essentially, commissioning the building ensures the owner gets what they paid for.

Some will wonder: is that not the role of the mechanical consultant the board has already retained and paid? Mechanical consultants are usually retained to design the mechanical system and to complete periodic reviews for compliance with contract documents. Commissioning is a much higher level of review that includes inspection of every component of the systems, and ensures the system is not only built according to the design intent, but also functions up to the same standard. A commissioning agent may also act as keeper and enforcer of board standards. A commissioning agent may be hired globally within a board to ensure consistent application of standards. It would be less desirable for a board to mandate a single mechanical consultant to achieve the same consistency.

The building's operation needs to be considered right from the design phase, whether this happens via input from operation staff or from a well-developed board policy. Any proposed green or efficiency feature should be tested against its operational implications. Is the measure over-complicated? Does it deviate greatly from board standards or current technology? Will it require extensive staff training or different staff qualifications, or break-in or adjustment periods? These are all questions that need to be asked – not that a measure should be rejected on this basis, but that appropriate remedial steps are in place to ensure potential operational issues are addressed and mitigated by designers, contractors and manufacturers.

In general, a green school design would include commissioning and an extensive building automation system. Building automation will allow for centralized monitoring to identify variance in performance from design models, while building system timetabling will allow for centralized control to maintain design set points. Boards may wish to consider system standardization to gain operation efficiencies. System standardization allows for optimization strategies developed in one school to be transferred board-wide, and operators can be transferred between schools without the need for re-training.

# OCCUPYING AND OPERATING A GREEN SCHOOL

- 4.0 Ontario green school Occupancy and Operation Checklist
- 4.1 Step 10: Occupying the green school
  - 4.1.1 Integrating the School into the Green Curriculum
  - 4.1.2 Green Student Programs
  - 4.1.3 Green Maintenance
  - 4.1.4 Green Transportation
  - 4.1.5 Green Purchasing
- 4.2 Step 11: Monitoring the green school

## 4.0 Green School Occupancy and Operation

This section covers the final phase for a green school - occupancy and operation - discussing topics of:

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### Occupancy and Operation

SECTION 4.1

### Monitoring Green Performance

SECTION 4.2.

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The following pages are intended to provide an open yet structured system to assist boards in the planning of green schools and consist of a Self-evaluation Checklist and more detailed Step by Step discussion in the individual sections 4.1 and 4.2. It is recognized that each board - and in fact each school site - faces unique challenges, thus the measures listed here are meant to help boards determine their own green path and are not meant to be prescriptive.

### Green School Planning

#### Self-Evaluation Checklist

Directly following this page is the green school Planning Self-Evaluation Checklist. This checklist is meant as a quick guide of typical “green” measures for board staff, consultants and contractors.

#### Green Question

These are typical questions a board may encounter in developing a green school. Questions have been gathered from a number of sources including: green school rating systems (e.g. LEED, Green Globes, and CHPS); input from stakeholders, and from Ontario school boards.

#### Question Rationale

In this column is listed the environmental, economic or student success benefits associated with the green question.

#### Possible Measures

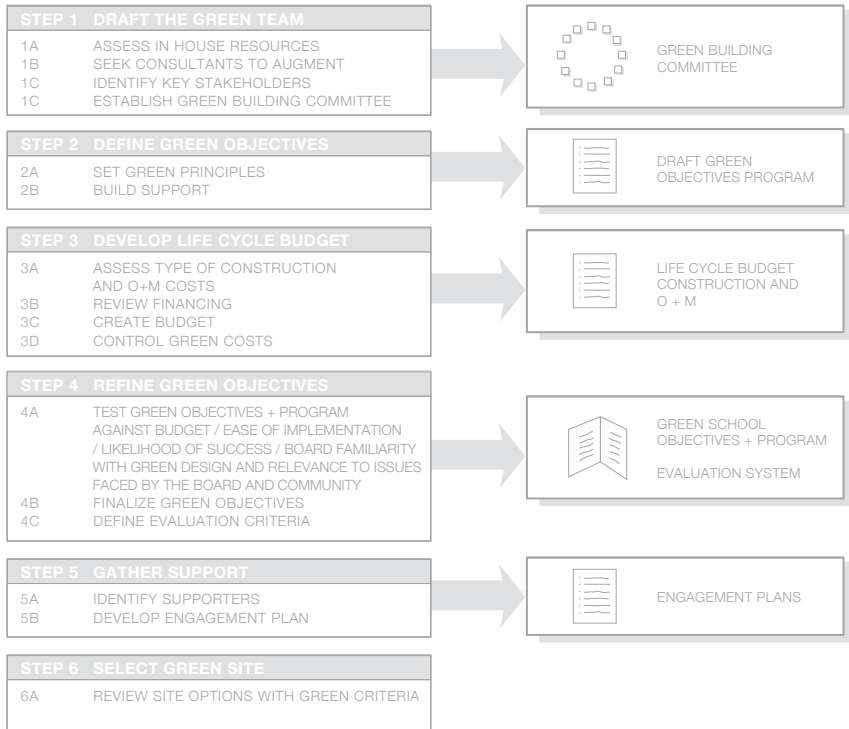
Listed under possible measures are typical strategies employed to address the environmental, economic or student success issues raised by the stated question.

# Green Design Process

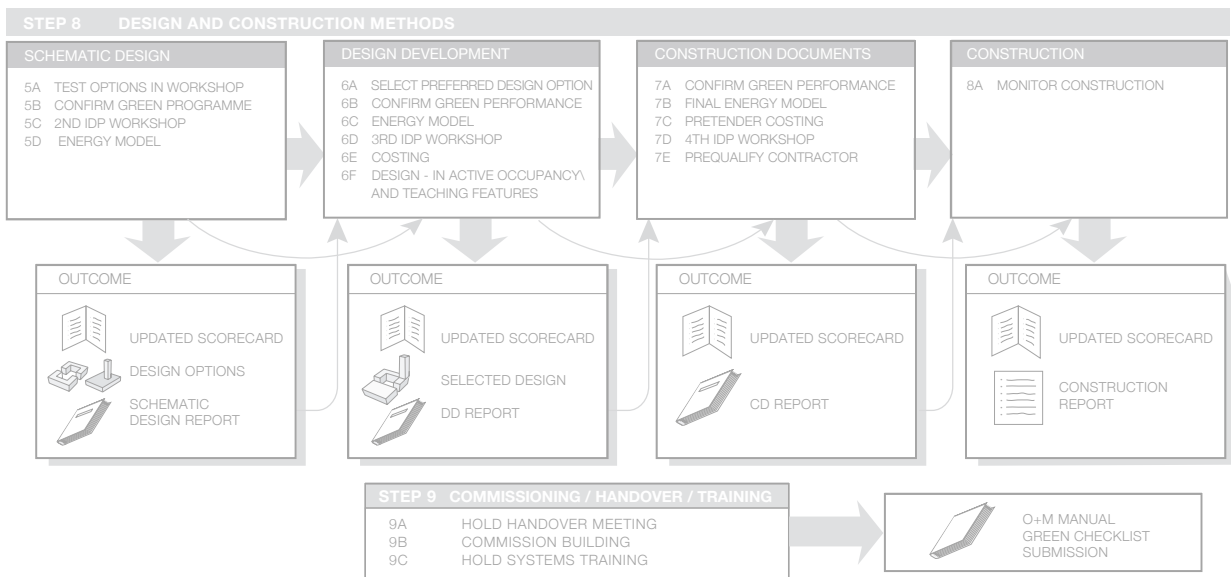
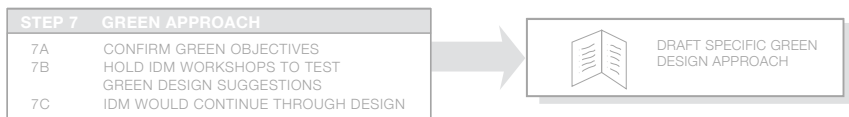
## SECTION 2 Planning

### STEPS

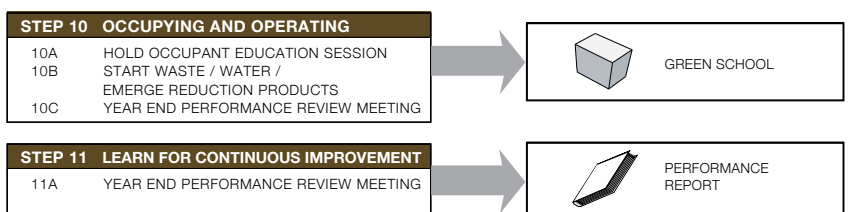
### OUTCOMES



## SECTION 3 Design Construction



## SECTION 4 Occupying and Operating



## Occupancy and Operation Checklist Notes

### Typical Project Impacts

\$	Less than 5% over conventional school development measure
\$\$	5 to 15%
\$\$\$	15% +

Incremental Costs and Typical Paybacks are based on typical case (described below) - as actual project costs will vary widely based on site and other project factors. All proposed target costs should be reviewed and confirmed with a professional design team and a certified cost consultant before proceeding.

The “Typical Project Impacts” were based on comparison to a hypothetical 2 storey 4,150 m<sup>2</sup> (45,000 sq.ft.) elementary school; for 450 students; on a 2 ha (5 acre) site; load bearing masonry construction and steel roof structure; brick exterior cladding with ASHRAE 90.1 (2004) compliant insulation and air barrier system; double glazed low-e insulated windows in aluminum frames; painted block interiors with NCR 0.55 acoustic ceiling tile; VCT flooring, except carpet in front office and library. Mechanical System: centralized mid-efficiency boiler, roof top air handling units, local air condition to office and library, basic building automation system and low flow plumbing fixtures. Building wide T-8 lighting fixtures with electronic ballasts except HID fixtures for the gym.

### Targets

Under this column the board official or consultant would record either a Yes (to be pursued) , No (not pursued) or ? (more information required).

### Proposed Project Specific Measures

Board staff or consultant records the specific measures their green school is proposing to implement.

### Typical Project Milestone

Listed as either Planning, Pre-design; Schematic Design; Design Development, Contract Documents, Construction, Post-Construction or Occupancy. This column lists the project milestones at which a proposed measure would typically need to be incorporated to avoid unnecessary costs.

### Team Member Responsibility

All team members must work cooperatively to successfully execute a green design. It is, however, useful to assign a point person or a team member with primary responsibility. This column suggests those members with primary responsibility

**Ontario Green School Occupancy and Operation Checklist**

Board:  
 School Name:  
 Project Address:

Green Questions	Question Rational	Possible Measures	Typical Project Impacts			Target	Proposed Project Measures		Typical Project Milestone	Team Member Responsibility
			Costs	Payback	Implementation		Y	N		
<b>Occupying and Operating a Green School</b>										
<b>4.1 Step - 10 Occupying the Green School</b>										
<b>4.1.1 Integrating the green school into the green Curriculum</b>										
Can the school building be used as a teaching tool?	A concrete example of green thinking and technology to inspire and inform	Create learning units around the school's green features. Expose otherwise hidden green building technologies and approaches.	\$	n/a					Post-Occupancy Architect	School Board Teaching Staff/Architect
<b>4.1.2 Green Student Programs</b>										
How can students and staff work to improve the buildings green performance?	The behaviour of building occupants can be responsible for 30% of energy use and the majority of waste produced.	Create staff and student awareness programs that involve occupants in reducing the environmental impacts.	\$	n/a					Post-Occupancy	School Board Teaching Staff and Students
<b>4.1.3 Green Maintenance</b>										
Can an exterior plan be developed to maintain landscaping and discourage pests?	Landscaping particular shade trees are important to reduce heat gain. Many indoor pest infestations start from a conducive exterior environment.	Create a exterior maintenance plan in conjunction with landscape consultant.	\$	n/a					Post-Occupancy	School Board - School Operations Landscape Consultant
Can green house-keeping be implemented?	To reduce volatile chemicals produced during the application of cleaning products.	Purchase materials that are low in VOC emissions and meet green certification by Ecologo or Green Seal.	\$	n/a					Post-Occupancy	School Board - School Operations
Could a indoor air quality management program be implemented?	To maintain high quality indoor environments over the life of the building.	Implement Health Canada's IAQ Tool for Schools Action Kit.	\$	n/a					Post-Occupancy	School Board - School Operations
Can an integrated pest management control program be implemented?	Integrated pest control uses physical means to control pests reducing the need for chemical controls.	Implement an integrated pest control plan.	\$	n/a					Post-Occupancy	School Board - School Operations
<b>4.1.4 Green Transportation</b>										
Can routing be maximized to reduce distance school buses travel?	A reduction in distance traveled lowers costs and emissions.	Implement efficient routing. Consider route mapping software to optimize trips.	\$	n/a					Post-Occupancy	School Board - School Operations
Can school buses emissions be reduced by limiting idling and upgrade to lower-emission vehicles and fuel?	Less idling and more efficient, clean burning fuels should cut costs and emissions.	Create idling policy and purchase more efficient vehicles and low-sulphur diesel.	\$	n/a					Post-Occupancy	School Board - School Operations
<b>4.1.5 Green Purchasing</b>										
Has a green procurement policy been implemented?	The Board has adopted a Green Procurement Policy.		n/a	n/a					Pre-Design	School Board
Can re-used or durable low VOC furniture be sourced?	Furniture can represent a significant environmental and IEQ issue.	Source re-used furniture, or select durable low VOC furniture.	Saving (or reused) or \$ (for green new furniture)	n/a					Post-Occupancy	School Board - School Operations Architect/ Interior Designer
Can energy efficient equipment be sourced?	Equipment can be a large energy user.	Purchase energy star rated equipment.	n/a	n/a					Post-Occupancy	School Board - School Operations
<b>4.2 Step 11 - Monitoring the Green School</b>										
Can green objectives established at project start be evaluated?	Evaluation is key to learning and to suggest improvements and future green schools.	Monitor for green objectives established. Include for energy and water use, occupant satisfaction, transportation model splits, Waste and recycling.	\$	n/a					Post-Occupancy	School Board - School Operations



## 4.1 Step 10: Occupying the Green School

Comprehensive and inclusive planning, creative and innovative design and diligent and responsive construction only set the stage for green performance. It is how the building is occupied and operated that will achieve the green promise inherent in the school's planning, design and construction.

The occupancy of the green school building will have two impacts. The first is realizing the potential of the building as designed and constructed. Secondly, and arguably of greater importance, is the realizing of the students' potential to be inspired and informed about green issues.

This section focuses on the operation and maintenance procedures as well as the user behavior that will result in the building meeting or exceeding the green targets set in the planning and design phase. The Canadian Green Building Council attributes a full two thirds of actual realized energy saving to a buildings operation and user behavior.

Topics covered include operation and maintenance, integrating the building into the green curriculum, green student programs, green transportation policies and green purchasing.

## 4.1.1 Green Operation and Maintenance

Green operation and maintenance is critical to meeting green performance targets. The school's energy and water use, indoor environmental quality, waste reduction, and the green design choices made in the design stage can all be significantly affected by how the school is operated and maintained. Even the best designed and installed system is only as good as its operation and maintenance. This is especially true for energy efficient systems. Thus maintenance has an important role to ensure that high efficiency systems deliver high efficiency results. Indoor Environmental Quality (IEQ) can benefit from developing an IEQ management plan that includes the use of green cleaning compounds, regular cleaning schedules, spill response and integrated pest control systems. Waste reduction can be greatly affected by maintenance.

### Energy Efficiency

One third of actual energy savings is attributable to operation and maintenance. Uninformed operation that ignores established set points and shut down periods and does not reflect the design intent can have a negative effect on system performance. Clogged filters, worn slack belts, ceased dampers, and other maintenance issues can all rob an HVAC system of efficiency. A well maintained and operated system can run several points above the expected energy efficiency. However, a poorly operated and maintained system can run, in some cases, 30% below expected energy efficiency. It is important

that maintenance staff understand the design intent and target efficiencies, are fully trained, and implement the manufacturer recommended maintenance schedule.

### Indoor Environmental Quality (IEQ)

Maintaining a healthy indoor environment requires a plan. Chemicals used for cleaning, areas of high humidity, build up of dust or other allergens, uncontrolled spills of hazardous substances and unchecked pest populations have all been linked to negative health affects in students and staff. Below are listed green maintenance measures schools should consider.

- Review Heath Canada's Indoor Air Quality (IAQ) - for Schools Guide

The IAQ Guide for schools is an easy to follow comprehensive guide to methods and procedures to create the conditions for and maintain high IAQ in schools. The guide underlines that good IAQ is everyone's responsibility and spells out roles for caretaking staff, teachers, designers, contractors, and administration staff. The guide covers topics of: Administration, Health, Air Handling, Classrooms, Relocatable Classroom, Building Maintenance, Custodial, Food Service, Waste Management, Renovation and Repair, and Design/Build/Lease-Back Facilities. The Guide is available at [http://www.hc-sc.gc.ca/ewh-semt/pubs/air/tools\\_school-outils\\_ecoles/intro-eng.php](http://www.hc-sc.gc.ca/ewh-semt/pubs/air/tools_school-outils_ecoles/intro-eng.php)

- **Green Cleaning Supplies**

The maintenance department should consider using green cleaning supplies. Many large suppliers now offer green lines at little if any extra charge. Look for products that have been certified as green by either EcoLogo, Green Seal, or CHIPS “Good for Schools” list. Refer to the product’s MSD sheet and avoid the most hazardous materials (e.g., acid toilet bowl cleaner, disinfectant and floor finish stripper) and those with the most volatile ingredients (e.g., sodium hypochlorite, 2-butoxyethanol, phthalates and ethanolamine). Place a preference on products that are: biodegradable; non toxic; water based; not in a sealed aerosol spray can; produce minimal or no irritation to skin, eyes or respiratory system; are not corrosive or highly flammable; concentrated; and work optimally in room temperature water. Whatever products are used, ensure staff are trained to correctly store, mix and use them.

- **Exterior Envelope and Building Systems**

Regularly inspect exterior envelope for moisture penetration, particularly around wall penetrations and where uninsulated materials may come in contact with cold outside air. HVAC systems should also be examined for moisture (from the exterior or condensation), dust or other contaminants. Water systems should be regularly checked for chemical levels to prevent microbe growth.

- **Integrated Pest Control**

Integrated Pest Control (IPC) methods use physical means to control pest populations and use chemical treatments only as a last resort. This benefits IEQ by control allergens associated with pests while avoiding the use of toxic products. The first step in using IPC is to keep pests out

-seal all cracks and holes on the outside. Next, remove pest food sources – by constant cleaning and separation of food waste for storage in sealed containers. Remove pest shelter – keep spaces free of nesting habitat use open shelving and clean regularly. Keep records – note pest sightings. target problem pests - first use non-chemical methods, such as traps and vacuums. For persistent pest problems, work with a pest control professional to select the least-toxic pesticides.

## Waste Reduction

Waste reduction can be effected on two levels: waste generated through school operations (e.g. lunch waste or paper) and waste generated due to the replacement of worn building materials. During the programming and design phase, at-source waste separation should be considered and given dedicated space both in millwork receptacles and a central collection place for all sources in the building.

## Green Design

Proper Operation and Maintenance is crucial to the success of any green school. Early in the design stages - if trade-offs can be found – significant capital costs can be offset by maintenance savings. These trade-offs can be identified through completing a Life Cycle Cost assessment. Components such as exterior cladding and roofing, floor and ceiling finishes should be subject to a life-cycle cost assessment. Even simply transferring staff duties can add to the green opportunities. For example, if linoleum is used for floor covering instead of VCT, summer floor waxing and stripping is not required. This resource can be reassigned to other initiatives such as exterior maintenance or increased shade planting.

## 4.1.2 Integrating Green into the School Curriculum

As cited in the EcoChampions case study below, environmental features need not be passive, but can actively engage students and the curriculum. Other examples include learning gardens that occupy once-dead spaces of parking lots and rooftops that provide environmental and teaching opportunities. The ways in which a green school can be linked to curriculum or used as a teaching opportunity are limited only by the imagination. Including the building users (staff and students) in the design phases of a project will increase the learning opportunities that are identified and incorporated into the design.

In Go Green, Ontario's Action Plan On Climate Change, the Government of Ontario states that "Educating Ontario's primary and secondary school students about the environment is a priority for the government." The Bondar Working Group, headed by astronaut and scientist Dr. Roberta Bondar, was convened by the province to study ways to enhance students' understanding of these issues through the provincial curriculum.

Among the group's recommendations was that schools should integrate environmental education into "all subjects in all grades" and work more closely with "community partners and other government ministries to enhance environmental education".

An example of this kind of partnership is York University's Ontario EcoSchools project, an environmental education program that addresses how schools are run and what students learn, with a focus on student success "in both academics and positive contributions to society". In fact, one of its four key purposes is to "align what is taught in classrooms with school operations". Ontario EcoSchools can provide educational resources and guides to reduce energy use, minimize waste, and design environmentally-friendly school grounds, while providing opportunities for student and staff participation outside the classroom to reinforce classroom learning. It can already be shown that Certified EcoSchools use 12% less electricity and 7% less natural gas than comparable non-Certified EcoSchools.

### 4.1.3 Green Student Programs

#### Teaching Students and Staff about Energy Efficiency

End users are responsible for at least a third of all energy consumption. Educating occupants is a key pillar in a board's energy conservation program, because, in a green school, students and staff are not seen as simply occupants of the building, but instead as active participants. For example, turning off the lights is a simple and easy conservation technique. Since there are usually 10 to 12 lighting fixtures per classroom, more light is used in a single classroom than in an entire family home.

Positive energy habits spread beyond the schoolyard to create a community that is better informed about the impact of everyday choices. A green school provides educators with a unique opportunity to use their surroundings as a teaching tool by displaying green features. Along with displaying green features, building systems and controls can be wired with feedback loops to illustrate cause and effect. The school can become an interactive learning tool. For example, turning off a light switch can register as a drop in energy consumption on a classroom computer.

