# INTEGRATED DESIGN CHARRETTE REPORT

# UPPER CANADA COLLEGE SPORTS COMPLEX

**Upper Canada College**
**June 14, 2004**

**By**

**Sustainable Buildings Canada**

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## INTRODUCTION

On June 14, 2004, Sustainable Buildings Canada (SBC) and Upper Canada College (UCC) hosted a 1-day Design Charrette focused on providing energy efficiency and environmental alternatives for a new Sports Complex (arena and swimming pool) to be located on UCC's Toronto campus. The Charrette attracted more than 40 participants, representing architects, engineers, educators, building operators and a variety of technology specialists.

With key funding support from Enbridge, NRCan and Ozz Energy Solutions, the Charrette attempted to demonstrate that superior environmental designs can be developed through the integrated design process.

Design Charrettes typically focus on new buildings and use the "integrated design process" to create more environmentally friendly and robust designs. The integrated design process is a method used to challenge designers to consider new strategies and products, in this case, for more sustainable sports complex.

- An integrated team formed early at the concept stage, can maximize the potential benefits. This is when concepts can change easily as new ideas are considered.
- An integrated team includes members with diverse expertise and experience to inform the process including property managers, energy simulators, costing experts, energy efficiency experts, envelope specialists, municipal engineers and planners and alternative energy specialists along with the design team members. These team members work together to achieve a higher performance, value added building. This multi-disciplinary relationship should continue throughout the design and construction phases.

For this Charrette, three teams were assigned to the new sports complex project and given specific scenario-based challenges for examining a variety of design alternatives. Each team consisted of approximately 10 core members, with floating experts and guests circulating among the teams.

Sustainable Buildings Canada is pleased to provide the following report and wishes to thank all those involved in making this important event happen. In particular, our host for the day and building owner - Upper Canada College, our core funders – NRCan, Enbridge and Ozz Energy Solutions, the Design Team – Zeidler Partnership, the facilitators, modellers and experts, and finally Innovolve Inc. for their excellent organizational support. Thank you to all.

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## DESCRIPTION OF THE BUILDING AND DESIGN SCENARIOS

Upper Canada College is in the midst of a developing a 10 year "Green School" Master Plan which will set out conceptual site plan(s) for various scenarios on its Deer Park Campus, illustrating spatial configuration and functional relationships of built and open space for all existing and future facilities. (See: www.ucc.on.ca/greenschool)
As part of this plan, the College intends to renovate or replace the existing Patrick Johnson Arena (PJA) in the Spring of 2005. The PJA will be part of larger plan for a new Arena and Athletic Complex that will include an additional NHL size hockey rink and a swimming pool. As part of the Master Planning process, the Consultants are being asked to prepare an Arena Complex design brief in line with the Green School initiative, including design criteria, and standards of sustainable performance for the building and systems.

This Design Charette is being undertaken as part of UCC's Green School initiative, and as such was carried out within the context of Green School principles. The principles are designed to infuse environmental awareness and responsibility into College life, and are as follows:

1. Integrate the UCC community harmoniously with its natural environment.
2. Provide an educational focus on how we conduct ourselves as an organization.
3. Consider all aspects of value and cost, both in the long and short term.
4. Strive for continual improvement in our demonstration of environmental responsibility.
5. Private School, Public Purpose: demonstrate leadership by being a model for others.

### Design Scenarios

Three teams were challenged to consider design alternatives for the project. Team 1 focused on energy use alternatives and CBIP based scenarios. Team 2 examined an environmental performance scenario while Team 3 examined life cycle costing issues. Each team was also requested to consider the financial planning options and a number of cost consultants worked closely with the teams to ground the assumptions with cost/financial input. The detailed scenarios were as follows:

*CBIP Scenario – Design Team 1*
*Facilitator: Mr. Scott Rouse. Modeller: Mr. Chris Jones*

The team will operate on the basis that the building form has been determined. Elements that cannot be changed by the team are listed below. All other elements can be changed. Energy efficiency to meet CBIP, a high level of occupant comfort, and water efficiency are the goals. The team will operate under the assumption that the building will be heated and cooled with a conventional system(s).

Fixed Elements:
1. Building shape and orientation.
2. General appearance of the building (e.g. ratio of fenestration: gross wall area)

Suggested Optional Elements:
1. Materials (make up of glass, pre-cast, etc.), and insulation values.
2. Mechanical systems including
3. Lighting in the common areas
4. Garage lighting & ventilation.
5. Roofing material and water retention.
6. Mechanical systems for Recreation facility.
7. Advanced systems for ice-making

*Environmental Performance Scenario (Energy, Water)– Design Team 2*
*Facilitator: Mr. David Chernushenko. Modeller: Mr. Jiri Skopek*

This is a scenario where optimum environmental performance is the goal. While the participant are encouraged to cover all of the energy and environmental performance issues, the team should put emphasis on the energy, water efficiency performance and consideration of renewables.

To ensure that all energy and environmental issues are covered in an integrated manner, the participants are encouraged to refer to the Green Globes questionnaire. The On-line Green Globes Design assessment: http://www.greenglobes.com/design/ will be used to evaluate the team's results.

*Environmental Performance Scenario (LCA, Healthy Indoors)– Design Team 3*
*Facilitator: Ms. Diana Hamilton. Modeller: Ms. Sandy Kiang*

This is a scenario where optimum environmental performance is the goal. While the participant are encouraged to cover all of the energy and environmental performance issues, the team should put emphasis on the material selection, waste minimization, pollution reduction and creation of a healthy indoor environment. The team will be challenged to reduce the LCA impact of the design.

To ensure that all energy and environmental issues are covered in an integrated manner, the participants are encouraged to refer to the Green Globes questionnaire. The On-line Green Globes Design assessment: http://www.greenglobes.com/design/ will be used to evaluate the team's results.

## RESULTS

Results representing key issues and are presented for each team. Model outputs including CBIP/EE4 proxies and Green Globes results are also provided. More detailed outputs from the assessment tools are provided in the Appendix.

### Team 1. CBIP Scenario

The Team focused primarily on energy use and identified opportunities to meet or surpass the CBIP standard. Scott Rouse of Energy@Work facilitated and Chris Jones of

Enersys Analytics modeled Team 1's deliberations using a hybrid CBIP Wizard Development Tool.

Deliberations took place in three sessions. The Team started with a visit to the proposed site and also examined the existing arena structure. The morning session then focused on establishing the current situation, the basic design features and key concepts. The early afternoon session combined part of its efforts with Team 3 to examine some specific technologies and scenarios and hear from a variety of the experts. The final session further developed the Team's results including preliminary modeling results.

**Session 1.**

**Current situation:** The current arena was built approx 30 years ago and primarily designed as a winter facility. More ice making facilities, as well as 2 dressing rooms have been added since then, but no change has been made to the "envelope" – the building shell remains the same. There are a number of considerations and concerns regarding the structure itself:

- Almost everything needs to be replaced, right down to the slab and concrete
- There is a 3 1/2 inch gap between the added change room facilities and the original structure
- The floor of zamboni room is sinking. This is very inefficient in terms of energy
- There is a large problem with humidity and moisture - many of the materials in the building (e.g., wood) are suffering as a result. The windows around the rink are also persistently fogged.
- The roof is leaking considerably
- Ice shavings – currently hot water is used to melt the shavings which is not ideal.
- 2 chillers – these evaporate the water and need to be replaced. Significant funding has been allocated for contingencies for the chillers ($100,000).
- The arena does not fulfill its primary purposes particularly because there is not enough change room facilities etc. Revenue sources from hockey tournaments are being missed as a result.

There is a distinct need to upgrade this facility as it is a major revenue source, a private venue, and an outdated facility. UCC would like to retro-fit the older rink. The older rink is also used for exams, indoor sports, etc., but it is not maximized to its full potential. The biggest cost is ice-making.

