Final Report
of the
Canadian Team
for
Green Building Challenge 2000

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1. Background

1.1. Introduction to Green Building Challenge 2000 (GBC 200)

1.1.1. What is it?

Green Building Challenge 2000 is a consortium of nineteen countries that is developing and testing a new method of assessing the environmental performance of buildings. The project consists of two stages: an initial two-year process, already completed, which culminated in a major international conference in Vancouver in October 1998 (GBC '98); and a new 18-month process of development, the result of which was one of the main attractions at the International Conference, Sustainable Buildings 2000 held in Maastricht, the Netherlands, in October 2000.

1.1.2. Why is it Important?

Building construction, operation and demolition account for nearly 40% of greenhouse gas (GHG) emissions in Canada. Improvements in all three areas are clearly of strategic importance in reducing Greenhouse Gas Emissions and helping Canada meet it's Kyoto commitments. The Green Building Challenge project is a key piece of the national and international effort to realise those improvements.

1.1.3. How will it Help?

The technology to design and build buildings with radically better performance than the norm exists today (by a least a factor of 2, without any increase in first costs), but there are a number of barriers to their implementation. Two of the most significant are, firstly, a lack of understanding by the market of what is possible and secondly, mediocre practices on the part of the design and construction industry. This project addresses the first of these directly, through the development and testing of a building assessment system and the second indirectly, through the assessment, comparison and publicising of real-world, best-practice buildings.

1.1.4. Outcomes - GBC Framework and GB Tool

The project is not primarily intended to have an major immediate effect on the way that buildings are designed, but it will have a major long-term impact.

The GBC project developed a second-generation assessment framework; one that is designed from the outset to reflect the very different priorities, technologies, building traditions and even cultural values that exist in various regions and countries.

The assessment framework has been produced in the form of software (GBTool) which facilitates a full description of the building and its performance, and also allows users to carry out the assessments relative to regional benchmarks.

Participating national teams test the assessment system on case study buildings in each country. In order to use the system, national teams must first adjust the values and weightings embedded in the system, thereby assuring results that are relevant to local conditions.

The direct output of this four-year process is primarily at the level of R & D; specifically, a thorough understanding of issues involved in designing such a system, as well as a continuing exchange of ideas on the subject by the best researchers in the field.

Notwithstanding the long-term nature of the project, the framework is nonetheless being used by some organisations and designers to inform the design process as to sustainability issues at the building level. Also, some countries that do not have an existing national rating or labelling scheme for buildings are using or adapting the GBC framework for their own countries.

1.1.5. What is Canada's Role?

Internationally:

This is a Canadian initiative that has gained widespread international support. Canada sponsors the work of the co-ordinating Secretariat, which carries out administrative functions and presents system design proposals to the decision-making body for GBC, the International Framework Committee (IFC). The IFC contains representation from all 19 of the participating countries: Canada, USA, England, Wales, France, The Netherlands, Sweden, Norway, Finland, Poland, Germany, Austria, Spain, Chile, South Africa, Japan, Hong Kong, South Korea, Australia.

Nationally:

Each participating country also has a National Team. Canada's team is comprised of leading figures in the field, representing both industry and government, and all geographic regions. These representatives contributed their time on a volunteer basis to complete the work required over the two years of the project.

1.2. Canadian National Team Objectives

To participate in GBC 2000 International process as a step towards:

- Development of an evaluation tool for the building industry in Canada
- To assess the potential environmental performance of buildings in the design stage
- Encourage the transfer of the tool and knowledge to all sectors the industry;
    - Design
    - Regulation
    - Construction
- Promote the "Greening" of the construction industry in Canada

1.3. Composition of Canadian National Team

1.3.1. Team Leader

Alex Zimmerman	*BCBC*	*Victoria*

1.3.2. Representing Organisations:

Robert Thibodeau	*RAIC*	*Vancouver*
Morad Atif	*NRC*	*Ottawa*
Nils Larsson	*NRCan*	*Ottawa*
Stephen Pope	*NRCan*	*Ottawa*
Marc Beaudoin	*RCMP*	*Ottawa*
Doug Pollard	*CMHC*	*Ottawa*
Sandra Marshall	*CMHC*	*Ottawa*
H. Vaidyanathan	*PWGSC*	*Ottawa*
Craig Boyle	*PWGSC*	*Ottawa*
Wayne Trusty	*Athena*	*Ottawa*
Jamie Meil	*Athena*	*Ottawa*
Ray Cole	*UBC*	*Vancouver*
Viv Walsworth	*DND*	*Ottawa*