Potential education targets could include:

- Providing display material in the building describing the green features to allow for informal learning for anyone who enters the school
- Developing an occupant awareness program such as EcoSchools or EcoChampions (see Case Study 1)
- Identify opportunities to align curriculum with green objectives

## CASE STUDY:

# EcoChampions Program

(YORK CATHOLIC DISTRICT SCHOOL BOARD)

The York Catholic DSB's EcoChampions Program is an engaging, educational and pragmatic approach to teaching and realizing the benefits of energy cost savings. The board is currently enjoying energy savings equal to 10% of previous costs, while the math and science curricula have been expanded to include energy conservation and other environmental subjects. Perhaps even more important, EcoChampions proves that an individual can really affect the environment – simply by turning off a few lights – which is the message that student ambassadors take home to their friends and families.

EcoChampions is a two-part program. An interval meter is installed in the school and is connected the building automation system. Energy statistics from the meter are displayed on a monitor in the school foyer and in classrooms via the intranet. If pre-set energy consumption thresholds are exceeded, "Save Energy" LED signs in all classrooms and public areas flash. When the LED flashes, an energy savings plan swings into action. As each tactic is introduced, students may log into the Eco Website or view the central system monitor to see the actual, verifiable impact of their conservation efforts.

The total program costs, mainly for meters, LEDs and wiring, amounted to \$7 thousand per school. The costs tend to be paid back through energy savings in a little over two years. Currently, 25 schools have signed up; YCDSB plans to have another 55 schools on the EcoChampions program by the end of 2010, and all schools will be completed by 2011.

## 4.1.4 Green Transportation

Emissions from school buses can affect the air quality in and around school buildings. By reducing school bus idling, retrofitting existing buses with devices that reduce pollution and/or using cleaner burning fuel, emissions from buses can be reduced.

A green school should consider the following policies to minimize the exposure of children to exhaust and reduce emissions.

- Locate vehicle drop-offs down wind and remotely from buildings air intakes, doors and operable windows
- Eliminate unnecessary bus idling, by limiting idling time during early morning warm-up to what the manufacturer recommends (generally no more than five minutes) and turning off engines as soon as possible after arriving
- Post signs and advise parents and delivery trucks to turn off engines when waiting on school grounds
- Replace the oldest buses in the fleet (manufactured prior to 1990) with new, less-polluting buses
- Maximize school bus routes to reduce the number of buses on the road.
- Upgrade or retrofit buses in the fleet with better emission control technologies (e.g., oxidation catalysts or particulate matter filters) and/or fuel them with cleaner fuels (e.g., biodiesel blended fuel and ultra low-sulfur diesel fuel)

## 4.1.5 Green Purchasing

Products that cause the least environmental impacts during their manufacture, shipping, use and eventual reuse, recycling or disposal are preferred for green schools. Green Purchasing can cover many areas including furniture, equipment and office supplies. Furniture buying decisions can affect the indoor air quality and environmental foot print of the school. Selection of equipment can also impact indoor air quality and energy consumption. Office supplies can impact the school's environmental footprint.

### Furniture

Off-gassing, particularly of new furniture, can result in poor air quality, including reports of a chemical smell, headaches and nausea. Low Volatile Organic Compound emitting furniture should be considered. Furniture can also be a source of environmental impacts resulting from the manufacturing process (toxic by-products and embodied energy) and from long distance shipping. Local manufacturers using low-toxicity materials and high recycled components would be preferable for a green school. Listing of preferred green suppliers and buyer guides are available from a number of sources. A Canadian eco-rating organization, TerraChoice, lists green office furniture choices on a searchable office furniture guide. The Collaborative of High Performance School also list green furniture choices available at [http://www.chps.net/manual/lem\\_table.htm](http://www.chps.net/manual/lem_table.htm)

### Equipment

Electrical and electronic equipment can represent more than 15% of a schools overall energy use. Environmental impacts of manufacturing and disposal of electronic equipment should also be considered. Energy Star™ copiers, fax machines, computers, printers, dishwashers, and refrigerators have the best energy efficiency.

### Office Supplies

Art supplies, inks, toners, and paper also have environmental impacts. A green school should consider ordering print jobs on post-consumer recycled paper and specify that such jobs be double-sided wherever possible. Use vegetable oil or water-based ink for printing. Purchase supplies and equipment made with recycled content materials (i.e., paper products, engine oil, paints, office products, carpeting, building materials and outdoor benches/tables). Consider remanufactured items, such as recharged toner cartridges, re-formatted computer disks and returnable office equipment.



## 4.2 Step 11: Monitoring the Green School

Measurement of actual building performance is critical for several reasons: it provides accountability, builds support for further green initiatives, and provides data for continuous improvement.

The roster of specific performance indicators to be tracked should be determined according to the green objectives established for the school. However, the following indicators should be considered for all schools:

- **Energy and water consumption savings**
- **Occupant satisfaction (via post-occupation survey)**
- **Transportation modal splits (how many students and staff walk, bike, drive or use public transit?)**
- **Occupant behavior**
- **Waste/recycling ratios**
- **Greenhouse emissions**
- **Curriculum integration**

Except for energy and water use, all of these indicators are to a certain degree subjective and influenced by factors beyond that of the building itself. They should not be taken as proof – one way or the other – of the benefits of green schools. These indicators are useful in establishing trends and benchmarks.

Celebrating the success of a project that delivers real benefits to operators, users and the community as a whole will build support for more green projects in the future. Reliable data provides important baselines that enable school officials to benchmark and keep records to determine which initiatives should be repeated, and which areas have potential for improvement.

Celebrating actual building performance provides accountability, builds support for further green initiatives and provides data for continuous improvement and optimization. School boards are accountable to ratepayers, to students and to staff. Any investment in green schools must demonstrate a return, whether that is in measured in terms of dollars, enhanced learning environments or improved environmental impacts. The only way to verify predicted returns is by measuring the actual benefits realized by a project over its useful life.

# REFERENCE MATERIAL

- 5.1 Integrated Design Process
- 5.2 Green RFP
- 5.3 Technology Data Sheets
- 5.4 Energy Incentive Programs
- 5.5 Green Building Rating Systems
- 5.6 Case Study Summary
- 5.7 Energy and Water Use Benchmarks
- 5.8 Green Resources
- 5.9 Emerging Green Issues
- 5.10 Frequently Asked Green Questions

## 5.1 Integrated Design Process

“The whole is greater than the sum of its parts”

– Aristotle

### What is it?

A Canadian innovation, the Integrated Design Process (IDP) is the key to reducing initial capital cost while optimizing long term building performance. The IDP is used to identify cost trade offs through the early design stage. This is achieved by close collaboration between all of the project stakeholders. The Goal is to start the design with all of the key players in the room to avoid committing to design directions that may have negative and costly impacts as the design progresses and the building is occupied.

For example, building orientation is often considered without input from mechanical consultants and end users in the traditional design process. The decision on orientation, however, could have major impacts on the design of mechanical systems and user comfort. Locating large areas of the school with western exposure, for instance, will greatly increase cooling loads or lead to overheating. Glare could also be a problem from the low afternoon sun. Through the IDP, however, other options could be explored. Providing exterior shading or high performance glass on the west façade will cost more but this cost may be offset by the savings resulting from a reduced mechanical system, thus creating a win-win situation of low capital costs, lower operating costs and improved occupant comfort.

Every project will have its own set of win-win conditions that can be identified through an Integrated Design Process, thus delivering a higher performing building at a lower cost.

### How?

The Integrated Design Process requires that all of the stakeholders (including those involved in the planning, design, use, construction, operation and maintenance of the facility) work together to evaluate the implications of proposed design solutions on cost, quality-of-life, future flexibility, efficiency, overall environmental impact, and productivity. Establishing project goals and the potential for synergies between the various building systems requires intense interdisciplinary collaboration from the outset of the project. IDP treats the individual components (including the site, the structure, HVAC systems, and the interior teaching/learning environment) as one complete building system rather than as a number of separate, independent systems. Understanding their interrelationships and interdependencies is a cornerstone of the IDP.

Involving specialty resources at the beginning is more practical and cost effective than trying to apply value engineering later on in the process. It also deviates from more conventional approaches, where the different disciplines either work in isolation or are not involved in the design process until after the design has been finalized.

## The IDP Process

### Establish Objectives

Confirm the board's commitment to green measures and develop an initial statement of performance goals, targets and supporting strategies. Review budget and pay-back requirements for compatibility with performance goals. Prepare a Functional Program and Performance Goals Report. This phase may be completed by board staff, or boards may wish to involve consultants to assist in drafting these objectives.

### Site Assessment

Assess the ecological quality of the site: soil type, any contamination, solar access, and natural features such as wind blocks. Identify any features in adjacent properties that may place constraints on the design of the subject building. Assess the suitability of any existing structure(s) on the site for adaptation to the new uses planned for the site. Assess the suitability of materials and components in any existing structure(s) on the site for re-use in the new building(s) planned for the site. Consider the possible impact of location on the transportation requirements of the facility. The site assessment may be undertaken as part of the board's due diligence when selecting a site, or, depending on the project schedule, the consultant team may complete some or all of these tasks.

**Selecting Design Team**

Ensure that the proposed design team is aware of project green objectives. Identify and retain design team members with skills and experience related to green schools. Refer to Appendix A Green RFP. Ensure sub-consultants fees are not based on the cost of their sub-discipline, thus creating a disincentive for optimization of costs.

**Green Design Workshop**

Invite design workshop participants, including those involved in the planning, design, use, construction, operation and maintenance of the facility. At the workshop, present the proposed green objectives, green school checklist and the energy simulations to provide a starting point for discussion. Develop two or three schematic options for improved performance. Hold an open discussion on performance, cost and other implications. Carry on with more detailed development of the most attractive option after the workshop, including preliminary energy simulations or estimates. Add additional specialized consultants (e.g. acoustical, commissioning, etc.) to the design team if necessary. Summarize the results of the workshop in a Design Workshop Report and Green School Checklist, and distribute to all stakeholders.

**Monitor Progress through Design, Construction and Operation**

Evaluate the design at end of Design Development and Construction Documentation, for adherence to the Design Workshop Report and/or Green School Checklist, include for commission agent peer review at key milestones. Include green school requirements in Tender Documentation. Hold Green Pre-Construction meeting with selected contractor. Throughout construction, consultants and commissioning agent should review the contractor's compliance with green requirements. Train building operation staff. Educate occupants on building's green features and positive behavior. Owner/Operator to provide reports on operations, maintenance, & utility bills. Carry out a Post-Occupancy Evaluation (POE) study.

**Resources**

Metro Vancouver – Build Smart – Design best practices – Integrated design, <http://www.gvrd.bc.ca/Buildsmart/integrated-design.htm>

Whole Building Design [www.wbdg.org](http://www.wbdg.org)

U.S. Department of Energy, Integrated Building Design for Energy Efficiency, <http://www.eere.energy.gov/buildings/info/design/integratedbuilding>

## 5.2 Green Request for Proposal (RFP)

This section presents a framework to guide school boards in writing Green Requests For Proposals (RFP). In general, a green RFP can follow the same structure and format as a typical RFP, with specific green tasks added to the basic structure. Specific tasks could include all or a number of the following tasks as deemed necessary by the board:

- **Defining, Tracking and Verifying Specific Green Project Objectives**
- **Developing Life Cycle Budgets**
- **Leading the Integrated Design Process**
- **Design and Construction Review**
- **Review and Modeling of Building Systems for Green Performance (e.g. Energy)**
- **Commissioning of Building Systems**
- **Post-occupancy Monitoring of Green Performance**

From the menu of tasks listed above, boards can determine which can be dealt with in-house and where an outside consultant would be of assistance. Boards should also consider if the green tasks should be packaged as one RFP, or separated out into several individual RFPs. The advantage of one RFP is one source of responsibility and coordination. Some boards, however, will issue separate RFPs for commissioning, as a way to establish and enforce a consistent set of board standards across all projects. Boards may also want to consider retaining a green building specialist to work in advance of the architectural consultant to aid in setting green project objectives and to assist in writing the architectural RFP.

It is key that the green goals and scope are presented in a clear way, to allow proponents to accurately determine the scope of the assignment and respond in a consistent and clear manner. Each project, site, and region will require a somewhat unique green response, so each RFP should identify its specific green design goals and scope. A strong, well-written RFP will capture the interest of potential consultants, accurately convey the full scope of the desired work, and result in more informed proposals being submitted.

Following is a suggested RFP outline, identifying the basic elements and important issues a Green RFP should consider. Evaluation procedures and methods for received proposals are then discussed, followed by some sample language taken from actual RFPs.

## 5.2.1 Core Elements of a Green RFP

### Introduction

The introduction should outline the School board's vision for the project, including:

- Project scope
- Green design targets
- The nature of services required

This can be articulated through a green design statement.

Please refer to section 6.2.3 for writing samples.

### Project Objectives

This is a general statement of goals that the proponent should address. These often include:

- Brief program description
- Intended improvements
- Aesthetic guidelines
- Building code and legal standards
- Green and environmental directives

Please refer to section 6.2.3 for writing samples.

### Qualifications and Experience

A detailed explanation of the proponent's qualifications and experience should be requested as part of the RFP response. Information for both the firm and the proposed project personnel should be provided. This includes:

Firm Qualifications and Experience:

- A narrative of selected relevant projects listing: project statistics (size, budget, program), important green building features, lessons learned, client reference and how the proponent sees this project as relevant to the proposed project. If available, proponents should be encouraged to provide performance data, such as actual energy use, occupant surveys, etc. from projects they have completed.
- Any green certification achieved on previous projects – list of certifications or awards
- A demonstration of a proponent's commitment to constant improvement – a description of expertise gained from previous projects and how this would guide the proponent's approach to this project.
- Information about firm activities in professional associations, such as the RAIC Committee on the Environment or the Canadian Green Building Council.

Individual Qualifications and Experience:

- **Resumes**
- **Certification**
- **Accreditation information**
- **A list of published papers**
- **Environmental conferences, seminars, workshops, and professional meetings attended by team members in recent months**

Sample language can be found in section 6.2.3.

### **Services Required & Approach**

This section should describe what the board wants the consultant team to do. It should lead the proponent to describe their process and approach, both in general terms and in specific applications to the project at hand.

These descriptions are not only useful when evaluating proponents, but also provide the respondents with green design expertise opportunities to suggest a sophisticated or tailored approach the board may not have considered.

Specifically, green design projects involve specialty disciplines that operate most efficiently when incorporated at the beginning of a project. The board should specify that it wants a broad and inclusive team from the outset and look for a proponent presenting a comprehensive plan to achieve an integrated design. At a minimum, the proponent's approach should address how they would engage with board staff and work with consultants, at what point consultants would be brought on board, how green objectives would be tracked throughout the design and construction phase, and, finally, the method for evaluating the success for the project.

Sample language can be found in section 6.2.3.



## Project Scope

In this section, the RFP should incorporate key phases of the work, critical deliverables, and other tasks to be completed into a description of the entire project. The key differences in project scope for a green project will be the additional work in the pre-design phase and the review and adjustment phase during the first year of operation. Generally a green scope of work would include:

- Project vision
- Green objectives
- Site and resource analysis
- Design charrettes (include number of expected charrettes 3 to 5 would be typical depending on project size and complexity)
- Project programming
- Contract documents
- Design Development
- Construction Management
- Building Commissioning and Close-out
- Post Occupancy Review and Adjustment
- Warranty and performance review

When defining the project scope, the board has an opportunity to go into greater detail regarding Green performance benchmarks. While not essential, if a board has already established desired performance benchmarks it is useful to list these in the project scope.

Performance Benchmarks could include:

- Energy and/ or Water use targets (e.g. 30% below ASHRAE 90.1)
- Benchmarks for other parameters such as materials use, IAQ, and solid waste handling. Some of these benchmarks are found as standards in municipal regulations, ASHRAE, and green building standards.
- A range of potential solutions the board has already used or considered to meet performance targets.

A detailed performance profile assists the proponent in gauging the requirements of the assignment and establishes if specialized consultants may be needed to augment their team.

A green RFP would also likely include provisions for services and deliverables beyond the norm, items such as:

- Simulation and modeling costs
- Commissioning
- Certification, if the board is using a green building rating system

The provision of the services and deliverables should be very clearly defined as proponents could all take very different approaches, making comparisons difficult. The board should lay out which services and deliverables the board is expecting and if that cost is to be included in the base fees, listed as a separate or additional fee, or separately provided by the board but to be coordinated by the consultant. Proponents will only be able to price accurately if there is clear direction.

## Budget

A construction budget should be determined, even if it is only a range.

## Optional Items or Services

Provide proponents with an opportunity to propose creative or innovative options for green schools. It is important to indicate that items/services presented in response to this section must be clearly identified as options. Associated costs of items/services must be shown separately, clearly marked, and not included in the total cost of the project.

## Submission Requirements

A list of the submission components, may include the following::

- Cover letter
- Introduction to the proponent’s organization and team
- Explanation of proponent’s philosophy and approach
- Explanation of deliverables
- Detailed schedule linked to project deliverables and key milestones (based on dates the board provides)
- Resumes of key personnel
- Explanation and list of green design “tools” that the team would use
- Statement of qualifications
- Fees broken down by deliverable
- Sample projects and performance data or lessons learned
- Client References

Remember to clearly state:

- Specific directions for submission (if e-submissions are acceptable)
- Submission deadline
- Policies on late submission
- Page limits, double sided and number of copies, if hard copies are required.

## Proponent Evaluation Criteria

A key element to allow proponents to provide focused and concise responses is a clear description of the evaluation criteria. Boards should consider:

- Outlining the criteria that will be used to evaluate proponents
- Outlining how criteria will be weighted
- Identifying stakeholders represented on the evaluation committee
- Outlining the proposal review, short-list, and interview processes.

## 5.2.2 Evaluating Responses to the Green RFP

How can a board determine which group will bring the right experience, skills and attitude to make their project a success? When reviewing individual proposals, the evaluation team should look for:

### Specific answers to specific questions

Proponents should answer with specific data in the proposal and any interview question. Answers should include data, such as energy intensity of similar projects, and examples of previous installations of the same green measures proposed on your project.

### Detailed response to the RFP call

Proponents should be prepared to sketch out an approach to a specific site, based on project information provided in the RFP and context considerations such as solar angles, prevailing wind directions, green corridors, transportation routes, etc.

### A team approach

Proponents should demonstrate an ability to coordinate, facilitate, and lead meetings with the design team and external stakeholder groups. This may include examples of past process, a specific plan for implementing an integrated design method for this project, or setting a team facilitation task in the interview.

### A detailed implementation plan

The proponent should have a detailed implementation plan on how to move the process forward. This should be included in the proposal or provided at interview. It should include a list of stakeholders and consultants to be involved, the level of involvement from the various participants throughout the project, timelines and number of meetings or workshops, and expected outcomes and measures of success.

### Demonstrated continual improvement

The proponent should demonstrate experience in designing green schools and be able to articulate in detail the lessons learned from previous experiences.

### 5.2.3 Examples of RFP Language

#### Writing Sample 1 – a statement combining project vision with specific green objectives:

“The Oak Ridges Community Centre and Park will be a leading example of environmental stewardship and will provide ecological benefits to the Oak Ridges Moraine and Lake Wilcox. The development will achieve a sensitive balance between the recreational programs and the natural site features, through the enhancement of natural site amenities such as:

- improvements to watercourses and shoreline edge,
- best storm water and forest management strategies,
- recognition of existing and potential terrestrial and aquatic habitats,

The Oak Ridges Community Centre will be a landmark facility within an integrated site development and will be a leading edge example of environmental sustainability. The building design will be the most appropriate to provide support and complement the ecologically sensitive park design. The building design will recognize LEED initiatives and will pursue a ‘silver’ certification as a minimum. The Community Centre will be located to enjoy the dramatic views of Lake Wilcox, while the architecture will turn it into a sensitive visual amenity within the shoreline setting.”

The Corporation of the Town of Richmond Hill,  
RFP 46-07, pC-1  
Provision of Architectural Services for the Oak Ridges Community Centre

#### Writing Sample 2 – Green Objectives:

“General Requirements of the building

10. The Architect will be expected to conceive and design a building that:
  - 10.1 is in conformance to relevant building codes and local regulatory requirements;
  - 10.2 features and promotes barrier-free accessibility standards;
  - 10.3 has prominent “environmentally-friendly” characteristics;
  - 10.4 takes advantage of the latest energy conservation technologies subsidies and techniques;
  - 10.5 features low-maintenance finishes and materials...”

Hamilton-Wentworth District School board  
Pre-Qualification of Architectural Firms and Request for Proposals  
Non-Instructional Building Projects, p2

### Writing Sample 3 – Green Objectives:

While your team may propose any type of innovative, environmentally sound building technologies, the board is particularly interested in those that address the following:

- Ecological site design: on-site erosion, control, water purification/pollution reduction and storm water management (bioswales, ecoroofs, storm water filtration etc.).
  - Transportation: promoting bicycle, pedestrian and transit use.
  - Waste reduction: building reuse, job site recycling and efficient use of materials.
  - On-site management of sewage and organic wastes, such as gray water systems and biological wastewater treatment.
  - Energy efficiency: efficient thermal envelopes, efficient space and water heating, lighting, controls and monitoring.
  - Renewable energy: photovoltaics, geothermal pumps, wind turbines, micro-turns and fuel cells.
  - Water efficiency, both domestic and irrigation, including a rainwater harvesting for irrigation and toilet flushing.
- Materials and resources:
    - Durable building envelopes and long-life materials and assemblies
    - Recycled-content materials
    - FSC-certified woods
    - Safer, less toxic (low VOC producing) materials
    - Innovative application of natural materials (characterized by low embodied energy, local available, good performance, biodegradable, safe, aesthetic) such as straw, earth and other composites
    - Indoor environmental quality, pollution reduction, teacher and student safety, air cleaning, humidity control and thermal comfort
  - Operations and maintenance:
    - Monitoring of energy, water, waste, air quality and transportation use
    - Resource-efficient building operations practices”

Writing the Green RFP, American Institute of Architects, p3

## Sample Language 4 - Qualifications & Experience:

“The Poudre School District believes that an integrated design approach can greatly increase the chance of success of meeting sustainable design goals without facing unexpected challenges. Traditional design approaches to construction facilities has largely been a linear process. The architect progresses from conceptual/schematic design, to design development, to construction documents, to contract administration, while retaining technical consultants along the way. Integrated design employs a multidisciplinary approach, where all project stakeholders are involved in the design process from start to finish on a collaborative basis. The process recognizes that a design decision made unilaterally may have a major impact on achieving sustainable design goals.”