**Fixed elements**: building shape, exterior
**Areas of discussion**: mechanical systems, parking lot options, ice-making systems, materials, location of pool, indoor corridor, public space (sport shop, skate sharpening, retail, coffee shop etc.), and phasing of new construction.

**Structurally** – the metal purlins are in good shape; the envelope itself is not insulated but in good shape. The entire slab is deteriorating and needs to be replaced.
**Operations -** $40,000.00 is spent on maintenance annually on mechanics alone. Energy consumption, gas, heating, etc are added costs.

**Key Concepts:**

- **Shape orientation**: Having the dressing rooms and corridors on the south sides of the building. This would reduce the solar load on the arena parts. A better understanding of the issues related to southern exposure is required.

- **Existing parking lot**: UCC is considering building underground parking – what effect would this have? Is it possible to bring the arena's side by side? There is currently a heritage tree and the headmaster's house to consider.
- **Maximizing green space and field playing space**.
- **Moving the pool into the older arena**: considerations include humidity factors, modifying the envelope, esthetics, etc.
- **Modifying the shape and purpose of the building** to maximize green space, function, tennis courts, spectator possibilities, structure, etc.

**Core principles**:
- Focus on intended use
- Structural integrity
- Required end uses
- Long term objectives
- Natural light
- Ice Surface
- Heat balance
- Water and ice removal

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**Session 2: Panel of experts after lunch (Groups 1 & 3 combined)**

This session was dedicated to hearing from experts from various backgrounds and area's of expertise. Major issues identified included:
- Synergies exist between the pool and the rink – a mutual relationship between heating and cooling. This would be beneficial between the summer/winter months. Heating buildings through their foundations is a new practice and can be implemented. This would optimize the size of the geothermal field (although geothermal fields have low static loads).
- Heat transfers from the geothermal field are very portable. Heat can be transferred quite far.
- A rink facility was demonstrated that uses geothermal heat pumps for heating and air conditioning. Significant excess heat is generated providing potential opportunities for heat recovery. These rinks are often combined with swimming pools and are a great example of how to maximize geothermal effectiveness. E.g., the swimming pool is heated using the heat from the ice rink.
- Most modern rinks have under-ice heating.
- Radiant heating in the underground parking lot was identified as a possible alternative.
- What is the structural effect of freezing concrete? If the concrete is mature there will be no structural effect. Required thickness of the concrete will depend on the months of operation for the rink. Concrete will stand up to many elements provided that the temperate environment is taken into account as part of the structural design..
- Using **wood** as the structural material is often optimal. Generally arena operators prefer wooden structures for ice surfaces. Its benefits includes general environmental impacts and leak prevention. If a pool is also constructed, given the chemical atmosphere, wood also has the benefit of not requiring the expensive coatings that other materials might.

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**Session 2**: Team 1 continued

**Potential restrictions imposed by the site, include**
- height, green space, zoning, and cost.

**Solutions**
- Keep some of the structure underground, some of the structure above ground, and use the existing tennis and parking areas.

**Phasing concern**
▪ **Interrupting the ice time** is an important consideration. Should the old rink be retrofitted first or concentrate on building the new one? The energy balance would benefit from building the swimming pool first rather than two arena's and no pool.
▪ Re-use the **existing shed** (the original arena structure) and its footprint for all the pool and support services. The subsequent arena can be designed and built accordingly.
▪ This would also be a benefit for **fundraising** as new arena is likely more attractive for a funding drive.

**Phase 1**: Build a new arena
**Phase 2**: Renovate the old arena/shed into the pool, creating a mutual relationship and support areas between the two.
**Phase 3**: Build the second rink adjacent to the new arena, using the green space to the north for bleachers onto the field. Putting the arenas side by side ("**twinpad**") would be very efficient in terms of square footage, seating, shared space, general traffic, etc.

▪ The two arenas in the current plan would represent approximately 78,000 square feet. Side by side would represent approximately 54,000 square feet – including the change rooms. This could reduce the square footage and the cost considerably.
▪ It would also reduce the competition between old and new rinks. Having two new NHL sized rinks could be great asset to UCC including sponsorship and revenue generation..
▪ Additional options for a multi-level facility can be considered incorporating many features including a weight room, bleachers, lounge, etc.

**Session 3**:

**Areas of discussion**: Windows in the pool area, percentages of light, harvesting daylight, etc. Chris Jones presented an examination of current energy use based on the model:

Refrigeration: 49% of costs
Heating: 42% of costs
Domestic gas: 11% of costs

Retrofitting the current system would yield energy savings, including:
- heat recovery on the existing condenser. Total cost for retrofitting existing arena: $80,000.00. With an Ice Kube system approximately 40% savings are possible.
- UCC has modeled the school in four phases: the main campus, the prep school, the boarding houses and the arena.

**Three components of the new model**: two arenas and one pool – with one existing structure. There is also an opportunity to marry this vision to the fund raising effort. See above phasing schedule – saving space, square footage, cost, etc. This facility would have the ability to serve as a set up for bleachers, etc. Natural light, heat efficiency, green space and space are all factored into this new model.

**Priority:** Use as much rejected heat as possible to reduce excess.

**General Discussion**

**Angling** the field toward the roof would create a natural green space for bleachers.

**Parking** remains an issue. Underground parking is expensive. More parking spaces could also be created from the square footage saved by making the arena "twinpad" and using the extra space for underground parking. There are also structural and cost synergies that also realized from this approach..
*** Traffic and off-site parking** are relevant issues as well, however Team 1 deferred this issue to the other Teams.

**Windows:** Discussion about glazing – glazing is typically put it in an arena at the top 8-10 feet of the windows. Generally the glazing does not extend to the floor. The weakest link with glazing is the potential for heat loss. An advantage of the site is the deciduous trees which will shade the arena in the summer. Consideration should be given to the use of triple glazed windows as they will eliminate condensation which is typically a problem in arenas and pools. From a framing perspective, vinyl is the best option, followed by wood and fiberglass.

**NRCan CBIP Process**
Is cost a downfall by using the NRCAN CBIP approach? The design process needs to be integrated for the process to be effective – interlinking the processes during the design stage and creating a general concept of cohesiveness – this saves money in the long run. If time, efforts, and cohesion are not optimized then the process can suffer. The CBIP application ensures that the integrated approach is used and funding to off-set incremental design costs is available. It does not necessarily delay the project and should enhance the design team process.

**Conclusion**
Team 1 reached a consensus that building the two arenas in a "twin pad" configuration with the pool in the existing shed as a 3-phase development would optimize energy, cost, green space, materials, and common space, making the process wholly efficient.

**Team 1 Modelling Results**

EnerSys was able to provide valuable modeling assistance to help illustrate the possible energy performance of a new arena complex. Using the existing arena DOE2.1E model, the energy savings for a retrofitted arena were modeled and are reported in the Appendix.

**Team 2. Environmental Performance – Energy and Water Use**

Team 2 was led and facilitated by David Chernushenko and Jiri Skopek provided modeling results. Team Two's scenario was environmental performance including site resource issues such as water use and re-use, landscaping and energy supply. The primary focus was on energy, water proficiency, and resources. The team chose to primarily examine issues concerning the sports complex (two arenas and a pool).