1.3.3. Other Leading Individuals in Green Building practise:

Bob Bach	*Engineer*	*Toronto*
Peter Busby	*Architect*	*Vancouver*

Doug Cane	*Engineer*	*Toronto*
Steve Carpenter	*Engineer*	*Guelph*
Woytek Kujawski	*Architect*	*Ottawa*
Gord Shymko	*Engineer*	*Calgary*
Jiri Skopek	*Architect*	*Toronto*
Dave Stewart	*Engineer*	*Halifax*

2. Canadian Team Process

2.1. Governance and Sponsorship

The Green Building Challenge 2000 Canadian Team operates under the aegis of the non-profit Green Building Information Council (http://greenbuilding.ca) for the purposes of raising funds to support its activities.

Sponsorship was obtained from a number of Canadian federal government departments and agencies, provincial public works-type organisations and private sector sponsors. Key to the success of the fund-raising from the various federal government organisations was the efforts of the Assistant Deputy Minister of Real Property Services, Public Works, Supply and Services, Mr. Michael G. Nurse, who took on the role of Executive Champion for the Canadian Team within the federal government.

2.2. General

In order to select buildings for evaluation, the team decided to make a public call for participation by project teams and building owners. The team developed selection criteria and advertised, using those criteria, for projects in the fall of 1999. The call for participation closed in early 2000 and the team met to select the projects for evaluation. The evaluations were undertaken by sub-committees of the Canadian Team. Since the team included many active practitioners in the green building field, some of whom were part of submitted entries, evaluation sub-committees were selected on the basis, that a team member could not sit on an evaluation sub-committee that would consider a project with which the member had any other involvement. This ensured that the evaluations avoided any apparent or actual conflict of interest.

Three buildings were selected for full evaluation. Six additional buildings were selected for presentation as poster projects. Following selection, the project teams were notified and the work began on data gathering and assessments. Due to the significant information requirements, project teams were reimbursed for their work in gathering project data for the evaluation. Separate contracts were awarded for operating energy simulation, embodied energy calculations and modification of framework for national conditions.

In order to ensure that there was a consistent approach to evaluation across building types, specialists in the major subject areas were contracted to perform the assessments for their subject area for each of the projects. For remaining issues and to ensure that all of the other assessment work was completed, assessment teams were established to co-ordinate the specialists' work and do the remaining assessments.

2.3. Building selection criteria

Mandatory	One building in each of the 3 GBC Categories, Schools, Residential, Offices, with the potential to do more if the budget allows and enough worthy projects are put forward.
Mandatory	Work towards representing climatic and regional variations in Canada
Mandatory	"Green" Achievement level
Mandatory	Availability of data and co-operation of owner

Important	Architectural quality (adjudicated independently by Marco Polo of Canadian Architect magazine)
Important	Repeatability of project (including economic viability) - for education and transfer
Optional	Both private and public projects

3. Selected Projects

3.1. Results Of Evaluation Process:

A total of 14 submissions were received.

Other / Education Category: 3 submissions received;
1 project recommended for full assessment:
York University Computing Science Building, Toronto, ON

1 project recommended for poster: Liu Centre for the Study of Global Issues, UBC, Vancouver, BC

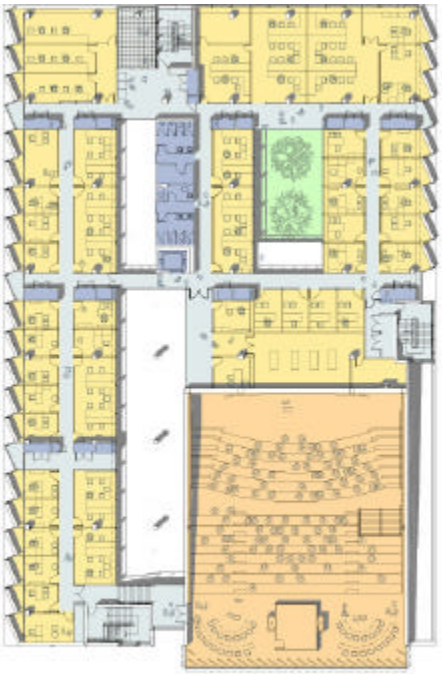
Multi Unit Residential Category: 2 submissions received;
1 project recommended for poster: 77 Governors Road, Dundas, ON

Office Category: 9 submissions received:
2 projects recommended for full assessment:
Telus Head Office, Vancouver, BC
Angus Shops, Montreal, PQ