RFP: Poudre School District Prototype  
Elementary School  
Fort Collins, Colorado (2000)  
American Institute of Architects,  
Writing the Green RFP

## Sample Language 5 - Services Required & Approach:

“Demonstrated ability to provide green building consulting and design services for public and commercial buildings. These services can be provided by the proposed firm or individual, as well as through the use of specialized subcontractors. Firms and individuals responding to this RFP will be required to submit information specifying in which of the following areas they can provide expert services.

- Recycled-content and green building product selection, specification, and procurement
- Waste reduction strategies, such as construction and demolition waste management plans and specifications, deconstruction plans and specifications, storage and collection of recyclables and other reuse opportunities
- Use of LEED Green Building Rating System to guide project design
- Design charrettes...
- Development of design guidelines and master specifications for public agencies
- Partnering opportunities in building projects with organizations such as DOE and PG&G
- Use of creative financing for green buildings
- Green operating and maintenance plans
- Commissioning a green building
- Energy modeling and analysis
- Monitoring and tracking of final projects once they are operational (tracking back to original models)”

Alameda County Waste Management Authority  
San Leonardo, California  
RFQ: Green Building Assistance (2002)  
American Institute of Architects,  
Writing the Green RFP

### Sample Language 6 - Additional Services:

“9.0 Optional Items or Services

Any items or services identified as optional may be provided. A detailed description of the proposed options with the associated costs and the benefits or value to the City in considering these options must be provided under separate cover. This section should be clearly marked and not included in the Total Cost to the City. All costs for optional items are to be shown separately.” (p12)

City of Mississauga, Architectural Services for the  
Redevelopment of  
Burnhamthorpe Library & Port Credit Arena  
Procurement No: FA.49.182-06,  
p 11 & 12 respectively

### RESOURCES & ACKNOWLEDGMENTS

This document has been inspired by and/or includes quotations from the following documents:

Brant Haldimand Norfolk Catholic District School board, RFP, Architectural Design Services for Proposed New School at 120 Ninth Avenue, Brantford, Ontario, Document P-1-08-BHNC (closed Feb/08)

Hamilton-Wentworth District School board, Pre-Qualification of Architectural Firms and Request for Proposals for Architectural Projects (closed July/2007)

The American Architectural Association Document, “Writing the Green RFP.” To view the original, please visit <http://www.aia.org>

The Corporation of the City of Mississauga, Procurement No. FA.49.182-06, RFP for Architectural Services for the Redevelopment of Burnhamthorpe Library & Port Credit Arena (2007)

The Corporation of the Town of Richmond Hill, RFP 46-07, For the Provision of Architectural Services for the Oak Ridges Community Centre in the Town of Richmond Hill (closed: Jan, 2008)

The Town of Milton, RFP 07-243, Architectural Design Services – Milton Branch Library (closed: July, 2007)



## 5.3 Emerging Green Technical Data Sheets

The following data sheets cover newer green technologies that have enjoyed a relatively high public profile and generate more interest among the general public. These data sheets are meant to provide a brief description of the technology and potential benefits, risks and costs. These are very generalized analyses and boards should consult with a qualified professional before making any decisions for a specific project.

Incremental Costs and Typical Paybacks are based on typical case (described below) - as actual project costs will vary widely based on site. Other project factors should be reviewed and confirmed with a professional design team and a certified cost consultant before proceeding.

The “Typical Project Impacts” were based on comparison to a hypothetical 2 storey 4,150 m<sup>2</sup> (45,000 sq.ft.) elementary school; for 450 students; on a 2 ha (5 acre) site; load bearing masonry construction and steel roof structure; brick exterior cladding with ASHRAE 90.1 (2004) compliant insulation and air barrier system; double glazed low-e insulated windows in aluminum frames; painted block interiors with NCR 0.55 acoustic ceiling tile; VCT flooring, except carpet in front office and library. Mechanical System: centralized mid-efficiency boiler, roof top air handling units, local air condition to office and library, basic building automation system and low flow plumbing fixtures. Building wide T-8 lighting fixtures with electronic ballasts except and HID fixtures for the gym.

- 5.3.1 Waterless Urinals
- 5.3.2 Green and White Roofs
- 5.3.3 Demand Control Ventilation
- 5.3.4. Geothermal Heating and Cooling
- 5.3.5 Solar Electric Generation
- 5.3.6 Wind Generation
- 5.3.7 Thermal Energy Storage

## 5.3.1 Waterless Urinals

### Why?

Reduce water use.

### Description

Waterless urinals are very similar to water flush models in appearance and in that urine is drained to the sanitary plumbing system. Where they vary is that waterless urinals require no water supply for flushing and instead use a chemical trap that contains an oil and deodorant mix that floats above the urine preventing odor from escaping into the room.

### Benefits

- Reduced water used for urinal flushing by 100% which could amount to 1,800 litres per year
- Improved sanitary conditions as flushing tends to atomize urine droplets which then become airborne traveling throughout the washroom

### Risks

- 2% min. pipe fall must be maintained especially between the urinal and connections into the rest of the sanitary system – where urine is diluted. Concentrated urine is highly corrosive to metal piping and thus slopes must be maintained throughout the system.
- In the past waterless urinals have been made of fibreglass which had durability issues. However, vitreous china models are now available

- Most complaints regarding waterless urinals result from maintenance issues. Waterless urinals do require more attention
- Chemical trap cartridges are patented technologies and lock the board to a single supplier.

### Cost

- Waterless urinals are more costly than water flush versions, but deleting water supply will usually offset this cost.
- 1 to 3 yr payback (based on an incremental cost of \$50 - 100/ urinal. A saving of 50 two litre flushes per day over a 180 day school year equals 18,000 litres of water use reduction or a saving of \$36/ year based on a water cost of \$2/ m<sup>3</sup>)

### Maintenance

- Daily mopping out of urinal bowls
- Regular replacement of chemical trap cartridges

### Case Studies

Prince Edward and Hastings School Board has standardized on waterless urinals and have installations in 10 schools.

## 5.3.2 Vegetated Roofs

### Why?

Reduce storm water run-off and cool roofs, addressing internal building cooling loads and heat island effect.

### Description

A growth medium is placed on top of a roofing membrane to allow for plant growth on the school's roof. Plant growth on the roof will reduce storm water run-off as water is trapped in the growth medium for plant use and evaporation. The plants will act to shade the roof and the growth medium provides some additional insulation thus reducing cooling loads in the school building. A green roof will absorb less heat and therefore will lower the localized heating commonly known as the urban heat island effect.

Systems vary but are divisible into tray systems and site built systems based on depth of soil. Tray systems consist of plastic trays pre-planted with vegetation in a growth medium that is placed on top of an installed roof membrane. Site built systems are built up above the roof membrane with first a drainage layer, a root barrier, and then the growth medium. Vegetation is then individually planted or seeded into the growth medium. Tray systems have the advantage of being brought to the site green. Site built systems allow more flexibility in planting and soil depth. Vegetated roofs are also categorized by medium depth and thus the types of plants the medium can support. Extensive systems typically have a medium depth between 50 and 100mm and support grasses and sedums. Most tray systems are extensive. Intensive systems have medium depths of 150mm and greater and can support a wide variety

of plants even up to trees. Generally extensive systems are used on inaccessible roofs just to green the roof and intensive systems are used on accessible landscaped roofs. Intensive systems also provide greater environmental benefits.

In any case vegetated roofs are expensive, and the question should be asked if the same environmental benefits can be achieved by using a lower cost "white" roof, storm water management and planting on the ground.

### Benefits

- Reduced storm water run-off and lower cooling loads.
- Very visible green building feature.
- Prolong expected roof membrane life.

### Risks

- Presence of a vegetated roof complicates roof repairs and replacement.
- Structural reinforcement is required for additional loading.

### Cost

- Range from \$20/sq.ft. to \$60/sq.ft. depending on system and planting.
- no real payback as typical payback periods would exceed expected life.

### Maintenance

- Varies depending on system and planting. A grass extensive system can be essentially maintenance free, if the board doesn't mind a "brown" roof in summer.

### Case Studies

Jackman Avenue Public School, Toronto District School board has installed a 90m<sup>2</sup> Intensive green roof.

### 5.3.3 Demand Control Ventilation

#### Why?

Reduce energy use by avoiding over-ventilation of conditioned building spaces.

#### Description

While mechanical systems are designed to the maximum needs of a conditioned space, actual occupancy is often at least 25% below design. Demand control ventilation (DCV) is a method of providing only necessary ventilation to avoid excess space conditioning. Real-time sensors are installed to identify current system demand. These are most often CO<sub>2</sub> sensors which estimate current building occupancy. When sensors note demand is low, they tell the system to provide less fresh air by slowing fan speeds or closing inlet vanes. This reduces the volume of air entering the building, and the corresponding power needed to heat, cool and move air. Providing DCV functionality in a system can reduce ventilation, heating and cooling loads by 10% to 30%.

#### Benefits

- 10-30% reduction in heating, cooling, ventilating loads
- Can reduce associated energy costs by 20%
- reduces building environmental footprint
- ideal for spaces with large variation in occupancy (gyms and libraries)
- can reduce peak energy demand and associated charges

#### Risks

- still being adopted into standards and building codes
- makes HVAC installation more complex
- control system must support sensor input
- relies on sensor calibration
- may not address non-human pollutants

#### Cost

- \$650 per zone installed (\$0.20/ft<sup>2</sup>) new system
- 1 to 3 yr payback (refer to analysis in Section 5.7)

#### Maintenance

- Sensors must be maintained
- System operation requires training

#### Case Studies

Oregon Department of Energy provides numerous DCV studies

Ayr Public School, Waterloo

#### Resources

NRCan Office of Energy Efficiency -  
DDC Control Strategies

US Department of Energy: Energy Efficiency and  
Renewable Energy

American Society of Heating, Refrigerating and  
Air-Conditioning Engineers

## 5.3.4 Ground Source Heat Pumps

### Why?

Use earth or ground water as a source of heat in winter, and as a sink for heat-removal in summer.

### Description

A Ground Source Heat Pump (GSHP) transfers heat between the earth and a conditioned space, concentrating temperature in the same way as a refrigerator. An open-loop system uses water from a nearby body of water to circulate heat between the water and the conditioned space. A closed-loop system uses an isolated fluid loop to draw or discard heat to the ground. A GSHP uses electricity for moving the circulation fluid and concentrate the heat it contains for practical use. A GSHP can supply about three times as much heating or cooling energy as it requires to run. The circulation loop can be installed vertically or horizontally, and range in size from 1.5kW to 300 kW. The Heating Seasonal Performance Factor (HSPF) rates system efficiency, and is typically between 6.5 and 11.2 for closed loop systems.

### Benefits

- Energy savings of 30% to 70%
- Less building floor space required
- Can be integrated with water-heating to provide ‘free’ hot water in summer
- Reduces environmental footprint
- Life expectancy of 25+ years

### Risks

- Higher maintenance costs
- High electrical demand fees reduce cost savings when comparing to a natural gas system
- Vertical systems must balance seasonal soil temperature
- Application is site-specific, depending on soil type and conductivity
- System may not be able to operate at capacity during extreme weather

### Cost

- Capital cost: \$3 to \$7 per ft<sup>2</sup> installed
- 10 to 15 yr payback (based on a 50% reduction in energy use or \$0.3 saving/ sq.ft.)

### Maintenance

- Yearly cleaning/inspection suggested

Natural Resources Canada: RetScreen:	
Loop Type	Considerations
Horizontal	<ul style="list-style-type: none"> <li>• Lower cost</li> <li>• Suitable for large site areas</li> <li>• Suitable for very cold climates</li> <li>• Suitable with large systems</li> </ul>
Vertical	<ul style="list-style-type: none"> <li>• Higher cost from drilling</li> <li>• Suitable for confined site areas</li> <li>• Suitable for warmer climates</li> <li>• Suitable for moderate system sizes</li> </ul>

### Case Studies

Available at [www.retscreen.net](http://www.retscreen.net)

Available at [www.canren.gc.ca/Resources](http://www.canren.gc.ca/Resources)

## 5.3.5 Solar Photovoltaic

### Why?

Generate electricity from the sun's rays.

### Description

Solar photovoltaic (PV) panels use semiconductors to convert sunlight into electricity, providing energy whenever the sun is shining. Solar PV systems are easily scalable, providing any desired amount of power by linking individual panels together to form arrays. Panels are easy to integrate, having little impact on other building systems. For optimum efficiency a panel must be installed in an unshaded area and angled to face the sun as often as possible. Building-integrated photovoltaic (BIPV) systems reduce costs by replacing instead of adding building materials.

### Benefits

- generates renewable clean electricity
- reduces building energy costs
- reduces building environmental footprint
- generation profile follows daily usage
- Over 20 year warranties available

### Risks

- generation depends on current weather
- panels must be kept cool for best efficiency
- high capital cost and long payback
- location of system has a direct impact on ROI

### Cost

- Capital cost of \$10,000 per kiloWatt installed
- Payback 10 years (based on a 1200kWh of generation per year and a \$0.81/ kWh provincial renewable generation electricity purchase agreement)

### Maintenance

- Low-maintenance
- \$0.05 per installed Wh per year

### Case Studies

Goodwin Hall, Queen's University, Kingston  
Horse Palace, Exhibition Place, Toronto

### Resources

Canadian Solar Industries Association:  
[www.cansia.ca](http://www.cansia.ca)

Canadian Renewable Energy Network:  
[www.canren.gc.ca](http://www.canren.gc.ca)

	Efficiency	Peak Output	Suitable for use with
<b>Rigid Crystalline</b>	12%-15%	120 – 150 W/m <sup>2</sup>	<ul style="list-style-type: none"> <li>• Direct Sunlight</li> <li>• Tracking systems</li> </ul>
<b>Thin Film</b>	5.5% – 7.5%	55 – 75 W/m <sup>2</sup>	<ul style="list-style-type: none"> <li>• Indirect light, overcast skies</li> <li>• Vertical &amp; BIPV systems</li> </ul>

## 5.3.6 Wind Turbines

### Why?

Generate electricity from wind.

### Description

Wind turbines can be scaled to deliver power on a residential, commercial, or community scale ranging in size from 0.3kW to 6,000kW. The power provided by wind increases drastically as wind speed increases. Turbines also gather more energy as rotors increase in diameter and are placed higher above the ground. Building-integrated wind turbines are currently being developed and marketed to harness the increased wind speed created by a building's roof edge.

### Benefits

- a clean renewable energy source
- proven technology
- experienced manufacturers and installers available
- moderate payback period
- relatively low installed cost

### Risks

- Highest efficiencies are found in large-scale installations
- Wind does not always parallel demand periods
- Small-profile wind turbines can be noisy
- Permitting & zoning can be difficult
- Opportunities are site-specific
- Visual impact
- Avian impact
- Ice buildup

### Capital Costs

- Installation cost of \$3,500/kW
- 15 year financial payback (based on a 1100 kWh of generation and a \$0.81/ kWh provincial renewable generation electricity purchase agreement)

### Maintenance

- Regular O&M is required, projected at \$3,000/yr on commercial installations
- 25 year typical lifetime

### Case Studies

RERL School Study - Hull Wind One  
[http://www.ceere.org/rerl/about\\_wind/](http://www.ceere.org/rerl/about_wind/)  
 CanWEA website includes on- and off-grid case studies

### Resources

Canadian Wind Energy Atlas:  
[www.windatlas.ca](http://www.windatlas.ca)

Canadian Renewable Energy Network:  
[www.canren.gc.ca/](http://www.canren.gc.ca/)

Canadian Wind Energy Association:  
<http://www.canwea.ca/>

CanWEA Small Wind Energy Site:  
[www.smallwindenergy.ca](http://www.smallwindenergy.ca)

### 5.3.7 Thermal Energy Storage

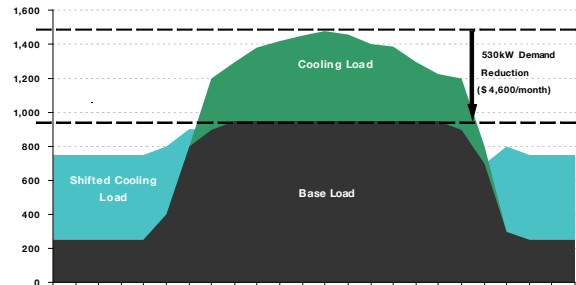
Shift energy use of your building’s cooling equipment to off-peak times when energy is cheaper.

#### Description

Thermal energy storage allows building cooling to be generated at night when electricity costs are low, and then releases it during the day. Water, ice, or a salt solution is placed in a thermal storage reservoir in or near the building. At night during off-peak hours, a chiller cools or freezes the storage medium in the reservoir. During the day the chiller is set-back or turned off, and the building uses the cold storage medium to circulate cooling within the building. Because chillers have little or no work to do at this time, they avoid high daytime electricity costs. Both building chillers and the power plants that generate their electricity operate more efficiently at cooler night temperatures. This means thermal energy storage not only reduces cost, but also lowers energy use and air pollution. Cost savings are largest where utility rates include high on-peak demand charges in buildings which have a substantial cooling load.

#### Benefits

- Up to 80% peak demand reduction
- 10% to 30% electricity cost savings
- Potential to increase chiller efficiency
- Reduced equipment & duct sizing and cost
- Proven performance in thousands of projects



- Uses off-peak power which is less GHG-intensive and more efficient to produce
- Can increase system’s cooling capacity without installing additional chillers

#### Risks

- Educated design & installation is essential
- Experienced installers are limited

#### Cost

- Capital Cost: \$1,500/kW installed for smaller systems
- \$0.50 - \$0.90/ft<sup>2</sup> capital cost-avoidance from reduced equipment & duct sizing

#### Maintenance

- Minimal routine maintenance & inspection required

#### Case Studies

Fossil Ridge High School; The Hewlett Foundation; Credit Suisse, 11 Madison Ave, NY; Other case studies available at [www.ari.org](http://www.ari.org)

#### Resources

ASHRAE Design Guide for Cool Thermal Storage  
Air-Conditioning, Heating and Refrigeration Institute  
British Columbia Hydro

Storage Medium	Volume (ft <sup>3</sup> /Ton-hr)	Cooling Fluid Temperature (°F)	Suitable for
Chilled Water	10.7 - 21	41 - 46	<ul style="list-style-type: none"> <li>• Existing chillers</li> <li>• Low-temperature systems</li> <li>• Existing chillers</li> </ul>
Ice	2.4 - 3.3	34 - 36	
Salt Mixture	6	48 - 50	



## 5.4 Energy Incentive Programs

Energy incentive programs are offered for every sector from homes to vehicles to commercial, industrial and institutional facilities and cover everything from composters to appliance recycling to renewable energy.

Incentive programs designed specifically for commercial and institutional facilities are offered by federal, provincial, and local municipalities to promote energy and demand reductions in electricity and the reduction of natural gas consumption.

### Federal Program Sources

- Natural Resources Canada
- Office of Energy Efficiency
- Sustainable Development Technology Canada

### Provincial Program Sources

- Ministry of Energy and Infrastructure
- Ministry of Northern Development, Mines and Forestry
- Ontario Power Authority
- Enbridge Gas Distribution
- Union Gas Distribution

### Local Program Sources

- Better Buildings Partnership (City of Toronto)
- Toronto Atmospheric Fund (City of Toronto)
- Toronto Environment Office (City of Toronto)
- Toronto Hydro Electric System Ltd. (City of Toronto)

### Incentive Programs Advisor

The Ministry of Education, as part of its' Energy Conservation Initiative, has retained an Incentive Programs Advisor (IPA) to assist district school boards apply for financial incentives to support the implementation of projects that reduce electrical and natural gas usage. Working hand-in-hand with school boards, the IPA matches a board's energy efficiency projects with available incentive funding to extend their financial resources.

The IPA is a shared sector resource and has current incentive program information. The sector benefits by sharing their knowledge and experience from energy efficiency projects.

For a current list of incentive programs, contact Robert Smith at 905.713.1211, Ext. 2493.

### Sample Listing of Programs

Links to specific funding or incentive programs are included in the summary table below. For the latest list of incentive funding programs, please contact the sector's Incentive Program Advisor.

Note that there may be restrictions in receiving funding from more than one program.

