Toronto City Hall & Nathan Phillips Square
Sustainability & Energy Efficiency Charrette

Wednesday May 2, 2007

TORONTO

CLINTON FOUNDATION

Sustainable Buildings Canada

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1.0 Executive Summary

City Hall was built in an era of cheap, plentiful energy and its mechanical and electrical design and systems reflect this. To modern eyes there is a large amount of waste that can be eliminated without compromising function or comfort. One of the worst examples is the cool air supply. Energy is used to cool the air but if it is too cold, steam is used to reheat it to a more acceptable level.

Although each team took a different approach, they ended up with several themes and strategies in common. Before committing to any new equipment in any type of retrofit scenario, all teams made demand (or load) reduction their central strategy:

- improve the building envelope – particularly glazing
- maintain appropriate levels of HVAC and lighting only when the building is occupied- eliminate 24/7/365 operation by the use of the building automation system
- address continuously rising plug load
- take full advantage of the building shape and orientation- far too much electricity goes to lighting a structure designed to maximize natural light.
- decouple air circulation from thermal comfort (i.e. ventilation air is provided separately from thermal comfort such as can be provided by a radiant system in the ceiling which could keep occupants warm or cool while ventilation air is provided separately)
- keep passive technologies top-of-mind
- reduce building use through internet-based solutions

Other common approaches:

- clear leadership with ongoing management, training and policy review are crucial
- the building exists in a larger urban context with the attendant opportunities
- strategies for water will become more critical as the climate changes

Team 1 went into detail with energy efficiency and Appendix 1 presents the impressive savings predicted by the energy model. Energy use is reduced to 1/3 of current demand thereby saving $1.7 million annually.

Team 2 delivered a strategy to have the building powered completely by renewable energy by the year 2040, and to potentially become a net producer of electricity and steam thus going beyond carbon neutral and becoming a carbon-reducing building. Greenhouse gas credits were not explored but there is potential to generate revenue for the city.

Team 3 approached Environmental Performance with BOMA's Go Green as a guide.[1] The team bettered the 2030 Challenge (zero GHG buildings by 2030) by giving themselves until 2020 to reach that target. Their macro view included transportation and water policy as well as using energy-from- waste. They emphasized the critical importance of a single, responsible point person to manage the process.

Intervention in any historical building is a complex challenge, and extra care must be taken with City Hall, which is seen as a focal point, cultural icon and international symbol of the City. The proposals contained in this report illustrate that a healthy respect for the building and site can be maintained while addressing the challenges of the present and future.

The City Hall Sustainability and Energy Efficiency Charrette was undertaken with the intention of identifying potential energy and sustainability actions and technologies that the City could undertake as part of its goal of making City Hall a truly green and sustainable building. As part of the initial goal-setting exercise, attendees agreed that City Hall must strive to be both a showcase for innovation and sustainability, and be operated in a manner such that it is a net zero energy building by the year 2030. Ideally the building would not have to rely on the purchase of green power from offsite to achieve this latter goal. This represents the key goal coming from the Charrette, which is consistent with the vision of creating a truly green and sustainable building.

By their nature, Charrettes deliver a small number of viable options from a large pool of possibilities – to get to a firmer conclusion or next steps, the City should carefully consider the results presented herein, define which options are viable and decide how it wants to proceed. The common themes and approaches identified above represent a very good place to start however, at this early stage there are still a number of iterations that need to take place before any concrete steps are taken. At this point the City may wish to hire a consultant familiar with green buildings to help in the process of firming up the recommendations and identifying the next steps.

[1] A complete BOMA Go Green Assessment has been undertaken and provided to the City as a separate document. Appendix B provides a summary of the BOMA Go Green results.

2.0 Introduction

On May 2nd, 2007, the City of Toronto, with support from the Clinton Foundation, organized a one-day Sustainability & Energy Efficiency Charrette for Toronto City Hall and Nathan Philips Square. Organizational assistance and coordination was provided by Sustainable Buildings Canada (SBC).

Toronto Mayor David Miller has pledged that Toronto will become North America's greenest city. This Charrette is both a symbolic and pragmatic move in that direction. Deputy Mayor Joe Pantalone, in his opening remarks, pledged that money would be dedicated to achieve sustainability and energy efficiency at City Hall.

Design Charrettes use the "integrated design process" (IDP) to create more environmentally friendly and efficient designs. The integrated design process is a method where stakeholders collaborate in the initial design stages, rather than working in isolation. The process has been widely applied to new buildings and is starting to be used for major renovations of existing buildings as well. It works equally well in both, however the focus for existing buildings is aimed more at considering improvements within the existing structure(s).

The Charrette process challenges participants to consider new strategies, systems and products that more appropriately support a sustainable design or operations scheme. An integrated team includes members with diverse and comprehensive expertise and experience to inform the process and work together to achieve a higher performance, value-added building. At the early stages of a project concepts can change easily and the team can maximize the potential benefits.

This event attracted more than 50 participants[2], representing the City, the Clinton Foundation, architects, engineers, planners, and a variety of technology specialists including those involved in renewable energy, glazing and building envelope, passive solar, water conservation, energy simulations, and electrical and mechanical systems.

This report has been prepared from the notes, flip charts, sketches and presentations prepared by each of the three teams.

Sustainable Buildings Canada wishes to express our appreciation to all those involved in making this important event. Thank you to all.

[2] The Attendee List is provided in Appendix D.

3.0 Approach

The Charrette began with a series of presentations aimed at identifying the key aspects of the building and the renovations/retrofits that have been undertaken in the past, the proposed re-design of Nathan Philips Square and the current energy use characteristics.[3] Toronto Hydro presented a feasibility study that had been undertaken which identified a number of potential retrofits and improvements. Plant Architect presented the proposed changes to Nathan Philips Square. GreenSim presented a "base line" model of energy usage of the building. These presentations served to establish the current parameters of the building and the site and to identify some preliminary actions the City may wish to consider.

Attendees were then led through a goal setting exercise that established the basic vision for a re-designed City Hall. Attendees agreed that City Hall must strive to be both a showcase for innovation and sustainability, and be operated in a manner such that it is a net zero energy building by the year 2030. Ideally the building would not have to rely on the purchase of green power from offsite to achieve this latter goal.

With the completion of the goal setting exercise, attendees were introduced to the integrated design portion of the day. Attendees were assigned to one of three teams challenged to explore sustainability and energy efficiency options for city hall including the site, building and underground parking. Each team consisted of 15-20 members, with a variety of experts available to all the teams. Each team was assigned a facilitator and a computer modeler. The computer modeler used advanced simulation software to track the changes, recommendations and revisions examined by the team in "real time". This exercise enabled the teams to rationalize their discussions and attempt to maximize the performance of the buildings.

The team assignments were as follows:

Team 1 **Energy Efficiency,** using the e-Quest Model
Team 2 **Renewable Energy,** using a hybrid Renewable Energy Model
Team 3 **Environmental Performance** Energy, Water, Waste & Transportation, using the BOMA Go Green Building Rating System[4]

The teams were instructed to ensure that their deliberations culminated in a 15 to 20 minute presentation to the larger audience. The team presentations and reports of the deliberations are provided in Sections 4 to 6. The detailed model and rating systems results for Teams 1 and 2 are provided in Appendix A, and the BOMA Go Green Plus results for Team 3 are provided in Appendix B.

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[3] The Agenda is provided in Appendix C.
[4] With the support of the local BOMA Chapter

4. 0 Team 1 - Energy Efficiency

Facilitator: Mr. Mike McGee. Modeller: Mr. Brian Fountain

Scenario: The team will operate on the basis that some energy improvements (such as lighting retrofit) have already been made. The team will examine the energy and emissions benchmarks and determine what retrofit or operational improvements can be made. Optimum energy efficiency is the goal, but water conservation should also be considered.

Suggested Optional Considerations:

1. Air sealing and insulation values
2. Garage lighting & ventilation
3. Roofing material and water retention
4. High efficiency equipment
5. Preventative maintenance
6. Window performance

The following provides a summary of the discussions. Model results and presentation are provided in Appendix A.

Context and Goals

The team started with a consideration of the current building characteristics and then identified some key targets:

At Issue with Building 'as is'

- Envelope
- Mechanical/Electrical Systems
- Lighting Systems
- Off-site steam use may set the 'today' benchmark even higher
- Space planning deficiencies

Timeline

- 2010

Target

- 100 kWh per m^2 - Down from current 610 kWh/m^2 (note – based on leasable area only)
- Is it economically achievable?
- Make a revenue-positive proposition
- Budget
- Energy - $40 million
- Assuming it can be paid off by 2010
- Leaseable space - $2.2 million cash flow

Goals

- User comfort improvements
- Recognize current deficiencies – e.g. 10°C flux
- Improved health & productivity for inhabitants
- Reduction plug - load
- Optimize space planning
- Individual user control/accountability
- Improve indoor air quality
- Improve acoustic issues
- Densification of downtown
- Increase leasable space

Framework

- Loads
- Reduce loads significantly
- Systems
- Systems load survey
- Plants
- Residual loads accommodated by sustainable options
- Personnel management
- Hotelling opportunities
- Decanting/relocation costs