The Team spent a large part of its time examining alternative configurations for the buildings and potential environmental outcomes:

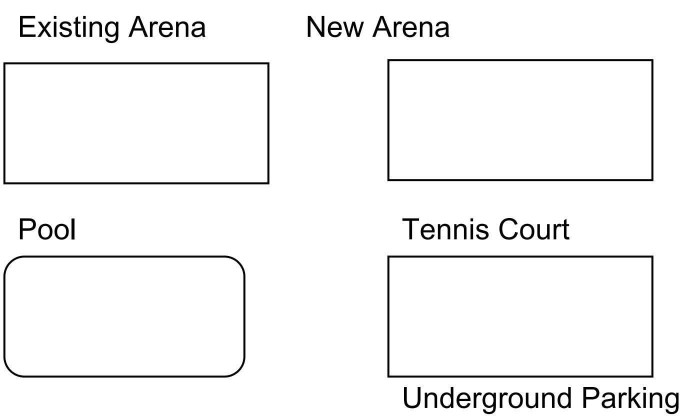
**Site:**

- Potential site location seems to be very restricted.
- A former river flowing underground.
- Program:
    - Existing Arena = 31, 410gsf
    - New Arena = 47, 289gsf
    - Swimming Pool = 36, 900gsf
- Key questions:
    - How to achieve best accessibility of the pool from the Lower School?
    - How to reduce energy demand?
    - How to provide the compact development and minimize the transfer of energy
    - What are the potential energy sources?

**Site plan:**

Following a review of several alternatives the team settled on the spatial disposition indicated below based on the following considerations:

- Accessibility to the pool from the lower school is maximized
- The side-by-side proximity of the two arenas minimizes energy distribution (e.g. sharing the operational equipment runs easily)
- Placing tennis courts on the top of underground parking garage minimizes the structural loading requirements (compared to an arena) and lowers the embodied energy of parking garage roof material
- Tennis court can also be positioned on the roofs of arenas




**Site Issues**

Using the Green Globes framework the team examined several site development issues such as

- wind protection
- use of earth berming as a part of the arena structure and bleachers for the playfield.
- Site traffic management
- shading by surrounding structures
- solar access and orientation
- use natural landscaping and water treatment on site,
- stormwater management and increased infiltration through
    - water retention pond
    - series of micro storage with rainwater directed by bioswales
    - application of ecoturf and green roofs

**Energy Issues**

The team has identified the main energy uses the heating and cooling of the pool and the ice hockey arenas, and the ice-making process load.

**Pool Energy Issues:**

The suggested means of reducing the energy demand of the pool were as follows:

- Specialized HRV.
- Natural lightning and ventilation both in the pool and in the arenas.
- Pool blanket.
- Use of “dumped” pool water on site.
- Natural shading.
- Better commissioning; monitoring.
- Use of photo-chromic glass.

**Arena Cooling/ Heating Issues:**

The team identified a number of potential mechanisms, technologies and approaches that might address the cooling/ heating of the ice arenas:

- Natural Gas cogen system (absorption cooling)
- Geothermal heat pump system distributing energy between the pool, ring and the underground garage.

The selection of the system has several implications on the environmental performance issues

- High efficiency chillers for ice arenas.
- Synergy (up); Waste (down).
- Excess heat from ice plant to be used for range of heating needs:
    - Pool
    - Zamboni
    - Ice Melt
    - Bubble
    - Showers
- Storage of heat –hot glycol; Storage of cold –ice battery.
- Maximize use of day light but avoid glare and direct light. Direct light on the ices surface will affect quality of the ice.

- HVAC:
  - Minimize demand (natural options).
  - Maximize air quality.
- Water:
  - Demand, re-use, recycling.
- Renewables:
  - Passive solar, solar hot water, PV.
  - heat recovery
- re-orient building and use Solera glazing for day lighting of arena and gym.
- Consider the use of triple glazed windows to eliminate condensation and provide greater insultation.
- Opportunities to collect waste heat from arena mechanical systems – the Team strongly recommends that any potential design incorporate advanced heat recovery systems as these should have significant potential energy savings and IAQ attributes.
- Use of a solar wall for make-up air (may not be needed given potential heat gain from arena
- Need for as much fresh air as possible and use of maximum day-lighting to minimize energy use. Recognition of potential impacts of day lighting on ice surfaces. Need to mitigate heating impact.

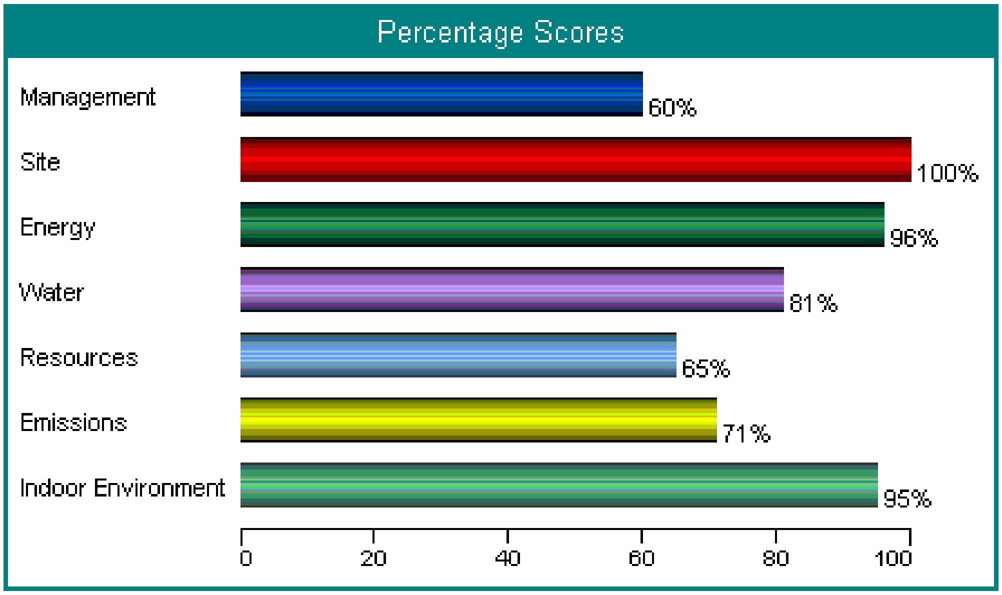
The team also emphasized the importance of considering different types of materials for both their embodied energy characteristics and their potential for positive energy impacts in the building. Notably:

- Large heat/cooling sinks using concrete
- The need for a holistic approach to the selection of construction materials

The Team's deliberations were incorporated in a preliminary Concept Design Green Globes Assessment. Team 2 achieved an overall score of 88%, which would result in a Four Green Globes rating.

The percentage of points achieved by Team 2 for each module is provided below[1]

[1] The full Green Globes Report is provided in the Appendix




**RATING:** 

Four Green Globes

**Team 3. Environmental Performance – Life Cycle Assessment & Healthy Indoors**

Team 3 was led and facilitated by Diana Hamilton. Sandy Kiang provided a concurrent Green Globes™ energy and environmental performance assessment.

Team 3 was charged with addressing a design of an arena complex while maximizing environmental performance, with particular emphasis on minimizing the life cycle impact of the design (material selection), waste minimization, pollution reduction, and creating a healthy indoor environment. The group was asked to review the design the Patrick Johnson Arena (PJA) based on UCC's Green School sustainability principles, goals and guidelines and was challenged to consider design alternatives for two different scenarios that meet or exceed the criteria set out in the design brief. Although the site itself was predetermined, there were no design or cost constraints given to Team 3. The team focused on creating a design that was both practical and feasible.

Team 3 began with a tour of the study area. At this point, important considerations were noted:

- 300 seats were required in the swimming pool complex.
- There was unknown height restrictions placed on the buildings.
- 110 new parking spaces were needed (The proposed design has to address the parking deficit).
- There was a demand for a second arena for approximately 500 seats.
- There was a need for six tennis courts.

Essentially, the four areas that were considered in the design were: the parking lot, the ice arena, tennis courts and the swimming pool.