<a href="#">BLUE TEXT</a> LINKS TO WEBSITE				Appropriate for:			
Program	Max funds	Description	Valid Date Range	New Construction	Energy Efficiency Retrofits	Solar Energy (Air heating, water heating or electricity generation)	Source/ value last confirmed date
<b>Government and Utility Programs</b>							
<a href="#">High Performance New Construction(HPNC)</a> by OPA <a href="https://www.opa.hpnc.ca/portal/server.pt">https://www.opa.hpnc.ca/portal/server.pt</a>	<ul style="list-style-type: none"> <li>• up to \$400 / verified kW saved for building owner</li> <li>• up to \$100 / verified kW saved for architect</li> <li>• 100% of modelling costs, up to \$10,000</li> </ul>	Applies to OBC Part 3 new construction and major reno. Compares energy usage to OBC minimum requirements. Available throughout Ontario, outside 416 area	Aug 2007 – Oct 2010	Y	Y	Y	April 2008
<a href="#">Design Advisory Program (DAP)</a> by Enbridge Consumers Gas ( Union Gas has similar incentive in their territory )  <a href="http://www.egd.enbridge.com">http://www.egd.enbridge.com</a>	\$4,000/bldg	OBC Part 3 buildings Pays for energy simulation and design facilitation costs aimed at improving energy and environmental performance	ongoing	Y	N*	Y	April 2008
<a href="#">Electricity Retrofit Incentive Program</a> (ERIP) by OPA <a href="http://business.everykilowattcounts.com">http://business everykilowattcounts.com</a>	Lesser of \$150/kW saved, 50% of incremental project costs, amount required to top -up other incentives to 50% of total project costs	Existing commercial, institutional, industrial buildings	Approved before Dec 31, 2010, running by Dec 1, 2011	N	Y	N	April 2008
<a href="#">MultiCHOICE Incentive</a> by Enbridge <a href="https://portal.plumprod.cgc.enbridge.com">https://portal plumprod.cgc.enbridge.com</a>	\$30,000	Pays \$0.10/m <sup>3</sup> of gas saved in first year (3 measures or more) Register before retrofit	ongoing	N	Y	Y	April 2008
Prescriptive Incentives for School Boards <a href="https://portal-plumprod.cgc.enbridge.com">https://portal - plumprod.cgc.enbridge.com</a>	\$1,000 per elementary school, or \$4,300 per secondary school	Applies to Ontario School Boards. Replacement of space heating boiler with a new non - atmospheric boiler with an efficiency of 83% or higher	Ongoing	N	Y	N	June 2008
<a href="#">Commercial Audit Incentives</a> by Enbridge <a href="https://portal-plumprod.cgc.enbridge.com">https://portal - plumprod.cgc.enbridge.com</a>	\$15,000	of obtaining an energy audit for building(s). \$0.01/m <sup>3</sup> of natural gas consumed, or ½	Ongoing	N	Y	N	April 2008

BLUE TEXT LINKS TO WEBSITE				Appropriate for:			
Program	Max funds	Description	Valid Date Range	New Construction	Energy Efficiency Retrofits	Solar Energy (Air heating, water heating or electricity generation)	Source/ value last confirmed date
<b>Government and Utility Programs</b>							
plumprod.cgc.enbridge.com		cost of audit up to \$5,000(1/3 if receiving other audit incentives) For multi - residential: 25% natural gas savings minimum					
<b>Retrofit Incentive</b>  by Enbridge  https://portal - plumprod.cgc.enbridge.com	\$100,000	Pays \$0.05/m of gas saved in first year (regardless of number of measures) Register before retrofit	ongoing	N	Y	Y	April 2008
<b>Energy Monitoring and Targeting</b> by Enbridge https://portal - plumprod.cgc.enbridge.com	Not Specified	\$0.05/m <sup>3</sup> annually saved to promote continuous operational improve ments using predictive modeling		Y	Y	Y	June 2008
Water Conservation by Enbridge  https://portal - plumprod.cgc.enbridge.com	Not Specified	To qualified buildings: - free low - flow showerheads  - \$75 incentive per front load washer replacement.		Y	Y	N	June 2008
<b>Condensing Boilers</b>  by Enbridge  https://portal - plumprod.cgc.enbridge.com	\$30,000/bldg	One-time payment of \$0.10/m <sup>3</sup> for estimated first year natural gas savings from condensing boiler technology.		Y	Y	N	June 2008
<b>New Building Construction Program (NBCP)</b> by Enbridge  Union Gas has similar incentive for their franchise territory	\$0.075/m <sup>3</sup> natural gas savings up to \$15,000/bldg	projected annual gas savings from adding efficiency measures to a reference design building; use EE	ongoing	Y	Y	Y	June 2008

BLUE TEXT LINKS TO WEBSITE				Appropriate for:			
Program	Max funds	Description	Valid Date Range	New Construction	Energy Efficiency Retrofits	Solar Energy (Air heating, water heating or electricity generation)	Source/ value last confirmed date
<b>Government and Utility Programs</b>							
<a href="#">ecoENERGY Retrofit Incentive for Buildings</a> by NRCan	\$50,000/project	Lesser of \$10/GJ estimated energy savings, or 25% of eligible project costs. <a href="#">(Link to Application process and documents.</a> – from previous incentive – must be updated for ecoENERGY) Building must have been occupied for at least 5 yrs for similar purpose; must apply before starting work	ongoing	N	Y	Y	June 2008
<a href="#">ecoENERGY for Renewable Heat</a> by NRCan  Similar provincial scheme: Ontario Solar Thermal Heating	\$80,000/installation; \$2M/corporate entity	Solar air and water heating. 25% of eligible project costs (40% in remote communities)	April 2007 – April 2011	Y	Y	Y	June 2008
<a href="#">ecoENERGY for Renewable Power</a> by NRCan	\$80 million over 10 yrs	\$0.01/kW, for capacity of 1MW or greater from renewable sources; electricity generated can be sold or used on site	April 2007 – April 2011	Y	Y	Y	April 2008
Green Municipal Fund – <a href="#">Projects</a> by the Federation of Canadian Municipalities	Not Specified	Up to 80% of the eligible costs. Specific funding opportunities each year in: brownfields, energy, transportation, waste, and water.		Y	Y	Y	Dec 2007
<a href="#">Better Building Partnership</a> – Existing Building (BBP -EB) by City of Toronto	\$400/kW peak demand reduction or up to \$0.05/kWh annual energy savings (depending on size of project); max. 40% of eligible costs	for energy efficiency retrofits and building renewal; applies to multi-residential, municipal, academic, social, hospitals Sites occupied within Toronto on or before July 5, 2006	July 17, 2006 – Dec 1, 2010	N	Y	Y	April 2008

<a href="#">BLUE TEXT</a> LINKS TO WEBSITE				Appropriate for:			
Program	Max funds	Description	Valid Date Range	New Construction	Energy Efficiency Retrofits	Solar Energy (Air heating, water heating or electricity generation)	Source/ value last confirmed date
<b>Government and Utility Programs</b>							
<a href="#">Better Building Partnership</a> – New Construction (BBP -NC) by City of Toronto	Up to \$7,000 for energy modeling (\$2000 + \$0.20 /m2 gross floor area) ; \$350/peak kW saved or \$0.04/annual kWh saved; can get \$100,000 after construction	Applies to OBC Part 3 new construction and major renovation ; baseline is OBC min. requirements; Available in Toronto (M postal code)	August 2006 – Dec 2010	Y	Y	Y	April 2008
<a href="#">Federal Tax Deductions</a>	No limit	Tax deduction of up to \$1.80/sq.ft. for buildings that save at least 50% of the heating and cooling energy of a building that meets ASHRAE Standard 90.1 - 2001.  Partial deductions of \$0.60/sq.ft. for improving building envelope, lighting or heating and cooling systems.		Y	Y	Y	Dec 2006
<a href="#">EcoEnergy Validation</a>	Technical Support for energy model up to \$1,000	<a href="#">For new buildings or major renovations with restriction</a>		Y	Y	-	June 2008

\* Funding provided only for building retrofitted to meet MNECB Mandatory Provisions.

## 5.5 Green Building Rating Systems

The following summarizes the school rating systems most broadly used across North America, and reviews their main objectives, characteristics and applicability to the educational sector.

### Rating Systems Summary

The table below presents a summary of the most common rating systems applicable to schools across North America. The following systems are compared:

#### 1. Leadership in Energy and Environmental Design (LEED)

- a. Canadian Green Building Council Version (CaGBC)
- b. US Green Building Council (USGBC)
- c. LEED for K-12 Schools

#### 2. Collaborative High Performance Schools (CHPS)

#### 3. Green Globes

#### 4. Living Building Challenge

	LEED CaGBC	LEED For K-12 Schools	LEED USGBC	CHPS	Green Globes	Living Building Challenge
<b>Applicability</b>	New construction schools/ Major Renovations	New construction schools/ Major Renovations	New construction schools/ Major Renovations	New construction schools/ Major Renovations	New Construction Buildings	New Construction Buildings/ major renovations
<b>Market Update</b> as of Jan 2009	Registered: 856 projects (48 schools)	Registered: 245 schools	Registered: >6,000 projects	Registered: Over 120 schools in US	Registered: Unknown	Registered: Over 20 projects in North America
	Certified: 106 (6 schools)	Certified: None	Certified: >800 Projects	Certified: Over 25 schools	Certified: Over 100 projects in Canada	Certified: None
<b>Certification</b>	Third party certification	Third party certification	Third party certification	Optional third party verification	Optional third party certification	Third party certification
<b>Registration and Certification Cost</b>	>CAD3,5 00 <CAD16,000	>US\$6,000 <US\$60,000	>US\$6,000 <US\$60,000	Design -free Verified - >US\$3,300 <US\$7,000	>CAD3,000 <CAD5,000	>CAD1,200 <CAD25,200
<b>Development Costs (above standard practice)</b>	High	High	High	High	Low to Medium	Very High
<b>Documentation Requirements</b>	High	High	High	High	Easy	Easy
<b>Performance Requirements</b>	Medium to High	Medium to High	Medium to High	Medium to High	Low to High	Very High

## 5.5.1. Rating System Description

### Leadership in Energy and Environmental Design (LEED)

#### Description

Leadership in Energy and Environmental Design (LEED) is a third party certification program based on existing proven technologies and practices. It evaluates environmental performance from a “whole building” perspective, defining benchmarks for what constitutes a “sustainable, high efficient” building. Up to 71 credits, each with a measurable performance requirement, are available under the following five areas related to human and environmental health:

- sustainable site development,
- water savings,
- energy efficiency,
- materials selection, and
- indoor environmental quality.

It is the most widely used green building certification program in North America. It was first created by the US Green Building Council and adopted in 2004 by the Canadian Green Building Council (CaGBC), which developed an adapted Canadian version of the system.

### LEED for Schools

In 2007, the USGBC developed a LEED rating system for K-12 Schools for use in the U.S. The LEED for Schools Rating System is based on the LEED for New Construction with modifications to address the unique characteristics and demands of the design and construction of K-12 schools, including indoor quality in classroom spaces, and children’s health issues.

The LEED for Schools is not offered by the Canadian Green Building Council (CaGBC) in Canada. However the CaGBC is updating (the LEED Canada Initiative) LEED to incorporate the unique requirements of building types. This is expected to be available in 2009 or 2010.

### Compliance Process

- Performance based – Established, quantitative evaluations of the designed building performance are compared to established performance benchmarks
- Prescriptive – Referenced standards must be met to verify compliance



Credit example: EA pr 2- Minimum Energy Performance

## Minimum Energy Performance

### Intent

Establish the minimum level of energy efficiency for the base building and systems.

### Requirements

#### *Option 1 - New Buildings:*

- Reduce the design energy consumption to comply with Natural Resources Canada's Commercial Building Incentive Program (CBIP) requirement for a 25% reduction relative to the consumption of the reference building designed to the Model National Energy Code for Buildings 1997 (MNECB) including supplemental CBIP requirements. Compliance shall be demonstrated by using whole building energy simulation. The calculation of percentage energy reduction shall be in accordance with the procedures used in the CBIP program (i.e., includes "non-regulated" plug loads but excludes process equipment).

OR,

- Reduce the design energy cost by 18% relative to the reference building designed to ASHRAE/IESNA 90.1-1999 (without amendments). Compliance shall be demonstrated using whole building energy simulation. The calculation of percentage energy reduction shall be in accordance with ASHRAE 90.1 procedures and excludes "non-regulated" loads.

#### *Option 2 - Major Renovations to Existing Buildings:*

- Reduce the design energy consumption by 10% relative to the consumption of the reference building designed to the CBIP adaptation of the MNECB. Compliance shall be demonstrated by a whole building energy simulation. The calculation of percentage energy reduction shall be in accordance with the procedures used in the CBIP program (i.e., includes "non-regulated" plug loads but excludes process equipment).

OR,

- Design the building to comply with ASHRAE/IESNA Standard 90.1-1999 (without amendments).

#### *Option 3 - Low- and High-rise Multi-unit Residential Buildings:*

EFFECTIVE UNTIL DECEMBER 31, 2006:

- Design the building to comply with ASHRAE/IESNA Standard 90.1-1999 (without amendments) or 10% better than the MNECB based on energy consumption, or the local energy code, whichever is more stringent. A modeling path (not the prescriptive path) must be used to demonstrate compliance. To establish savings relative to the MNECB, the calculation of percentage energy reduction shall be in accordance with the procedures

## Minimum Energy Performance

*(continued)*

used in CBIP (i.e. includes "non-regulated" plug loads but excludes process equipment).

- The project must be registered under LEED Canada on or before December 31 2006, AND a building permit must be issued within 12 months of December 31 2006 in order to be eligible for this option.

EFFECTIVE JANUARY 1, 2007:

- The LEED Canada requirements for new and existing buildings as described in options 1 and 2 will come into effect for low- and high-rise residential buildings. Option 3 for low- and high-rise multi-unit residential projects will no longer be available.

Whichever compliance path is chosen for this prerequisite must also be utilized for Energy and Atmosphere Credit 1, Optimize Energy Performance, if that credit is sought.

Computer modeling should follow the procedures in Part 8 of the MNECB 1997 for projects using CBIP compliance and the procedures described in ASHRAE/IESNA 90.1-1999 for projects using ASHRAE compliance. All projects shall follow the modeling guidelines in the most recent version of Natural Resources Canada "Procedures for Modeling Buildings to CBIP and MNECB". Regulated loads include HVAC (heating, cooling, fans and pumps), service hot water and interior lighting. Non-regulated loads include plug loads, exterior lighting, garage ventilation, elevators (vertical transportation) and process loads.

### Submittals

- Provide a LEED Letter Template signed by a licensed professional engineer or architect, stating that the building complies with the appropriate energy performance level (defined above).

AND

*For CBIP Projects reviewed and approved by Natural Resources Canada:*

- Provide a copy of the letter from Natural Resources Canada indicating that the building qualifies for the CBIP program, and passes LEED Energy & Atmosphere Prerequisite 2 requirements.

*For CBIP Projects not reviewed by NRCan or ineligible CBIP Projects:*

- Provide a review report by an independent CBIP Design Assessor indicating that the design meets the requirements of this prerequisite,

**Implementation:**

Implementation requires thorough documentation during design and construction, and other specialized consultants to address some credit requirements, e.g. energy modeler, commissioning agent, etc.

**Support:**

Training available through USGBC, CaGBC.

**Transparency:**

General information and requirements are available to the public online. Strategies and in-depth credit description available only in the LEED reference guide, which is available for a fee. Certification is carried out by a third party, non-profit organization with a democratically elected board of directors.

**Cost:**

The cost of registration plus certification depends on the size of the building and ranges between \$6,000 and \$60,000. Total costs (administrative, design and capital) vary widely, but are typically reported to be a 0-5% premium.

**Certification**

- **Performance level:** The level of performance depends on the number of credits achieved: Certified (29-36), Silver( 37-43), Gold ( 44-57), Platinum (58-79)
- **Final product:** The final product is a building certification and a plaque.

**Strengths**

- **Verifiable:** Extensive documentation, as well as third party quantitative and qualitative performance-based evaluation, provides a high level of confidence that the performance requirements have been met.
- **Credible:** Third party certification and extended documentation describing environmental performance provides reliability. LEED has become the main rating system in North America, and is used not only as a benchmark for sustainability evaluation but also a marketing tool in the green building sector.
- **Comparable:** The widespread use of this system in the public and private sectors simplifies comparisons.

**Weaknesses**

- **Limited Scope:** LEED focuses on the design and construction stages of the building life cycle only. Ongoing operation and performance reviews are not included in the rating system ,and there are no references to policies that address the operation of the building by future occupants.
- **Complexity of certification process.** The extent of the documentation required and the need for external consultants for credit compliance adds a level of complexity and cost.
- **Cost:** The cost of registration and certification are high, especially for small buildings.

**System maturity:**

The original rating system, LEED for New Construction, is a well established system with over 10 years in the market. LEED for K-12 Schools has been just over one year in the market.

**Users**

There are over 800 certified LEED projects around the world and over 6,000 registered. There are no schools certified under LEED for Schools yet, but 245 schools in the U.S. are registered under this system.

In Canada there are 6 school projects certified under LEED Canada New Construction, with 45 pursuing certification.

**Contact:** <http://www.cagbc.ca>

## Collaborative for High Performance Schools (CHPS) Rating System

### Description

The CHPS Criteria is a system of environmentally responsible benchmarks designed by the CHPS technical committee (comprising the school district, CHPS and an assigned third party assessor). It was developed to facilitate the design, construction and operation of high performance schools that create environments that are not only energy and resource efficient, but also healthy, comfortable, well lit, and with the amenities for a quality education.

CHPS is based on LEED NC, with adaptation for K-12 school projects. It was first released in California, and has been modified and adopted in Massachusetts, Washington and New York. CHPS is presented in two versions, CHPS Design, which is a self assessment tool, and CHPS Verified, which requires third party certification

### CHPS – MA

For our evaluation, CHPS Massachusetts has been selected due to comparable climate considerations.

CHPS MA is an adaptation of CHPS California, managed by the Massachusetts Technology Collaborative. In 2007, the Mass Schools Building Authority (MSBA) included the CHPS-MA indoor environmental quality criteria in its 2007 Construction Regulations. The MSBA provides up to 2% additional funding of construction costs for schools meeting the CHPS-MA Criteria.

Similar to LEED, up to 89 credits are available within 6 environmental categories.

### Compliance Process

CHPS is based on LEED-NC and the documentation requirements are very similar:

- Performance based- Established quantitative methods for evaluating building performance and compared to established performance benchmarks
- Prescriptive- Referred standards shall be met to verify compliance

Credit Example: Energy Efficiency prerequisite

## ENERGY EFFICIENCY

### PREREQUISITE 4: EXCEED CODE BY 20%

Required for  
Green Schools

EP 4. Exceed the MA Building Energy Code (780 CMR Chapter 13) by 20% on an energy cost basis in accordance with either the Performance-based OR the Prescriptive approaches defined below.

Select either the Performance Approach or the Prescriptive Approach for determining energy cost savings. The Performance Approach is presented first followed by the Prescriptive Approach. The two approaches may not be combined. Select one or the other.

#### Performance Approach

Model the school using LEED energy savings calculations protocol (version 2.1 of LEED) to show that it will achieve 20% less energy cost than a Massachusetts energy code minimum building (780 CMR Chapter 13), regulated loads only. Calculations may be made according to ASHRAE 90.1-2001, Section 11- Energy Cost Budget Method, Informative Appendix G Performance Rating Method to account for the contribution of certain green design features. Some exceptions and simplifications to the energy cost budget (ECM) method may be allowed—see Appendix B at the end of this document for additional information.

The following are acceptable energy modeling software programs: various versions of DOE-2 such as PowerDOE, and E-Quest, VisualDOE, DOE-2.1e. *Equivalent programs may be used with permission, provided they are submitted for approval prior to use.* Contribution from on-site generation can be counted towards energy savings. Savings should be based on regulated loads only as described in the LEED savings calculation protocol.

#### Performance Approach

The energy modeling report submitted must include the following key elements:

- Executive summary with the results of the energy modeling study stated clearly.
- Facility and site narrative describing the type of construction, hours of operation, and size and configuration of building. Describe the mechanical system, lighting systems, equipment loads, domestic hot water system, and any renewable energy systems.
- Narrative summarizing the analysis methodology, the baseline design, and results of energy modeling.
- Table summarizing and comparing the different systems in the 'as designed' case versus the baseline case, such as code compliant boilers, chillers, motors, windows, and wall and roof insulation versus higher efficiency equipment.
- Table that details utility incentives (where applicable) for each incentivized energy conservation measure (ECM) and provide a column that shows the simple payback for the incremental cost of each ECM.
- Table summarizing the annual energy consumption for the design case and the base case (see template below).



Table 7—Annual Energy Consumption, Design Case versus Base Case

Item	Annual Energy Consumption				Total Energy Costs (\$)
	Electricity (kWh)	Natural Gas, oil, other (therms, gallons, other)	Total site Btu (MM Btu)	Total Source Btu (MM Btu)	
Design case					
Base case					
Savings subtotal					
Contribution from on-site generation					
Total Savings					
Total % Savings					

- Table summarizing cost savings (see template below). Use actual retail utility rate structures and schedules. In the absence of a local utility rate schedule, use the energy rates provided in the LEED Reference Guide under Energy and Atmosphere Credit 1.

Table 8—Cost Savings Summary

Measure	Units	Baseline Building	As Designed Building	Savings
Electricity consumption	kWh			
Electricity consumption/ft <sup>2</sup>	kWh/ft <sup>2</sup>			
Electricity cost	\$			
Electricity cost/ft <sup>2</sup>	\$/ft <sup>2</sup>			
Natural gas, oil or other fuel consumption	Therms, gallons, other			
Natural gas, oil or other fuel consumption/ft <sup>2</sup>	Therms, gallons, other/ft <sup>2</sup>			
Natural gas, oil or other fuel cost	\$			
Natural gas, oil or other fuel cost/ft <sup>2</sup>	\$/ft <sup>2</sup>			
Total site energy consumption	MMBtu			
Total site energy consumption/ft <sup>2</sup>	MMBtu/ft <sup>2</sup>			
Total site energy cost	\$			
Total site energy cost/ft <sup>2</sup>	\$/ft <sup>2</sup>			

- An electronic version of all input and output data from the school building energy model must be submitted with the application for green school certification.
- Paper copies of each of the following energy modeling reports for both the base case and the as-designed case (These should also be made available to the school’s facilities personnel as well):

*Building Energy Consumption per End Use (BEPU)*—This report shows annual building energy use according to energy type (electricity, natural gas, etc.) and energy end use (lights, space heating, space cooling, fans, etc). The energy use should be shown in the actual units of consumption, such as kWh for electricity, therms for gas, etc.