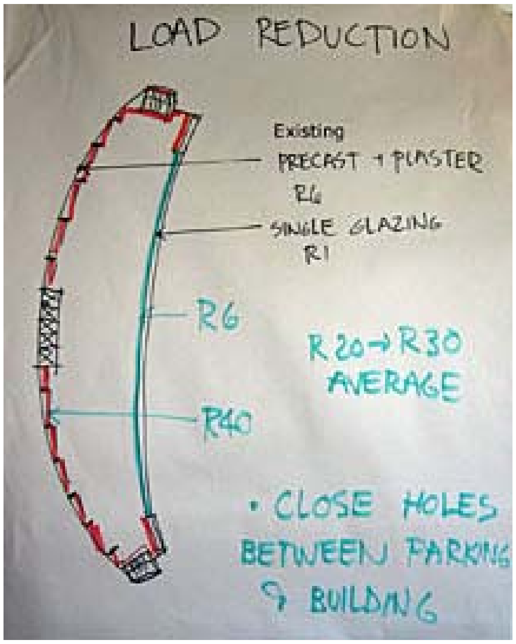
Brainstorming: East and West Tower Loads

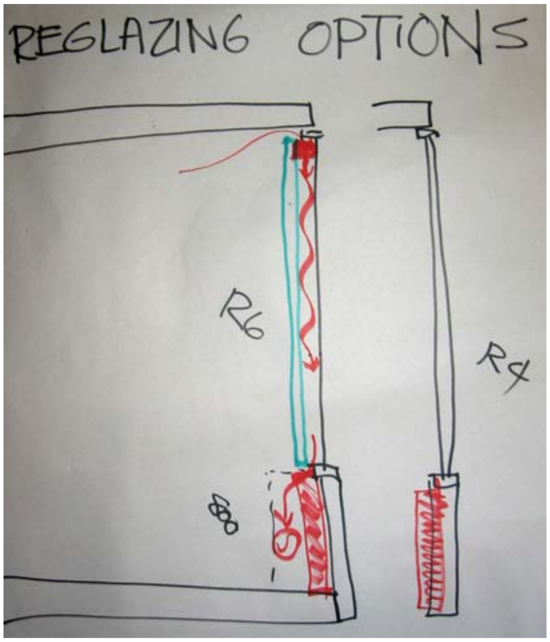
Building Envelope Improvements:

R20-R30 overall average (including glazing)

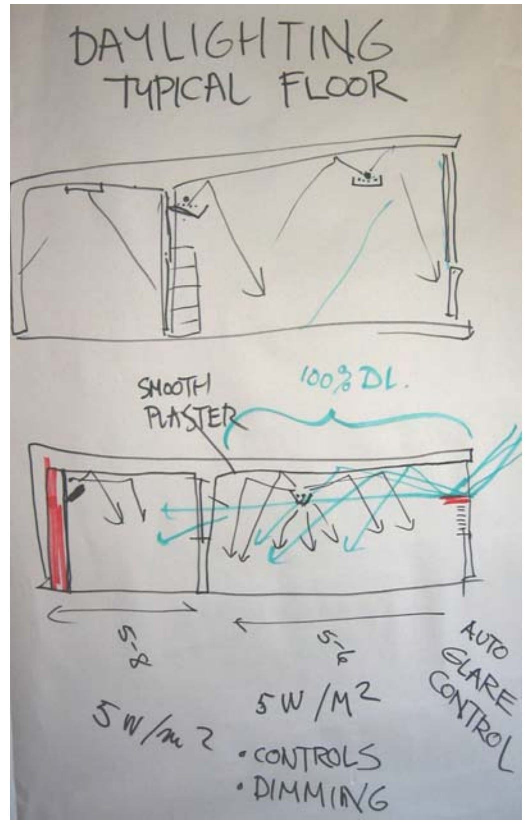
- Insulate inside of precast to R40
- Add new double glazed window system on inside of existing to preserve exterior appearance. Operable for cleaning of existing window system.

(1) Trade offs
Daylighting & Light Penetration
Heritage issues
(2) Uncontrolled infiltration/exfilitration
Loading docks, parking, shafts, curtain wall
Separation between external & internal
Doors, windows curtain wall improvements, mechanical spaces
(3) New curtain wall at R4 *versus* renovated insulated unit at R6
(4) Automated roller blinds
Issues: solar shading, night time heating loss
(5) Remove existing glazing film to improve daylighting (20 years old and in poor condition)
(6) Return air through curtain wall system
(7) Increased insulated spandrel back panel to R20 (feasible with removal of ductwork from induction units)





Lighting/Daylighting

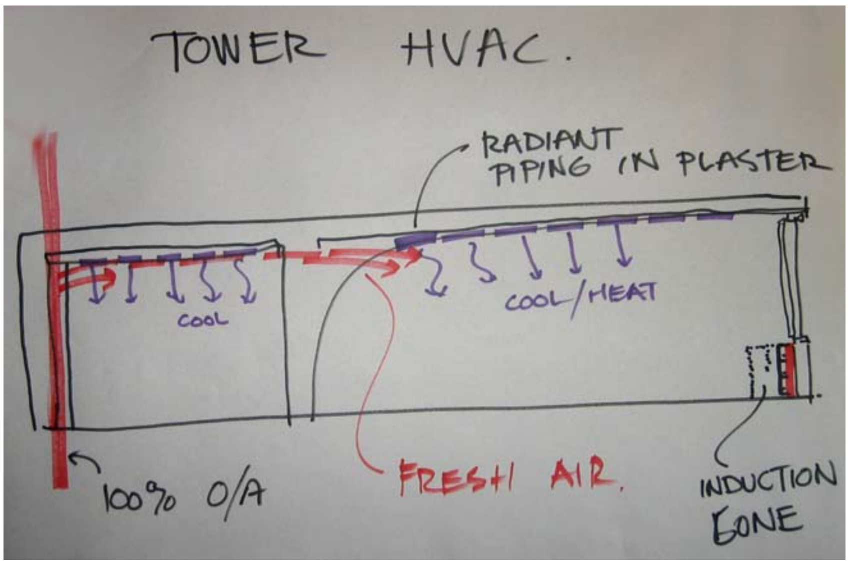


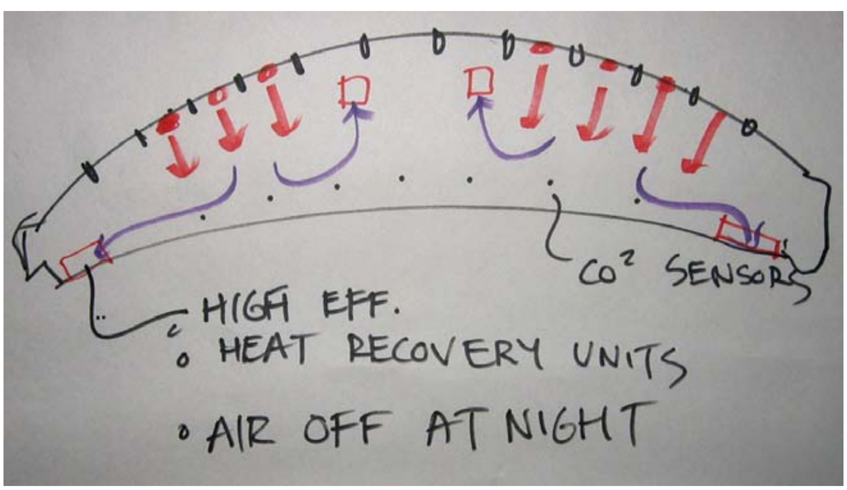
1. Replace/remove existing oversized light fixture – add downlight component (perforate)
2. Design variable light-shelf to direct light deeper into core
3. All lighting (daytime) will be natural 95% of occupied time: use task lighting for workspaces
4. New or relocated linear light source at centre for illumination at night -direct/indirect 5 W/m^2 (~ 0.5 W/ft^2)
5. Indirect/direct cove lighting in meeting areas with task
   lighting - 5 w/m^2 or .5 w/sf
6. Asbestos remediation in ceiling space, re-plaster smooth ceiling with set reflectance value (improves daylighting and indirect lighting and can be done in conjunction with installation of radiant panels for perimeter conditioning).
7. User/BMS (Building Management System) control of lighting system
   - Occupancy sensors
   - Daylight sensors
   - Addressable ballasts
8. Glare control below light shelf
   - User & BMS control
9. Improve perceptible light levels and contrast between spaces
   - Luminance ratios

* 240 volt lighting may be an issue/T5HO ballast may be required

Mechanical

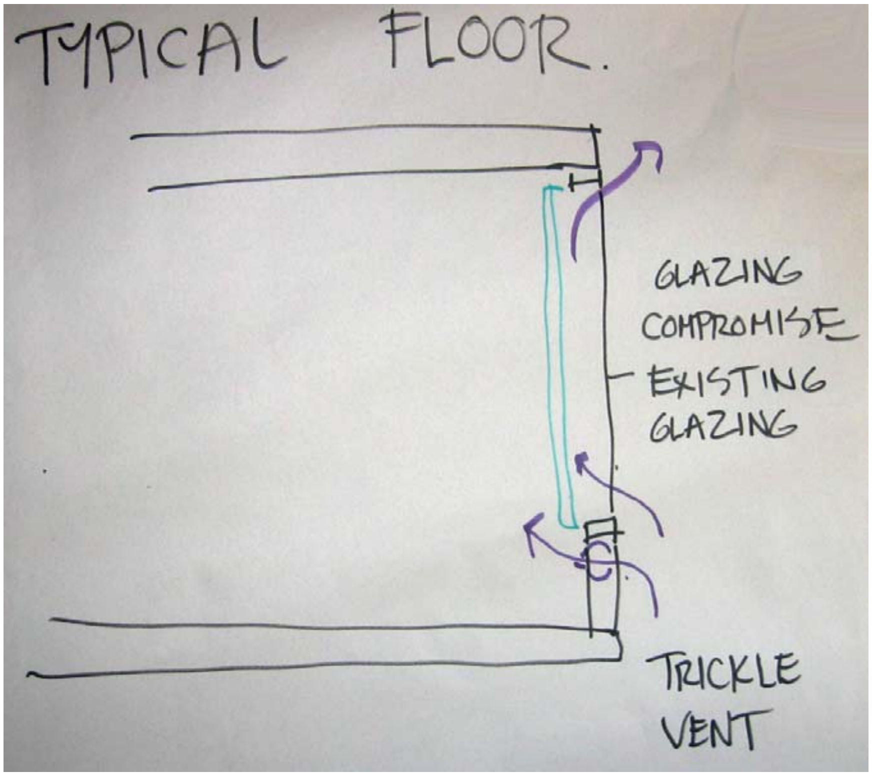
1. Remove existing induction units
2. Radiant heating/cooling on underside slab - warm/cool water circulation – greatly improved comfort conditions adjacent to glass wall
3. New insulated back shaft providing supply air
4. New leasable space created through removal of induction units: 18-24” of space at perimeter
5. Large mechanical room freed up - 25-50% reduction in mechanical space reclaiming +/- 20,000 SF @ $500,000
6. Maintain existing centralized return air
7. Remove existing cooling towers and reclaim space