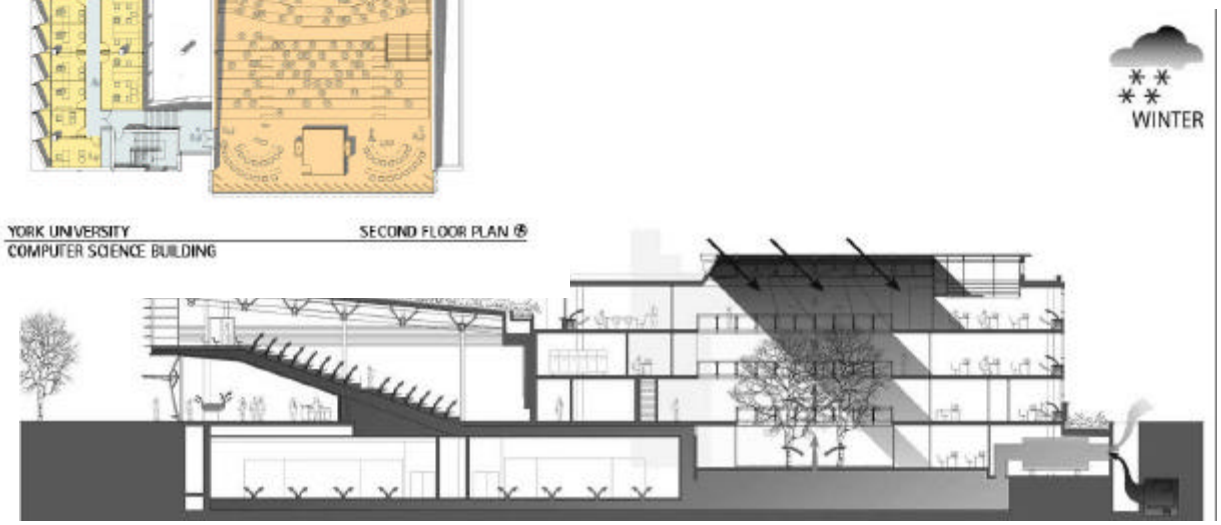
3 projects recommended for poster:
BC Gas Operation Centre, Vancouver, BC
MDSI Sun Life Building, Richmond, BC
Mountain Equipment Coop Head Office, Vancouver, BC

3.2. York University IT Building, Toronto

- Efficient land use: infill site
- Green roof retains site vegetation and controls white water runoff
- Good use of recycled materials, brick, steel, aluminum, fly ash in concrete
- Significant reduction in life-cycle energy use over benchmark
- Careful consideration to water use
- Provision for future use of renewables
- Reduced GHG and acid gas emissions due to energy efficient building supported by a central plant with gas turbine-cogen for steam and chillers using HCF-134a & HCFC-123
- Storm water flows controlled by Green roof & holding tanks
- Building and plantings designed to control wind and snow, based on wind studies
- Excellent use of daylight; limited interference with daylight for other buildings



- Careful attention to envelope and indoor systems to ensure good moisture and pollutant control
- Natural ventilation system for spring/fall Full cross ventilation in all teaching and support areas
- Larger temperature set point span, winter humidification, summer cooling when required
- Excellent use of daylight combined with high quality lighting and control systems