*Building Energy Consumption per End Use (BEPS)*—This report is very similar to the BEPU report described above. The difference is that the values in this report are all converted into the same units (MMBtu), allowing a direct comparison of end-use intensities.

*Energy Cost Summary (ES-D or ES-E)*—This report summarizes the monthly energy consumption and cost for all utility rates that are defined for/applicable to the project (electric rate, gas rate, etc.).

*Summary of Spaces Occurring in the Project (LV-B)*—This report provides a list of all the zones occurring in the model along with the assigned lighting wattage, number of people, equipment wattage, infiltration amount, square footage, and volume.

*Building Peak Load Components (LS-C)*- This report provides a breakdown of the building cooling and heating peak loads according to the source of the loads (walls, roof, windows, occupants, light, equipment, infiltration, etc). This report does not include the loads due to ventilation air.

*Equipment Loads and Energy Use for Central Plant Components (PS-C)*—This report would be required only for projects that include central plant equipment such as boiler(s) or chiller(s). For each central plant component this report provides annual heating and/or cooling load, the electrical and fuel consumption, and performance information in a bin format, including hours of operation at different partial loads, and the total annual hours of operation.

Examples of each of these reports are included in Appendix E.

*Important:* Conversion factors for electricity are: 3,412 Btu/kWh per site Btu and 10,000 Btu/kWh per source Btu.

## Prescriptive Approach

Applicants may demonstrate compliance with Energy Prerequisite 4 by incorporating the prescriptive package of energy conservation measures listed below. The prescriptive measures have been researched and are modeled to achieve at least 20% greater building energy efficiency than a comparable baseline building that meets the minimum requirements of the current Massachusetts State Building Code, 780 CMR Chapter 13 (Energy Efficiency).

1. *Lighting Power Density (LPD):* Average Installed lighting equipment power density shall not exceed 1.0 Watts/ft<sup>2</sup> for the entire school.
2. *Automatic Light Reduction:* Control systems, such as occupancy sensors, timed lighting schedules, and/or timed switches, that shut interior lights off when spaces are unoccupied for 15 minutes or more shall be employed in all the following spaces:
  - General classrooms
  - Art rooms
  - Music rooms
  - Science rooms
  - Computer rooms
  - Library
  - Physical education
  - Special needs, remedial, and collaborative space
  - Cafeteria
  - Administration spaces

### *Exceptions:*

- Emergency lighting
- Night security lighting
- Task Lighting
- Spaces with only one luminaire
- HID luminaires shall reduce the connected lighting load in a reasonably uniform illumination pattern by at least 40 percent.

3. *Dimming/Switching/Bi-Level Control for Lighting.* Light switches shall be installed such that more than one level of artificial illumination is possible. Note the addition to the code (Massachusetts Building Code 780 CMR 1308.2.3) shown below in bold typeface.

Each perimeter **and non-perimeter regularly occupied space** enclosed by ceiling-height partitions shall have a manual control to allow the occupant to uniformly reduce the connected lighting load by at least 50%.

This requirement applies to the following spaces:

- General classrooms
- Art rooms
- Music rooms
- Science rooms
- Computer rooms
- Library
- Physical education
- Special needs, remedial, and collaborative space
- Cafeteria
- Administration spaces

*Exception:* HID luminaires shall reduce the connected lighting load in a reasonably uniform illumination pattern by at least 40 percent.

4. *Daylight Responsive Lighting Control:* Incorporate daylighting throughout the school building such that 15% of the installed electrical lighting wattage is dimmed or turned off when sufficient natural light is present.

*Exception:* Theatrical lighting, specialty lighting, and task lighting.

5. *Fenestration Performance:* The U-Factor of the window assemblies shall not exceed 0.45 for metal-framed window systems and 0.35 for non-metal-framed window systems. For further guidance, see *Advanced Buildings Benchmark Version 1.1*, pp. 62–63. Massachusetts is in climate zone “5 Humid.”
6. *Premium Efficiency Motors:* For all motors greater than or equal to 1 horsepower, install premium efficiency motors as defined by the National Electrical Manufacturers Association (NEMA). Link: [www.nema.org/stds/complimentary-docs/upload/MG1premium.pdf](http://www.nema.org/stds/complimentary-docs/upload/MG1premium.pdf).
7. *Mechanical System Design:* Employ best practices design techniques to improve system performance and meet ASHRAE Standard 55. The design engineer shall document the following actions in the design process.

When sizing the heating and cooling equipment, perform load calculations using interior load assumptions that are consistent with sustainable design practices. This includes using the design interior lighting, accounting for the actual glazing characteristics, providing credit for displaced loads if displacement systems are used, and base miscellaneous loads on field-verified measurements or field-based research rather than typical owner programming assumptions. Where not feasible, document the non-standard load assumptions for owner concurrence.

When sizing the fan and air distribution systems, document fan-sizing calculations with zone-by-zone load calculations. Perform calculations to determine critical path supply duct pressure loss. Compare fitting selections for oval duct where feasible to lower leakage and reduce pressure loss. Separate all fittings in medium and high-pressure ductwork by several duct diameters to reduce system effects wherever feasible. Where possible, provide automatic dampers on exhaust in lieu of barometric dampers to reduce fan power and increase barometric relief.



Perform a second set of calculations using part-load conditions (maximum likely load and/or standard operating conditions). This includes using benchmark data, average daytime temperatures and non-peak solar gain, and other assumptions to define part-load conditions for the heating and cooling system. Include diversity factors for interior loads and other factors that will allow proper assessment of part-load operation.

Describe the system operation at these conditions and describe features of the design that will facilitate efficient operation at these part-load conditions. Document how the system will deliver ventilation air, maintain comfort in accordance with ASHRAE Standard 55 and operate in an energy efficient manner.

Source: Advanced Buildings Benchmark Version 1.1, New Buildings Institute

8. *Boilers/Burners Selection and Sizing:* When the school design includes a boiler plant, the size of any single boiler shall not exceed 50% of the calculated design building heating load. For power burners larger than 400,000 BTU/h, fully modulating burners shall be used.

Boilers are typically sized to meet the building heat loss and ventilation air heating loads at winter design temperature conditions without taking credit for internal heat sources such as lights, equipment, and people. This results in the boilers that are oversized for most of their operating conditions. Oversized boilers are inefficient due to fixed losses, such as radiative heat losses. These fixed losses are inversely proportional to the boiler load. Therefore, radiative heat losses, which can be as little as 1% at full load, can become 5% to 20% at partial load.

On top of fixed losses, inefficiencies also result when boilers “short cycle”; which occurs when an oversized boiler quickly satisfies the heating load, cycles off for a brief period, and then cycles on again. Larger boilers with power burners that have pre- and post- purge cycles are particularly inefficient when they undergo short cycling, since with each cycle, air used to flush the boiler during purging is heated and vented to the chimney. Short cycling also adversely affects the boiler life because the boiler is rapidly heated then cooled, and burner motors are cycled on and off, reducing the longevity of the boiler heat exchanging surfaces and burner motors.

To avoid these problems, size the boiler plant to efficiently meet both the peak and part load heating requirements of the building. Provide multiple boilers, each sized at some fraction less than 50% of the design building heating load, and use modulating burners on larger boilers so that they can operate over a wide load range without short cycling.

*Exception:* Boiler plants that utilize condensing boilers or plants where each boiler capacity is smaller than 300,000 BTU/h.

9. *Boiler Efficiency.* If installing gas-fired boilers, they must have a rated thermal efficiency of at least 80% or a rated combustion efficiency of at least 83%. If installing oil-fired boilers, the boilers must have a rated thermal efficiency of at least 83% or a combustion efficiency of 85%. Boilers shall be rated according to test methods referenced in the current Massachusetts Building Code, Chapter 13.
10. *Efficient Cooling Equipment:* Install air conditioning equipment in accordance with Advanced Buildings—Benchmark Version 1.1 prescriptive criteria “Mechanical Equipment Efficiencies Requirements” addressing package terminal air conditioners, heat pumps, electric chillers, and absorption chillers. Refer to Appendix A in this document for efficiency values. Tables in Appendix A listing heat pump efficiencies, unitary air conditioning, and condensing unit efficiencies are provided by the Consortium for Energy Efficiency (CEE), which developed specifications for use in voluntary energy-efficiency programs. Tables in Appendix A for package terminal air conditioners and chillers were developed by the New Buildings Institute for their Advanced Buildings - Benchmark efficiency criteria. Be sure to check the web links for updated

versions of the efficiency tables.

Source: Advanced Buildings -Benchmark, New Buildings Institute Version 1.1.

[www.poweryourdesign.com/ABbenchmark.pdf](http://www.poweryourdesign.com/ABbenchmark.pdf)

Consortium for Energy Efficiency—[www.cee1.org/com/hecac/hecac-tiers.pdf](http://www.cee1.org/com/hecac/hecac-tiers.pdf)

11. *CO<sub>2</sub>-Based Demand Controlled Ventilation*: Install CO<sub>2</sub>-based demand controlled ventilation systems in large volume areas with variable occupancy, such as gymnasiums, cafeterias, auditoriums and cafeteriums.

Demand controlled ventilation is a “smart” ventilation strategy for spaces with varying levels of occupancy throughout the day. For example, the school cafeteria may be occupied sparsely most of the school day except for lunch periods when occupancy reaches maximum levels. Carbon dioxide sensors installed in the occupied space measure the CO<sub>2</sub> in the air, compare the CO<sub>2</sub> levels to levels measured by outdoor CO<sub>2</sub> sensors, and continuously adjust the amount of fresh air delivered based on the number of people in the room. When more people are in the room, the airflow increases, when there are fewer, the ventilation rate decreases proportionally. This ventilation control method avoids heating and cooling large quantities of outside air when few people are using the space. Gymnasiums and auditoriums are also examples of spaces that can have high design ventilation air volumes but, for most of the time, are not fully occupied.

When siting the outdoor CO<sub>2</sub> sensor, it is critical to locate the sensors away from other sources of CO<sub>2</sub>, such as exhaust vents, which would provide a false reading of ambient carbon dioxide levels. To maintain the design ventilation rates, it is also critical that the CO<sub>2</sub> sensors are recalibrated at intervals according to the manufacturer’s recommendations. This recalibration of the sensors must be written into the school’s preventive maintenance plan.

Use the language below to guide design assumptions. *Note the addition to the code (Massachusetts Building Code 780 CMR 1305.3.6.2) shown below in bold typeface.*

Systems with design outside air capacities greater than 3000 cfm serving areas having an average design occupancy density exceeding **50** people per 1000 ft<sup>2</sup> shall **automatically reset outside air rates based on the CO<sub>2</sub> concentration levels in the space as compared to the outdoor CO<sub>2</sub> level.**

*Exceptions:* Systems with heat recovery. The minimum effectiveness of the heat recovery system must be 50% for total energy recovery or 65% of sensible heat recovery.

12. *Variable Speed Control*: Individual pumps serving variable flow systems and VAV fans having a motor horsepower of 7.5 hp or larger shall have controls and/or devices (such as variable speed control) that will result in pump or fan motor demand of no more than 30% of design wattage at 50% of design flow.

Note 1: If an HVAC unit has a 7.5 hp or larger supply fan, but the return fan is smaller than 7.5 hp, the requirement of this measure still applies. This assumption is made since the control method used on the supply fan is almost always the same as that used on the return fan.

Note 2: In some types of boiler plant configurations (especially where larger, non-condensing boilers are used in conjunction with primary-only variable flow hot water loops), it is possible that a net energy cost penalty may occur if the hot water pump is optimized through this measure (i.e. variable frequency drives (VFD’s) are installed for hot water pump capacity control). Although VFD’s reduce electricity consumption for pumping, they simultaneously reduce heat energy from the pump. As a result, more thermal energy is required from the boiler plant. Depending on one’s utility rate structure, the efficiency of the boiler plant at part loads, and other factors, VFD’s for the hot water loop may result in a net energy cost increase for the building. In such circumstances,



the VFD requirement for the hot water pump may be waived. Quality engineering analysis shall be applied to assess whether such exception may be relevant to a particular project.

## Documentation

### *Prescriptive Approach*

1. *Lighting Power Density*—U.S. Department of Energy's ComCheck output clearly indicating lighting power densities for the entire building.
2. *Automatic Light Reduction*—Supply a letter signed by the project's professional engineer certifying that the automatic lighting reductions will be achieved according to the criteria listed above. Include a brief narrative of the approach used; reference appropriate specification sections for lighting controls and drawing numbers of lighting control schedules and drawings showing the control devices as designed. For computer scheduled lighting reductions, provide a narrative describing how your system works including relevant software and hardware.
3. *Dimming/Switching/Bi-Level Control for Lighting*—Supply a letter signed by the project's professional engineer certifying that the above criteria for controlling lighting levels will be achieved. Include in the letter references to appropriate specification sections for dimming, switching or bi-level controls; reference drawing numbers of dimming, switching, or bi-level control schedules; and reference drawings showing the devices as designed.
4. *Daylight Responsive Lighting Control*—Supply a letter signed by the project's electrical professional engineer showing the total lighting wattage of the school building and the total lighting wattage controlled by daylight responsive lighting controls. The ratio of daylight responsive wattage to the total installed wattage should be 15% or greater.
5. *Fenestration Performance*—Reference fenestration specifications. Please designate the CSI numbers, sections, and page numbers that highlight the U-Factor for each type of fenestration.
6. *Premium Efficiency Motors*—Reference specification sections. Designate the CSI numbers, sections, and page numbers that highlight compliance with this requirement.
7. *Mechanical System Design*—Provide documentation that shows the methodology for calculating peak load and partial load conditions. Please model your response on a sample letter provided in the Application Template.
8. *Boilers/Burners Selection and Sizing*—Supply a letter signed by the project's mechanical professional engineer certifying that the above criterion is met. The letter should include the assumptions and calculations that guided the sizing of burners and boilers. Include with the letter, outputs from HVAC system design software (e.g. Trane/Trace or Carrier software, or other equivalent software) showing peak load design parameters.
9. *Boiler Efficiency*—Reference specification sections for boiler efficiency. Designate the CSI number, section, and page number that highlight compliance with this requirement.
10. *Efficient Cooling Equipment*—Reference specification sections for efficient cooling equipment. Designate the CSI number, section, and page number that highlight compliance with this requirement.
11. *CO<sub>2</sub>-Based Demand Controlled Ventilation*—Reference appropriate specification sections indicating the implementation of CO<sub>2</sub> sensors and their placement away from outdoor sources of CO<sub>2</sub> exhaust OR reference specifications calling for heat recovery systems with a minimum effectiveness of 50% or total energy recovery of 65% sensible heat.
12. *Variable Speed Control*—Supply a letter by the project's mechanical professional engineer certifying that the criteria for Variable Speed Control systems are met; include references to appropriate specification sections and drawings.

### Implementation

Exhaustive definition of requirements. Requires detailed documentation during design, construction and operations. There is an alternative prescriptive energy compliance path that avoids energy modeling, simplifying the certification process.

#### Support:

CHPS offers workshops to school districts and other stakeholders on the green school development process, including assisting school districts in creating district-wide resolutions on green school construction. Additionally, CHPS offers an annual conference on high performance schools, Greentools for Healthy Schools.

#### Transparency:

Free complete Rating System information and Design Guidelines available on-line.

[http://www.chps.net/manual/MA-CHPS\\_Green\\_School\\_Guidelines\\_10\\_20\\_06.pdf](http://www.chps.net/manual/MA-CHPS_Green_School_Guidelines_10_20_06.pdf)

#### Cost:

Free for the CHSP Designed Program (self-assessment), and between \$3,250 - \$6,850 for CHSPS Verified.

### Certification

- Final Product: Schools can self-certify their school through the free CHPS Designed program, or seek third-party verification of their high performance school through the CHPS Verified program.

- Performance level: The level of performance depends on the number of points achieved. There are two point thresholds to determine the extent of the financial incentive offered by the MSBA . Over 30 points, 1.5% total maximum allowable project costs financed. Over 34 points, 2% of maximum allowable project costs financed

### Strengths

- Exclusive for schools: CHPS has been developed by school boards for school boards.
- Verifiable: Optional verification through a third party review process. The third party review is conducted by an independent assessor selected by CHPS. This option is available to Canadian schools if a compliance path adapted to Canada is presented for credits:
- SS.0- Code Compliance, and
- EE.0 and EE.1 Minimum and Superior Energy Performance.
- Credibility: Those projects which pursued verification will have the credibility of a third party certification. The verification process is carried out by a CHPS committee.
- Comparable: The system allows for comparison and can be used as a benchmark.

**Weaknesses**

- Scope: CHPS requirements are very close to those in LEED and since LEED has a better recognition in the market, it may be the preferred rating system.

**System maturity: 6 years****Users**

Over 25 schools certified across the US and 120 schools registered.

**Contact:**

<http://www.chps.net>

### 3 Green Globes

#### Description

Green Globes is an online building environmental design and management tool which provides a rating system and guidance for green building design, optional operation and management of the building. It provides market credibility through optional third-party verification. The following environmental categories are addressed:

- Project Management
- Site
- Energy
- Water
- Resources
- Emissions, Effluents & Other Impacts
- Indoor Environment

#### Compliance Process

- Online checklist which includes:
  - Performance based credits – Established quantitative methods for evaluating building performance and compared to established performance benchmarks
- Multiple choice credits
- Prescriptive credits- Referenced standards shall be met to verify compliance

**Implementation**

Online questionnaire is written in plain language. It is structured to facilitate input from all project team members.

**Support:**

The website generates a report that includes suggestions for further improvements to the design and hyperlinks to information on building systems and management.

**Transparency:**

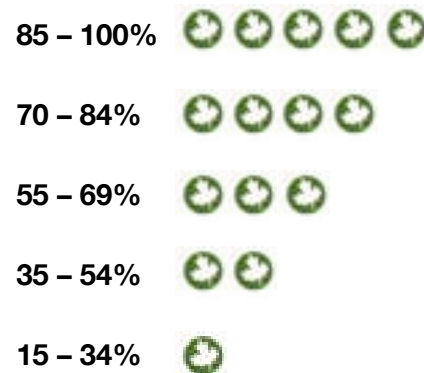
General information and requirements are available to the public online. However, project scoring methodology and strategies and in-depth credit description are available only after project registration.

**Cost:**

The cost of registering a project and gaining access to the online assessment questionnaire is CAD \$250. The total cost of registering as well as obtaining third-party verification, which is required to achieve certification, is typically CAD \$3,000 to CAD \$5,000.

**Communicability**

Performance level: The level of performance depends on the number of points achieved:



Final product: The final product is building certification and a certificate.

**Strengths**

- **Assessment tool:** It is a quick tool for establishing and reviewing sustainability objectives during the design process.
- **Ease of use:** The online questionnaire automatically generates a report with recommendations; required submittals are minimal and are already produced through the course of the project.
- **Scope:** Buildings projects of any size can use the system. Different rating systems are available for new construction, fit-ups, and management and operations of existing buildings.
- **Comparison with portfolio:** Owners and developers with multiples properties can compare the performance of various buildings within their portfolios.

- **Cost:** It is less expensive to register and obtain certification.

**Weaknesses**

- **Verifiability:** While an independent third party review is conducted during the design phase and after completion, it is not an in-depth review, and is conducted by an independent assessor, not by a stable technical committee.
- **Credibility:** Because the process is less strenuous to implement, and the required documentation is less extensive, the system is viewed by some as less credible and less marketable.

**System maturity: 4 years**

**Users**

There are over 100 Green Globes certified projects under Green Globes Canada. The system has been adopted and often renamed as a standard by public and private organizations across the country such as BOMA. BOMA Canada's Go Green Plus program is Green Globes for existing commercial office buildings. The projects include some schools, such as Burnaby Mountain Secondary School in B.C. and Mother Teresa Elementary School in Oakville, ON.

**Contact**

<http://www.greenglobes.com/design/homeca.asp>



## Living Building Challenge

### Description

Living Building Challenge is a standard aimed to define the highest measure of sustainability possible, according to the best current practices and trends. It is intended to move design beyond the requirements of LEED Platinum.

It proposes a set of 16 mandatory prerequisites. These include climate and building type considerations. They define performance requirements but do not address how the requirements are met. The intent is to reduce efforts in documenting compliance. The system is based on the actual performance of a building. The Certification can be achieved after one year of continuous building operation.

The following environmental categories are addressed:

- Site
- Materials
- Energy
- Indoor Quality
- Water
- Beauty and inspiration

### Compliance Verification

- Performance based – Established quantitative methods for evaluating building performance.

Credit example:

### Energy

A living building relies solely on current solar income.

### Major Environmental Issues/Prerequisite Intents

The majority of energy generated today is from unsustainable sources including coal, gas, oil and nuclear energy. Large-scale hydro, while inherently cleaner, brings widespread damaging ecosystem impact. The effects of these energy sources on regional and planetary health is becoming more and more evident, with climate change being the most worrisome of major global trends due to human activity. The intent of this prerequisite is to signal a new age of design, whereby all buildings rely solely on renewable forms of energy and operate year in and year out in a pollution-free manner. Since renewable energy sources are inherently more expensive than energy efficiency measures, efficiency as a first step is assumed.

### Ideal and Current Limitations

The ideal is simple - a safe, reliable decentralized power grid relying completely on renewable energy powering incredibly efficient buildings. The major limitation currently is cost.

