# Resilient Building Deep Retrofit Strategies: Making The Case For A Multi-Unit Residential Building

November 04, 2022

BCBEC

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Associate, Senior Building Performance Engineer

Read Jones Christoffersen Ltd.
Creative Thinking **Practical Results**

North

**Climate change affecting composition of Yukon forests, study finds**

Saskatchewan

PEI · Photos

**P.E.I. National Park du**
**dramatic' erosion fror**

Visitors being asked to stay away fror

Kevin Yarr · CBC News · Posted: Sep 27, 2022 8:

Over 20,(

Flood risk has beer Theresa Kli
upstream reservoirs

Bryan Labby · CBC News · Posted:

cbc.ca + Follow View Profile

Calgary · Analysis

**Tallying Alberta's oil revenue losses from Fort McMurray wildfires**

Total oilsands production loss could hit 40 million barrels, according to FirstEnergy Capital

Paul Haavardsrud and Kyle Bakx · CBC News · Posted: Jun 11, 2016 7:00 AM MT | Last Updated: June 11, 2016

Smoke and flames from the wildfire erupt behind a car on the highway near Fort McMurray, Alta., on May 7. (Mark Blinch/Reuters)

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'We're scared to death': low-income Nova Scotians struggling to restock food after Fiona

Nicola Seguin - 13

Nova Scotia

st directly impacted' by

? Blame the

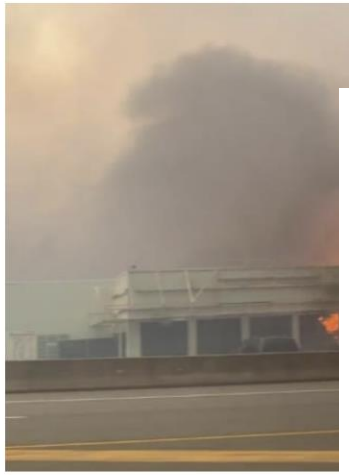
# And that's just Canada.

# Across the globe, it's happening and affecting our loved ones.

Nunavut accounted fo

More than 1,000 people fled village and surrounding are
those unaccounted for

Rhianna Schmunk · CBC News · Posted: Jul 01, 2021 8:30 AM PT | Last Up



A building in Lytton is engulfed in flames on Rivers Remix Society)

British Columbia

**595 peopl**
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More than 231 d
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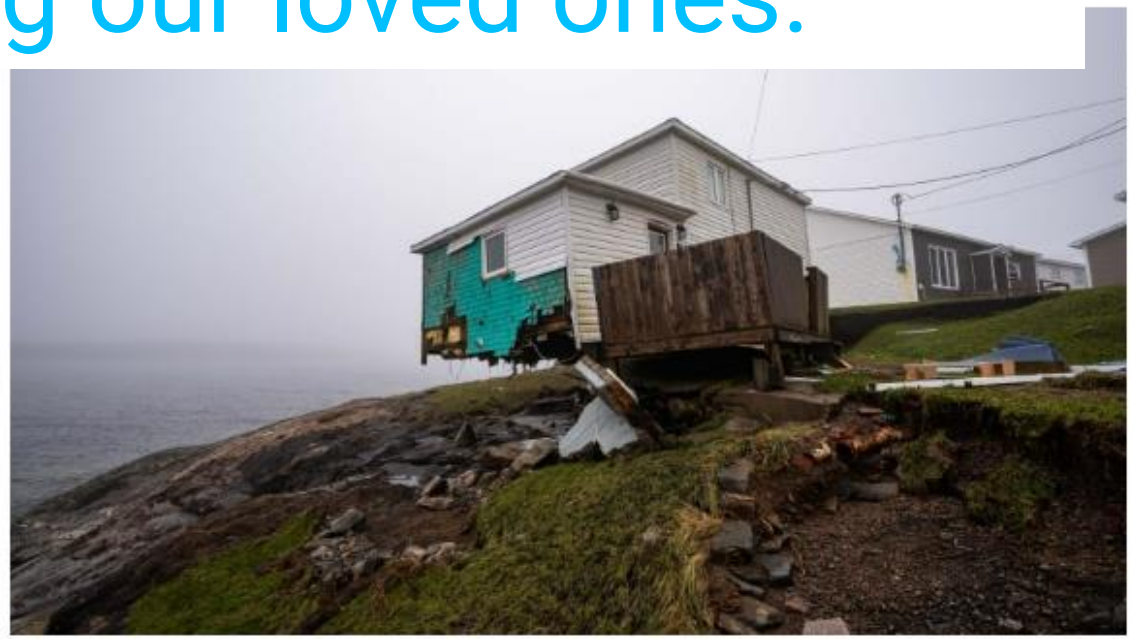
Rhianna Schmunk · C