Natural Ventilation – Tower

Trickle vent in curtain wall (possible)



Electrical

Reduce plug load through education and information messaging to staff.
Improved insulation and perimeter zone conditioning will allow removal of electric heaters.
Crack the "Always On" I.T. nut (the policy of keeping computers on for overnight system updates)

Water Efficiency

- Domestic hot water recognized as a small load
- Possible solar domestic hot water heating
- Ultra low flow fixtures and instantaneous heating of domestic hot water

Brainstorming: Podium Building Loads

Mechanical

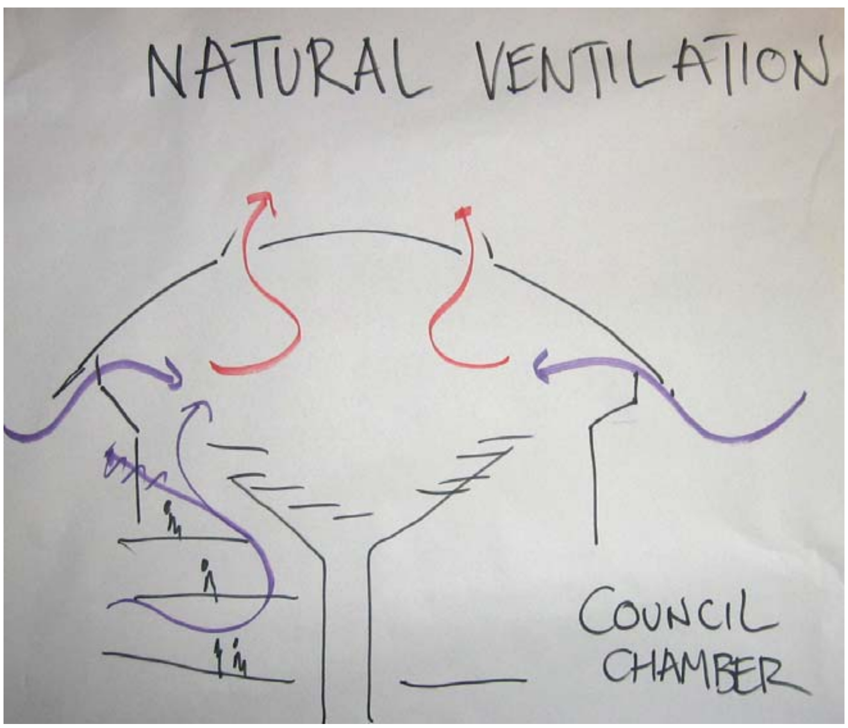
Heat Pump versus V.A.V. Unit

- **Heat Pump:** reduce AMV, reclaim space from basement, controlled fresh air supply, heat transfer between towers and podium
- **V.A.V. Units:** smaller electrical load

Heat pump to heat interior zone and perimeter

Natural Ventilation - Base Building

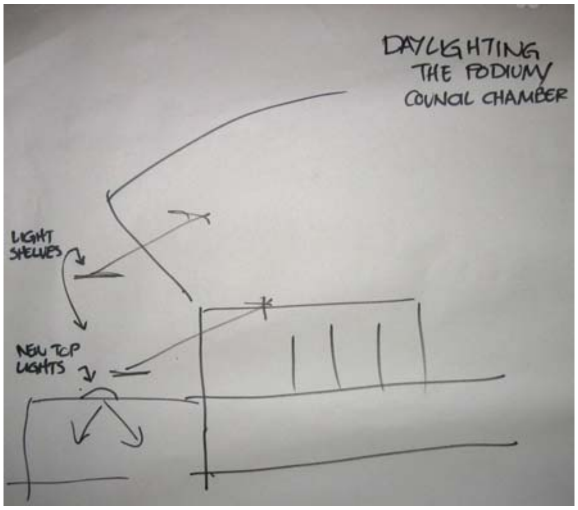
Clerestory operators in council chamber/first floor intake of fresh air (supply)
Exhaust through operable skylights

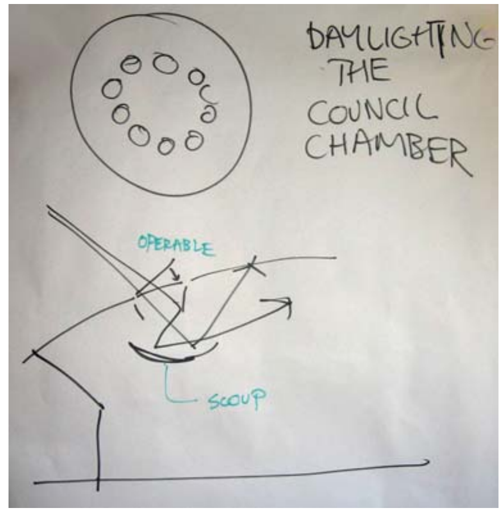


Lighting

1. Compact fluorescent lamps to replace all indirect fluorescent fixtures/incremental efficiencies
2. Direct/Indirect daylighting in council chamber roof through skylights
3. Skylighting strategies in podium offices, aligned with vertical circulation
4. Metal halide lighting in council chamber, e.g. 70 W metal halide
5. Dimmable/programmable lighting in parking areas (where is this power coming from?)
6. TIR light pipes to naturally daylight parking garage

7. Basic BMS controls and user education program (knowledgeable commissioning)





Big Issues Missed

- Skating rink condensate
- L.E.D. technological advances (10-15 year time frame)
- Revise timeline to 2012
- Is $40 million the capital cost only?
- Moving, decanting, timing & costs (Pentagon strategy – move only once for renovation)
- Recycling building material plan

Usable Area Re-capture Calculation

As part of its post Charrette calculations, Team 1 calculated the potential area re-capture and re-use due to the elimination of certain mechanical equipment. Assuming a $50/sq.ft. future lease rate above ground and $25/sq.ft. below ground provides an estimate of the potential revenue gain:

Location	**sq ft**
West tower typical floor: 165 lin ft at 19 floors =	4,700
East tower typical floor: 220 lin ft at 26 floors =	8,580
East and West Mechanical Rooms area reclaim =	20,000
Cooling Tower area reclaim, requiring construction of maybe 2 levels =	12,000
Total sf above ground	45,280
Mechanical Room in sub basement– out of a total of approximately 50,000 sq ft potential to reclaim at least, if not more than….	20,000
	65,280
lease value, $50 dollars PSF x 45,280	$2,264,000
lease value, $25 dollars PSF x 20,000	$500,000
space value: annual rent	$2,764,000

5. TEAM 2 - Renewable Energy

Facilitator: Mr. Bob Bach, Modeller: Mr. Songyang Hu

This is a scenario where the goal is to optimize the use of renewable energy forms – in all their potential formats. This includes a consideration of building integrated systems including (but not limited to) wind power, passive solar, solar thermal and solar photovoltaics, biofuels, hydrogen systems etc. The Team is encouraged to consider how any of these systems might affect or integrate with Nathan Phillips Square and the surrounding area.