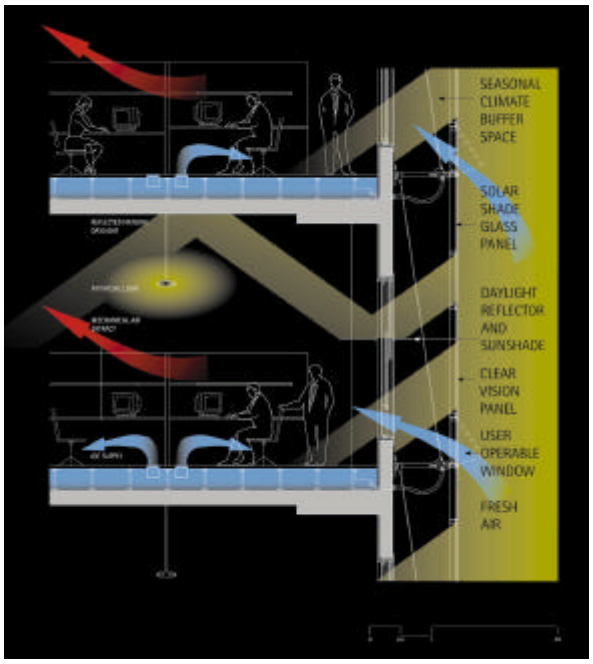


3.3. Telus Headquarters Office Building, Vancouver

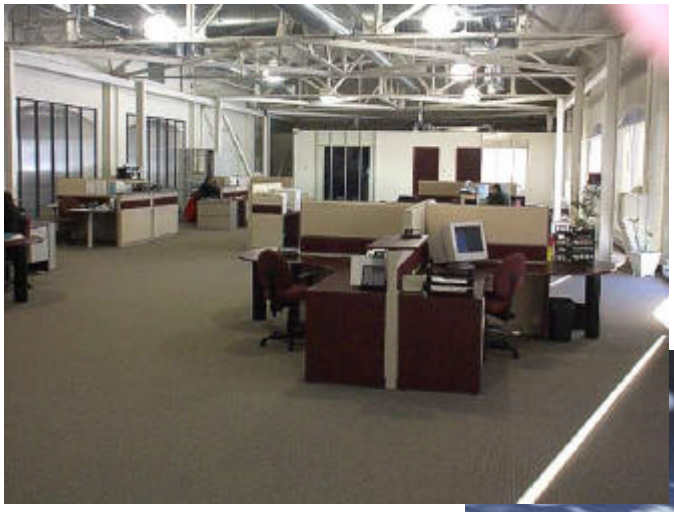
- conversion/ refurbishment of 1940's 12,000 m^2 switchgear & office tower
- architect persuaded client to accept refurbishment rather than brand new
- saved embodied energy by re-using existing structure and windows
- high-tech skin, operable windows
- energy performance target 55% of ASHRAE 90.1

- new second layer of fritted double glazing added
- suspended 900 mm from the existing building
- operable windows
- allows natural ventilation strategies
- effectively becomes "triple-skinned"
- typical external wall section
- interior light shelves
- indirect lighting

- raised floor ventilation and cooling
- windows operable by users
- natural ventilation possible in moderate temperatures



3.4. Angus Technopole, Montreal



- The envelope was significantly upgraded by roof insulation and superior insulation for all new outside walls.
- The team developed a strategic green option to recycle/reuse of the entire building.
- Free summer night cooling by integration of louvered windows and air extractors with skylights - reduction of air conditioning (see section).

- The building features natural ventilation, natural daylighting, operable windows.
- The building has retained most of the structure. The interior furnishing and fitting were reused.
- The building uses existing, refurbished brick walls as "screen "walls.
- Fenestration with low emissivity glass .
- High level of deconstruction principles
- Maintains the look of the original building
- Excellent effort to mate building with site
- The building demonstrated excellent repeatability

4. Assessment Results

4.1. Scoring

Each project was scored using the assessment framework, in the following categories:

Environmental Sustainability Indicators (ESIs) are a limited set of *absolute* performance measures that characterise sustainable building practices and that facilitate international comparability. An ESI represents a *fundamental* performance requirement for all buildings in a sustainable society, e.g., it must relate to areas of non-renewable resource consumption, environmental loadings and human health concerns.

Resource Consumption - performance issues that relate to the depletion of natural resources.

Loadings - performance issues that relate to the outputs from the building construction, operation and demolition which place stress on natural systems potential impact on the immediate surroundings.

Indoor Environmental Quality - performance issues that relate to the building characteristics that affect the health and comfort of building occupants.

Quality of Service - performance issues that relate to characteristics of the case-study building that enhance adaptability, flexibility, controllability and maintainability.

The ***Performance Scale*** for each of the indicators ranges from –2 to +5. A score of 0 is equivalent to the performance of the benchmark building for the area. A score of 3 is considered to be equivalent of the economic best practise for the area. A score of 5 is considered to be equivalent of the best attainable for the area, regardless of economics.

An example performance scale for primary energy is given below.

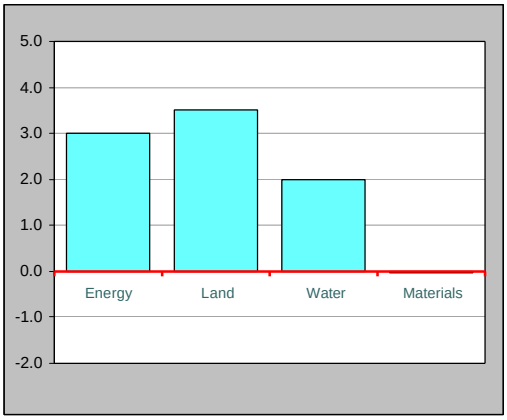
Score	Default Performance
	The annualized primary embodied energy consumption plus the annual primary delivered energy, normalized for net area and annual occupancy is:
-2	130% of the benchmark value or more
-1	115% of the benchmark value
0	Equal to that of a building of the same size and shape as the case-study building, assuming a structural system, building envelope and mechanical/electrical systems that would be typical for a conventional building in the region. (100%)
1	85% of the benchmark value
2	70% of the benchmark value
3	55% of the benchmark value
4	40% of the benchmark value
5	25% or less of the benchmark value

More information on the Framework and GBTool can be found on the Green Building Information Council website (http://greenbuilding.ca).