Post-tropical storm Fiona left a path of destruction on the southwest corner of the Newfoundland, destroying nearly 100 homes with high winds, towering waves and a strong storm surge. (Submitted by Cpl. Braden Trudeau)

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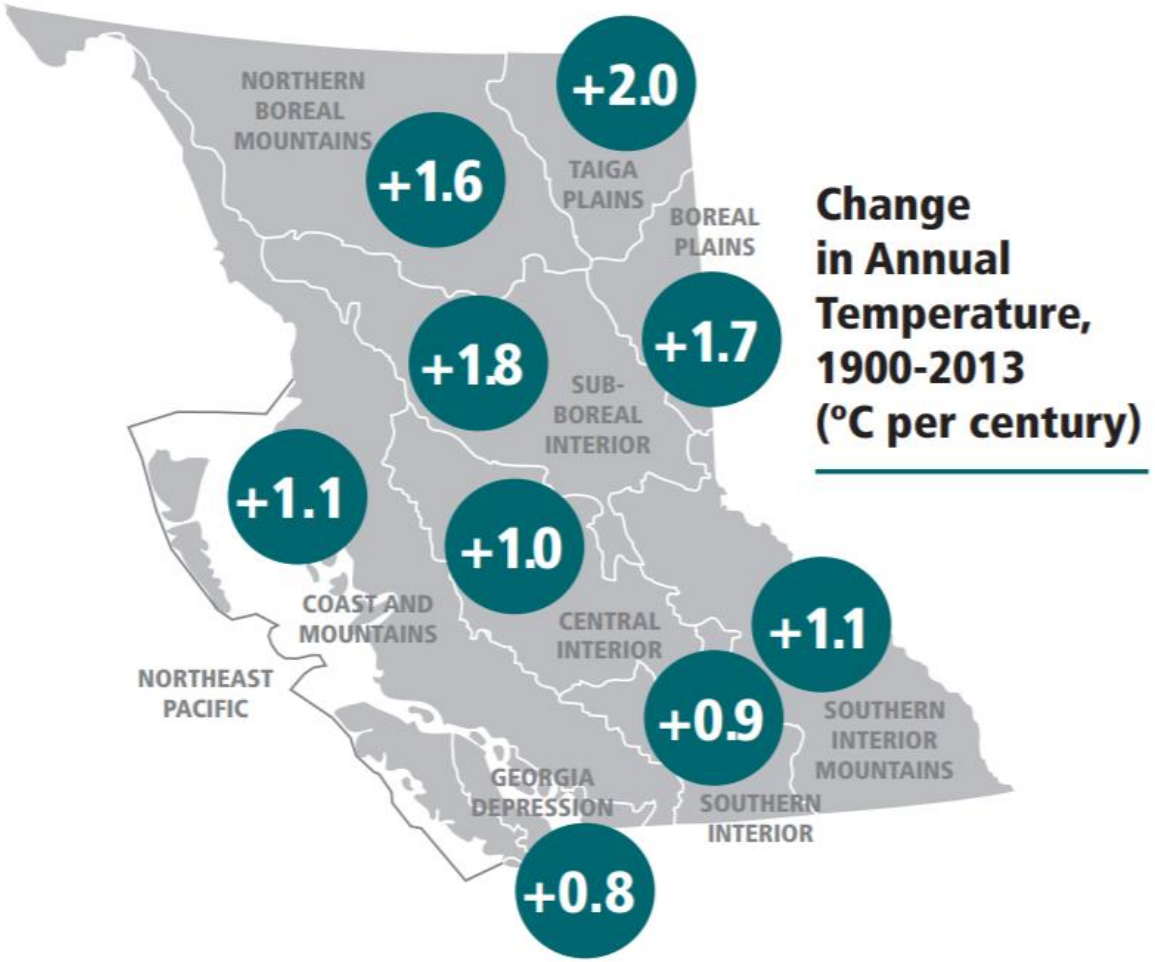
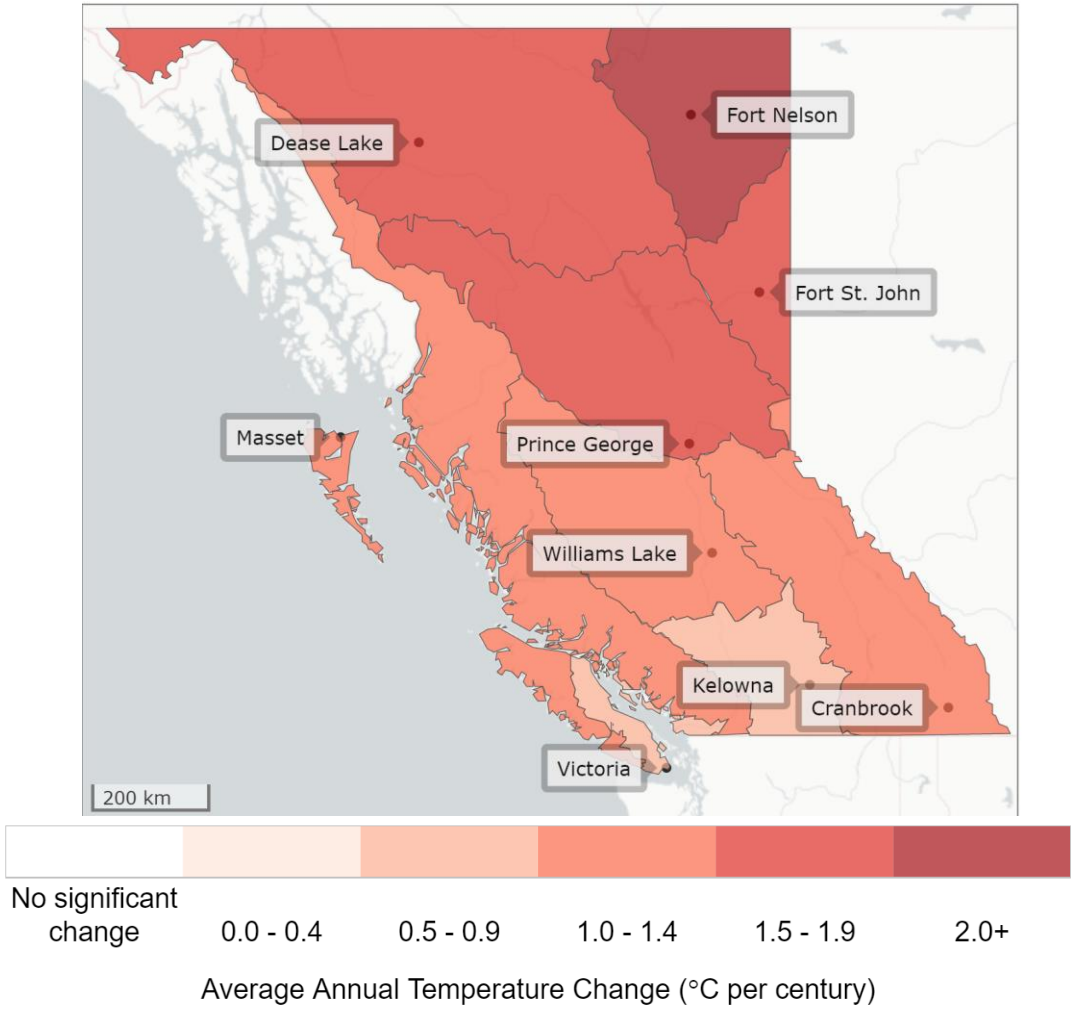
# Climate Change: British Columbia




