Passive House Goes to Work: Western Canada’s First Passive House Office Building
- and -
Passive House Design for Commercial Offices - Scaling Up, Design Tools, Overheating, and a Client’s Motivation

Presented by

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PASSIVE HOUSE FOR COMMERCIAL OFFICE

OVERVIEW

1. Introduction to Charter Telecom
   • design brief
   • location & climate
2. Design Challenges and Process
   • site geometry & constraints
3. Construction Status and Lessons Learned
4. Take-Aways and Recommendations
5. Questions
• 2 levels office + 1 level amenity/meeting/exec suites

• 16,186 sqft [1,504 sq m] gross floor area
  (Floor Area Ratio calculation)

• 9,718 sqf [902.8 sq m]
  TFA (Passive House Calculation)
BC Energy Code:
- ASHRAE 90.1-2010 or
- (Canada) NECB
- “Baseline vs. Proposed”

BC Energy Step Code
- “Net Zero Energy Ready” by 2032

Absolute Metrics:
- TEUI ~ PE
- TEDI ~ Qh
- Mandatory energy model
- Mandatory air tightness testing
PROJECT INTRODUCTION

CLIMATE

- Langford, BC (Greater Victoria, BC, Canada)
- Pacific NW - Climate Zone 4 (~2950 HDD18ºC or 5310 HDD65ºF)
**PROJECT INTRODUCTION**

**CLIENT AND TEAM**

- Client
  - Tech Company; recent expansion
  - Project will consolidate 55 staff from 2 existing locations

- Design & Construction Team
  - some PH experienced, others new to PH
PROJECT INTRODUCTION

CLIENT’S MOTIVATION

- Private development – build, hold, occupy, maintain
- Not driven by typical build-to-lease pressures (LEED)

- Desire for:
  - Occupant Comfort and Quality Work Environment
  - Resilience and High Quality of Construction
  - Reduced Operating Costs
  - ... without major premium on construction cost
Narrow (20m)
- Adjacent properties expected to be developed
- South elevation – primary entrance and frontage
- Significant east and west exposures
PROJECT DESIGN
BROAD STROKES

Ground
Level 2
Level 3
Level 4
DESIGN CHALLENGES AND PROCESS

BROAD STROKES
DESIGN CHALLENGES AND PROCESS

BROAD STROKES
PROJECT DESIGN
SITE CONSTRAINTS
PROJECT DESIGN
SITE CONSTRAINTS
• Conditioned vs. Unconditioned Space
  • Elevator lobbies and stairs are outside of thermal building envelope
  • Reduce complexity, exposure, articulation, interface with unconditioned parking
  • Transient occupants anyway
DESIGN CHALLENGES AND PROCESS

CONSTRUCTION SEQUENCING
DESIGN CHALLENGES AND PROCESS

CONSTRUCTION SEQUENCING
DESIGN CHALLENGES AND PROCESS

STRUCTURE AND PENETRATION COORDINATION

- Cross-Laminated Timber (CLT) Construction
Mass Timber Construction - Cross-Laminated Timber (CLT) & Gluelam
DESIGN CHALLENGES AND PROCESS
STRUCTURE AND PENETRATION COORDINATION

• Mass Timber Construction - Cross-Laminated Timber (CLT) & Gluelam
DESIGN CHALLENGES AND PROCESS

STRUCTURE AND PENETRATION COORDINATION

• Why we didn’t go with concrete
DESIGN CHALLENGES AND PROCESS

STRUCTURE AND PENETRATION COORDINATION

- Mass Timber Construction - Cross-Laminated Timber (CLT) & Gluelam
CONSTRUCTION STATUS & LESSONS LEARNED

FINAL ENVELOPE SYSTEM

MEMBRANES & INSULATION

STRUCTURAL TRADES

CLADDING TRADES
CONSTRUCTION STATUS & LESSONS LEARNED

FINAL ENVELOPE SYSTEM
CONSTRUCTION STATUS & LESSONS LEARNED

FINAL ENVELOPE SYSTEM
DESIGN CHALLENGES AND PROCESS

COOLING DEMAND INTENSITY

• Commercial Office PH in Canada – unique?

• External climate is heating dominant

• Most local PH examples and experience are in smaller and residential-use projects.