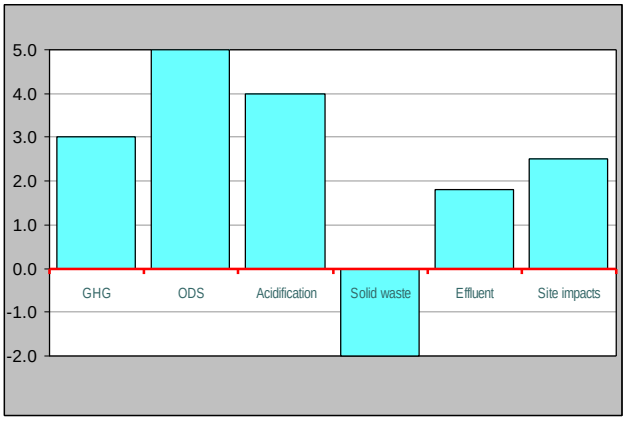
4.2. York University IT Building - Scoring

	Environmental Sustainability Indicators for Design	by area only	area & occup.
ESI-1	Net annual consumption of primary energy for building operations in MJ, normalized for net area and occupancy	**2021**	**324**
ESI-2	Net area of land consumed for building and related works, normalized for net area and occupancy	**0.46**	**1.97**
ESI-3	Net annual consumption of potable water for building operations, normalized for net area and occupancy	**18.7**	**6.2**
ESI-4	Net annual GHG emissions from building operations, kg. CO_2 equiv., normalized for net area and occupancy	**24**	**11**
ESI-5	optional, at discretion of national teams		
ESI-6	optional, at discretion of national teams		