The team 3 established a list of principles to guide their design::

- Reduce energy consumption
- Reduce ecological footprint
- Zero run-off
- Use of green materials
- Maximize green space
- Use renewable energy materials
- Combine synergies
- Reuse materials
- Eco-efficiency
- Increase social / cultural opportunities
- Minimize artificial energy
- Decrease traffic (contingent on current traffic study being conducted)
- Explore different access to buildings
- Stacking and tucking buildings to increase green space
- Integrate ecological systems
- Connect swimming and arena as closed loop structure
- Exercise leadership and stewardship
- Set green strategy for future development
- Engage students and community in the design process.
- Build a fun and interactive sports facility

A fundamental design parameter for Team 3 was that most or all of the proposed facilities be located underground to maximize energy efficiency and minimize the ecological footprint.

A series of structural designs were examined to increase synergies. These included:

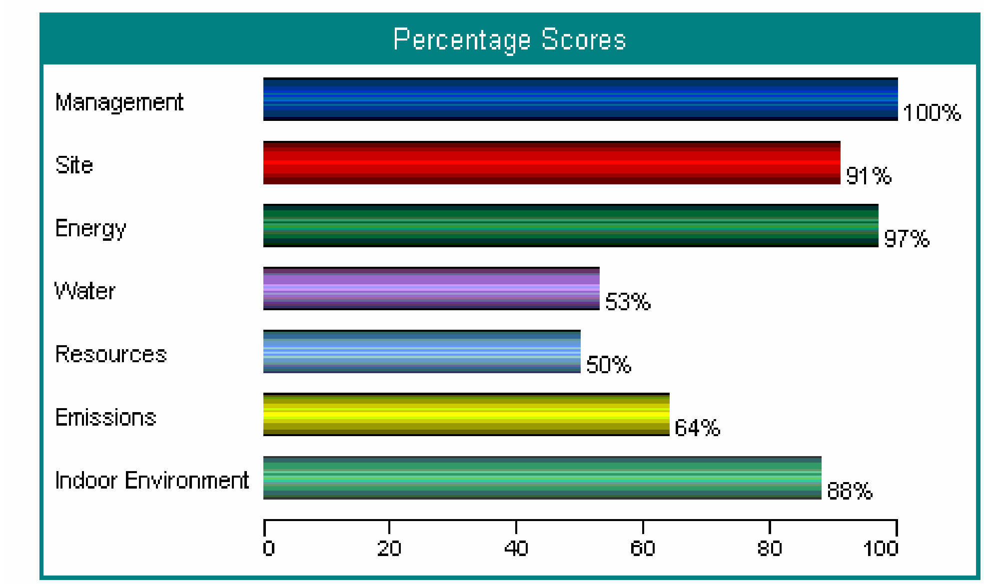
1. **Stacking vs. Side by Side**: Stacking the swimming pool on top of the rink (or vice versa). Issues of humidity, gravity, heaving, and lighting arose. A dryatron was suggested to dehumidify the arena. It was decided that the new arena and the existing arena could be located side by side, connected by a spine-like corridor.
2. **Greenhouse**: The greenhouse would be located on top of the spine (west side on the roof) and act as a living machine for educational and interactive learning purposes. Mirrors required for deflecting light sideways into the connected greenhouse.
3. **Windows**: double glazed operable with soft-low E and argon fill to reduce glare.
4. **Geothermal applications:** to heat building by liquid exchange. The mechanic system will be linked underground, in addition to the pedestrian walkway.
5. **Amphitheatre**: on the north side the pool could be buried with an outdoor viewing amphitheatre on grade.
6. **Solar Panels**: Any flat surface for solar panels.
7. **Trees:** Replant trees a possible solution.
8. **Tennis Court:** locating on top of buildings (east side) from a landscape perspective will leave green space for more robust landscaping operations.
9. **Parking**: Parking under the arena to heat parking area was considered by rejected due to high costs. A grade permeable parking lot would be more ideal, either behind the buildings or single spaces along the driveway. A suggestion was made: having transit drop-off locations (shuttle service to campus). Left parking issue unresolved since parking study is underway.
10. **Existing Arena**: Replace existing arena roof with wood. Wood would be obtained from sustainable, local, forest sources. Issue with doing a green roof on a wood roof. Roof would also have to be light in colour to minimize the heat island effect. Arena would be reused.
11. Storm water pond Could use a storm water pond to be used in the cooling system.

Team 3 also considered but did not model a number of other measures/improvements and recommends that these be considered in the final planning:

1. Storm water pond to be used in the cooling system
2. Variable speed pumps and fan drives
3. Parking garage air handling systems and C0 exhaust control
4. $CO_2$ controls on ventilation air
5. Natural ventilation via operable windows
6. Excess heat can be piped to other buildings on campus.
7. Bio-fuel – diesel vs. natural gas. Could grow canola as a bio-diesel fuel.
8. Gray water reuse system
9. The reuse of the old arena.
10. Change rooms need to be on the same level as the corresponding facility.
11. Daylighting potential.
12. Window shading (blinds, overhangs, fixed shading, ground vegetation)

Team 3 also made use of the Green Globes Environmental Assessment Tool as a checklist for ensuring all pertinent environmental considerations were covered. Subsequently, Sandy Kiang generated a Green Globes report based on the information developed in the session indicating the preliminary Concept Design Green Globes results. The following diagram summarizes the point achieved in each module:

Percentage of points achieved by Team 3 for each module:




Team 3 achieved an overall score of 84%, which would result in Four Green Globes rating.

**RATING:** 

Four Green Globes

# APPENDIX

## MODEL RESULTS USING

## DOE2
## &
## GREEN GLOBES

## DOE 2 Model Results – Team 1

### *The Building Models*

This summary report discusses two general building cases:

- The **proposed case** is the building with retrofit measures, as proposed by the planning team. The proposed building is a "snapshot" of the building taken at some particular time in the design process during and/or after the Workshop.
- The **baseline case** is the building as modelled at the start of the Workshop

### Model Calibration

An essential component of the model development for retrofit analysis was calibration of model results to actual utility bill information. Scott Rouse provided four years of utility bill summaries (EnerSys did not review the actual bills). EnerSys used the period from August 2002 through September 2003 to calculate a calendar-normalized monthly utility bill profile. For an accurate comparison, EnerSys obtained hourly weather data from Environment Canada for the same calendar period. We then calibrated the model energy use to the utility bill data by fine-tuning the energy model characteristics. The resulting calibrated model served as a baseline for energy retrofit planning and can be used for retrofit verification in the future.

Some caution was required when reviewing the utility bill allocation for the Arena model. There is one main electrical meter for the campus. UCC has installed three submeters: one serving the Upper School and Boarding House, one serving the arena, and one serving the Prep School. There were significant discrepancies between the submeter totals and the main meter readings. Scott Rouse provided an estimate of percentages of the main meter to use for the three submeters. EnerSys used those percentages to assign monthly electrical energy use to the Arena. Each of the buildings had a single gas meter. Gas energy was calibrated to the monthly energy from the utility bills for these two meters.

### *Energy Performance Workshop Strategies – Arena*

Average utility Rates were determined by Scott Rouse:
Electricity – Toronto Hydro:
    Energy: $0.101 per kWh – average blended cost over the past year.
    Demand: $0.0 per kW – demand is not broken out on the Toronto Hydro bills.

Natural Gas – Enbridge:
    Energy Arena: $8.21 / GJ – average cost over the past year.

During the Workshop, we reviewed the following energy efficiency measures for the Arena:

1. Low-emissivity ceiling liner.
2. Heat recovery from refrigeration system condenser water to pre-heat domestic hot water (DHW). The main use for DHW is for ice resurfacing.
3. Replace the existing ice plant and surface with a new ice plant and surface. One disadvantage of the current system is that the under ice heat is by electric

resistance. Modern ice plants use a warm brine loop under the ice surface. This way, heat recovered from the condenser can be fully utilized.

Table 2 details the savings of the three items. The first bundle noted in Table 2 includes items 1 and 2 above. The second bundle includes 1 and 3. Figure 3 compares the energy by end use. Figure 4 shows the cost savings.