### Prerequisites

#### Prerequisite Four – Net Zero Energy<sup>13</sup>

100 percent of the building's energy needs supplied by on-site renewable energy<sup>14</sup> on a net annual basis.

### Compliance/Documentation

Compliance is outlined in the forthcoming Living Building User's Guide.

<sup>13</sup> Must include all electricity, heating and cooling requirements. Back-up generators are excluded. System may be grid-tied or off the grid.

<sup>14</sup> Renewable energy is defined as photovoltaics, wind turbines, water-powered microturbines, methane from composting only, direct geothermal or fuel cells powered by hydrogen generated from renewably powered electrolysis.

**Implementation :**

The requirements are simple and clear to understand, but the performance level requirements are very high. It assumes that best practices and standards are met. Specific consultants not required.

**Support:**

The Living Building Community does not have any training program or support available.

**Transparency:**

General information and requirements description available to the public online. Strategies and the User's Guide is available only after Living Building Community registration.

**Cost:**

Registration under the Living Building Community at a cost of \$100 is required prior to project registration, which costs an additional \$100. Certification cost ranges from \$1,000 to \$25,000.

**Communicability**

- Performance level: There is only one performance level. All the requirements are prerequisites.
- Final product: The final product is building certification and a certificate.

**Strengths**

- Ease of use: The prerequisites are clear and there are low documentation requirements.
- Clarity: The requirements are very clear, though well above what is currently considered "best practice" and the goals are straight. There is not much possibility for the implementation of questionable strategies.
- Verifiable: Certification is only awarded after one year of continuous operation, which guarantees the performance level claimed is real.
- Flexibility: Buildings projects of any size can use the system. The system is generic and allows for any type of building to choose the strategies to meet the prerequisites.
- Cost: It is not expensive to register and obtain certification.

**Weaknesses**

- **Verifiability:** An independent third party review is conducted after completion.
- **Credibility:** Given the characteristics and the stringency of the prerequisites, the system is viewed as an “ideal” but is not yet understood as a realistic tool.
- **Not comparable:** The generic scope of the rating system and the flexibility on the definition of compliance makes it difficult for comparisons and setting performance benchmarks.

**System maturity: 1 year.**

**Number of Buildings Certified**

To the date, there are no Living Building Challenge certified projects around the world.

**Contact**

<http://www.cascadiagbc.org/lbc>

## 5.6 Case Study Summary

CASE STUDY	SUMMARY	OBJECTIVES	KEY POINTS	SOURCE
<b>CANADA</b>				
Markham High School	Retrofit \$464, 870	Improve Energy efficiency through energy audit & retrofit	Achievements: <ul style="list-style-type: none"> <li>40% energy savings over ASHRE 90.1 1999</li> <li>47.6% energy cost savings (2.6 yr payback)</li> </ul> Strategies: <ul style="list-style-type: none"> <li>Occupancy sensors on lighting, photocells in cafeteria</li> <li>Reduce lighting power density to 2/3 of MNECB allowances</li> </ul>	Energy Efficiency Recommendations for Markham Highschool
Markham, ON				
Valley View Public School	\$15.2M 62,000 ft <sup>2</sup> 5% cost premium for Green Strategies	Integrate sustainability into Rainbow Board business through strategic planning and decision making	Achievements: <ul style="list-style-type: none"> <li>70% of sewage water is filtrated and reused in the building</li> <li>100% outdoor ventilation</li> <li>50% energy savings (vs. standard building)</li> </ul> Strategies: <ul style="list-style-type: none"> <li>Waterless urinals, wetland bio-filtration system</li> <li>Geothermal heat pump, high efficiency condensing boilers</li> <li>Under-floor air ventilation</li> <li>90% heat recovery</li> <li>100mm insulation in roof and walls, high efficiency windows with solar gains controls</li> <li>T8,T5 lighting and occupancy sensors</li> <li>Low embodied energy and maintenance materials and systems</li> </ul>	Rainbow School Board – Valley View, Sudbury, ON Presentation
Sudbury, ON				
Val Caron Public School	Retrofit & Expansion 5,455 m <sup>2</sup> (58,700 ft <sup>2</sup> )		Achievements: <ul style="list-style-type: none"> <li>55.7% more energy efficient than MNECB reference</li> </ul> Strategies: <ul style="list-style-type: none"> <li>Ventilation air heat recovery (85% efficiency)</li> <li>Highly efficient lighting with T-8 luminaires, lighting density 7.5 W/m<sup>2</sup></li> <li>Highly efficient envelope</li> <li>Demand control ventilation</li> </ul>	Val Caron CBIP report SCDSB
Sudbury, ON				
Assumption College Catholic Secondary School	Retrofit 15,900 ft <sup>2</sup>	Implement sustainable objectives of Rainbow School Board	Achievements: <ul style="list-style-type: none"> <li>32% electricity consumption reduction</li> <li>23% gas consumption reduction</li> <li>14% potable water reduction</li> </ul> Strategies: <ul style="list-style-type: none"> <li>Conversion of MAU/HRU units to include heat recovery wheels</li> <li>Replacement of boilers to condensing type</li> <li>Replacement of domestic heating system from tank to tankless</li> <li>Installation of urinal flush tank controls</li> <li>Replacement of Building Automation System</li> <li>Retrofitted large pumps and motors to VSDs</li> <li>Lighting controls installed</li> <li>Full commissioning implemented</li> </ul>	Assumption College Catholic Secondary School – Interview BHNCDDB
Brantford, ON				
St. Marguerite School	New School 4,600m <sup>2</sup> (49,500 ft <sup>2</sup> )		Achievements: <ul style="list-style-type: none"> <li>55.7% more energy efficient than MNECB reference</li> </ul> Strategies: <ul style="list-style-type: none"> <li>High efficiency boilers</li> <li>Highly efficient lighting with T-8 luminaires</li> <li>Highly efficient envelope</li> </ul>	St. Marguerite – CBIP report YCDSB
Richmond Hill, ON				

CASE STUDY	SUMMARY	OBJECTIVES	KEY POINTS	SOURCE
St. Padre Pio Catholic School Woodbridge, ON	New School 4,800m <sup>2</sup> (51,700 ft <sup>2</sup> )		Achievements: <ul style="list-style-type: none"> <li>35.4% more energy efficient than MNECB reference</li> </ul> Strategies: <ul style="list-style-type: none"> <li>Fully modulating boilers</li> <li>Heat recovery ventilator (57% efficiency)</li> <li>Highly efficient lighting, lighting density (9.7 W/m<sup>2</sup>)</li> <li>26% potable water reduction</li> <li>Highly efficient envelope</li> </ul>	St. Padre Pio – CBIP report YCDSB
North Shore Elementary School Keene, ON	New School 6,668m <sup>2</sup> (71,800 ft <sup>2</sup> )		Achievements: <ul style="list-style-type: none"> <li>39.4% more energy efficient than MNECB reference</li> </ul> Strategies: <ul style="list-style-type: none"> <li>Ventilation heat recovery (65% efficiency)</li> <li>Highly efficient lighting, density (8.5 W/m<sup>2</sup>)</li> <li>Highly efficient envelope</li> </ul>	North Shore – CBIP report KPRDSB
St. Veronica Elementary School Mississauga, ON	New School 6,600m <sup>2</sup> (71,800 ft <sup>2</sup> )		Achievements: <ul style="list-style-type: none"> <li>29.9% more energy efficient than MNECB reference</li> </ul> Strategies: <ul style="list-style-type: none"> <li>Highly efficient windows</li> <li>Highly efficient lighting, density (8.5 W/m<sup>2</sup>)</li> <li>VAV system</li> </ul>	St. Veronica – CBIP report DPCDSB
St. Jerome Elementary School	New School 4,735m <sup>2</sup> (51,000 ft <sup>2</sup> )		Achievements: <ul style="list-style-type: none"> <li>34% more energy efficient than MNECB reference</li> </ul> Strategies: <ul style="list-style-type: none"> <li>Highly efficient modulating boilers (85% efficiency)</li> <li>Highly efficient lighting, density (9.8 W/m<sup>2</sup>)</li> <li>Heat recovery wheel (43% efficiency)</li> <li>Highly efficient pumps and motors</li> <li>Highly efficient glazing system</li> </ul>	St. Jerome – CBIP report YCDSB
Sacred Heart Catholic Elementary School Norfolk, ON	New School 29,257 ft <sup>2</sup>	Preliminary Energy Model Comparison of VAV vs. Water Source Heat Pump	Achievements: <ul style="list-style-type: none"> <li>Annual savings of \$0.01/ft<sup>2</sup> through use of WSHP</li> <li>In both cases lighting accounts for 32% of total annual costs</li> <li>Site energy is 81.8 kWh/m<sup>2</sup>(WSHP) vs. 97.7 kWh/m<sup>2</sup>(VAV)</li> <li>Source energy is 245 kWh/m<sup>2</sup>(WSHP) vs. 240 kWh/m<sup>2</sup>(VAV)</li> </ul>	Preliminary Energy Model Comparison of VAV vs. Water Source Heat Pump for use in a new school design NCDSB

**NORTH AMERICA**

Sidwell Friends Middle School Washington, D.C.	55yrs, major renovation Students: 350. K-12 72,500 ft <sup>2</sup> \$386 / ft <sup>2</sup>	Demonstrate commitment to sustainability as a core value	Achievements: <ul style="list-style-type: none"> <li>curriculum tied-in with green strategies</li> <li>60% energy savings to ASHRAE 90.1 1999</li> <li>90% municipal water use reduction</li> <li>on-site wastewater treatment</li> <li>no landscape irrigation</li> </ul> Strategies: <ul style="list-style-type: none"> <li>passive energy design for heating and cooling</li> </ul>	<a href="http://www.usgbc.org/DisplayPage.aspx?CMSPageID=1721#schools">http://www.usgbc.org/DisplayPage.aspx?CMSPageID=1721#schools</a>
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CASE STUDY	SUMMARY	OBJECTIVES	KEY POINTS	SOURCE
Clearview Elementary Hanover, PA	New School Students: 250. K-4 43,000 ft2 \$145/ft2 LEED Gold	Create a healthy, efficient & sustainable school	<p>Achievements:</p> <ul style="list-style-type: none"> <li>\$18,000/yr in energy savings (9 year payback)</li> <li>30% potable water reduction</li> <li>superior IAQ</li> <li>40% regional materials used in construction</li> <li>75% construction waste diversion</li> <li>56% energy savings to ASHRAE 90.1 1999</li> </ul> <p>Strategies:</p> <ul style="list-style-type: none"> <li>curved sunscreen acts as sundial for educational connection to environment</li> <li>floor-mounted air system with CO2, humidity, and temperature response</li> <li>low-flow water fixtures</li> <li>water efficient landscaping, indigenous plants</li> </ul> <p>Cost Premium:</p> <ul style="list-style-type: none"> <li>2.5% premium for LEED certification</li> </ul>	<a href="http://www.usgbc.org/DisplayPage.aspx?CMSPageID=1721#schools">http://www.usgbc.org/DisplayPage.aspx?CMSPageID=1721#schools</a>
Fossil Ridge High School Fort Collins, Colorado	Age: New Students: 1,800. 290,000 ft2 \$179/ft2 LEED Silver	Create a healthy school with added learning opportunities	<p>Achievements:</p> <ul style="list-style-type: none"> <li>60% energy savings to ASHRAE 90.1 1999</li> <li>\$11,500/yr in water savings</li> <li>low VOC design</li> <li>75% construction waste diversion</li> </ul> <p>Strategies:</p> <ul style="list-style-type: none"> <li>daylighting from windows, roof monitors and Solatubes</li> <li>occupancy sensors for lighting &amp; HVAC</li> <li>Ice storage cooling</li> <li>low-flow fixtures</li> <li>artificial turf on athletic field</li> <li>raw water pond used for site irrigation</li> <li>regional materials used in construction</li> </ul>	<a href="http://www.usgbc.org/DisplayPage.aspx?CMSPageID=1721#schOols">http://www.usgbc.org/DisplayPage.aspx?CMSPageID=1721#schOols</a>
Alder Creek Middle School Lake Tahoe, California	Age: New Students: 1,000. Gr. 6-8 87,000 ft2 \$275/ft2 CHPS guidelines employed in design	Demonstrate performance of CHPS design guidelines	<p>Achievements:</p> <ul style="list-style-type: none"> <li>60% energy savings to ASHRAE 90.1 1999</li> <li>\$11,500/yr in water savings</li> <li>low VOC design</li> <li>75% construction waste diversion</li> </ul> <p>Strategies:</p> <ul style="list-style-type: none"> <li>daylighting from windows, roof monitors and Solatubes</li> <li>occupancy sensors for lighting &amp; HVAC</li> <li>Ice storage cooling</li> <li>low-flow fixtures</li> <li>artificial turf on athletic field</li> <li>raw water pond used for site irrigation</li> <li>regional materials used in construction</li> </ul>	<a href="http://www.usgbc.org/DisplayPage.aspx?CMSPageID=1721#schOols">http://www.usgbc.org/DisplayPage.aspx?CMSPageID=1721#schOols</a>
Georgina Blach Intermediate School Los Altos, California	Major renovation Students: 450. Gr. 7-8 65,000 ft2 CHPS guidelines employed in design	Demonstrate performance of CHPS design guidelines	<p>Achievements:</p> <ul style="list-style-type: none"> <li>38% energy savings to California Title 24</li> <li>lighting power use of 0.8 W/ft2</li> <li>142 issues identified by the commissioning agent, 124 resolved</li> </ul> <p>Strategies:</p> <ul style="list-style-type: none"> <li>dimnable ballasts, photocells</li> <li>natural ventilation through doors and clerestories</li> <li>financed by grants from PG&amp;E</li> </ul>	CHPS 2006 Edition BPM Volume 1

CASE STUDY	SUMMARY	OBJECTIVES	KEY POINTS	SOURCE
Cahuenga New Elementary School Los Angeles, California	Age: New Students: 804. K-5 CHPS guidelines employed in design	Comply with regulation requiring CHPS design guidelines be adopted	Achievements: <ul style="list-style-type: none"> <li>32% energy savings to California Title 24</li> <li>reduced light pollution</li> <li>reduced heat-island effect</li> </ul> Strategies: <ul style="list-style-type: none"> <li>daylighting, photocells and occupancy sensors control lighting</li> <li>exterior light cutoffs</li> <li>shaded impervious surfaces, use of high-albedo surfaces, landscaping and open-grid paving</li> <li>split-unit heat pump</li> <li>low-flow fixtures</li> <li>75% construction waste diversion target</li> <li>high performance acoustic materials</li> </ul>	CHPS 2006 Edition BPM Volume 1
Cesar Chavez Education Center Oakland, California	Age: New Students: 600. 72,500 ft2 CHPS guidelines employed in design	Act as a high performance school demonstration site	Achievements: <ul style="list-style-type: none"> <li>20% energy savings over California Title 24</li> <li>low-VOC design</li> </ul> Strategies: <ul style="list-style-type: none"> <li>daylighting, photocells, angled bay windows and skylights</li> <li>natural ventilation, fan coils, occupancy sensors on HVAC</li> <li>low-flow fixtures</li> <li>reduced roof heat-island effect</li> <li>all open space and some facilities open to the community</li> <li>funding from grants by CEC</li> </ul>	CHPS 2006 Edition BPM Volume 1
Waipahu Intermediate School Waipahu, Hawaii	Age: New Students: 750. 19,200 ft2	Achieve LEED To support commitment to conservation and improved	Achievements: <ul style="list-style-type: none"> <li>16% energy savings over ASHRAE 90.1 1999</li> <li>39 kWh/m2/yr simulated energy use</li> <li>55% reduction in electricity used for lighting</li> </ul> Strategies: <ul style="list-style-type: none"> <li>daylighting, shaded north- and south-facing clerestories and jalousies for light infiltration</li> <li>natural ventilation, roof designed to create a thermal chimney for stack effect</li> <li>Ventilation</li> </ul>	ASHRAE Advanced Energy Design Guide for K-12 School Buildings
Desert Edge High School Goodyear, Arizona	Age: New Students: 1,600. 218,800 ft2 \$97/ft2 Phase II certified LEED Silver		Achievements: <ul style="list-style-type: none"> <li>28% energy savings (\$58,000/yr) over ASHRAE 90.1 1999</li> <li>1.09 W/ft2 lighting power use</li> </ul> Strategies: <ul style="list-style-type: none"> <li>daylighting, occupancy sensors for lighting</li> <li>demand-controlled ventilation with CO2 sensors</li> <li>high-efficiency chillers and water-side economizer</li> <li>chiller bypass for indirect evaporative cooling</li> <li>variable speed pumps</li> <li>web-based M&amp;V system</li> <li>R-19 wall insulation, R-30 roof insulation, low-e windows (0.33 U-factor)</li> </ul>	ASHRAE Advanced Energy Design Guide for K-12 School Buildings

CASE STUDY	SUMMARY	OBJECTIVES	KEY POINTS	SOURCE
Homewood Middle School  Homewood, Alabama	Age: New Students: 1,000. 190,000 ft <sup>2</sup> \$121/ft <sup>2</sup>	Build an energy-efficient and sustainable school	Achievements: <ul style="list-style-type: none"> <li>36% energy savings over ASHRAE 90.1 1999</li> <li>209 kWh/m<sup>2</sup>/yr measured energy use</li> <li>use of daylighting in 95% of school</li> </ul> Strategies: <ul style="list-style-type: none"> <li>kiosk showcases sustainable designs, and displays energy savings</li> <li>daylighting, light shelves, window shading on south face</li> <li>larger north face windows, photocell dimmable control and occupancy</li> <li>sensors for lighting</li> <li>CO<sub>2</sub> control on gymnasium HVAC system</li> <li>air-side economizer on central chiller (9.8 EER)</li> <li>R-10 wall insulation</li> </ul>	ASHRAE Advanced Energy Design Guide for K-12 School Buildings
Knightdale High School  Knightdale, North Carolina	Age: New Students: 1,600. 281,000 ft <sup>2</sup> \$95/ft <sup>2</sup>	Reflect commitment by building team to high-performance design	Achievements: <ul style="list-style-type: none"> <li>8% improvement over energy use prediction</li> <li>177.2 kWh/m<sup>2</sup>/yr measured energy use</li> </ul> Strategies: <ul style="list-style-type: none"> <li>daylighting by clerestories, skylights, dimmable independently-controlled</li> <li>lighting</li> <li>exterior shades on south face windows</li> <li>four-pipe hydronic heating and cooling</li> <li>high-efficiency condensing boilers</li> <li>VAV AHUs with hot-water coil zone reheat, CO<sub>2</sub> monitoring</li> <li>relative humidity monitored in the AHU return duct</li> <li>DDC control of HVAC system</li> <li>variable-frequency drive pumps</li> <li>R-16 wall insulation, R-26 ceiling insulation</li> </ul>	ASHRAE Advanced Energy Design Guide for K-12 School Buildings
Third Creek Elementary School  Statesville, North Carolina	Age: New Students: K-12 92,000 ft <sup>2</sup> \$95/ft <sup>2</sup> LEED Gold	Reflect commitment by building team to high-performance design	Achievements: <ul style="list-style-type: none"> <li>25% predicted energy cost reduction over ASHRAE 90.1 1999</li> <li>33% realized energy cost reduction</li> <li>194 kWh/m<sup>2</sup>/yr measured energy use</li> </ul> Strategies: <ul style="list-style-type: none"> <li>shading on south face windows, lightshelves and reflective ceiling tiles for</li> <li>daylighting</li> <li>multi-level lighting control, occupancy sensors</li> <li>high-efficiency water-source heat-pumps with variable-speed pumps</li> <li>high-efficiency condensing boiler</li> <li>DDC for M&amp;V</li> <li>systems for independent after-hours control of gymnasium, stage and</li> <li>dining room for community use</li> <li>R-22 wall insulation, R-45 roof insulation</li> </ul>	ASHRAE Advanced Energy Design Guide for K-12 School Buildings



CASE STUDY	SUMMARY	OBJECTIVES	KEY POINTS	SOURCE
Bolingbrook High School	Age: New Students: 3,600. 569,000 ft <sup>2</sup> \$169/ft <sup>2</sup>	Reflect commitment by building team to high-performance design	Achievements: <ul style="list-style-type: none"> <li>360,000 gallons of water saved from condensate recovery system</li> <li>daylighting in 90% of occupied spaces</li> <li>297 kWh/m<sup>2</sup>/yr measured energy use</li> </ul> Strategies: <ul style="list-style-type: none"> <li>school-within-a-school design</li> <li>interior courtyards for views and daylight</li> <li>multi-level lighting on override switches, timed on/off schedule</li> <li>photocells on main concourse lighting</li> <li>HVAC on time schedule, fans defaulted off</li> <li>condensate recovery system for reuse of rooftop chiller water</li> <li>bio-swales to filter surface-water runoff</li> <li>high-albedo roof</li> </ul>	ASHRAE Advanced Energy Design Guide for K-12 School Buildings
Bolingbrook, Illinois				
Whitman-Hanson Regional High School	Age: New Students: 1,350. 234,500 ft <sup>2</sup> \$175/ft <sup>2</sup>	Act as pilot project for the Massachusetts Green Schools Initiative	Achievements: <ul style="list-style-type: none"> <li>39% energy savings over ASHRAE 90.1 1999</li> <li>196 kWh/m<sup>2</sup>/yr measured energy use</li> <li>1.15 W/ft<sup>2</sup> lighting power use</li> <li>5% of annual energy consumption provided by solar array on roof</li> <li>curriculum developed around solar array</li> </ul> Strategies: <ul style="list-style-type: none"> <li>daylighting through skylights and windows, photocells</li> <li>HVAC control by occupancy sensors, VAV boxes, ventilation dampers</li> <li>high-efficiency hybrid chiller comprised of high-efficiency water-cooled chiller for base load, and air-cooled chiller for peak loads</li> <li>high-efficiency condensing boilers</li> <li>demand controlled ventilation with ERV</li> <li>variable-flow pumping</li> <li>51 kW photovoltaic roof system funded by MTC</li> <li>windows have low-e coatings, high visible light transmittance</li> <li>R-10 wall insulation, under-slab insulation used on floors</li> <li>Cost Premium: <ul style="list-style-type: none"> <li>\$4.85/ft<sup>2</sup> (2.83% of total cost)</li> </ul> </li> </ul>	ASHRAE Advanced Energy Design Guide for K-12 School Buildings
Whitman, Massachusetts				
Westwood Elementary School	Age: New Students: 750. 75,000 ft <sup>2</sup> \$160/ft <sup>2</sup>		Achievements: <ul style="list-style-type: none"> <li>255 kWh/m<sup>2</sup> measured energy use</li> </ul> Strategies: <ul style="list-style-type: none"> <li>oriented to maximize solar and wind patterns</li> <li>occupancy and daylight sensors on lighting</li> <li>ERVs used to reduce energy use and peak loads</li> <li>displacement ventilation</li> <li>high-efficiency condensing boiler</li> <li>variable-frequency pumps</li> <li>R-18 wall insulation, R-22 roof insulation, low-e glazing</li> <li>web-based building automation system</li> </ul>	ASHRAE Advanced Energy Design Guide for K-12 School Buildings
Zimmerman, Minnesota	LEED certified			