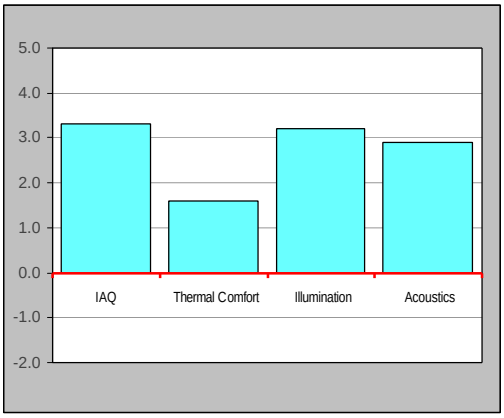
Resource Consumption



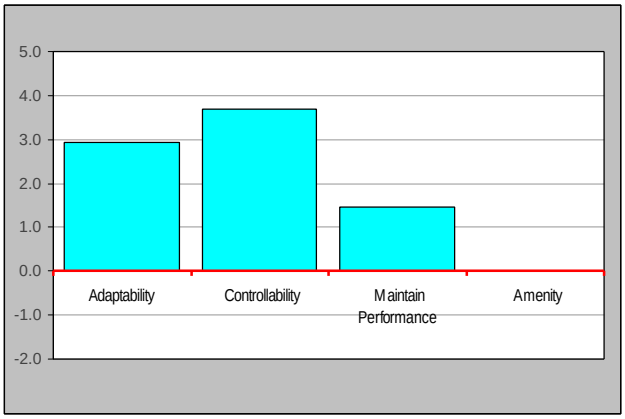
Environmental Loadings



Indoor Environmental Quality



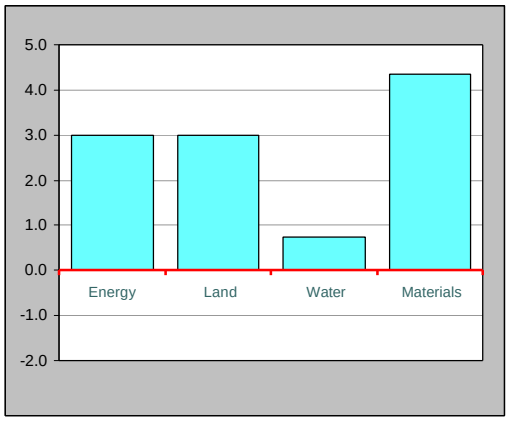
Quality of Service



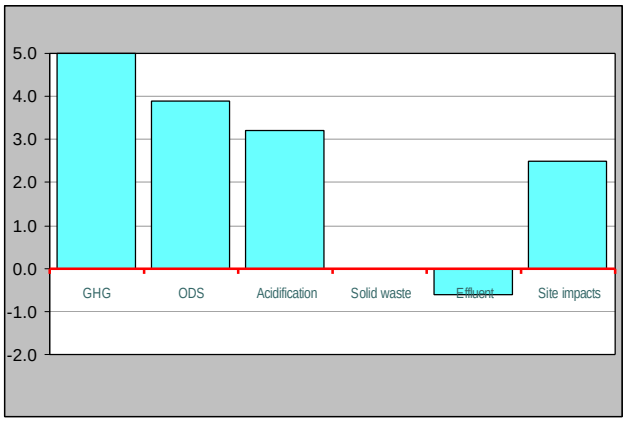
4.3. Telus Headquarters Office Building - Scoring

	Environmental Sustainability Indicators for Design	by area only	area & occup.
ESI-1	Net annual consumption of primary energy for building operations in MJ, normalized for net area and occupancy	**1464**	**805**
ESI-2	Net area of land consumed for building and related works, normalized for net area and occupancy	**0.15**	**2.61**
ESI-3	Net annual consumption of potable water for building operations, normalized for net area and occupancy	**31.2**	**8.6**
ESI-4	Net annual GHG emissions from building operations, kg. CO_2 equiv., normalized for net area and occupancy	**42**	**9**
ESI-5	optional, at discretion of national teams		
ESI-6	optional, at discretion of national teams		