Table 2. Arena Strategies Explored

| **Energy Efficiency Measures (Applied to Baseline)** | **Economic Analysis** | | | | **Discussion** |
|---|---|---|---|---|---|
| | Incre-mental Capital & Labour | Annual Costs Savings | | Simple Payback | |
| | | O&M | Energy | | |
| Low-e Ceiling Liner | $52,800 | $0 | $5,848 | 8.6 years | Replace existing white liner with new low e liner. |
| DHW Condenser Heat Recovery | $30,360 | $0 | $6,479 | 4.6 years | Capture heat from condenser to preheat DHW for Zamboni. |
| New Ice Plant | $800,000 | $0 | $25,687 | >25 years | Install new Ice Cube system. Includes heat recovered for under rink warm brine. |
| **Bundle Ceiling Liner and DHW Recovery** | $83,160 | $0 | $12,327 | 6.5 years | Combination of measures saves over 17% energy. |
| **New Ice Plant and Low-e Ceiling Liner** | $852,800 | $0 | $28,439 | >25 years | Combination of measures saves over 27% energy. |

Note 1: Costing has been provided by Curran McCabe Ravindran Ross Inc. The costs include 20% for contractor's overhead and profit and a 10% design contingency.

**Figure 3. Arena Estimated Annual Energy Use Comparison by End-Use**

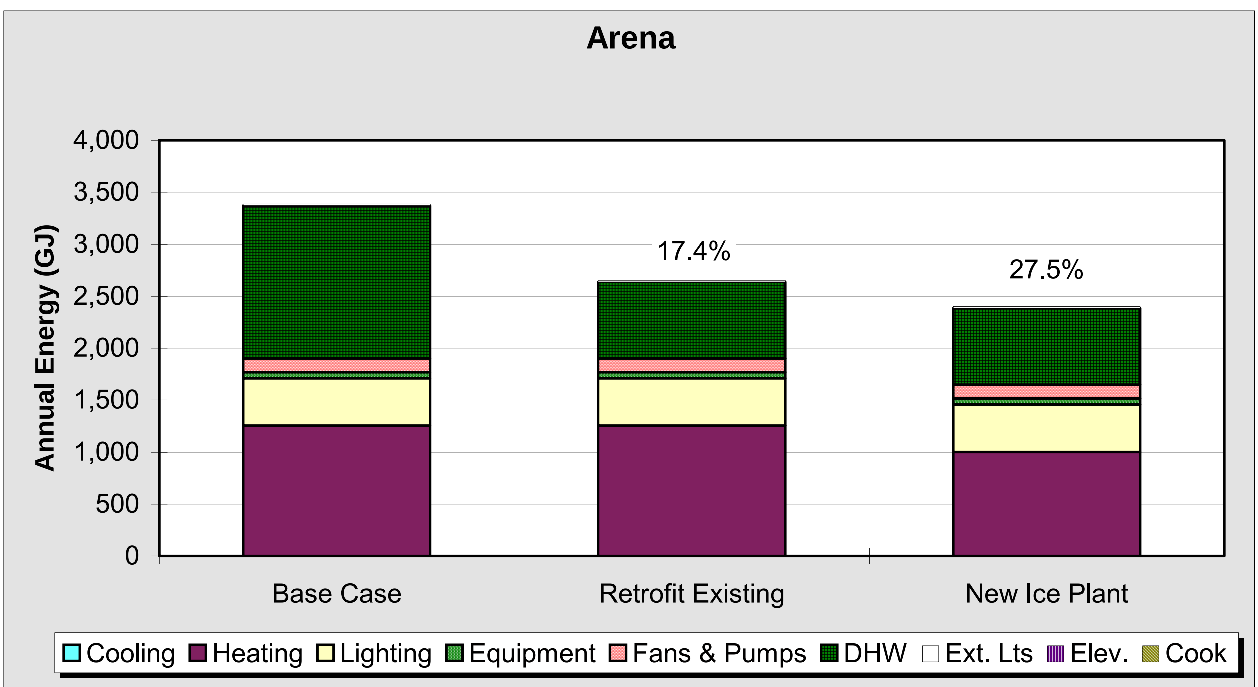
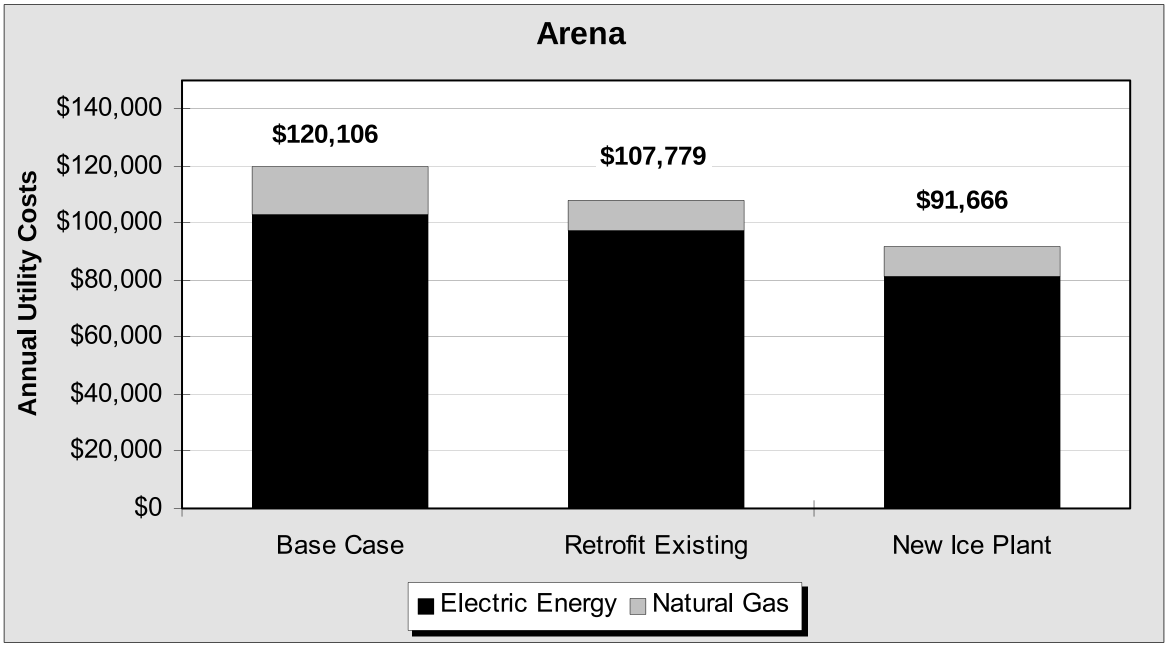


**Figure 4. Arena Estimated Annual Utility Cost Comparison**




Compared to the original arena baseline, the first of the two measures ("Retrofit Existing") is expected to save over $12,000 in annual energy costs. The energy saved is over 900 GJ. The net capital costs for these measures are estimated at $83,000. The payback would be less than 7 years.

In contrast, a new ice plant and ceiling liner would save $28,000 over the baseline building. The energy saved is over 1,400 GJ. The capital costs are estimated at $883,000 with a payback of more than 25 years.

The current energy cost for the Arena is approximately $4.50/sq.ft per year. With a new, conventional ice plant, this cost would drop to approximately $3.4/sq.ft. A new, geothermal ice plant and geothermal heating and cooling of the entire arena would cost approximately $2.75/sq.ft.

The proposed concept design for the new athletic center includes a swimming pool. A geothermal system would use heat rejected by the ice plant to heat the swimming pool water and to heat the ventilation air when required. A significant modeling effort would be required to accurately capture these energy savings.

