Carbon Retrofit Case Studies

Rod Yeoh, P.Eng., P.E., LEED® AP BD+C
Principal, DIALOG

September 2018
WE ARE PASSIONATE ABOUT DESIGN
WE BELIEVE IT CAN, AND SHOULD,
MEANINGFULLY IMPROVE
THE WELLBEING OF COMMUNITIES
AND THE ENVIRONMENT WE SHARE.
Location, Location
September 2017

Robert Ivy, FAIA
EVP/Chief Executive Officer
The American Institute of Architects
1735 New York Avenue NW
Washington, DC 20006-5292

Dear Robert:

RE: AIA 2030 Commitment Program

DIALOG, a 600 person firm with studios in San Francisco, Vancouver, Calgary, Edmonton, and Toronto, is hereby signing on to the AIA 2030 Commitment program and its goal of carbon-neutral buildings by the year 2030.

As a firm of architects, planners, interior designers, landscape architects, and engineers, DIALOG understands the need to be leaders in creating the built environment. Our vision is to improve the well being of the communities and the environment we all share. As a result, it is paramount to our practice to encourage our clients and stakeholders, as well as the entire design and construction industry, to make the choices that will shift the course of the planet’s future. We recognize that a multi-year effort will be required to alter current design and construction practices and, likewise, it will take years for the regeneration of natural resources, but we are eager to assist in making it happen.

The places and buildings where we live, work and play represent the largest sources of greenhouse gas emissions in North America and around the world, and we recognize the trust given to design professionals to strive to continuously improve what we do, and to mitigate the impacts we make. The design and construction industry has made significant strides toward creating high performance buildings of all types and uses. As a result, the industry is positioned to have a profound impact by continuing to improve and advocate for building performance and reducing building-related greenhouse gas emissions.

Therefore, DIALOG agrees to take the following steps that are part of the AIA 2030 Commitment program:

- Within two months of the commitment date, DIALOG will establish a team or leader to guide the development and implementation of the firm’s plan;
- Within six months of signing the commitment, DIALOG will implement a minimum of four operational action items from the list provided. These actions will be undertaken while the long-term sustainability plan is in development;
- Within one year of signing the commitment, DIALOG will develop a sustainability action plan that will demonstrate progress toward the AIA’s 2030 goals; and,
- At the conclusion of the year, and each year thereafter, DIALOG will report on the progress of the firm’s design portfolio toward meeting the 2030 goals by using the AIA 2030 Design Data Exchange.

In addition, we will support the critical need for more consistent and more rigorous metrics related to measuring and validating building performance. We further commit our firm’s assistance to the AIA and others in the ongoing development of effective metrics and standards for reporting purposes. It is understood by DIALOG that reporting through the AIA 2030 Commitment program must respect the confidentiality of information about specific clients, projects, and proprietary tools.

We look forward to working with you and our professional colleagues to achieve the goals of the AIA 2030 Commitment.

Sincerely,

Jim Anderson, Principal
Martin Nielsen, Principal

dialogdesign.ca
City of Vancouver Energy Upgrades for Existing Buildings

- Implemented January 1, 2015 as part of the City’s Building Code
- Energy upgrades “triggered” by renovations
- Stepped Trigger system
- Level of upgrade required is contingent on extent of renovation
- Industry consultation and feedback
- CoV already had similar upgrade triggers for Fire and Life Safety, Structural and Non-structural Seismic, and Accessibility
City of Vancouver Energy Upgrades

Rehabilitation Project (Flow Chart #1)