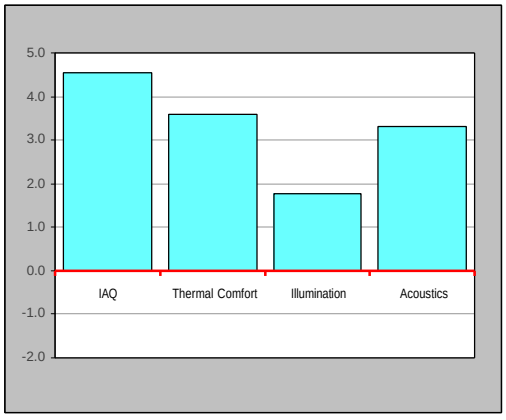
Resource Consumption



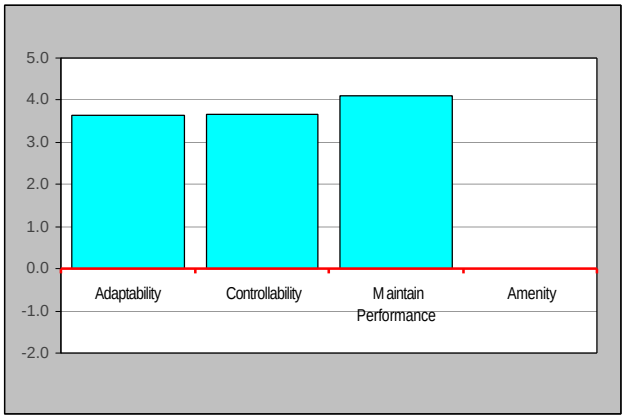
Environmental Loadings



Indoor Environmental Quality



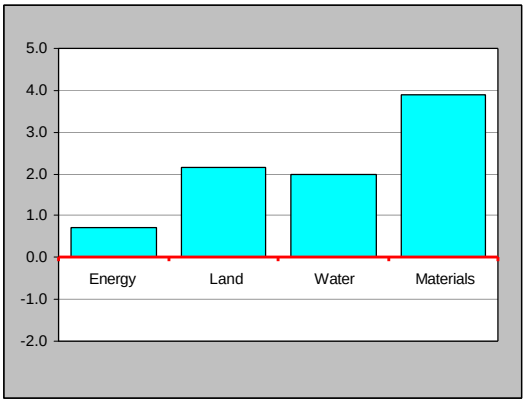
Quality of Service



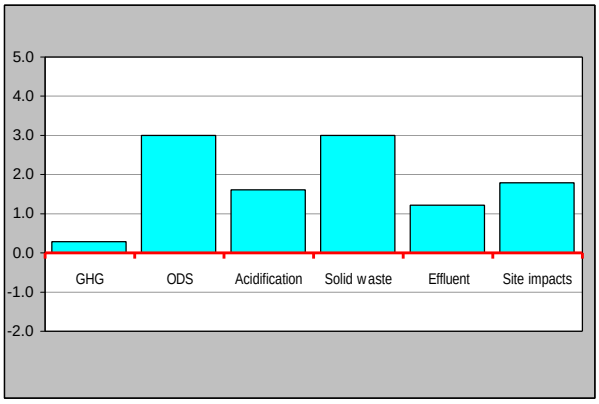
4.4. Angus Technopole - Scoring

	Environmental Sustainability Indicators for Design	by area only	area & occup.
ESI-1	Net annual consumption of primary energy for building operations in MJ, normalized for net area and occupancy	**1448**	**2379**
ESI-2	Net area of land consumed for building and related works, normalized for net area and occupancy	**0.96**	**42.22**
ESI-3	Net annual consumption of potable water for building operations, normalized for net area and occupancy	**25.5**	**11.6**
ESI-4	Net annual GHG emissions from building operations, kg. CO_2 equiv., normalized for net area and occupancy	**33**	**54**
ESI-5	Net one time (initial) embodied energy impact for the design building in MJ, normalized for net area and occupancy	**-425.0**	**-700.0**
ESI-6	Net one time (initial) GHG emissions from embodied energy, kg. CO_2 equiv., normalized for net area and occupancy	**35**	**57**

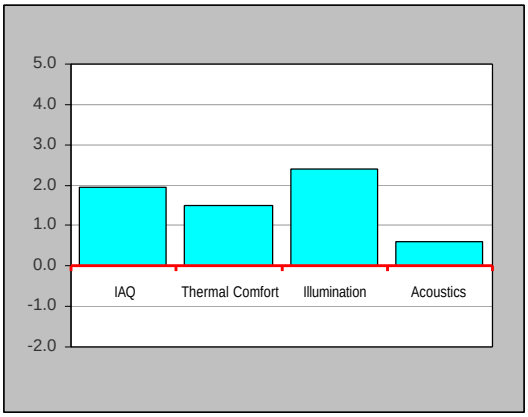
Resource Consumption



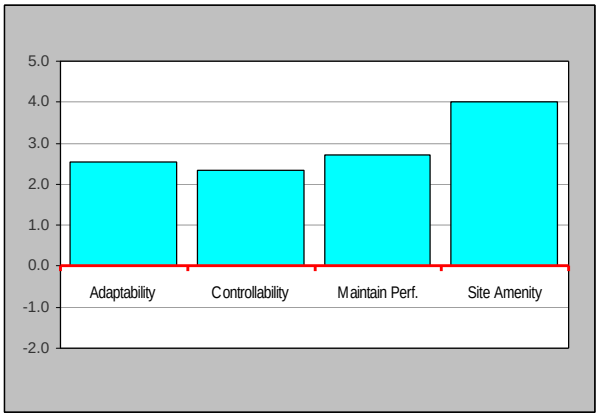
Environmental Loadings



Indoor Environmental Quality



Quality of Service



5. The Maastricht Experience

The Canadian Team, like all the other national teams, faced a number of challenges in completing the assessments, including data gathering, ensuring consistency of analysis and credibility of results. This was done through a combination of means. Project teams were contracted to do the data gathering, specialists were contracted to perform regional adjustments to the default baseline, perform embodied energy calculations and operating energy simulations. The final assessments were performed by volunteer sub-committees of the whole team.

The assessment sub-committees concluded that The GBC framework and the GBTool provides a logical approach towards understanding sustainability in buildings. The sub-committees also concluded that, besides assessment, the tool can also help during the planning and design phase by enumerating the issues and guiding the direction for design to move towards sustainability. Although this version of the Tool was much more transparent than the version used in GBC 98, it would require fine tuning to make it a "retail-level" user-friendly tool. One of the sub-committees felt that "Urban Context" was important enough that it should be a mandatory part of assessment and should be included among the overall sustainability indicators. Most of the project partners were reasonably satisfied that the ratings obtained from GBTool reflected the "green" performance of their projects.

The GBC sessions at Maastricht were one of several parallel streams at the Sustainable Buildings 2000 conference, but they were all very well attended. The Canadian Team presentation was introduced by Bruce Lorimer of PWGSC, who was representing Mr. M.G. Nurse, the GBC 2000 Canadian Team Champion. The overview of the Canadian Team process was given by the team leader Alex Zimmerman , the Angus Technopole project was presented by the assessment sub-committee leader Vaidy Vaidyanathan and the York and Telus projects were presented by project architect Peter Busby and project engineer Kevin Hydes. The presentations were well received and a number of favourable questions and comments were made to team members later.

