Carbon 101: What you need to know!

Case Study:
Ontario Association of Architects
Headquarters NetZero Carbon Renovation
Carbon 101:
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Case Study: The OAA Retrofit

• The OAA
• Establishing a Target
• Project Description
• Project Team

The Ontario Association of Architects

By Provincial Legislation,
- Regulates the profession of architecture AND
- Promotes architecture, including architectural
  science, for the good of the public.

The OAA has 4000 member who are charged
with designing all buildings over 600sm GFA, and
all buildings with one suite above another.
International Targets

On Earth Day, 2016 Canada signed the Paris Accord, agreeing to a target global temperature rise below 1.5°C.
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IPCC Scenarios
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Ontario:
Peaked in 2000
Overall GHG reduction commitments:
- 15% reduction from 1990 levels by 2020
- 37% reduction from 1990 levels by 2030
- 80% reduction by below 1990 levels by 2050

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In perspective ...

Ontario’s Progress to date & future targets

1980: - 6%
2015: - 74%
2050: 35 years

Our rate of reduction needs to be 10x faster
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None of Today’s cars will be on the road in 2050

Most of Today’s building will still be standing in 2050
Some New cars are now Zero GHG emitting, but they have time

All new buildings or communities must be zero GHG emitting, starting now.
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Common Features of Net Zero Carbon Design

More Electricity, less gas

Focus on comfort, because you can't adjust later with extra heat

More capital investment, lower operating costs.
Finding a Target

OAA HQ before new Curtain Wall: 482 ekWh/m²/yr
BOMA benchmark 282 ekWh/m²/yr
Current Ontario Building Code Av.: 259 ekWh/m²/yr
2030 Challenge 2016 Offices Target: 91.5 ekWh/m²/yr
Infrastructure Ontario Target: 100 ekWh/m²/yr
Net Zero Carbon: 0 ekWh/m²/yr

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Project description

- **Building Description**
- The approach
- Assets and Liabilities
- Envelope upgrades
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Assets
- Air tight Envelope
- Atrium
- Fantastic Daylighting
- Windows on the South, not on the North

Liabilities
- Six sides radiating to exterior
- Lots of thermal bridging
- Large curtainwall area

The Approach
The mechanical system does not take advantage of the building assets.

We are demolishing the mechanical system, and replacing it with one that works in concert with the rest of the building design.
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<table>
<thead>
<tr>
<th>ASSEMBLY</th>
<th>EXISTING NET R-VALUES</th>
<th>PROPOSED R-VALUES</th>
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<tr>
<td>Roof</td>
<td>4.0 – 4.8</td>
<td>7.0</td>
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<tr>
<td></td>
<td>23.5 - 27.5</td>
<td>40</td>
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<tr>
<td>Walls</td>
<td>0.35 - 1.15</td>
<td>11.4 - 1.3</td>
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<td>2 - 6.5</td>
<td>6.5 – 30</td>
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<tr>
<td>Exposed Floors</td>
<td>3.3</td>
<td>8.8</td>
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<th>CENTRE-OF GLASS VALUES</th>
<th>FRAME</th>
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<tr>
<td></td>
<td>U/R-value (SI)</td>
<td>U/R-value (IP)</td>
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<tr>
<td>Existing</td>
<td>1.79/0.56</td>
<td>0.32/0.2</td>
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<tr>
<td>Proposed</td>
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<td></td>
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<tr>
<td>Option 1</td>
<td>0.52/0.0</td>
<td>0.09/11.4</td>
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<tr>
<td>Option 2</td>
<td>0.52/0.0</td>
<td>0.09/11.4</td>
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* with original thermal break

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</thead>
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<tr>
<td></td>
<td>U/R-value (SI)</td>
<td>U/R-value (IP)</td>
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<tr>
<td>Skylight</td>
<td>0.73/1.37</td>
<td>0.13/7.5</td>
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<tr>
<td>Clerestory</td>
<td>0.71/1.41</td>
<td>0.125/8.0</td>
</tr>
<tr>
<td>Curtainwall</td>
<td>0.71/1.41</td>
<td>0.125/8.0</td>
</tr>
</tbody>
</table>

* new, with thermal break
* with retrofit thermal break
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Figure 1: A “Blower Door” installation – Computer-controlled fans are installed in special shrouds that expand to fit into a door opening. Six fans were set up for the OAA Headquarters test.
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Air Tightness Results

It is common for the actual measured air leakage performance to be much greater than the standards and guidelines noted above, as actual air leakage is typically not quantified in commercial construction (except for the US Army). Accordingly, actually achieving air leakage within the range of the noted guidelines and standards is a significant achievement, let alone exceeding many of them.