http://www.env.gov.bc.ca/soe/indicators/climate-change/temp.html

# A sneak peek at Vancouver

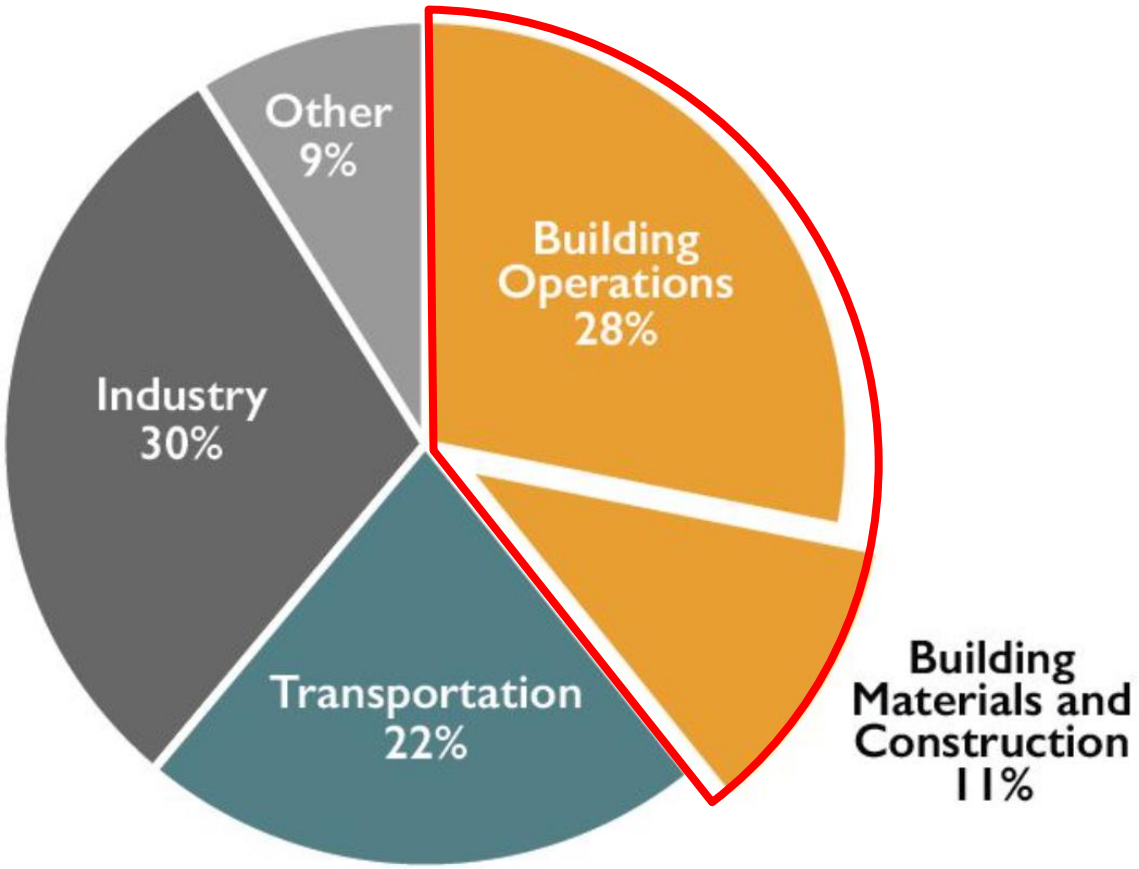

## High-Carbon Climate Change Projections*

| Change | 1976-2005 Mean | 2051-2080 Low | 2051-2080 Mean | 2051-2080 High |
|---|---|---|---|---|
| *Typical hottest summer day* | 29.3 °C | 30.5 °C | 33.7 °C | 36.9 °C |
| *Typical coldest winter day* | -8.3 °C | -7.6 °C | -2.1 °C | 2.6 °C |
| *Number of +25 °C days per year* | 18 | 43 | 72 | 100 |
| *Number of +30 °C days per year* | 1 | 2 | 16 | 35 |
| *Annual precipitation* | 1567 mm | 1294 mm | 1695 mm | 2118 mm |
| *Mean annual temperature* | 10.6 °C | 12.8 °C | 14.2 °C | 15.5 °C |