A GBC 2000 CD containing the conference case-study project presentations, posters and team posters is to be completed by about mid-January of 2001.

6. Lessons learned from Maastricht

6.1. Canadian Effort

It became evident during the presentations by other participating GBC countries at the conference in Maastricht that the task for Canada was larger and more difficult than for many other countries because of several factors:

- the early decision to assess three projects from diverse climatic areas, necessitating regional adjustments to default baselines, whereas most participating countries tend to be more climatically uniform;

- the decision to perform life-cycle energy calculations using the Canadian-originated Athena tool – many countries have no such equivalent database and tool and therefore simply do not perform these calculations;
- the decision to perform operating energy simulations using DOE 2.1 simulation program – many countries either have no such tool available, or used simplified methods to estimate operating energy.

Generally, most other countries had a more simplified participation in the GBC 2000 process than did Canada, with a notable exception being Japan. The other countries, for the most part, either made use of existing assessment processes in their countries or assessed only one project using simplified methods. As a result, the cost and time of their participation was much less than that of the Canadian team. In light of this, Canada may want to re-consider the scope and depth of its assessment efforts, and be clear on the rationale for doing so, for the next round leading to GBC 2002 in Norway.

6.2. Summary of Plenary Session Presentation by Ray Cole: GBC 1998 vs GBC 2000

- GBC 98 characterised by more assessment vs more emphasis on design in GBC 2000;
- GBC 98 characterised by simplicity vs GBC 2000 by more complexity;
- GBC 98 emphasis on environment only vs GBC 2000 emphasis on whole building;
- Fluctuating emphasis for research of market-based mechanisms;
- Many of the same members, but more collective experience;
- Changed framework – different structure, organisation, scope of assessment issues;
- Environmental Sustainability Indicators – country names removed for neutrality, but no major surprises in terms of differences between continents;
- Goals for designing green buildings – lots of innovation in GBC 2000;
- Goals for evaluating green buildings – this emphasised the importance of international indicators.

7. Future Directions for GBC

7.1. International Initiative for a Sustainable Built Environment

A new organisation has been formed, comprised of a small group of international researchers who are active in the issues relating to the environmental impact of the built environment (buildings and urban infrastructure), and in the changes that may be necessary in design, construction and operation to move towards a sustainable built environment . The organisation is called International Initiative for a Sustainable Built Environment (iiSBE).

iiSBE will actively facilitate and promote the adoption of policies, methods and tools to accelerate the movement towards a global sustainable built environment. It will be active in three principal areas:

- Map current activities and establish a forum for information exchange on SBE initiatives for participating organizations, so that gaps and overlaps may be reduced and common standards established;
- Increase awareness of SBE initiatives and issues amongst non-participating organizations and in the international user community, and:
- Take action on fields not covered by existing organisations and networks.

iiSBE has a number of specific tasks, but the major one of concern here is that it will take over international management and coordination of the Green Building Challenge (GBC) process, as agreed to by the GBC International Framework Committee (IFC). iiSBE will assume international management of the GBC process, as of January 1, 2001. Expected results include:

- iiSBE will be able to provide better management
- IFC will be still be making the decisions re. GBC

- IFC Chair will report to iiSBE Board
- The iiSBE Board is to include representation of GBC, CIB (Conseil International du Bâtiment), etc.

7.2. Sustainable Building 2002

All participants at the Maastricht SB 2000 Conference, along with the GBC IFC, agreed that another conference in the series should be held in two years time. A number of Norwegian agencies have agreed to sponsor SB 2002 in Oslo, Norway in the fall of 2002.
A number of new countries are interested in participating more fully in SB 2002, including Argentina, Italy, Spain, Australia, and Israel. SB 2002 may also see the return of Switzerland to the process.
The next meeting of IFC will be in Santiago, Chile, during March 2001.

8. Final financial statement

The Team is not able to issue the final financial statement at this time, as two major contributions have not yet been received and a number of invoices are still outstanding.
An interim statement will be issued by mid-December, pending the receipt of contributions and invoices, and pending review by an accountant.
The value to this project of unpaid volunteer work from private sector Professional Architects and Engineers, while not tracked, significantly exceeds their estimated $200,000 worth of time contribution.