Context and Goals

- Heritage building with limitations on exterior and interior changes
- Site is 13 acres of potential solar and water harvest
- 1400 employees plus visitors
- 40% of electrical load is for lighting suggesting that the daylighting advantage inherent in the building design is not being used
- 25% of electrical load for fans
- Upper floors overheat
- 40 large air handling units
- 2 pipe induction system – no zoning
- many occupancy sensors already in use- not in all washrooms
- committee rooms have sophisticated lighting controls- does staff know how to operate them?
- Some cooling is needed 9 months/year but building still heating-dominated

<u>Goal</u>

- To achieve 100% renewables for heat and power by steps
- Electrical consumption target- 100 ekWh/m^2/yr or 5,200 MWh/yr
- Steam consumption target - 50 ekWh/m^2/yr or 2,600 MWh/yr

Renewable Opportunities

- Towers are in the wind path (higher tower does not block lower tower) for wind generation
- Wind speed is double ground level at top of towers - room for 12 generators
- 13 acres of sunshine- integrate PV into building and Nathan Philips renovation
- Wind and solar can contribute 1% of current use
- Public education opportunity
- City produces hydrogen at Exhibition Place - fuel cell opportunity

- City Hall as district supplier- hotel across Queen Street, Old City Hall, Osgoode Hall
- Water- store runoff for all non-potable requirements

Design Principles

- Load reduction before introducing renewables
- Policy - green procurement
- Flexible infrastructure
- Permeability to light and air
- Consider the larger urban context

Step 1: Reduce Load

- Improve Envelope
- Minimize internal loads
    - Lighting
    - Plug load
    - Ventilation/HVAC
    - Fans and pumps

Step 1a: Improve Envelope

- increase thermal resistance of envelope to current advanced building standards – improves comfort and allows relative humidity to rise without condensation
- window replacement- currently single glazed R-1
    - exterior double skin glazing option
    - internal skin with heat recovery
    - double glazed, low-e with film

Step 1b: Minimize internal loads

- Ventilation/HVAC
    - Decouple ventilation from heating and AC
    - Replace induction system (increases usable area)
    - Natural ventilation if possible- operable windows governed by external temperature sensors
    - Unclutter return air vents
    - Convert to floor-by-floor water loop heat pump
    - Radiant heat/cool retrofit into ceiling
    - Underfloor supply – individual control
    - Deep Lake Water cooling
    - Solar thermal for domestic hot water
- Fans and pumps
    - High efficiency variable speed
- Lighting

- Daylighting should predominate in towers- need sensors and controls
    - Introduce LED lighting as it becomes viable/affordable
- Plug load
    - Replace CRTs with LCDs
    - Phase out desktops in favour of laptops- battery by day, recharge at night
    - Select only EnergyStar equipment or better

Step 1c: Policy

- Green and local procurement
- congestion charges for cars to improve air quality and increase productivity
- large increase in parking garage rates
- Permeability to light and air - no light or vent "ownership" in workstation layout – move corridor to window side

Near Term Goal for Energy

Electricity

- 100 ekWh/m^2/yr or 5200 MWh/yr

Steam

- 50 ekWh/m^2/yr or 2600 MWh/yr

Near Term Renewable Solutions

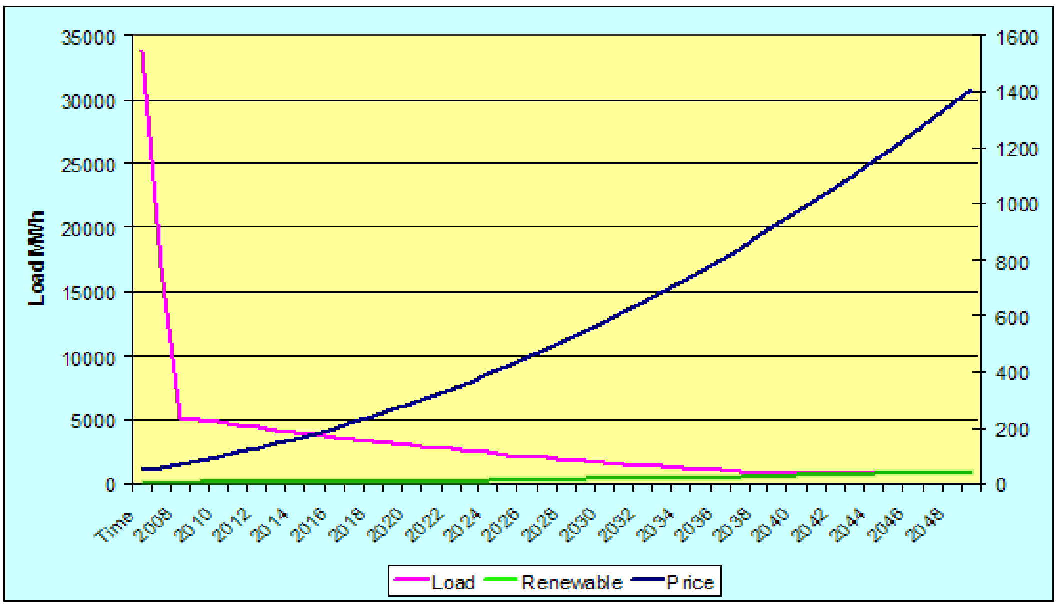
- Wind turbine - 50 kW or 80 MWh/yr
- Solar PV - 50 kW or 60 MWh/yr
- Solar thermal - 50 kW or 20 MWh/yr
- Co-generation Biofuel - 1.5 MW CHP engine-generator 2007-2022

Long Term Goal for Energy

- Efficiency improvements will increase solar PV and wind turbine outputs when they are replaced
- Co-generation - Biofuel CHP replaced by hydrogen fuel cell CHP in 2022 – hydrogen supplied from existing City-owned hydrogen refueling station at Exhibition Place. City becomes district steam and electricity producer.

Team 2's deliberations supported the notion that interior loads could be driven down significantly in the short term. In the medium term, these (lower) loads would be primarily served by conventional energy sources. By the year 2040, renewable energy would supply all the energy needs of the building. Figure 4.1 depicts the energy requirements, the expected price of energy and the renewable fuels supply curve.

Figure 5.1 City Hall Energy Demand and Renewable Energy Supply



6. Team 3 - Environmental Performance

Facilitator: Mr. Rob Maxwell. 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 reusable and recyclable materials to reduce waste. Transportation issues may also be considered.

To ensure that all energy and environmental issues are covered in an integrated manner, the participants are encouraged to refer to the BOMA Go Green Plus questionnaire. The On-line BOMA Go Green Plus assessment, available at http://www.bomagogreen.com/ggc.html , will be used to evaluate the team's results.

Context and Goals

"Make no small plans for they have not the power to stir mens' hearts" - Goethe

Overall Goal: Zero Green Houses Gases by ~~2030~~ **2020**

Actions for Success

Team 3 identified a series of 13 strategic actions for success that the City should undertake to achieve the goals of being the greenest city ion North America and having the greenest city hall. These include:

1) **CREATE A "SUSTAINABILITY CZAR"**
   Specific city point person (staff) to be hired to be lead / manage project(s) full-time otherwise project will fail

2) **ADVISORY COMMITTEE OF KEY EXPERTS**
   To guide terms of reference for projects

3) **SET UP REPORT FOR SUCCESS**
   The "ducks are lined up and quacking"

4) **EXPLORE PARTNERSHIPS**
   with surrounding land owners

5) **IDENTIFY FUNDING SOURCES**

6) **BUILDING ASSESSMENT TOOLS**
   (Explore what tools to use first)

7) **LEADERSHIP**
   will be critical to all phases to realize the success of this project

8) TIE PLAZA PROJECT INTO RETRO-FIT
Purposeful integration

9) TIMELINES FOR PROJECT
To integrate various action items

10) USE THE THESI REPORT AS FOUNDATION
is a good baseline, but need a full sustainability audit (in parallel with what can be done now – don't wait for final report to start other actions!)

11) DEVELOP A FINANCIAL MODEL
that integrates avoided costs savings into package
(energy, waste, water & office space)

12) IMMEDIATE AUDIT
on "Waste", "Water" & purchasing practices & programs

13) KEEP
City Hall & Nathan Phillips Square CONNECTED!

14) DEFINE THE VISION
Communicate & Educate the clear vision

With these strategic actions in place, the Team developed specific considerations and recommendations for the major elements of the building.

Energy

- City Hall to be an optimized contributor to the bigger whole (city of Toronto)
  - Thermal storage
  - Ice storage
- City Hall seen as part of the adjacent buildings
- Renewable energy generated over a group of sites
- Generation of heat on site
- No use of electric light in tower when there is daylight
- Building that can run even if the power is shut off
- Only use energy when it is needed – appropriate control systems

- Replanning of offices to take advantage of natural light – improved space planning
- Provide for "plug-in" hybrid cars in the parking garage
- Metering on each floor so people can see what they are doing
- Plug-load issue for night-time computer – need technical solution
- Food-nutrient cycle is part of energy/carbon cycle
- Eliminate all hazardous waste

Water

- Water harvesting – 100% of water for site/building harvested
- Process all blackwater/wastewater on site (living machine) for use as potable water
- Water-efficient fixtures
- No water in or water out!
  Net zero
- Understand operational implications of a sustainable design building
- 50% of city energy budget open to pumping water & sewage
- LIVING MACHINE

Reuse & Recycle

- Use waste for creation of Biogas
  (off-site but part of city "system")
- Purchasing department MUST have recycle policies
- Only use Energy-Star appliances

Other

- Green-clean policy for
  - Cleaning
  - Materials
- TRANSPORTATION
  - Parking garage should provide for plug-in cars
  - Support sustainable cars
  - Free parking for Hybrids
  - Increase parking fee
  - Improve access from PATH to City Hall

Communication

- Comprehensive communication and education
- Clear metrics so public can understand benefits
- Review policy goals
  - Barriers to sustainable building
  - Chloride-free snow melting
  - No water bottles

Materials

- Eliminate hazards
  - PCBs
  - PVCs
  - Asbestos

Strategies for Water

- Collection
  - Water storage on P4
  - Also water storage space available on current mechanical floor space
  - Rainwater: Separate into
    - grey water for irrigation
    - Potable water
- Collection
  - Move water with PV (when the sun shines)
  - Plaza – evaporative cooling
- Indoor water pool – cooling
- Fountains on site
- Integration of a "LIVING MACHINE" demonstration or "solar aquatics"
  - Reeds – in dolomite system
- Interior environment
  - Living wall for clean air
- Waste streams as potential energy

Strategies for Waste

- Biogas in building:
  - Tonnes of bio waste: 43 tonnes (for city hall)
  - Other buildings as well surround the site
  - All packaging from supplies to be organically digestible
  - Use chunk of basement (2000 sq ft) to generate heat
  - Also – food waste from "hospital row" can be fuel
  - $70 tonne for waste
    1 tonne per day = 100 kwh
    2400 per day
  - Eternal flame – from bio gas!
  - Sustainability Tzar - One point of reference
  - Report – actions (costed)
  - OPTIONS (to be brought forward)
    - A. Just to City Hall
    - B. City Hall & surrounding sites