| *Number of below-zero days per year* | 30 | 0 | 5 | 15 |

https://climateatlas.ca/sites/default/files/cityreports/Vancouver-EN.pdf

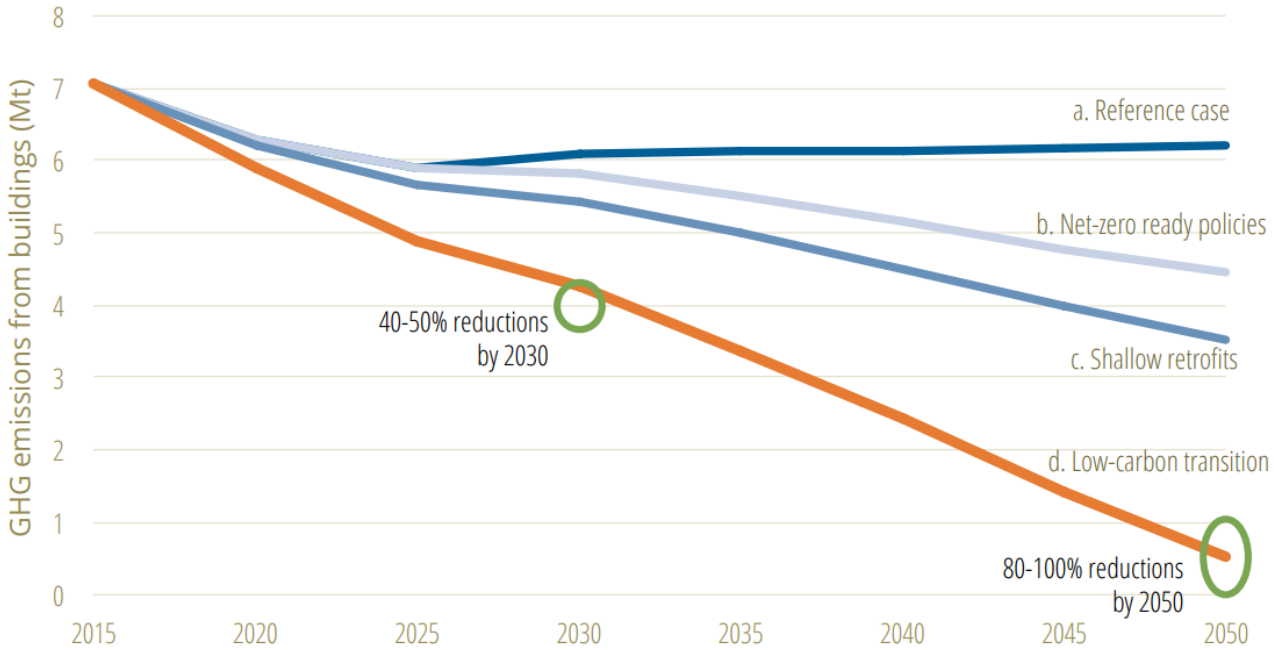
* Climate Data. The Climate Atlas of Canada includes climate change indices derived from 24 downscaled climate models obtained from the Pacific Climate Impacts Consortium (PCIC; pacificclimate.org). For each model, two emissions scenarios, the 'Low Carbon' scenario (RCP4.5) and the 'High Carbon' scenario (RCP8.5), and two future time periods, 2021-2050 and 2051-2080, are provided. The high and low model projections indicate the 90th and 10th percentiles values for the 24 model ensemble.