CASE STUDY	SUMMARY	OBJECTIVES	KEY POINTS	SOURCE
Silverthorne Elementary School	Age: New Students: 430. 62,500 ft <sup>2</sup> \$148/ft <sup>2</sup>		Achievements: <ul style="list-style-type: none"> <li>\$27,000/yr in energy savings</li> <li>88 kBtu/ft<sup>2</sup>/yr measured energy use</li> </ul> Strategies: <ul style="list-style-type: none"> <li>daylighting by windows, photocells, exterior light shelves on south face,</li> <li>clerestories, light shafts and skylight spines in other areas</li> <li>natural ventilation on warm days</li> <li>VAV AHUs with reheat, air economizers, and CO<sub>2</sub> control</li> <li>HVAC separated from classrooms for improved acoustics</li> <li>Solar hot water preheat</li> <li>R-19 wall insulation, R-30 roof insulation</li> </ul>	ASHRAE Advanced Energy Design Guide for K-12 School Buildings
Silverthorne, Colorado				
Corvallis School District	Schools: 8 Students: 6,850  School 1: High School Students: 1,300 230,000 ft <sup>2</sup> LEED Silver targeted		Achievements: <ul style="list-style-type: none"> <li>35% energy savings (high school) over ASHRAE 90.1 1999</li> <li>30% energy savings (middle school)</li> <li>curriculae developed using energy consumption &amp; savings data</li> </ul> Strategies: <ul style="list-style-type: none"> <li>promote behavioral change to turn off lights and computers when unused</li> <li>digital HVAC control</li> <li>energy efficient boilers</li> <li>photovoltaic system to supply renewable energy</li> </ul>	NREL - High-Performance Schools: Affordable Green Design for K-12 Schools
Corvallis, Oregon	School 2: Middle School Students: 550 125,000 ft <sup>2</sup> LEED Silver targeted			
Tucson Unified School District	Schools: 107 Students: 60,000 8 million ft <sup>2</sup>	Improve the learning and teaching environment by improving building and systems performance and energy savings	Achievements: <ul style="list-style-type: none"> <li>district wide energy and water savings of over \$1 million</li> <li>curriculae developed using photovoltaic technology installations</li> </ul> Strategies: <ul style="list-style-type: none"> <li>lighting retrofits</li> <li>photovoltaic systems installed in six schools to total 22 to 28 kW</li> <li>energy management system installed</li> <li>use of reclaimed water for irrigation</li> <li>"Resources Efficiency Awareness Program" providing monetary awards for savings</li> </ul>	NREL - High-Performance Schools: Affordable Green Design for K-12 Schools
Tucson, Arizona				
Marion County Public Schools		Save utility costs	Achievements: <ul style="list-style-type: none"> <li>8.5% reduction in energy consumption</li> <li>\$1 million in energy savings</li> <li>creating a sustainable design template for new elementary schools in the district</li> </ul> Strategies: <ul style="list-style-type: none"> <li>recouperated losses of \$300,000 in overbilling by utilities</li> <li>implementation of energy accountability programs</li> <li>programmable thermostats, timers for hot water heaters &amp; lighting</li> <li>high-efficiency HVAC and lighting, VSDs</li> <li>energy management system controls installed</li> <li>low-flow fixtures</li> <li>collaboration with an ESCo (energy services company)</li> </ul>	NREL - High-Performance Schools: Affordable Green Design for K-12 Schools
Ocala, Florida				

CASE STUDY	SUMMARY	OBJECTIVES	KEY POINTS	SOURCE
Roanoke Couty Public Schools	Students: 14,400	Reduce energy costs	Achievements: <ul style="list-style-type: none"> <li>▪ curriculae developed around energy efficiency projects data and concepts</li> <li>▪ 25% energy savings over ASHRAE 90.1 1999</li> <li>▪ \$2.9 million in savings over 5 years</li> <li>▪ Energy Star label on two buildings</li> </ul> Strategies: <ul style="list-style-type: none"> <li>▪ lighting upgrades (T8)</li> <li>▪ cooling by cross-ventilation instead of air conditioning</li> <li>▪ monitor/controller unit for boilers</li> <li>▪ data loggers in classrooms to record temperature, humidity and light</li> <li>▪ levels</li> <li>▪ energy management system installed</li> <li>▪ collaboration with an ESCo</li> </ul>	NREL - High-Performance Schools: Affordable Green Design for K-12 Schools
Roanoke, Virginia				
Montour School Distic	Schools: 5 Students: 35,000	Accommodate an energy budget which does not cover the rising cost of energy by reducing energy costs by 16%	Achievements: <ul style="list-style-type: none"> <li>▪ four schools retrofitted</li> <li>▪ \$1 million in savings over 10 years expected</li> </ul> Strategies: <ul style="list-style-type: none"> <li>▪ improved lighting levels &amp; systems (metal halides in gymnasiums)</li> <li>▪ lighting controls in gymnasiums, dimmable ballasts in computer labs</li> <li>▪ high-efficiency motors</li> <li>▪ energy management system installed</li> <li>▪ - 10 year energy performance contract (EPC) initiated</li> </ul>	NREL - High-Performance Schools: Affordable Green Design for K-12 Schools
McKees Rocks, Pennsylvania				
Elk River School District No. 722	Schools: 17 Students: 11,000	Create a better learning environ- ment for teachers and students	<ul style="list-style-type: none"> <li>▪ 25% energy savings over ASHRAE 90.1 1999 (\$175,000/yr) at Rog-ers High School</li> <li>▪ 50% energy savings over ASHRAE 90.1 1999 (\$65,000 - \$75,000/yr) at Westwood Elementary</li> <li>▪ some winter days require no heating cost</li> <li>▪ reduced HVAC sizing due to passive strategies</li> </ul> Strategies: <ul style="list-style-type: none"> <li>▪ daylighting</li> <li>▪ passive heating/cooling</li> </ul>	NREL - High-Performance Schools: Affordable Green Design for K-12 Schools
Elk River, Minnesota	Rogers High School: (built energy efficient) Students: 850 257,000 ft2 \$125/ft2			
	Westwood Elementary School: (built energy efficient) Students: 475 74,000 ft2 \$155/ft2 LEED Silver expected			

CASE STUDY	SUMMARY	OBJECTIVES	KEY POINTS	SOURCE
Council School District  #13 - Council, Idaho	Schools: 2 Students: 320	Reduce energy costs and showcase technologies to neighbouring small schools	Achievements: <ul style="list-style-type: none"> <li>curriculae developed around efficiency upgrades and biomass plant</li> <li>17% (50 tons/yr) fuel reduction</li> <li>\$53,000/yr in energy savings</li> </ul> Strategies: <ul style="list-style-type: none"> <li>T8 lamps, ballasts, light intensity reduction and digital controls for lighting</li> <li>hydronic heating/cooling</li> <li>advanced biomass wood-chip heating to replace 47-yr boiler and radiant electric heat</li> <li>natural cold ground water used for cooling</li> <li>return hydronic loop preheats service hot water</li> </ul>	NREL - High-Performance Schools: Affordable Green Design for K-12 Schools
Buckland K-12 School  Buckland, Alaska	Age: Renovation/new-construction Students: 270. K-12 41,000 ft2 \$300/ft2	Reduce energy consumption from fuel costs due to local fuel scarcity	Achievements: <ul style="list-style-type: none"> <li>construction cost competitive with other permanent local buildings</li> <li>30% energy cost savings over ASHRAE 90.1 1999</li> </ul> Strategies: <ul style="list-style-type: none"> <li>community involvement in design process</li> <li>daylighting and large open interior spaces</li> <li>aerodynamic form to reduce heat loss from surface area by snow drifting</li> <li>building and materials reuse</li> <li>improved insulation</li> <li>facilities available to the community</li> </ul>	NREL - High-Performance Schools: Affordable Green Design for K-12 Schools
Chiefess Kamakahalei Middle School  Lihue, Kauai, Hawaii	Students: 1,064 Size: 134,000 ft2	Meet student needs and demonstrate resource and energy efficiency	Strategies: <ul style="list-style-type: none"> <li>community involvement in design process</li> <li>oriented to maximize daylight and capture trade winds</li> <li>lighting by T8 fixtures with electronic ballasts</li> <li>natural ventilation by trade winds except in library and music buildings</li> <li>VAV systems with VSD used in library and music buildings</li> <li>heat recovery on hot water system</li> <li>R-19 roof insulation, low-e tinted windows</li> </ul>	NREL - High-Performance Schools: Affordable Green Design for K-12 Schools
<b>INTERNATIONAL</b>				
The Waldorf School  Kircheim, Germany		Approach education by allowing each pupil to find his or her own place in the world.	Strategies: <ul style="list-style-type: none"> <li>student involvement in design of new classroom additions to the school</li> <li>timber construction</li> <li>daylighting by rooflights, light-wells</li> </ul>	Human Hubner: the Steiner system of education offers many lessons to society in general.
The Waldorf School  Cologne, Germany		Approach education by allowing each pupil to find his or her own place in the world.	Strategies: <ul style="list-style-type: none"> <li>community-involved design and construction</li> <li>untreated timber &amp; grass roof construction</li> <li>daylighting from windows, glass roof in central hall</li> <li>passive solar heating, southeast glazing used for solar gain</li> <li>vertical hall uses stack effect for ventilation</li> <li>underground pipes preheat winter air, and precool summer air</li> </ul>	Social engagement - Peter Hubner's design of the Waldorf school in Cologne, Germany

## 5.7 Energy and Water Use Benchmarks

### 1. Schools Performance Analysis: Energy And Water

The purpose of this analysis is to evaluate energy and water performance data from schools to establish recommended performance benchmarks and targets to be included in the Green Schools Resource Guide.

Four sources of historical data have been selected to obtain energy and water performance data:

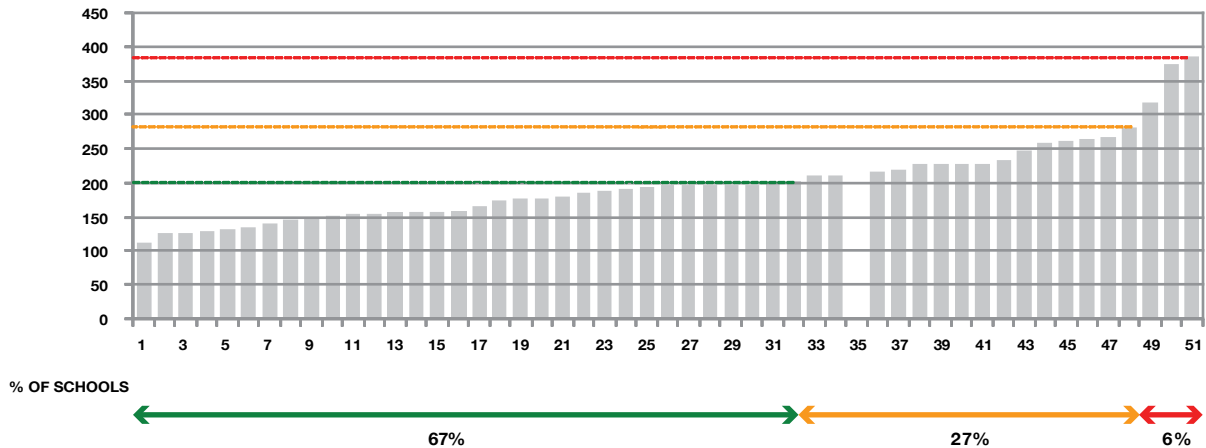
1. Toronto Regional Conservation Authority schools performance data
2. NRCan- Commercial Building Incentive Program ( CBIP) data
3. Case studies across North America
4. Ontario Schools energy and water data.

Energy consumption data and estimated CBIP energy savings were provided from 13 schools, and eight schools provided real consumption data. The real energy consumption data obtained have been normalized to account for geographical and climatic differences. Additionally, construction cost has been analyzed when available to estimate the cost premium of achieving a high energy performance school. The construction cost has not been normalized to account for geographical differences.

#### Results

- a. Predicted Energy Intensity and savings  
Results show energy savings ranging from 22% to 50% as compared to Code, with an average of 34%. The predicted energy intensity ranges from 200 to 300 ekWh/m<sup>2</sup>, with an average of 265 ekWh/m<sup>2</sup>.
- b. Real Energy Savings  
Real consumption data show an energy intensity ranging from 140 to 300 ekwh/m<sup>2</sup>, with an average of 205 ekWh/m<sup>2</sup>.
- c. Construction costs  
Construction costs range from \$100-\$241 sq.ft..

### Energy Consumption

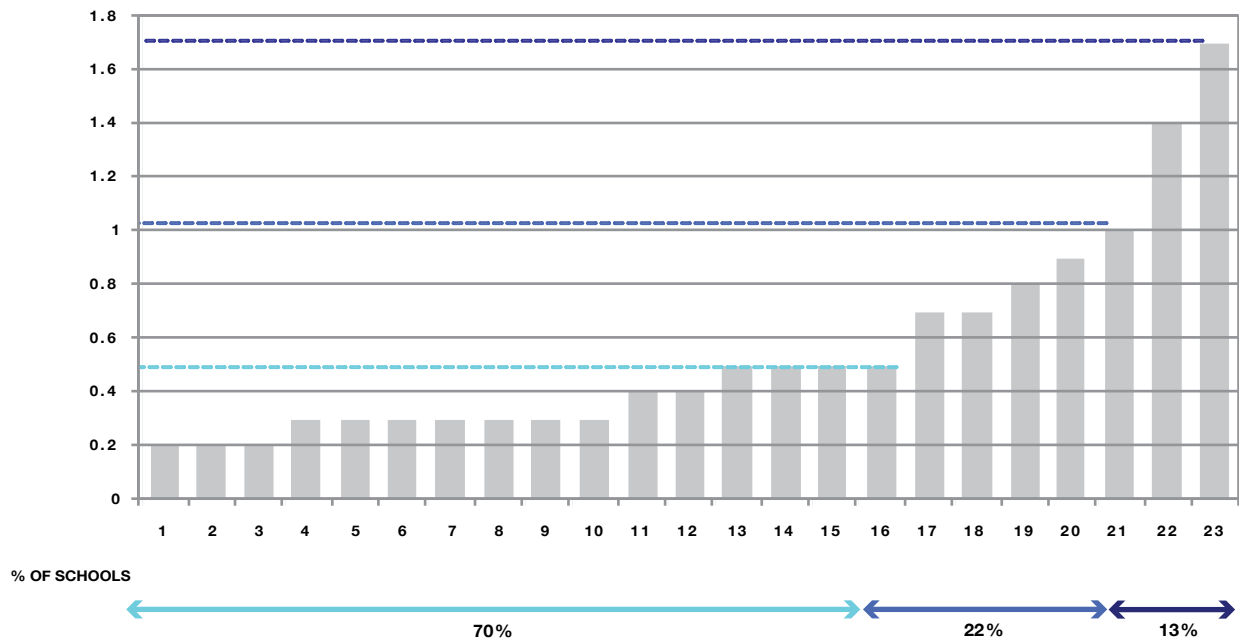


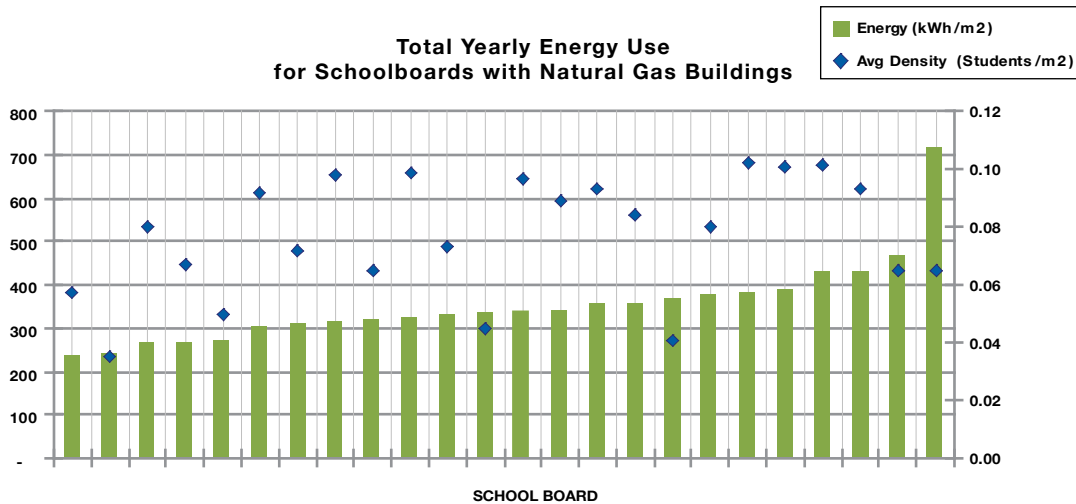
The table below shows the correlation between predicted and real energy intensity, predicted energy savings and construction cost.

#### d. Water

Five schools provided water consumption data. Within the sample, the water consumption average is 0.5 m3/m2. It is important to consider that this set of data doesn't specify water final use, (occupants use, irrigation, cooling towers).

### Water Consumption





## 2. Energy and Water Recommended Benchmarks

### Current Status

#### a. Ontario Ministry of Education Data

To estimate the actual energy consumption of the school boards across Ontario, energy cost data provided by the Ontario Ministry of Education have been analyzed. Only those school boards which use natural gas as a heating energy source have been analyzed to obtain a comparable data set for the data evaluated in the previous section. The data have been normalized to account for geographical and climatic differences. The average age of the schools in these boards ranges from 20 to 53 years.

The yearly energy consumption ranges from 241 to 469 ekWh/m<sup>2</sup>. Only one board exceeds the top range of the energy consumption, with 715 ekWh/m<sup>2</sup> per year. The average energy consumption excluding this exception is 338 ekWh/m<sup>2</sup>.

In 2001, NRCan, released a study indicating energy benchmarks for school boards across Canada. For Ontario, 444 schools participated in the program; the data were normalized to account for geographical and climatic differences.

The average energy consumption for Ontario school boards was found to be 258 ekWh/m<sup>2</sup>.

## Proposed Benchmarks

Based on the information presented in section 1, our recommended targets and benchmarks are:

Energy Savings	Energy Intensity (new schools)	Water Use
35% above MNECB	200 ekWh/m <sup>2</sup>	0.5 m <sup>3</sup> /m <sup>2</sup>

## Considerations

- The reference standard selected for establishing the benchmark is the MNECB because, in Ontario, this is the standard with which the industry has the most experience.
- The data analyzed does not provide guidance on how the benchmark should vary with uses such as gymnasias and cafeterias.
- Most of the schools don't monitor water consumption. More extensive data gathered through metering by end use is recommended to establish a well-defined benchmark in water consumption that accounts for the different water uses in a school.