Strategies for Waste & Water

- Deep Lake Water Cooling
  - Problem: over capacity
  - But satellite sites that could create ice (only 4 degrees Celsius difference between water & ice)
  - This increases deep-lake cooling capacity

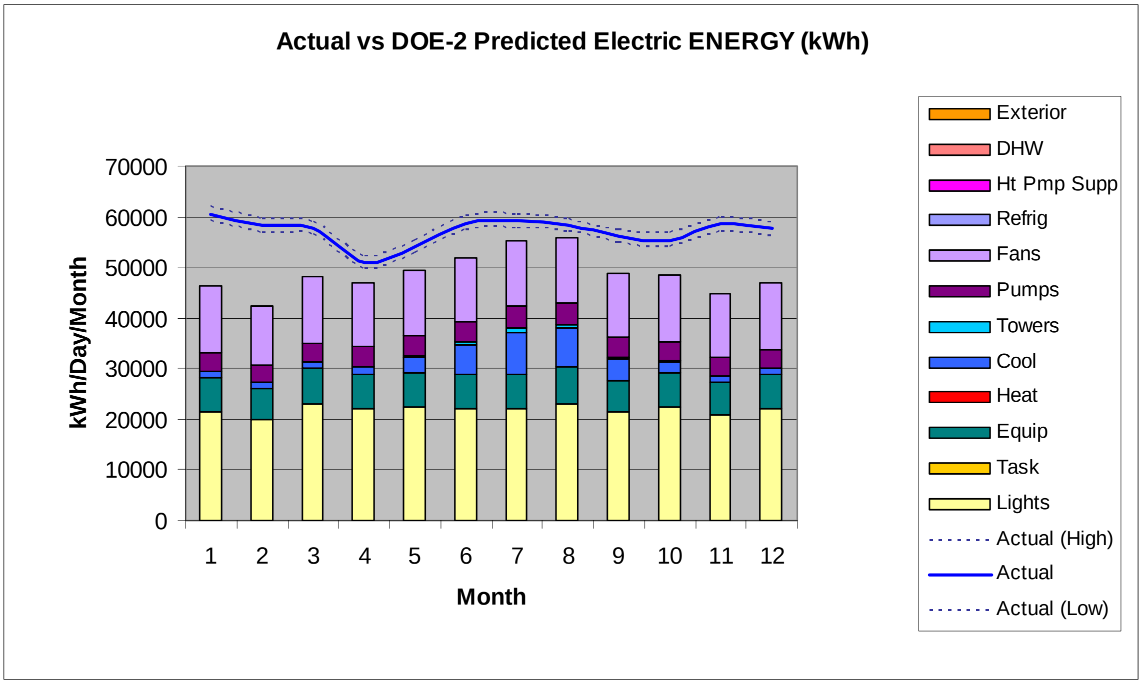
Garage & Transportation

- Subsidize public transit
- Differential parking charges
- Provide charging receptacles for plug-in cars
- 70% of staff take TTC (this is good) but subsidize pass
- Fleet management (already in place)
- Battery grid network in garage can store electric power
- Incentives for efficient cars
- Pedestrian connection to City Hall from PATH
- Provide for more city services via internet (to reduce trips to City Hall)
- Second floor of City Hall should be a demonstration project for key strategies (but be careful not to be 'lame')
- Like European cities, a demonstration place to see how to make home/business more efficient
- Use PV pedestrian lighting at podium level (60 lumens/w)
- Energy efficiency should be calculated as an investment
  (as it produces a return as opposed to a cost/expense)
- Needs to be a longer period to create the design for "the new city hall"
- See the process as something that can be replicated in other cities around Canada

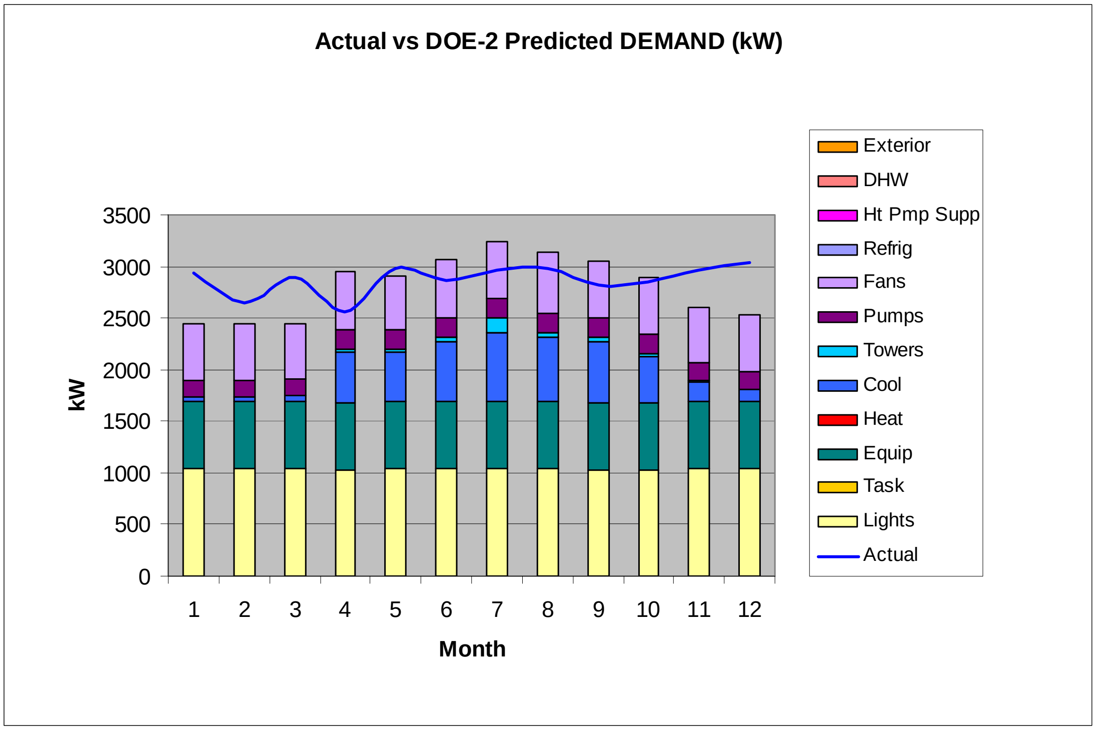
APPENDIX A – TEAM 1 Energy Simulation Results

Energy Model Results

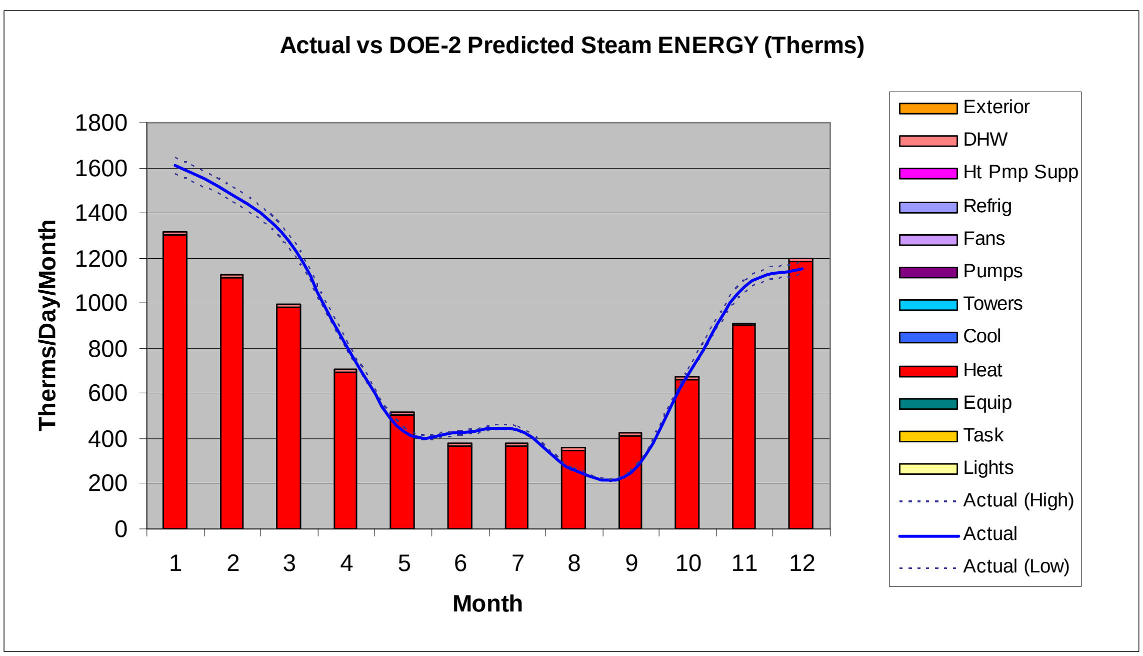
Current building Operation



This graph shows the model build up of the energy uses in the building (column graph) compared with the actual electrical consumption (blue line). There is a "winter extra" electrical load currently not included in the model – this is partly attributed to the rink refrigeration plant, and partially due to electric heating in the building.