**Green Globes Results – Teams 2 & 3**

# Green Globes Design

Preliminary illustrative assessment

**Project:** **Athletic Complex, Upper Canada College**

**Date:** **June 14, 2004**

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# Green Globes Eco-Rating Program

The Green Globes Eco-Rating Program was designed to evaluate and rate the energy and environmental design of buildings. The goal of the program is to guide environmental performance integration in the design of the buildings as well as to identify opportunities to save energy and water, reduce waste and prevent water, air and land pollution in the management and operation, based upon the key elements of eco-efficiency. The Program involves a graduated rating system designed to recognise buildings that are improving their energy and environmental performance. In general, the designations reflect the following objectives for each eco-rating level:

- **1 Green Globe**: To participate in the Green Globes Eco-Rating Program, a building design must have identified and initiated some measures to improve the energy and environmental performance such as energy use reduction strategies, water conservation steps, waste reduction, etc. A key component should be commitment to a set of guiding environmental principles.
- **2 Green Globes**: This designation indicates that the design has moved beyond awareness and commitment to sound energy and environmental design practices, and has demonstrated good progress in reducing environmental impacts.
- **3 Green Globes**: This designation indicates excellent progress in achieving eco-efficiency results through current best energy and environmental design practices.
- **4 Green Globes**: This designation indicates leadership in terms of energy and environmental design practices and commitment to continuous improvement and industry leadership.
- **5 Green Globes**: This designation is reserved for select building designs, which are serving as national or world leaders in energy and environmental performance, and are introducing design practices that can be adopted and implemented by others.

**This illustrative preliminary assessment was performed as a part of a sustainable design Charrette. The design assumptions were made based on the team discussion. These may not be reflected in an actual design by a professional design team.**

**Green Globes Concept Design Stage Assessment Report for UCC**

The Athletic Complex at Upper Canada College (UCC), Toronto, Ontario consists of

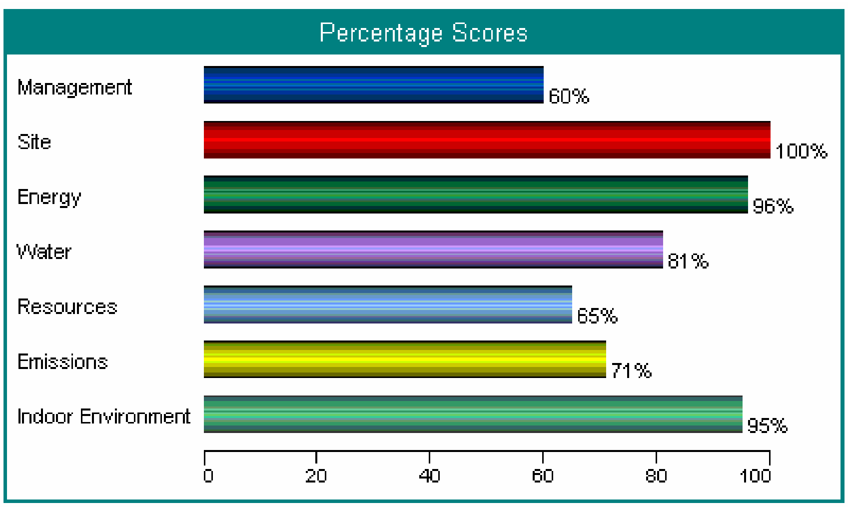
# *INTRODUCTION*

three one storey structures of 9,000 m² in total.

The Athletic Complex is described as follows:

*UCC intends to renovate or replace the existing Patrick Johnson Arena (PJA) in the Spring of 2005. The PJA will be part of larger plan for a new Arena and Athletic Complex that will include an additional NHL size hockey rink and a swimming pool with related support facilities. Part of the project is the development of tennis courts and parking for the complex.*

Percentage of points achieved by Athletic Complex for each module:




The Athletic Complex achieved an overall rating of 88%.

To find out how the performance of the Athletic Complex compares to other buildings that have been assessed, and to obtain certification, the data must be verified by a licensed engineer or architect who has undergone the Green Globes training and certification.

# *Section A: PROJECT MANAGEMENT POLICIES AND PRACTICES*

This section evaluates the extent to which an integrated design process and a team approach are being used to generate design solutions that will meet the needs identified in previous stages, as well as the purchasing policy and the commissioning plan.

The Athletic Complex achieved a score of 60% on the Green Globes™ rating scale for its integrated design process, integration of environmental purchasing and commissioning plan.

## A.1 Integrated Design Process

**Highlights**

- An integrated design process is being used in the SBC sustainable design Charrette process for site selection and the building design concept.
- The Charrette process used a multi-disciplinary team approach.
- Green design facilitation is being used to support green integration.

## A.2 Integration of Environmental Purchasing

**Highlights**

- Environmental purchasing, including the procurement of energy-efficient equipment is being addressed by the UCC Green Team.

## A.3 Commissioning Plan - Documentation

**Opportunities for Improvement**

- Produce a Design Concept Report.

- Prepare Basis of Design documentation in the Design Concept Report. Document the primary assumptions to guide design decisions and provide a narrative description of the building systems. Explain how the design intent goals will be achieved.
- Document the design criteria in the Conceptual Design Report, in response to functional and operational requirements described at the Programming Stage.

# *Section B: SITE*

This section evaluates design strategies for optimal use of the site based on information gathered during the Site Analysis Stage, and in response to the requirements set out at the Project Initiation Stage and further outlined in the Programming Stage.

Athletic Complex achieved a score of 100% on the Green Globes™ rating scale for site design and measures to minimize the impact of the building on the site and/or the site enhancement.

## B.1 Analysis of Development Area

**Highlights**

- The site analysis data for topography, geology, soils, water features, drainage, vegetation as well as previous land use, are being applied to the development of the site plan.

- The site is an existing serviced site.

- The site has been verified as not being a wetland or a wildlife corridor.

## B.2 Development of Strategies to Minimize Ecological Impact

**Highlights**

- The design recommends that undeveloped areas on the site that is areas which will not be build upon or used for parking or access roads, remain undisturbed.

- The design concept proposes the integration of native planting and landscape naturalization.

- There are strategies to avoid creating heat islands through consideration of green roof and planting.

- The design proposes exterior lighting that avoids glare, light trespass and night sky glow.

## B.3 Integration and Enhancement of Watershed Features

**Highlights**

- Site grading will be used to increase infiltration, reduce run-off and divert water from the building.

- The design proposes biological stormwater management features along drainage courses to retain and/or treat stormwater on-site. Stormwater management proposal considers increased infiltration through either or combination of:
  - water retention pond
  - series of micro storage with rainwater directed by bioswales
  - application of eco-turf and green roofs

- The design proposes that hardscapes be minimized and pervious material and vegetated areas be maximized on the site.

- The design proposes that rainwater be captured from impervious areas for groundwater recharge and reuse in the building.

## B.3 Strategies to enhance Site Ecology

**Highlights**

- There are strategies to enhance the site's natural features through paying attention to the existing grading and minimal disturbance of the site's natural features.

# *Section C: ENERGY*

This section evaluates strategies that are being considered to reduce the energy consumption of the building. The proposed solutions should be developed using an integrated design process that considers a wide range of factors such as the site's microclimate, space optimization, the integration of energy- efficient systems and transportation.