“Building Enclosure Air Leakage Evaluation” Halsall Associates, June 2012
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Thermographic Results
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HQ Asset: Great Daylighting!
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Proposed Upgrades
• Changes to glazing
• New exterior shading system
• New electric lighting system and controls
• Maximize daylight harvesting
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PRIVATE OFFICES-Option #1B

Current: 4 Switches Control the entire Building Interior
Future: Individual controls & daylight sensors
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[Diagram of COOLING & HEATING PLANT: SAGHP Solar-Assisted Ground Source Heat pump]

- Building Heating & Cooling: The heating and cooling supply requires hot and cold water temperatures only slightly different from room temperatures which can be obtained for much of the time from ambient sources such as low-grade solar heating.
- Heat Pump: In winter, Heat Pump operates at night to provide heat for building load using source heat from the Storage Tanks. In summer, Heat Pump cools the Storage Tank and rejects heat to the solar panel at night.
- Backup Heater: The current gas boiler system can be retained as a backup heating to augment heat pump heating in peak heating periods to ensure that the geothermal tanks do not drop below 5°C.

[Diagram notes: TANKS - sized to meet peak daytime cooling and nighttime heating loads - arranged in series to provide thermal stratification - storage is primarily operating as thermal storage - by burying in earth and insulating above, tanks makes use of soil contact to increase storage capacity and moderate temperatures between 5° and 15°C]
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Energy Use and Budget

**Figure 5.2A: Comparison of Total Energy Demand of Base and Proposed Cases**
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2nd Floor Plan
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“We believe that all major alternatives have been explored, and while Option 4 has the highest capital cost, its value is considerably more than other options.”

<table>
<thead>
<tr>
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<th>Option 1</th>
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<th>Option 3</th>
<th>Option 4</th>
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<tr>
<td>Capital costs for energy retrofit</td>
<td>$2,545,437</td>
<td>$3,441,368</td>
<td>$3,494,652</td>
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<tr>
<td>Cost per SF</td>
<td>$106</td>
<td>$143</td>
<td>$146</td>
<td>$178</td>
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<tr>
<td>Annual Energy Savings</td>
<td>$14,561</td>
<td>$93,875</td>
<td>$76,640</td>
<td>$102,217</td>
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<tr>
<td>Simple Payback</td>
<td>N/A</td>
<td>9.54</td>
<td>15.29</td>
<td>19.66</td>
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<td>Advocacy Value</td>
<td>Negative</td>
<td>Low</td>
<td>Low</td>
<td>High</td>
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<tr>
<td>Technical Risk</td>
<td>None</td>
<td>Construction</td>
<td>Construction</td>
<td>Construction</td>
</tr>
</tbody>
</table>

June, 2016, Council unanimously approved Option 4.
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Energy Cost
Electricity (3.05% Increase/yr)
Natural Gas (Mean Average)
Carbon Price Electricity
Carbon Price Natural Gas
TOTAL Energy Cost
TOTAL Premium Mortgage

Based on a 15 year Mortgage @ 3.05%
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**Architectural Team: Zero Carbon Design**

**Architect:**
- David Fujiwara Architect
- WSP
- WSP

**Mechanical Engineering:**
- Deborah Gottesmann and Associates
- Sheffield
- TTCn2r
- WSP

**Electrical Engineering:**
- National Research Council
- Greg Allen
- TBD
- EH Price
- Swallow

**Lighting Design:**
- National Research Council
- National Research Council
- TBD

**Structural:**
- National Research Council

**Cost Estimating:**
- National Research Council

**Commissioning:**
- National Research Council

**Design Challenge:**
- Greg Allen
- TBD
- EH Price
- Swallow

**Design Challenge Civil:**
- National Research Council

**CFD Modelling:**
- National Research Council

**Acoustic Consulting:**
- National Research Council

**Pre/Post Occupancy Studies:**
- National Research Council

**Performance Documentation:**
- National Research Council

**Ice Tank Consulting:**
- National Research Council

**The Building Committee**

**Chair:**
- Sheena Sharp, Councilor, Past President
- Toon Dreesen, Immediate Past President
- John Stephenson, President

**Member:**
- Marilyn McInnes

**OAA Staff Assigned:**

- Kristi Doyle
- Marilyn McInnes
Thank-you