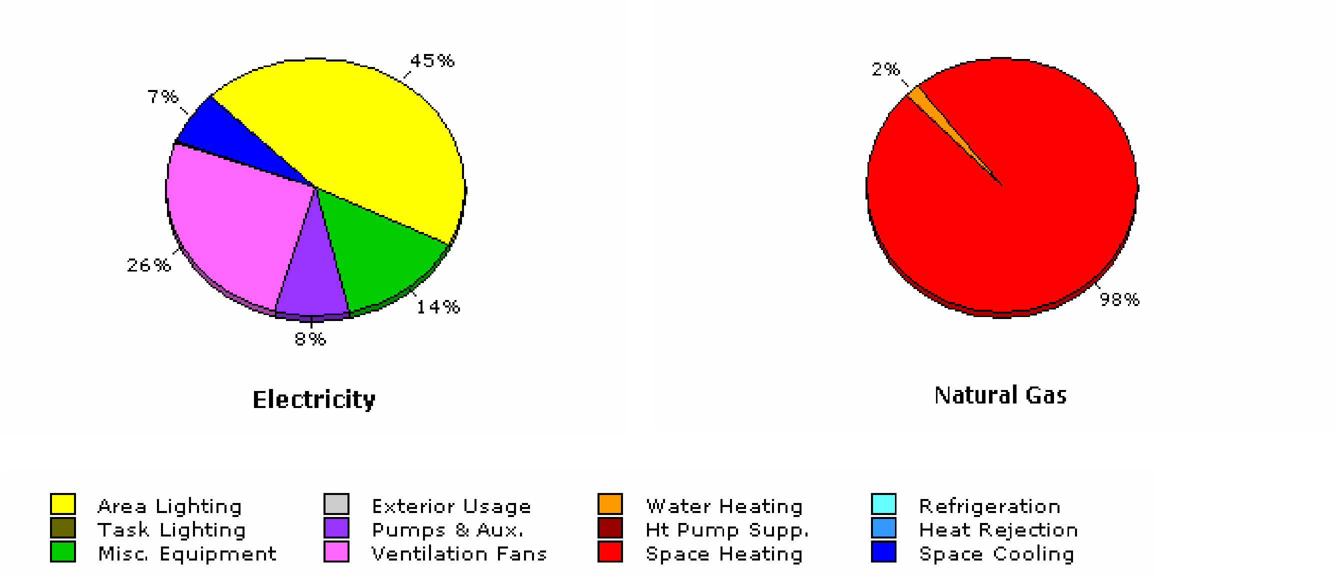


Peak monthly demand for the energy model compared with the actual building peak monthly demand. There is a reasonably good correlation between the model and the actual building energy peak electrical draw.

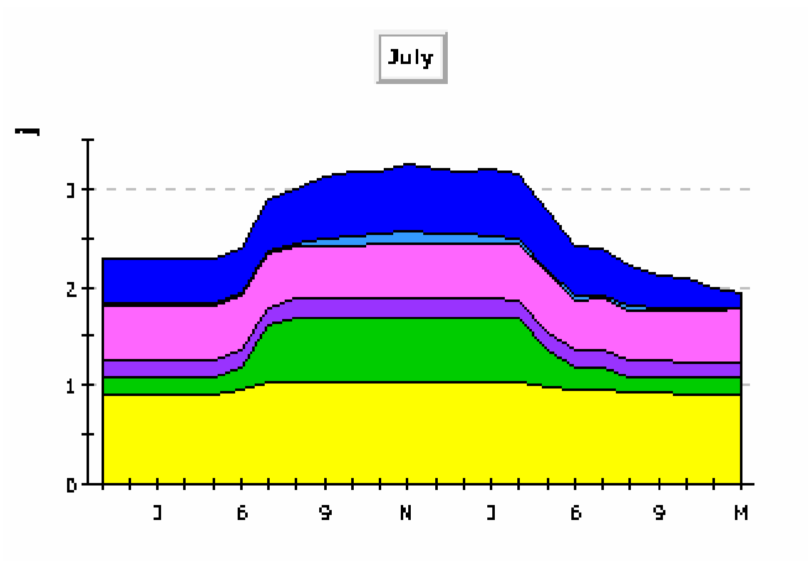


Steam use for the building compared with the model prediction. There is significant summer steam use in this facility. Very little of this goes to DHW heating – most of it goes to heating in the dual-duct units and to reheating already cooled air.

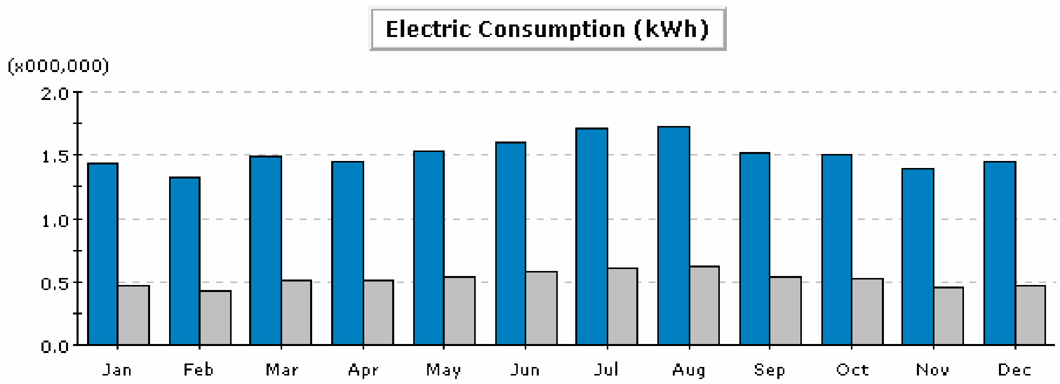
Energy end uses from the simulation



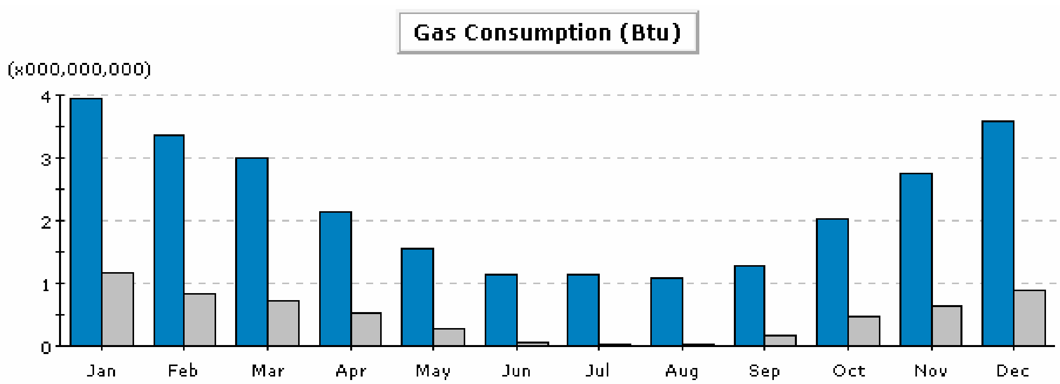
Peak day predicted electrical profile:



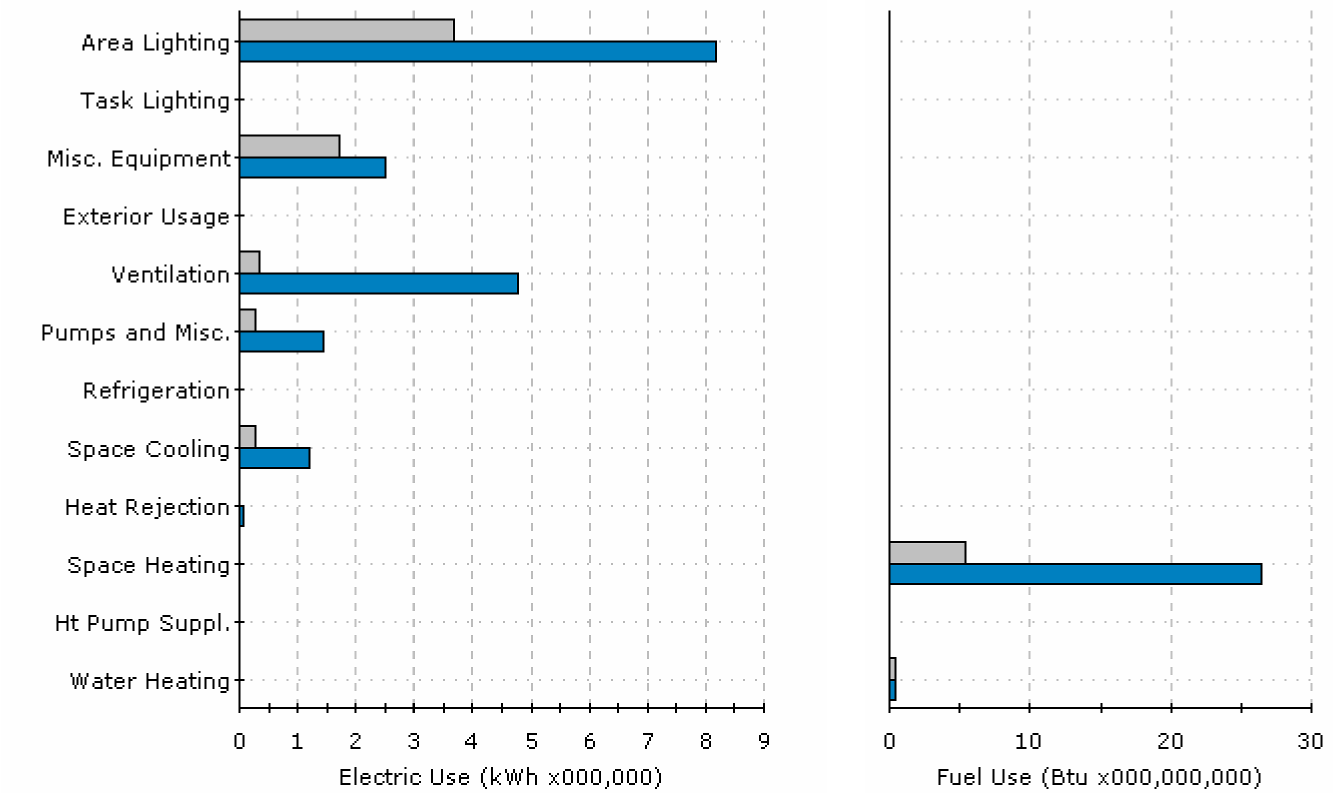
Energy simulation of Team 1 revised building:



Comparison of baseline (blue) and Team 1 vision (grey) building monthly electrical consumption.