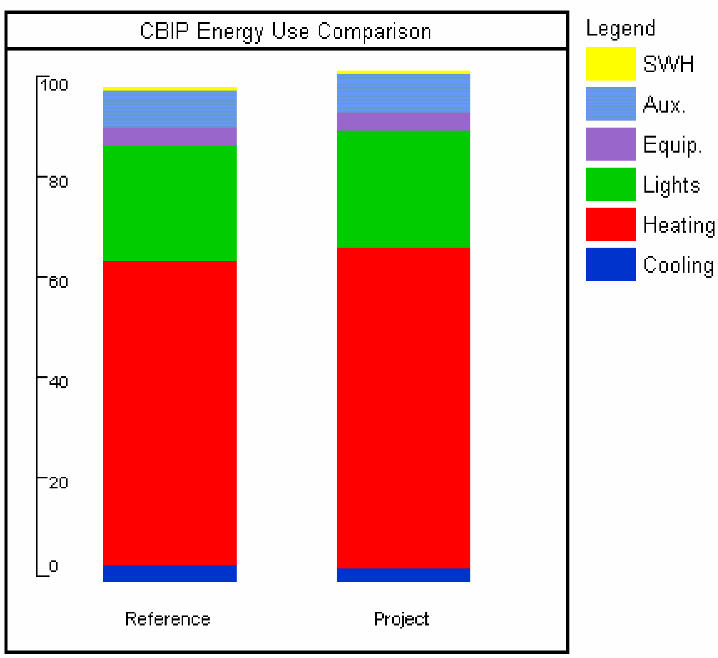
Building systems such as HVAC, lighting and heating of water use large amounts of energy. Energy is an important environmental parameter because it relates directly to climate change and global warming as well as a variety of air emissions. These include sulphur dioxide and oxides of nitrogen, which produce acid rain; as well as hydrocarbons and airborne particles. There is also a direct relationship between energy savings and cost savings.

The Athletic Complex achieved a score of 96% on the Green Globes™ rating scale for energy efficiency. This represents the weighted integration of the sub-scores for: modelling and simulation of the building energy performance, energy demand minimization strategies, integration of energy-efficient systems, integration of renewable energy sources, and planning energy-efficient transportation.

## C.1 Modelling and Simulation of Building Energy Performance; Establishing an Energy Target

Athletic Complex achieved a sub-score of 90% for its energy consumption. The expected annual energy use of the building, as calculated by the Commercial Building Incentive Program (CBIP) Screening Tool, is 2,449 GJ (76 ekWh per gross square metre per year). The projected energy savings as compared to the reference project are -3.2%. (Note the limitation of the estimate for this type of a building obtained from CBIP *Screening tool*.)

Figure: Annual energy use comparison between the reference building and the current design:



**Highlights**

- A preliminary building energy simulation has been carried out on each of the concept options.

## C.2 Energy Demand Minimization Strategies

The use of energy in buildings impacts on the environment through the consumption of non-renewable resources and by contributing to global pollution through greenhouse gas emissions. The reduction of this impact and improved comfort conditions starts with the space planning of the building and consideration of microclimatic conditions. The Model National Energy Code for buildings sets out the design requirements for improving the energy performance of buildings, focusing on both the building envelope and the building systems and equipment.

The Athletic Complex achieved a sub-score of 95% based on a review of space optimization, response to microclimate and topography, daylighting and design features of the building envelope that would be expected to affect the building's energy use and hence its carbon dioxide emissions.

**Highlights**

**Space optimization**

- The design concept accommodates the potential to phase construction.

**Response to microclimate and topography**

- The design proposes that spaces and openings be configured to optimize passive solar gains.

- The design proposes that the building be configured to minimize snow deposition and thermal loss due to wind.

- The design recommends that the building form, occupied spaces and fenestration be coordinated to allow natural or hybrid ventilation.

**Daylighting**

- The building will be located and oriented to maximize opportunities for daylighting.

- The window sizing and placement are being designed to optimize energy-savings and maximize daylighting but avoid glare and direct light.  Direct light on the ices surface would affect quality of the ice.

- Design strategies are being implemented to bring light deeper into occupied spaces, provide uniform lighting and prevent glare.

- The design proposes that window glazing be used to optimize energy-savings and daylighting. (use of Solera glazing for day lighting of arena and gym)

- The design proposes that shading devices are to be integrated to minimize overheating and glare.

- Integration of lighting controls is proposed in the design.

**Optimization of building envelope**

- The design proposes the use of building form and thermal massing to minimize heat loss through the building envelope.

- The design proposes that glazing with a low U-factor be used.

- The design explores material selection strategies to respond to ambient conditions, including wind, precipitation and other environmental forces, which would meet or exceed the performance requirements of the *Model National Energy Code for Buildings*.

- Measures are being proposed to prevent groundwater or driven rain from penetrating into the building.

- The design proposes a continuous air barrier.

**Energy metering**

- The design provides for interval metering or sub-metering of major energy uses such as the arenas and the swimming pool.

## Opportunities for Improvement

**Space optimization**

- Evaluate the proposed use of space and identify spaces that can accommodate more than one function or can be adapted to more or less intensive occupancy.

# C.3 Integration of Energy-Efficient Systems

Building systems such as HVAC, lighting and heating of water use large amounts of energy. The Model National Energy Code for buildings sets out the design requirements for improving the energy performance of buildings, focusing on both the building envelope and the building systems and equipment.

The Athletic Complex achieved a sub-score of 100% based on a review of individual design features of the building services that would be expected to affect the building's energy use and hence its carbon dioxide emissions.

**Highlights**

**Lighting**

- The design proposes the integration of the following lighting features:
    - high efficiency lamps
    - luminaires with electronic ballasts
    - focused lighting where suitable
    - appropriate personal lighting controls

**Ice Chillers**

- High efficiency ice chillers will be used or alternatively the integration of heat pumps.

**Motors**

- The design proposes the integration of energy-efficient motors.

**Building Automation Systems**

- The integration of building automation systems (BAS) is proposed.

**Hot Water Saving Devices**

- The design provides for the integration of hot water saving devices.

**Other Systems**

- Other energy-saving systems or measures are proposed which are listed below:
    - *Opportunities to collect waste heat from arena mechanical systems*
    - *Heat recovery desiccant humidification wheel and ice battery (cold storage) in the ice arena .*
    - *Pool blanket and Use of photo-chromic glass in the pool area.* Use of a solar wall for make-up air (may not be needed given potential heat gain from arena

## C.4 Integration of Renewable Energy Sources

Renewable energy sources are those that produce electricity or thermal energy without depleting resources or producing greenhouse gas. They include solar, wind, water, earth and biomass power, and energy from waste.

The Athletic Complex received a sub-score of 100% for integration of renewable energy sources.

The following energy systems are being considered:

- passive (Solar wall) and active solar-heating
- photovoltaic panels

## C.5 Planning Energy-Efficient Transportation

A daily journey totalling as little as 5 miles by car can, over one year, emit as much $CO_2$ as that emitted to provide heat, light and power for a person in an office.

**Highlights**

**Public transport**

- The site design will integrate the following features to reduce automotive commuting:
  - good access to public transport (new bus stops are being considered)
  - features promoting shared vehicle transport (car-pooling and drop off points for the students)

**Cycling facilities**

- The design proposes secure, sheltered and accessible bicycle storage.
- The design includes changing facilities in the building.

# *Section D: WATER*

This section calls for the development of strategies to conserve treated water and minimize the need for off-site treatment of water.

Athletic Complex achieved 81% on the Green Globes$^{TM}$ rating scale for water consumption and measures to minimize water use.

## D.1 Meeting a Water Performance Target

### Opportunities for Improvement

- Estimate the water usage targets for the building based on the integration of water-conserving features and strategies.

## D.2 Water Conserving Strategies

### Highlights

**Strategies to Minimize Consumption of Potable Water**

- The design proposes sub-metering of water consumption.

- The following water fixtures are being considered:
    - water-saving devices or proximity detectors on urinals
    - low flush toilets (less than 6 L)
    - water-saving fixtures on faucets (7.5 L /min) and showerheads (9.0 L/min.)
    - other water-saving appliances

**Strategies to Minimize Water for Irrigation**

- The design addresses the principles of xeriscaping with integration of native, drought-resistant species into the landscape.

- Rainwater and gray water irrigation systems are being considered including Use of “dumped” pool water on site.