- Voluntary Upgrade
  - Upgrade Level
    - Fire & Life Safety
      - NA
    - Structural
      - NA
    - Non-Structural
      - NA
    - Accessibility
      - NA
    - Energy
      - NA
- Repair/Small Suite
  - Upgrade Level
    - Fire & Life Safety
      - F1
    - Structural
      - S1
    - Non-Structural
      - N1
    - Accessibility
      - A1
    - Energy
      - E1/E2
- Minor Renovation
  - Upgrade Level
    - Fire & Life Safety
      - F1
    - Structural
      - S2
    - Non-Structural
      - N1
    - Accessibility
      - A2
    - Energy
      - E2
- Major Renovation
  - Upgrade Level
    - Fire & Life Safety
      - F2
    - Structural
      - S2
    - Non-Structural
      - N3
    - Accessibility
      - A3
    - Energy
      - E4
- Reconstruction
  - Upgrade Level
    - Fire & Life Safety
      - F4
    - Structural
      - S4
    - Non-Structural
      - N4
    - Accessibility
      - A4
    - Energy
      - E6
City of Vancouver Energy Upgrades
City of Vancouver Energy Upgrades
MacKimmie Complex
THE UNIVERSITY OF CALGARY
JUNE 2018
Project Stats.

Original Structures

- Built as a Library tower expansion in 1968
- Tower was initially 6 floors but expanded vertically 1971 with an additional 6.
- Projected to 22 stories.
- Concrete superstructure with precast cladding and curtain wall envelope.
- Low window to wall ratio.
- Envelope and M+E systems beyond serviceable life.
MacKimmie Block and Tower Redevelopment

Solar Analysis
MacKimmie Block and Tower Redevelopment
Climate Analysis and Potentials

**Annual total:**
1382 kWh/m²a

**Horizontal**
Equally high annual solar insolation on horizontal surfaces and South facing facades

**Calgary**
- 129% (66%)
- 70%
- 29%

**Berlin**
- 117% (63%)
- 100%
- 66%
- 63%
- 32%
MacKimmie Block and Tower Redevelopment
Climate Analysis and Potentials

- High winter solar potential on SW on SE–facades
- Low solar potential on NW-facade
• High annual temperature swing of > 60 K
• Substantial typical diurnal temperature swing of ≈ 15K

→ High potential for passive night cooling / night flushing
Solar Analysis

Climate Analysis and Potentials

Summary
• High solar potential also during winter
• Substantial typical diurnal (daily) temperature swing
• Low humidity levels also during summer

→ Design for:
• Passive solar utilization of sun exposed building facades (façade design)
• Active solar applications on roof and facades (Use the Sun)
• Natural ventilation (Use the Wind)
• Passive cooling by night flushing, high benefit from use of thermal mass, (Use the Concrete.)
  no humidity problem in summer
• Evaporative / Adiabatic Cooling
MacKimmie Block and Tower Redevelopment

Tower Façade Options

Double Façade vs. Single Facade

- Exterior Double or Triple IGU
- Interior Single Glazing
- Operable solar shading in DF cavity
- Natural ventilation of DF cavity by operable openings
- DF cavity serves as climatic buffer space

- Double or Triple IGU
- Interior operable solar shading
- Operable windows
MacKimmie Block and Tower Redevelopment

Tower Façade Options

### Double Facade

- Natural ventilation in winter → Excellent summer comfort
- Exterior solar shading

### Single Facade

- Natural ventilation in winter directly to outside = problem! → Overheating
- Interior solar shading

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**Operative Room Temperature during Operation Time (°C)**

- Double Facade:
  - Natural ventilation in winter
  - Exterior solar shading
- Single Facade:
  - Interior solar shading

**Specific Use Energy Demand (kWh/m²a)**

- Heating:
  - Double Facade: 21
  - Single Facade: 15

- Cooling:
  - Double Facade: 3
  - Single Facade: 3

- Electricity:
  - Double Facade: 60
  - Single Facade: 60
MacKimmie Tower Renovation Façade and Climate Concept

Tower Concept Options

V0

V1

V2

V3
Decentralized Fresh Air Supply
At Perimeter Zone
✓ Occupancy driven operation / individual control
✓ Reduced ductwork
✓ Ceiling can remain open
→ use of thermal mass for passive conditioning
and Transfer of Return Air to Core Zone