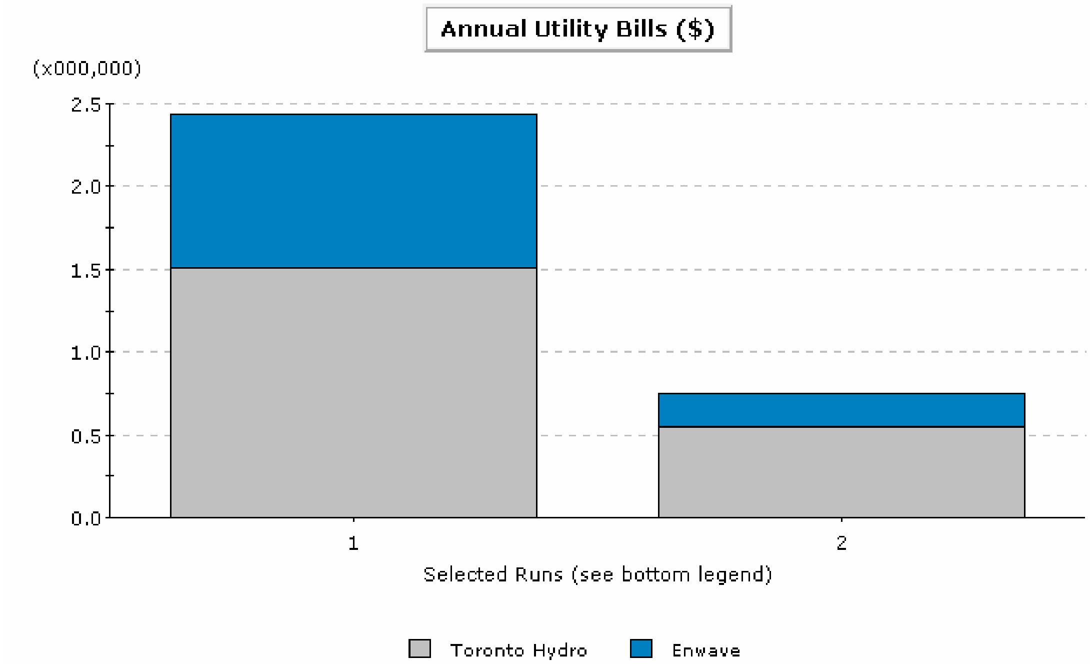


Steam use comparison of baseline (blue) and Team 1 vision (grey) steam use.



Comparison of energy end uses of Team 1 vision building (grey) against the baseline model (blue).

The revised model shows a 67% energy savings over the baseline energy use. Electricity use is predicted to be reduced by 65.5% to 6.25 million kWh/year from 18.14 million kWh/year (excluding rink electrical). Steam use is reduced by 78.2% from 26.98 million pounds per year down to 5.86 million pounds per year.



1. *Toronto City Hall – Baseline Design (annual bill = $2,439,259)*
2. *Toronto City Hall Vision B – Baseline Design (annual bill = $748,022)*

The energy cost savings are almost $1.7 million annually.

Key components to the energy savings:

- insulation on inner surface of precast
- installation of a double glazed window system on inside of existing glazing
- lighting loads reduced to 5 W/sq-m
- significant use of daylighting in tower and perimeter of podium
- replacement of induction system with radiant heating/cooling panels
- conversion of podium systems to VAV systems (eliminating summer heating)

Further energy savings were conceived by the team but were not included in the energy model. These included a heat pump type system which would use internal heat gains from the podium interior areas to offset envelope heat losses in the towers.

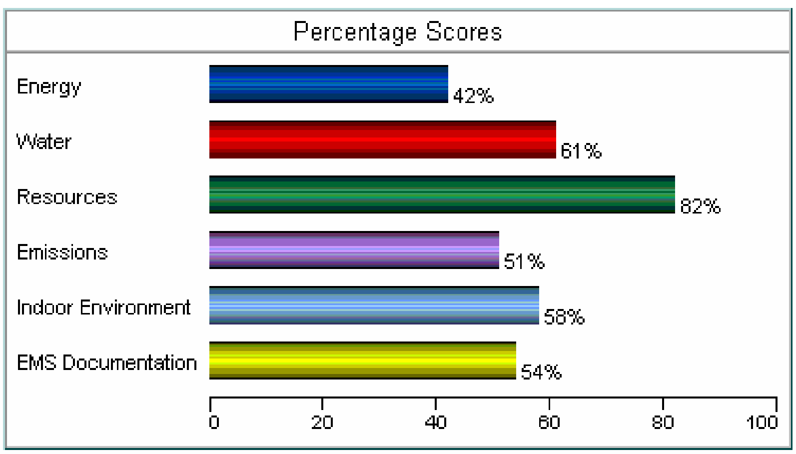
APPENDIX B – TEAM 3 Go Green Plus

Environmental Performance Scenario (Energy, Water, Waste) – Design Team 3
Facilitator: Mr. Rob Maxwell. Modeller: Mr. Jiri Skopek

This was a scenario where optimum environmental performance was the goal. While participants were encouraged to cover all of the energy and environmental performance issues, the team put emphasis on energy, water efficiency performance and a consideration of reusable and recyclable materials to reduce waste.

To ensure that all energy and environmental issues were covered in an integrated manner, the participants were encouraged to refer to the BOMA Go Green Plus questionnaire. The On-line BOMA Go Green Plus assessment: http://www.bomagogreen.com/ggc.html was used to evaluate the team's results.

City Hall BOMA Go Green Plus Assessment.
The BOMA Go Green Plus Assessment was used to establish a baseline for the energy and environmental performance. City Hall achieved an overall rating of 54% which currently would not qualify for the Go Green Plus certification, which requires a 70% score.



City Hall baseline score of 54%

The BOMA Go Green Plus assessment identified significant improvement potential particularly in the facility management area. This theme was particularly appropriate for Group 3.

The group identified several objectives among them

- 30% reduction in energy consumption
- Reduced automobile dependency
- Reduced water consumption
- Reduced waste diversion beyond 85%.

- Reduced toxic waste
- Improved indoor environment
- Environmental leadership

Several strategies to meet these objectives were identified including:
Reduction in energy consumption

- Eliminate chillers by providing deep lake cooling
- Increase the percentage of the building's total energy use supplied by renewable sources beyond 10% of total.
- Provide appropriate shading or reflective film to reduce the cooling load
- Air-seal the top and bottom parts of the building envelope.
- Provide training to implement energy efficiency improvements to the building staff, including new employees.

Reduced car dependency

- Implement bulk-purchasing of transit passes for the employees, provide free parking for hybrids, and improve pedestrian access from the PATH to reduce car dependency.

Reduced water consumption

- Harvest rainwater, and incorporate a gray water (living machine) system.

Reduced waste

- Investigate the possibility of city digester at Dufferin landfill

Reduced toxic waste

- Use chloride-free ice and snow treatment

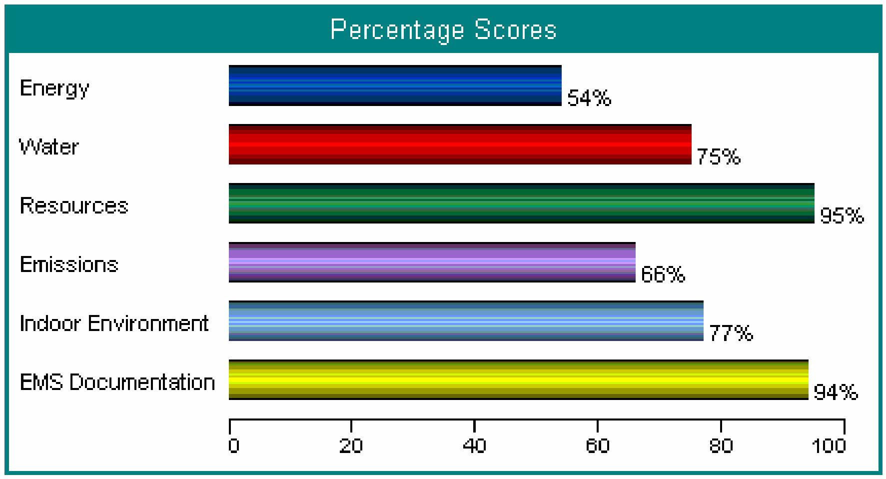
Improved indoor environment

- Provide a checklist of items connected to IAQ that must be discussed with architects, engineers, contractors, and other professionals prior to renovations, carrying out regular indoor air quality audits and repairs and having a documented means for addressing tenants/occupant concerns regarding indoor air quality (such as a complaint form and incident log)

Environmental leadership

- Establish an Environmental Advisory Group which would develop a written environmental policy for City Hall, and would oversee the implementation of the stated energy and water conservation and waste prevention and reduction goals and targets.
- Develop a policy re: reduction in packaging and in material management.
- Develop a three-tier communication strategy aimed at occupants, property management staff and the public at large.
- A possible addition to the communication strategy can be an Energy Efficiency demonstration centre situated at the city hall.