# Global Carbon Emissions by Sector




https://newbuildings.org/embodied-carbon-conundrum-solving-for-all-emission-sources-from-the-built-environment/

# Canada's Plan




From [Deep emissions reduction in the existing building stock]

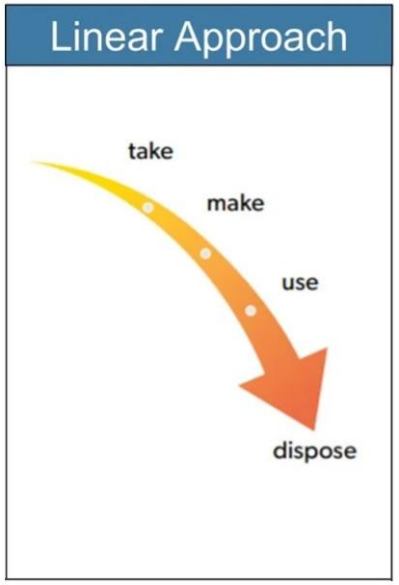
| | Homes | MURBs | ICI |
|---|---|---|---|
| Current stock | 1 million | 25,000 (575,000 units) | 60,000 (100 million $m^2$) |
| 3% | 30,000 per year | 800 per year (17,000 units) | 1,800 per year (3 million $m^2$) |

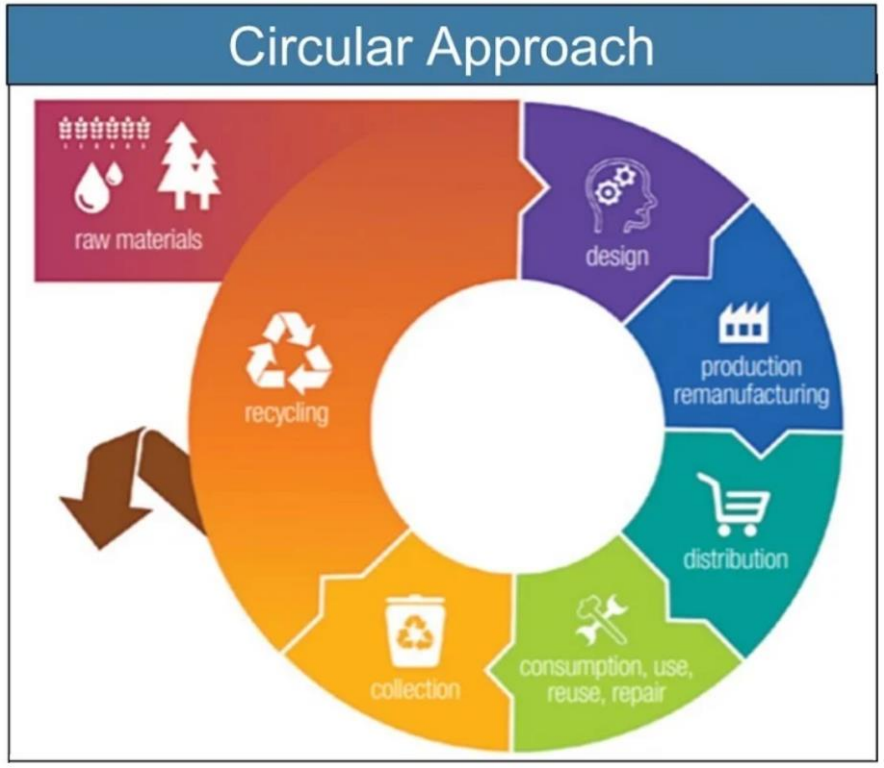
The most sustainable building is the one you don’t build

# Why Existing Buildings?
## ***Retrofits are a Plan for Hope***

It’s estimated 70 percent of buildings standing today will still be in use as of 2050

- Building conservation is circular economy at its best
- Retrofitting buildings is how we steward our embodied emissions