Central Mechanical and Ventilation
At Core Zone
• Meeting rooms and interior office spaces
• Washrooms
• Infrastructure spaces
• Other core spaces
Tower Facade

RAF + SHADING
Tower Facade

DAYLIGHT
Federal Building Carbon Neutral Renovations

All projects begin with Carbon Neutral Studies

- Study and Energy Modeling of Baseline and Four Bundles of Energy Conservation Measures of Life Cycle Basis
- Baseline – Carbon emissions for existing building
- Option 1 – Minimum Departmental Standards, also min 24% below National Energy Code for Buildings
- Option 2 – Bundle of measures that are cost neutral with baseline from life cycle cost perspective over 25 years – Minimum efficiency upgrades
- Option 3 – Bundle of measures that achieve maximum energy and carbon reductions, regardless of life cycle cost – “Shoot for the Stars”
- Option 4 – Bundle of measures that provides maximum carbon reductions while maintaining best value from life cycle cost perspective – usually combination of measures from options 2 and 3.
Federal Building Carbon Neutral Renovations

Project 1 – Windsor, ON, 4,800 SqM
**Federal Building Carbon Neutral Renovations**

Project 1 – Windsor, ON, 4,800 SqM

<table>
<thead>
<tr>
<th>Envelope Upgrades</th>
<th>Mechanical System Upgrades</th>
<th>Energy and Carbon Targets</th>
</tr>
</thead>
<tbody>
<tr>
<td>• R-20 walls (spray foam on inside of existing masonry walls)</td>
<td>• DOAS with Heat Recovery + VRF with radiant heating at perimeter (condensing boilers)</td>
<td>• Predicted EUI 101 kWh/m2</td>
</tr>
<tr>
<td>• R-40 roof</td>
<td></td>
<td>• 58% energy savings vs. pre-retrofit</td>
</tr>
<tr>
<td>• Triple pane glazing U-0.20</td>
<td></td>
<td>• 75% GHG reduction vs. pre-retrofit</td>
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- **Envelope Upgrades**
  - R-20 walls (spray foam on inside of existing masonry walls)
  - R-40 roof
  - Triple pane glazing U-0.20

- **Mechanical System Upgrades**
  - DOAS with Heat Recovery + VRF with radiant heating at perimeter (condensing boilers)

- **Energy and Carbon Targets**
  - Predicted EUI 101 kWh/m2
  - 58% energy savings vs. pre-retrofit
  - 75% GHG reduction vs. pre-retrofit
Federal Building Carbon Neutral Renovations

Project 2 – Toronto, ON, 42,442 SqM
## Federal Building Carbon Neutral Renovations

### Project 2 – Toronto, ON, 42,442 SqM

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<tr>
<td>• R-28 walls (board insulation with fibreglass supports)</td>
<td>• DOAS with Heat Recovery + FCUs for heating/cooling</td>
<td>• Predicted EUI 60 kWh/m2</td>
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<tr>
<td>• R-40 roof</td>
<td>• Heat recovery chiller connected to geothermal field</td>
<td>• 70% energy savings vs. pre-retrofit</td>
</tr>
<tr>
<td>• Triple pane glazing U-0.15</td>
<td></td>
<td>• 80% GHG reduction vs. pre-retrofit</td>
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Federal Building Carbon Neutral Renovations

Project 3 – Ottawa, ON, 911,500 SqM

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<tr>
<td>• R-14 walls (spray foam on existing precast panels)</td>
<td>• VAV distribution connected to district heating and cooling</td>
<td>• Predicted EUI 117 kWh/m2</td>
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<tr>
<td>• R-35 roof</td>
<td></td>
<td>• 77% energy savings vs. pre-retrofit</td>
</tr>
<tr>
<td>• Double pane glazing U-0.30</td>
<td></td>
<td>• 77% GHG reduction vs. pre-retrofit</td>
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Thank you!