The above strategies were inputted in BOMA Go Green Plus assessment as well as a small hypothetical improvement of 13% energy reduction (approximately 4,000,000 kWh/annum). The above measures resulted in significant improvement of the overall City Hall energy and environmental performance, as evaluated by the BOMA Go Green Plus assessment. These improvements resulted in an improved score of 71%, thus passing the BOMA certification threshold of 70%.



City Hall post Charrette score of 71%

Note that a full BOMA Go Green Report has been provided to the City in a separate document.

APPENDIX C – Agenda

TORONTO CITY HALL
SUSTAINABILITY AND ENERGY EFFICIENCY CHARRETTE

May 2, 2007, 8:00 a.m – 4:30 p.m.   Toronto City Hall, Members Lounge

WORKSHOP AGENDA

ITEM	PRESENTER	TIME
REGISTRATION & BREAKFAST (SERVED IN MEMBERS LOUNGE)		8:00 – 8:30
INTRODUCTION	Joe Pantalone, Deputy Mayor	8:30 – 8:40
CLINTON CLIMATE CHANGE INITIATIVE	Robert Bennett Clinton Climate Initiative	8:40 – 8:50
PURPOSE OF THE DAY	Mike Singleton, SBC	8:50 – 9:00
NATHAN PHILLIPS SQUARE	Chris Pommer Plant Architect	9:00 – 9:20
INTRODUCTION TO THE BUILDING	Jim Kamstra	9:20 – 9:30
PRELIMINARY RETROFIT ACTIVITIES	Paul Leitch Toronto Hydro Energy Services	9:30 – 9:50
BASE LINE ENERGY MODEL	Brian Fountain, GreenSim	9:50 – 10:00
GOAL SETTIN EXERCISE	Peter Busby	10:00 – 10:15
FORMATION OF THE TEAMS	Mike Singleton, SBC	10:15 – 10:20
COFFEE BREAK	All	10:20 – 10:30
DESIGN SESSION 1	Teams 1 – 3	10:30 – 12:00
LUNCH & GUEST SPEAKER	All	12:00 – 12:45
2 MINUTE UPDATES	Teams 1 – 3	12:45 – 12:50
DESIGN SESSION 2	Teams 1 – 3	12:50 – 2:10
COFFEE BREAK	All	2:10 – 2:20
DESIGN SESSION 3	Teams 1 – 3	2:20 – 3:15
FINAL REPORT PRESENTATIONS	Teams 1 – 3	3:15 – 4:00
WRAP – UP	Jodie Parmar City – Facilities & Real Estate	4:00 – 4:30

APPENDIX D – Attendees

Craig	Applegath	Cohos Evamy Architects	applegathc@cohos-evamy.com
Bob	Bach	Energy Profiles Ltd	bbach@energyprofiles.com
William	Begley	Toronto Hydro Energy Services	wbegley@torontohydro.com
Rob	Bennett	Clinton Climate Initiative	rbennett@clintonfoundation.org
Andrew	Bowerbank	TRCA	abowerbank@trca.on.ca
Ted	Bowering	City; Toronto Water	tbowerin@toronto.ca
Cindy	Bromley	City; Communications	cbromley@toronto.ca
Larry	Brydon	Ozz Corp	lbrydon@ozzcorp.com
Peter	Busby	Busby Perkins	peter.busby@busbyperkinswill.ca
Noel	Cheeseman	Enerlife Consulting	noel.cheeseman@enerlife.com
Gerry	Cornwell	G Cornwell & Associates	gerry@cornwell.ca
Peter	Daldoss	Optimira	peter.daldoss@optimira.com
Per	Drewes	Sol Source Engineering	pdrewes@rogers.com
Huston	Eubank	World Green Building Council	info@worldgbc.org
Samantha	Fisher	City; Communications	sfisher@toronto.ca
Brian	Fountain	GreenSim	bfountain@greensim.com
Bruno	Furlano	City; Facilities & Real Estate	bfurlano@toronto.ca
Shiela	Glazer	City; Facilities & Real Estate	sglazer@toronto.ca
Philip	Goodfelllow	Cohos Evamy	goodfellowp@cohos-evamy.com
Lauren	Gropper	Tridel	lgropper@tridel.com
Diana	Hamilton	Delcan	d.hamilton@delcan.com
Songyang	Hu	Toronto Hydro Energy Services	shu@torontohydro.com
Philip	Jessup	TAF	PJessup@tafund.org
Martin	Jewitt	Enermodal Engineering Ltd	mjewitt@enermodal.com
Jim	Kamstra	City; Facilities & Real Estate	jkamstra@toronto.ca
Peter	Klambauer	City; Parks, Forestry and Recreation	pklamba@toronto.ca
Braden	Kurszak	Enermodal Engineering Ltd	bkurczak@enermodal.com
Tim	Lee	City; Parks, Forestry and Recreation	tlee@toronto.ca
Clarine	Lee-Macaraig	The Innovolve Group	clarine@innovolve.com
Paul	Leitch	Carbonless Directions	paul@carbonless.ca
Kevin	Loughborough	Enwave Energy Corp	kloughborough@enwave.com
Mary	MacDonald	City; Mayor's Office	mmacdon@toronto.ca
Dolores	Maher	City; Facilities & Real Estate	dmaher@toronto.ca
Michael	Marchant	Toronto Hydro Energy Services Inc	mmarchant@torontohydro.com
Robert	Maxwell	City; Facilities & Real Estate	rmaxwell@toronto.ca
Eleanor	McAteer	City; Facilities & Real Estate	emcteer@toronto.ca
Blair	McCarry	Stantec	blair.mccarry@stantec.com
Mike	McGee	Energy Profiles Ltd	mmcgee@energyprofiles.com
Colin	McGugan	Conestoga College	cmcgugan@conestogac.on.ca

Kevin	Mercer	Riversides	info@riversides.org
Mark	Mitchell	Keen Egineering	mark.mitchell@keen.ca
Ajon	Moriyama	Moriyama & Teshima Architects	am@mtarch.com
Peter	Ortved	CS&P Architects	portved@csparch.com
Paul	O'Sullivan	Ameresco Canada Inc	posullivan@ameresco.com
Dragos	Paraschiv	MCW	dparaschiv@mcw-ers.com
Jodie	Parmar	City; Facilities & Real Estate	jparmar1@toronto.ca
Kim	Peters	City; Toronto Environment Office	kpeters@toronto.ca
Chris	Phibbs	City; Mayor's Office	cphibbs@toronto.ca
Chris	Pommer	Plant Architect	pommer@branchplant.com
Tom	Ponessa	Sustainable Buildings Canada	ponessa@sympatico.ca
Mike	Singleton	Sustainable Buildings Canada	Mike-singleton@rogers.com
Jiri	Skopek	ECD Energy & Environment Canada	jiri@bellnet.ca
Hao	Yuen	City; Facilities & Real Estate	
Guy	Zimmerman	City; Planning, Heritage Preservation	gzimmer@toronto.ca

Attendees were assigned to the teams as follows:

First Name	Last Name	Affiliation	Team #
Larry	Brydon	Ozz Corp	1
Noel	Cheeseman	Enerlife Consulting	1
Peter	Daldoss	Optimira	1
Brian	Fountain	GreenSim	1
Philip	Goodfelllow	Cohos Evamy	1
Braden	Kurszak	Enermodal Engineering Ltd	1
Tim	Lee	City; Parks, Forestry and Recreation	1
Clarine	Lee-Macaraig	The Innovolve Group	1
Mike	McGee	Energy Profiles Ltd	1
Dragos	Paraschiv	MCW	1
Kim	Peters	City; Toronto Environment Office	1
Bob	Bach	Energy Profiles Ltd	2
Andrew	Bowerbank	TRCA	2
Shiela	Glazer	City; Facilities & Real Estate	2
Songyang	Hu	Toronto Hydro Energy Services	2
Martin	Jewitt	Enermodal Engineering Ltd	2
Paul	Leitch	Carbonless Directions	2
Kevin	Loughborough	Enwave Energy Corp	2
Colin	McGugan	Conestoga College	2

First Name	Last Name	Affiliation	Team #
Mark	Mitchell	Keen Egineering	2
Peter	Ortved	CS&P Architects	2
Paul	O'Sullivan	Ameresco Canada Inc	2
Chris	Phibbs	City; Mayor's Office	2
Tom	Ponessa	Sustainable Buildings Canada	2
Guy	Zimmerman	City; Planning, Heritage Preservation	2
Craig	Applegath	Dunlop Architects	3
Rob	Bennett	Clinton Climate Initiative	3
Ted	Bowering	City; Toronto Water	3
Lauren	Gropper	Tridel	3
Diana	Hamilton	Delcan	3
Philip	Jessup	TAF	3
Dolores	Maher	City; Facilities & Real Estate	3
Robert	Maxwell	City; Facilities & Real Estate	3
Ajon	Moriyama	Moriyama & Teshima Architects	3
Chris	Pommer	Plant Architect	3
Jiri	Skopek	ECD Energy & Environment Canada	3
Peter	Busby	Busby Perkins	Expert
Gerry	Cornwell	G Cornwell & Associates	Expert
Per	Drewes	Sol Source Engineering	Expert
Huston	Eubank	World Green Building Council	Expert
Michael	Marchant	Toronto Hydro Energy Services Inc	Expert
Blair	McCarry	Stantec	Expert
Kevin	Mercer	Riversides	Late reg