### Opportunities for Improvement

**Strategies to Reduce Off-Site Treatment of Water**

- If a graywater system is to be used, evaluate how the various graywater technologies could be integrated into the design.
- Where appropriate, develop design strategies and select appropriate systems based on the facility’s program, occupants and site, for alternative waste treatment such as manufactured bio-filters, peat moss drain fields, wetlands, consolidated systems or composting toilets. For wetland systems, identify design requirements based on users, the facility’s capacity, the pollutants to be removed from the water, the area and detention time necessary for thorough treatment, vegetation and aquatic life survival requirements, and aesthetics.

# Section E: RESOURCES, BUILDING MATERIALS AND SOLID WASTE

This section evaluates strategies and design approaches, material selection and construction systems that use fewer resources, or enable materials to be reused or recycled. The design of facilities for storing recyclable waste is also considered.

Athletic Complex achieved a score of 65% on the Green Globes™ rating scale for managing resources through waste reduction and site stewardship.

## E.1 Integration of Systems and Materials with Low Environmental Impact

### Highlights

- The charrette format precluded more thorough investigation of LCA or preliminary lifecycle assessment to compare the environmental burden and embodied energy effects. However the team emphasized the importance of considering different types of materials for both their embodied energy characteristics and their potential for positive energy impacts in the building. Notably:
  - Large heat/cooling sinks using concrete
  - The need for a holistic approach to the selection of construction materials

### Opportunities for Improvement

**Integration of systems and materials with low environmental impact**

- Conduct a preliminary research and evaluation of building materials generically, such as concrete, steel, and wood. Explore the environmental effects of different design options or material mixes.

## E.2 Strategies to Minimize the Use of Non-Renewable Resources

**Highlights**

- The design proposes the incorporation of reused building materials and components.
- The design concept recommends the incorporation of building materials that contain recycled content.
- The utilization of locally manufactured materials is proposed for the project.
- The design stipulates that tropical hardwoods be avoided and solid lumber and timber panel products originate from certified or sustainable sources.

## E.3 Strategies to Reuse Parts of the Existing Building

**Highlights**

**Re-use**

- It is intended that at least 50% of the façade of existing ice arena will be reused.
- It is intended that at least 50% of the existing ice arena structures (other than the building shell) be reused.

## E.4 Design Strategies for Building Durability, Adaptability and Disassembly

**Highlights**

**Durability**

- The design proposes the incorporation of durable, low-maintenance building materials and components, particularly in areas likely to experience high levels of wear and tear.

**Adaptability**

- Design features to facilitate building adaptability are being considered.

**Disassembly**

- Design options are being considered to facilitate building disassembly.

## E.5 Strategies to Reuse and Recycle Demolition Waste

**Highlights**

- A construction, demolition and renovation waste management plan is proposed.

## E.6 Facilities for Recycling and Composting

**Highlights**

**Handling and Storage**

- The design proposes facilities to handle and store consumer recyclables.

**Organic Waste**

- While the actual Athletic Complex is not likely to generate much organic waste, the provision of facilities to compost organic waste on the campus is being considered.

# *Section F: EMISSIONS, EFFLUENTS AND OTHER IMPACTS*

This section evaluates strategies to avoid or minimize air emissions, ozone-depleting substances, effluents, pesticides, and hazardous materials. Note that it is assumed that halon containing materials will not be introduced into the building.

Athletic Complex achieved 71% on the Green Globes$^{TM}$ rating scale for emissions, effluents and other environmental impacts.

## F.1 Strategies to Minimize Ozone-Depleting Refrigerants

**Highlights**

- Where CFC (chlorofluorocarbon), HFC (hydrofluorocarbon) or HCHFC (hydrochlorofluorocarbon) refrigerants are proposed, their ozone-depleting potential will be equal to zero.

**Opportunities for Improvement**

Investigate cooling and air-conditioning solutions, such as ammonia, which do not use ozone-depleting substances (ODS) or potent industrial greenhouse gases (e.g. PIGGs-HFCs, PFCs and SF6).Wherever possible, integrate passive solutions (e.g. shading, insulation, building orientation, natural and forced ventilation) into new buildings and major renovations to reduce the cooling load. Consider evaporative cooling, natural ventilation or hybrid ventilation as alternatives to reduce the need for ODS refrigerants.

## F.2 Strategies to Control Surface Run-off and Prevent Sewer Contamination

**Highlights**

- Design measures will be taken to prevent sewer contamination.
- There will be measures to prevent storm-water run-off from the roof from entering public utilities.

## F.2 Pollution Reduction Strategies

## Highlights

### Strategies for Integrated Pest Management

- There are design features to promote integrated pest management.

### Strategies for Proper Storage and Control of Hazardous Materials

- The design provides proper storage of hazardous materials such as pool chemicals.

# *Section G: INDOOR ENVIRONMENT*

This section evaluates the strategies that are being used to ensure that the indoor environment is healthy and comfortable, in terms of providing a high level of indoor air quality, effective lighting, thermal comfort and suitable acoustic conditions.

Athletic Complex achieved 95% on the Green Globes™ rating scale for indoor environment and the measures to provide healthy, productive and comfortable environment.

## G.1 Strategies for Effective Ventilation

## Highlights

- The design proposes that air intakes be positioned so that they are far from sources of pollution and prevent recirculation. The openings will be protected.

- The suggested ventilation system provides sufficient ventilation rates in accordance with ANSI/ASHRAE 62-1999.

- A strategy for effectively delivering ventilation is being developed.

- The intended control systems will allow ventilation rates to be adjusted to meet varying needs throughout the building complex.

- The design will provide for easy access for cleaning and inspecting air filters.

## G.2 Strategies for the Source Control of Indoor Pollutants

**Highlights**

- There will be design measures for controlling moisture build-up in the building and to prevent the growth of mould.
- The air-handling units will be easily accessible for regular maintenance and drainage.
- The design will include a de-humidification system which will pose a low risk of sick building syndrome (SBS).
- The hot water design will help to avoid the occurrence of *Legionella*.
- The design proposes local exhausts for areas where contaminants are likely to be centrally generated.

## G.3 Strategies to Optimize Lighting

**Highlights**

**Daylighting**

- The lighting is being designed using an integrated, sequenced approach.
- The orientation and visual access of the building are being considered in terms of daylighting potential.
- The heights and depths of the perimeter spaces are being designed to optimize daylighting.

**Lighting design**

- The design proposes electronic ballasts fitted to luminaires.
- Measures to minimize glare will be integrated.
- The proposed lighting concept will follow the guidelines outlined in the *ISNEA Lighting Handbook for Lighting Levels* with regards to the selection of lighting levels for specific tasks.

- The local lighting controls will be adjustable to meet requirements relating to space occupancy, circulation space, and daylighting.

### Opportunities for Improvement

**Daylighting**

Calculate the percentage of the floor plan that would receive or need to be protected from the direct daylight based on various floor plan design options.

For critical spaces, calculate the daylight factor for different times of the year for clear-sky and overcast conditions. Use various energy-efficient lighting and daylighting design strategies to maximize the daylight where necessary. Aim for an average daylight factor of 5%, in 80% of work areas, for a well day-lit work place. For a partially day-lit workplace or a living/dining area in a typical dwelling unit, aim for at least 2%.

## G.4 Strategies for Thermal Comfort

### Highlights

- Based on thermal evaluation for critical spaces the thermal conditions will meet ASHRAE 55.

## G.5 Strategies for Acoustic Comfort

### Highlights

- Design strategies will be developed to control noise transmission from the site through the building envelope.
- There will be design measures to achieve desired vibration control and prevent noise transmission throughout the building.
- There will be design measures, such as zoning or isolating certain spaces, to achieve the required acoustic privacy and minimize the potential for occupancy-related acoustic problems.
- There will be design measures to achieve reverberation control/acoustic absorbency, consistent with speech intelligibility requirements.

- The design will propose measures to mitigate acoustic problems associated with noise and vibrations from mechanical equipment and plumbing systems.