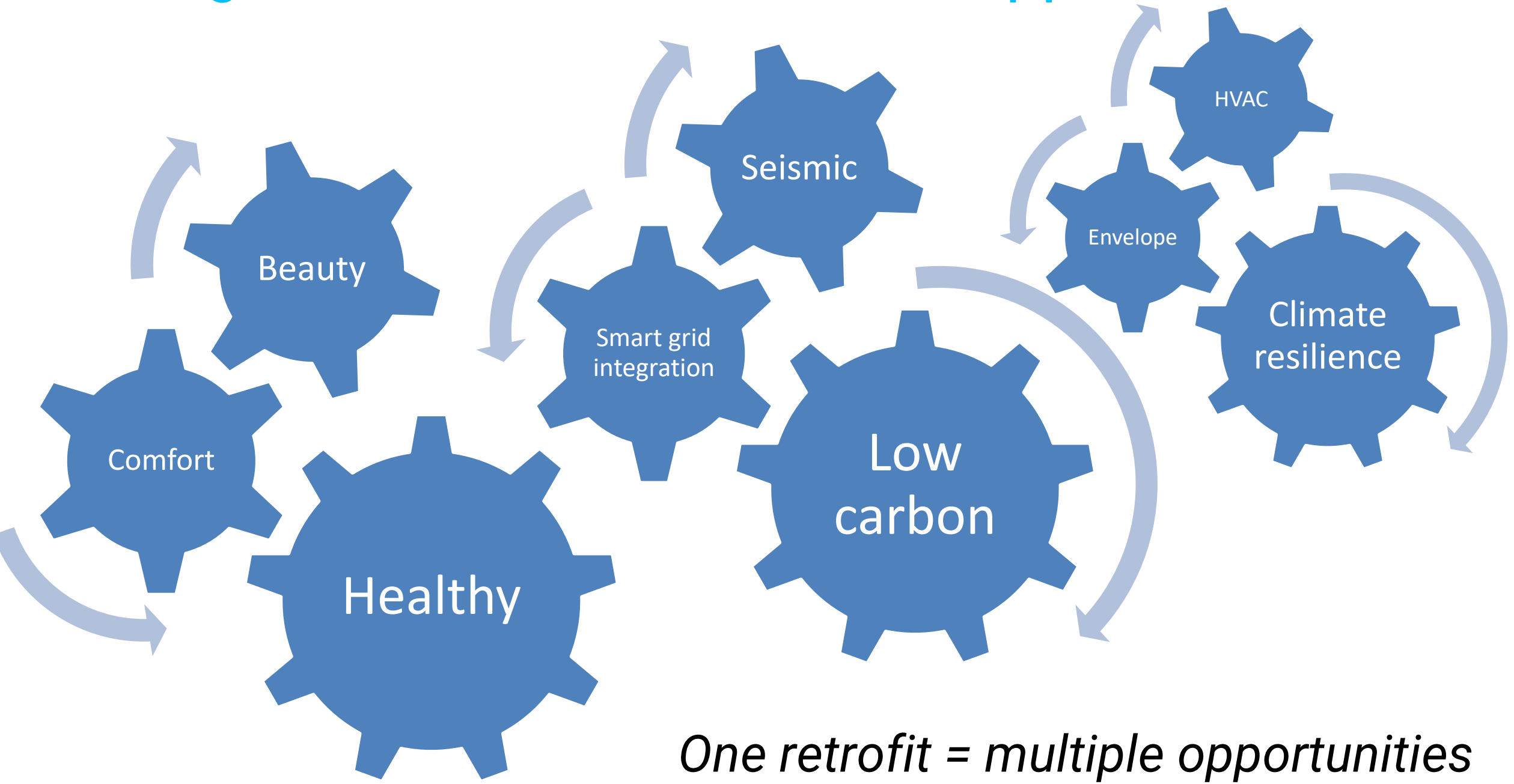



Circular economy

# Building Retrofit:
# Beyond Energy Efficiency

# Building Retrofit: A Multi-Faceted Approach




*One retrofit = multiple opportunities*