## 3. Energy and Water Efficiency Strategies

### Energy

As per the information presented in Section 1, the energy efficiency strategies most commonly implemented are:

- Building envelope Improvements (R values >25% better than code)
- Increased Heating efficiency (90% efficient condensing boilers)
- Increased DHW efficiency (90% condensing boilers)
- High efficient motors and pumps, and VSD
- Efficient lighting design (0.9 w/ft<sup>2</sup>)
- Ventilation Heat Recovery (>60% efficiency)
- Energy Management Systems

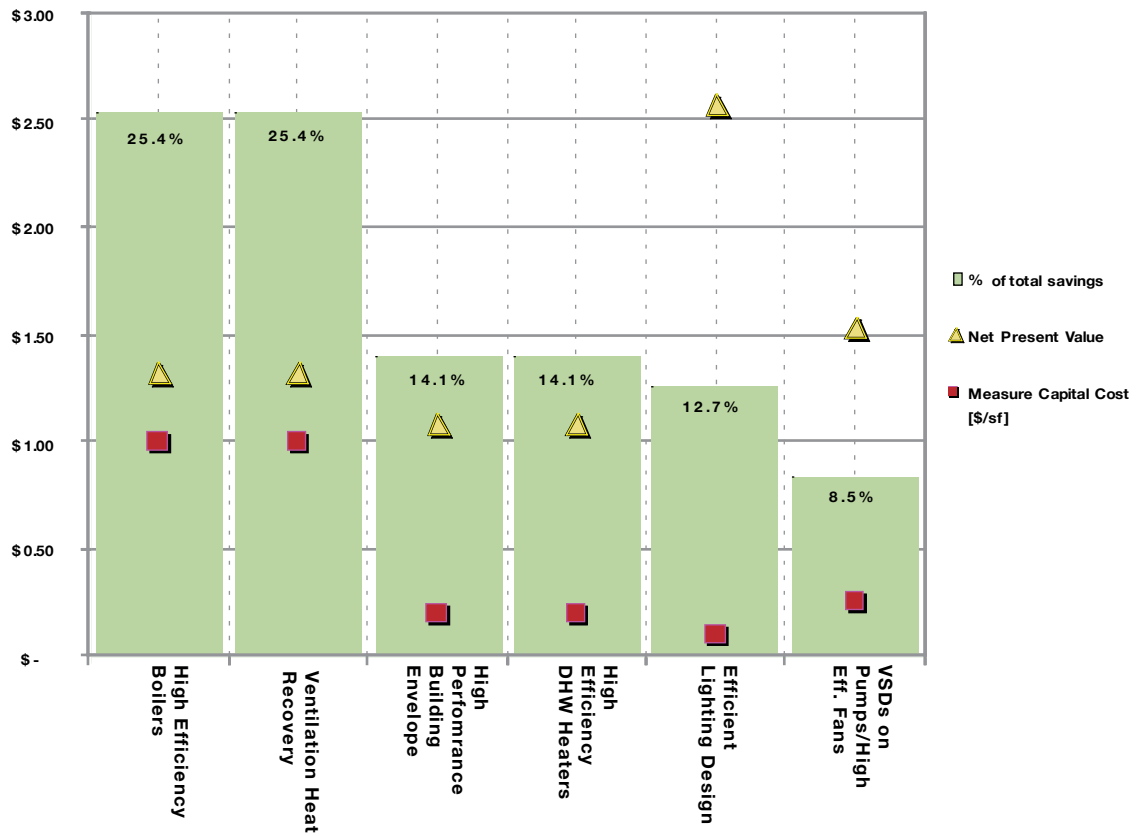
To evaluate each strategy independently, an energy model has been created on one of the schools analyzed from the York Catholic District School board, which included the above strategies.

For each strategy, the table below shows its fraction of total energy savings, annual percentage of energy cost savings, capital cost and net present value.

An approximation of each measure's capital cost, as well as the projected energy and cost savings associated with it is presented in the graph below. For the Net Present Value calculation it has been assumed a 20-year life cycle. This analysis has not considered replacement and maintenance cost over the life cycle of the building.



STRATEGIES	Fraction of Energy Savings	Savings of Yearly Energy Costs	Capital Cost [\$/sq.ft]	Yearly Energy Savings [MJ/sq.ft]	Yearly Cost Savings [\$/sq.ft]	Net Present Value [\$/sq.ft]
<b>Envelope</b>						
High performance building	14%	5%	\$ 0.20	6.47	\$ 0.08	\$ 0.55
<b>Heating/Cooling</b>						
High efficiency boilers	25%	9%	\$ 1.00	11.65	\$ 0.14	\$ 1.33
High efficiency DHW heaters	14%	5%	\$ 0.20	6.47	\$ 0.08	\$ 1.09
VSDs on pumps/high eff fans	8%	3%	\$ 0.25	3.88	\$ 0.11	\$ 1.53
<b>Ventilation</b>						
Ventilation heat recovery	25%	9%	\$ 1.00	11.65	\$ 0.14	\$ 1.33
<b>Lighting</b>						
Efficient lighting design	13%	4.50%	\$ 0.10	5.82	\$ 0.16	\$ 2.57
<b>Total</b>	<b>100%</b>	<b>36%</b>	<b>\$ 2.75</b>	<b>45.95</b>	<b>\$ 0.71</b>	<b>\$ 8.40</b>



From a life cycle perspective, the best strategies are high efficient lighting together with VSD in motors, giving the highest return value and low capital cost.

**Water**

As per the information presented in Section 1, the water efficiency strategies most commonly implemented are:

- Low flow fixtures
- Water efficient landscaping

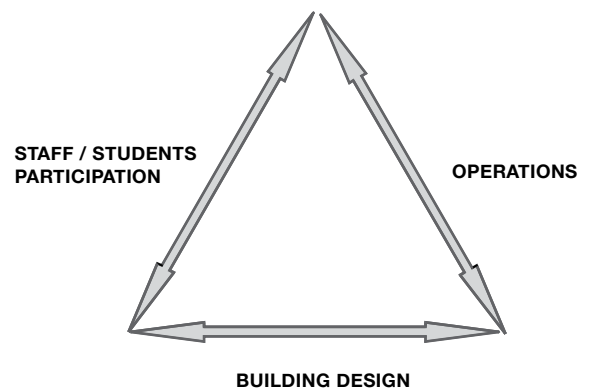
The following table presents water savings attributable to each of the strategies above:

	<b>Strategy</b>	<b>Savings</b>
Low flow fixtures	Toilet 4.6LPF	40%
	Urinal 1.9 LPF	
	Lavatory 1.9 LPM	
Water efficient landscaping	Drought tolerant plants	50% to 100%
	High efficient irrigation	

**Further Opportunities**

From the information analyzed and conversations with the boards, there is a significant potential energy savings when efforts are across the three areas of influence:

- Design: Review of design prior to tender by Commissioning Agent.
- Operations: Significant energy savings can be achieved by implementing commissioning and scheduling of building operations (i.e., allowance for local systems turn on, operations scheduled by zones, after hours systems schedule...)
- Staff/Students education: Some of the boards have implemented education and monitoring programs aimed to:
  - Provide teachers with environmental educational resources
  - Implicate students and teachers in the task of improving the energy efficiency of the building through active participation.



Some examples are:

- Rainbow Sustainability plan
- Ontario EcoSchools

Energy consumption in schools which already have implemented these types of programs have dropped by an average of 10% their energy consumption.

## 5.8 Green Resources

There are literally thousands of green school resources available. Below is a carefully selected group of resources - vetted to be the most relevant to Ontario school boards. It is important to note that these resources are being provided for the reader's convenience. The authors are not endorsing these resources nor have they reviewed these sources for accuracy and/or validity of the statements contained therein. Readers must exercise their own good judgment when reviewing any of this material.

### General green school Resources

- **Council of Education Facility Planners International (CEFPI)**

CEFPI is a North American wide professional association whose sole mission is improving the places where children learn. Their web site contains numerous resources on green schools. They also hold conferences, expert panels and award programs for green schools.

Link: <http://www.cefpi.org>

- **Collaborative for High Performance Schools (CHPS)**

CHPS is a U.S. non-profit collaborative of state (originated in California), school board officials, educators, consultants and industry to promote "high-performance" or green schools. CHPS groups have since been set up in ten different states and provides a rating tool, training, best practices manual, and resources (including a directory of low emitting materials).

Link: <http://www.chps.net>

- **National Clearing House for Educational Facilities (NCEF)**

Created in 1997 by the U.S. Department of Education, the National Clearinghouse for Educational Facilities (NCEF) provides information on planning, designing, funding, building, improving, and maintaining safe, healthy, high performance schools.

Link: [www.edfacilities.org](http://www.edfacilities.org)

- **Canadian Green Building Council**

CaGBC is a non-profit organization which aims to transform building construction to a more environmentally responsible, profitable, and healthy mode. The CaGBC is best known for administrating the LEED program in Canada but also has training and research into green buildings and is a valuable resource.

Link: <http://http://www.cagbc.ca>

- **Ontario Eco-Schools**—Program developed for Ontario schools to implement sustainability strategies into curriculum, school building and culture. No particular document provided.

Link: [http://www.tdsb.on.ca/\\_site/ViewItem.asp?siteid=207&menuid=1425&pageid=1052](http://www.tdsb.on.ca/_site/ViewItem.asp?siteid=207&menuid=1425&pageid=1052)

- **Schools for the Future: Design of Sustainable Schools Case Studies**—Compiled and prepared by the Department for Education and Skills, London UK, 2006. Contains detailed information pertaining to UK sustainable school building practice. Is organized into three major themes including emerging themes in design, 12 detailed case studies and the tools needed to support sustainable design.

Link: <http://www.p4s.org.uk/documents/SustainableschoolsCasestudies.pdf>

### Energy Efficiency Resources

- Office for Energy Efficiency  
The federal governments clearing house for research and information on energy efficiency. Includes information on active grants, current research, and the energy star programme.  
Link: [www.oeenrncan.gc.ca](http://www.oeenrncan.gc.ca)
- American Society of Heating and Refrigeration Engineers (ASHRAE)  
In particular the 2007 ASHRAE publication Advanced Energy Design Guide for K-12 Schools. A comprehensive and detailed manual on methods to achieve a 30% energy reduction in K-12 Schools. The guide gives specific recommendations on measures divided by climate zone.  
Link <http://ashrae.org/publications/page/1604>
- National Best Practices Manual For Building High Performance Schools—Prepared by the US Department of Energy with assistance by the Energy Smart Schools team. This manual was designed specifically for architects and engineers. Covers 10 specific areas of importance in design including site design, daylighting and windows; energy-efficient building shell; lighting and electrical systems; mechanical and ventilation systems; renewable energy systems; water conservation; recycling systems and waste management; transportation; and resource-efficient building products.  
Link:[http://arkansasedc.com/business\\_development/energy/files/PDF/K12/ESSBestPracticesHighPerfSchools.pdf](http://arkansasedc.com/business_development/energy/files/PDF/K12/ESSBestPracticesHighPerfSchools.pdf)

### Indoor Environmental Quality Resources

- Heath Canada's IAQ Tool Kit  
The Tools for Schools IAQ Action Kit provides a process and tools to help a school board or administrative unit address all aspects of indoor air quality in each of its schools. The kit aims to foster an interdisciplinary team-based approach, which draws on the skills and commitment of everyone involved in the planning, maintenance, operation and use of a school building.  
Link: [http://www.hc-sc.gc.ca/ewh-semt/pubs/air/tools\\_school-outils\\_ecoles/get\\_started-debuter-eng.php](http://www.hc-sc.gc.ca/ewh-semt/pubs/air/tools_school-outils_ecoles/get_started-debuter-eng.php)
- Green Seal  
Green Seal is a non-profit organization that provides science-based environmental certification standards that are credible, transparent, and essential. Green Seal provides certification on paints and sealers, windows and doors, chillers, cleaning products, office paper and transportation.  
Link: [www.greaseal.org](http://www.greaseal.org)
- National Research Council  
As part of Canada's National Research Council, the Ventilation and Indoor Air Quality Research group is focused in three key areas that are necessary for delivering and maintaining acceptable conditions in buildings: ventilation; indoor air quality; and occupant well-being. Thus is a valuable source of information on IAQ.  
Link: <http://irc.nrc-cnrc.gc.ca/ie/iaq>

- Environmental Protection Agency  
EPA's IAQ Tools for Schools Program is a comprehensive resource to help schools maintain a healthy environment in school buildings by identifying, correcting, and preventing IAQ problems.

Link: [www.epa.gov/iaq/schools](http://www.epa.gov/iaq/schools)

- Green schools: Attributes for Health and Learning  
A comprehensive study from the U.S. National Academy of Sciences submitted via the Massachusetts Technology Collaborative (MASSTECH), the Barr Foundation the Kendall Foundation, the Connecticut Clean Energy Fund, the US Green Building Council and the National Research Council. The study includes detailed examinations and recommendations of the key variables that support a healthy learning environment in “green” schools. Excellent analysis and review with a strong research panel.

Link: <http://www.nap.edu>

- Acoustics in Educational Settings:  
Technical Report  
Prepared by the American Speech-Language Hearing Association, ASHA Working Group on Classroom Acoustics. Provides some analysis on classroom acoustics and student performance. Discusses signal-to-noise ratios and allowable levels of variant noise and its impacts on younger student performance.

<http://www.asha.org/NR/rdonlyres/066CDD53-6052-405F-8CB7-3D603D5CCD0F/0/AcousticsTR.pdf>

### Green Building Costs Resources

- A Business Case for Green Building in Canada  
Written by Morrison Hershfield for the Canada Green Building Council and relates to the long term financial benefits of “green” building as opposed to business as usual development. Looks to improve the image of “green” building in Canada and to highlight the benefits of such development.

Link: <http://www.cagbc.org/uploads>

- Costing Green: A Comprehensive Cost Database and Budgeting Methodology, June 2007—  
Prepared by Davis Langdon as a follow-up to a 2004 study. Looks entirely at the cost of construction and emphasizes that many building teams already achieve sustainable design guidelines within their budgets. The analysis put forward focuses on the aspects of LEED that are most easily obtained as well as feasibility and contractor relations

Link: [www.davislangdon.com/USA/Research](http://www.davislangdon.com/USA/Research)

- **Managing the Cost of Green Buildings: k-12 Public Schools, Research Laboratories, Public Libraries, Multi-Family Affordable Housing**  
Prepared by the State of California's Sustainable Building Task Force, The California State and Consumer Services Agency and the Alameda County Waste Management Authority, October 2003. Deals specifically in the context of California and highlights numerous areas of green building budgeting and management. However, the main component of this report is the K-12 Public Schools section. The section reviews a comparison between CHPS and LEED in application to California high schools, with emphasis on real and perceived costs of each as well as the overall benefits of engaging in either program for school development.

Link: [www.ciwmb.ca.gov/greenBuilding/Design/ManagingCost.pdf](http://www.ciwmb.ca.gov/greenBuilding/Design/ManagingCost.pdf)

- **The Green Building Finance Consortium—A project founded and driven by the Muldavin Company Inc.** This is a research task force developed to improve the current culture surrounding sustainable building investment within the capital marketplace. It is tasked with improving communications and coming to a common set of vocabulary and frameworks from which to draw conclusions and make intelligent investment decisions.

Link: <http://www.greenbuildingfc.com>

## 5.9 Emerging Green Issues

Scientific understanding and public consciousness around environmental issues and the possible impacts on our planet and an individual's health has grown dramatically in recent years. Since Rachel Carson's book *Silent Spring* in 1962, new scientific research has continually driven important and sometimes obscure new environmental findings into mainstream discussion. This trend shows no signs of abating. Climate change and Biphenyl A are only two examples of how issues can move rapidly from the margins to the mainstream debate and effect significant policy change.

The evolving ground rules of energy costs and regulations will require constant review of new products and techniques. New facilities will need to be monitored for performance, and the lessons learned from those facilities used to improve the next generation of schools. Meanwhile, students, staff, and citizens are becoming more informed on environmental issues. Boards will need to respond to questions with reliable and current data. All this points to the need for a constant cycle of improvement through monitoring, analysis, and innovation.

### Emerging issues

Following is a discussion of six emerging green issues: carbon neutral and emission targets, carbon tax and trade systems, environmental toxins, indoor environmental quality and emerging green technologies. This is by no means an exhaustive list of environmental issues. These are, however, some of the most important green issues school boards should pay attention to.

### Emerging Green Technologies

New and improved technologies are continuously coming to market. New technologies can move from experimental to the mainstream in only a few years. Photovoltaic (PV) panels, for example, cost a third of what they cost only five years ago, and their costs continue to fall. In a few years PV could go from financially unfeasible to attractive. The movement in green building technology has been swift and boards will want to stay abreast of the latest developments. To plan a building that will be in use for 50 years into the future, it is critical to understand the leading thinking today. For a discussion of eight specific emerging technologies (waterless urinals; green and whiteroofs; demand-control ventilation; geothermal; solar electrical generation; wind generation; solar domestic hot water heating, and thermal energy storage), refer to Section 5.3.

### Carbon Neutral Emission Targets

The concept of carbon neutrality is gaining currency in the public debate. Simply put, "carbon-neutral" refers to zero net amount of carbon being released into the atmosphere as a result of a specific action - in this case building and operating a school. Straight carbon neutrality is currently very difficult to achieve, given that every aspect of a building's construction and operation should be considered, including transportation, energy used during construction and operation, and so on. Net carbon neutrality is more practical, since carbon offsets can be used to achieve net neutral carbon emissions.

Carbon offsets are specific measures taken by anyone to reduce emissions below a baseline or capture atmospheric carbon in order to reduce the net carbon present in the atmosphere. For example, installing a wind turbine in Texas would offset X number of tonnes of carbon that would normally be produced if that same electricity were generated by a coal plant. The saved carbon could be applied to offset the carbon generated by a diesel school bus, a crane used to install steel during construction or any other carbon releasing activity required by a school in Ontario. Since carbon is emitted into the global atmosphere, offsets need not pertain directly to the site; they can be purchased anywhere in the world. Carbon offsets, however, are unregulated at this point and not all carbon offsets are created equal. If offsets are to be purchased, it is best to buy from sources that are trusted and recognized by leading non-profits such as the David Suzuki Foundation for Clean Air – Cool Planet. Through using offsets, a net carbon-neutral school building and operation is possible – it is only a matter of the costs of the offsets.

The first step is to create a carbon budget for the project by calculating capital (construction) and ongoing operational carbon emissions. Numerous carbon calculators are available on-line to assist with this process. Once a carbon budget has been established, like a monetary budget, the first goal should be to reduce the project's carbon budget to the lowest achievable level – carbon value engineering. The final carbon budget will be used to calculate the required carbon offset. Currently “high-quality” carbon credits can be purchased for around \$30/ tonne.

### Future Emission Targets

On June 18, 2007, Ontario announced a set of ambitious but realistic greenhouse-gas (GHG) targets demonstrating Ontario's commitment to fighting climate change in Go Green: Ontario's Action Plan On Climate Change:

- A reduction of GHGs to 6% below 1990 levels by 2014, or 61 Mt
- A reduction of GHGs to 15% below 1990 levels by 2020, or 99 Mt
- A reduction of GHGs to 80% below 1990 levels by 2050

To meet the 2050 target, all operational schools at that time would have to be 80% more energy efficient than a 1990 code-compliant school or be generating renewable energy or buying carbon offset to make up the difference.

### Carbon Tax and Cap-and-Trade Systems

One of our federal parties has already suggested a national carbon tax, and British Columbia has introduced Canada's first carbon tax. The US is currently considering a cap-and-trade system (which allows carbon savers to trade their margin below a set carbon cap to carbon emitters who are over that cap). Carbon trading is already taking place. Over 24 million metric tonnes, worth over \$160 million were traded on the Chicago Climate Exchange in the first quarter of 2008 alone, and a Canadian exchange has just opened in Montreal. It is very early for both carbon taxes and markets but there is great potential for both of these financial instruments to fundamentally change the economic equation on carbon emissions.



### Environmental Toxins

Carcinogens, Endocrine Disrupters and Neurotoxins are environmental toxins that have been linked to a variety of health issues in humans.

Scientists have only recently begun to investigate the environmental links to human health issues. As a result, boards should consider taking a precautionary approach, and if possible avoid products that contain **Carcinogens, Endocrine Disrupters and Neurotoxins. Material Safety Data Sheets (required by law to be supplied with every product)** can be a valuable starting point. As they list suspected carcinogen and other potential health risks. Specifications can be written to require MSD sheets be provided by the suppliers. The board's consultants should be asked to source non-toxic alternatives and report on the available, cost and any maintenance impacts of substituting materials. If the substitution is of equal quality and value, then it should be considered.

### IEQ and Student Performance

As discussed in Section 1, a relationship between occupant performance and green buildings has been suggested but not clearly documented. However, a fair amount of research is being undertaken in this area, particularly with respect to worker productivity, performance, health and indoor environment. This research may not be specifically undertaken in school environments, however, much of this research would be applicable. Particularly research on performance in the area of the knowledge economy – will be relevant to the school environments and student learning.

## 5.10 Green School Web Survey Results

In March 2008 ZAS Architects Inc. and Halsall Associates conducted a web based survey of Ontario School Boards. The Boards were invited to participate in the survey via an e-mail letter sent to all School Boards from the Ministry. In all, there were 53 responses received to the survey.

The survey consisted of 21 questions and was intended to gain an understanding of five key questions:

- Did Ontario School Boards see the demand for green school increasing in the future?
- What issues might drive or diminish demand for green schools?
- What experiences have School Boards had with developing Green Schools?
- What barriers did School Boards see in developing Green Schools?
- Which Green measures were School Boards already implementing?

Highlights of the survey results are summarized below:

- **95%** of Boards that responded, expect demand for **green schools to rise** in the coming years.
- Boards reported the primary reasons for the expected **increase in demand for green schools** were due to: ongoing **energy, maintenance and operation costs, and indoor environmental quality** concerns.
- Boards identified student performance, indoor environmental quality & energy costs as the most important issues in developing new schools.
- 50% of Boards scored their own familiarity with “green”, “sustainable” or “high performance” schools as moderate or low.
- Less than 20% of the Boards have direct experience in design or construction of a green school.
- Less than 50% of Boards have staff who have attended green school training seminars.
- Boards reported the main constraint to implementing green schools is funding.
- 66% of the Boards have less than 2% allowance for implementing green strategies.
- The Boards with green school building experience reported implementing mainly low cost - low risk – moderate return - energy efficiency measures.

## Disclaimer

The Green Schools Resource Guide is intended as a general information source for board of education trustees, administrators, staff, and design professionals hired by the boards. While the information in this guide has been extensively researched and prepared by experts in the field and reviewed by a committee with broad based experience in school development, there are no warranties, either expressed or implied, made as to the completeness or accuracy of the information contained herein. Due to the variety of school development projects and the basic nature of the guide, specific results should not be expected from the general information provided in this publication. Readers are strongly advised to seek qualified professional advice on any specific school development project.

The information contained within this document is subject to change beyond the control of the authors, including but not limited to: URL's for web sites, incentive and government programs, costing and payback assumptions. The reader should verify any information with a qualified professional before undertaking or planning any actions based on the information contained in this document.

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