• Key difference...?
Internal Gains!
Passive House Certification Criteria:
• Cooling + Dehumidification Demand < 15 kWh/m²-yr + dehum contribution
  OR
• Cooling Load < 10 W/m²

10 W/m² criteria barely covers office lighting → unrealistic to this criteria for commercial buildings

Typical Office Cooling Loads...
• Sedentary Office Occupant...
  • 245 BTU/h (71 W) per person
• Typical Lighting...
  • 0.7 to 1.1 W/sqft
• Typical Computers “Medium Density”...
  • 1.0 W/sqft
• Typical Photocopier...
  • 550 W
• Typical Coffee Machine...
  • 1200 BTU/h (350 W)
## DESIGN CHALLENGES AND PROCESS
### COOLING DEMAND INTENSITY

- **Comparison of Cooling Loads:**

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<th>W/m²</th>
<th>W/sqft</th>
<th>sqft/ton</th>
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<td>Passive House Criteria</td>
<td>10</td>
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<td>ASHRAE Internal Gains at:</td>
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<td>• 1.0 W/sqft lighting</td>
<td>25.4</td>
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<td>• 1.0 W/sqft equipment</td>
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<td>• 5 people/1000sqft</td>
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<td>Typical Commercial Office</td>
<td>63</td>
<td>5.85</td>
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<td>Rule of Thumb</td>
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- **Actual design capacity for Charter Telecom**

  18.5 tons over 12,000 sqft = 650 sqft/ton = 58 W/m²
Ventilation & Equipment Limitations

- HRV-1 – Office Level 1 (2000 CFM)
- HRV-2 – Office Level 2 (2000 CFM)
- HRV-3 – Executive Hospitality Suites (200 CFM)
- HRV-4 – Amenity/Meeting (1200 CFM)
DESIGN CHALLENGES AND PROCESS
HVAC SYSTEM TYPE AND ZONING

• Variable Refrigerant Volume (VRV) System
• CO-2 Air-Source Heat Pump (Sanden)
• Missed Opportunity to reduce CDI and PE using Natural Ventilation and Passive Cooling?
### Passive House Construction Status & Lessons Learned

- **Treated Floor Area:** 903 sq m [9,718 sq ft]
- **Envelope Area:** 2025 sq m [21,797 sq ft]
- **Ratio TFA:** Envelope 2.24
- **Wall Insulation**
  - U-value 0.123 to 0.142 [R 40 to 41]
- **Roof Insulation (average for sloped insulation)**
  - U-value 0.128 [R 40]
In framing, envelope started.
CONSTRUCTION STATUS & LESSONS LEARNED

COSTS Envelope

• Framing/finishing costs similar to any other building of this type

• Envelope ~$22/sqft

• I-joist, insulation, air barrier, WRB, rain screen
• Some of these costs are not “extra”, they are just different
• Total extra envelope cost works out to about $200,000
CONSTRUCTION STATUS & LESSONS LEARNED

COSTS Mechanical

- $125K Plumbing ($10/sqft)
- $309K VRV HVAC System ($25/sqft)
- $213K HRVs + Sheet Metal ($18/sqft)
- $80K Insulation, Firestop, T.A.B.
- **TOTAL = approx $60/sqft**

- Mechanical is on-par with comparable non-PH office.
CONSTRUCTION STATUS & LESSONS LEARNED

COSTS TOTAL

• Total Construction Cost = $6.0M CAD
  (approx. ~$375 / gross sqft)

• Represents higher-end range of Class A low-rise office construction including interior fitout.

• Vancouver Island region has seen recent surge in construction costs, driven by recent demand for residential development.
CONCLUSIONS

TAKEAWAYS AND RECOMMENDATIONS

1. Passive House principles can offer comfort, quality, and value for private commercial developments.
2. Beware cooling requirements. Consider an Engineered Natural Ventilation System if climate allows.
• On track for certification

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<th>Treated floor area m²</th>
<th>Space heating</th>
<th>Heating demand kWh/(m²a)</th>
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Empty field: Data missing; -: No requirement
CONCLUSIONS

TAKEAWAYS AND RECOMMENDATIONS

4. Integrated Design Process - the only way to design and build Passive House for a reasonable cost