# Building Retrofit: Climate Impacts

Flood

Wildfire

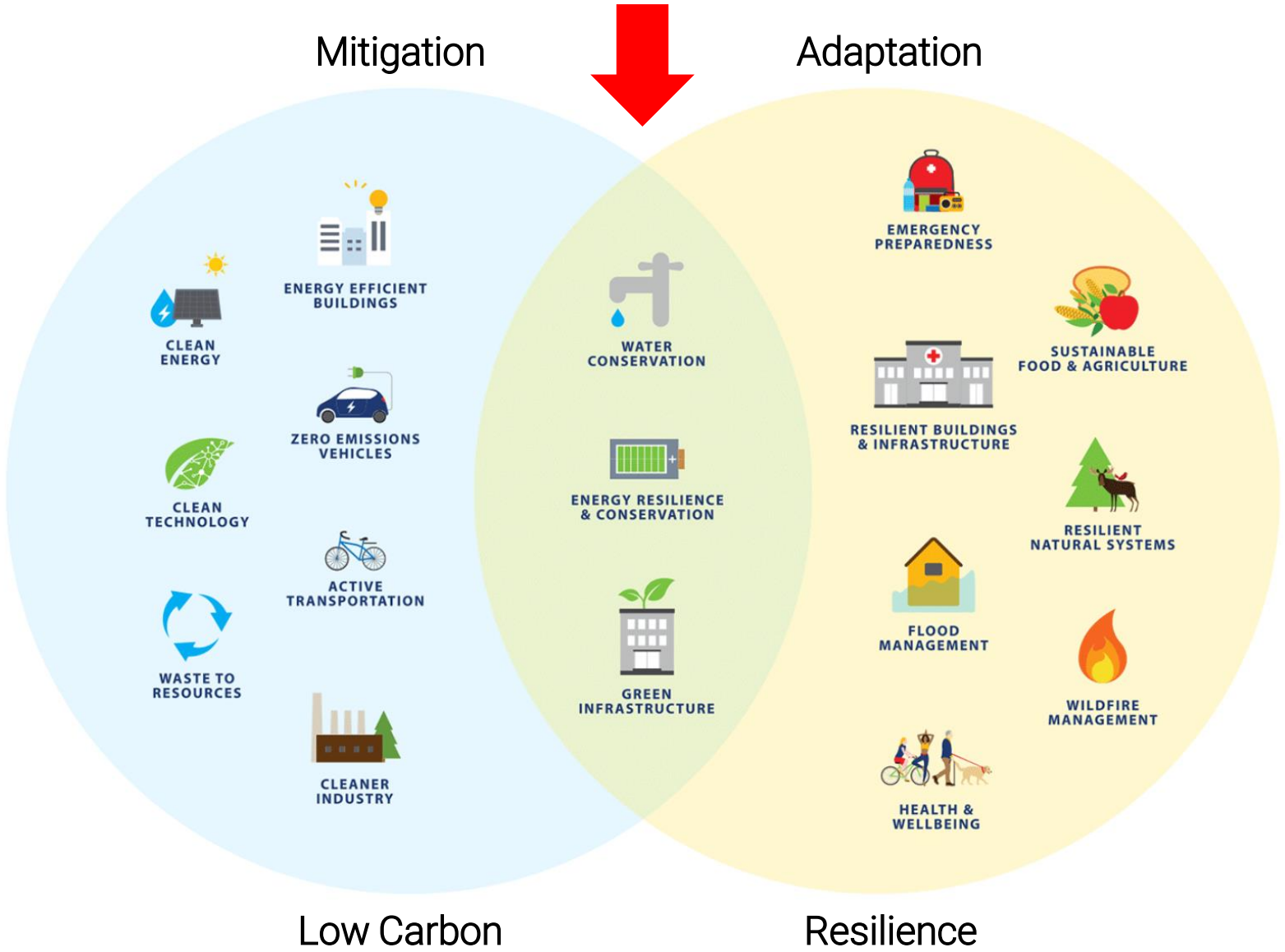
Storm

Drought


Extreme Heat

Earthquake

# Low Carbon Resilience (LCR)

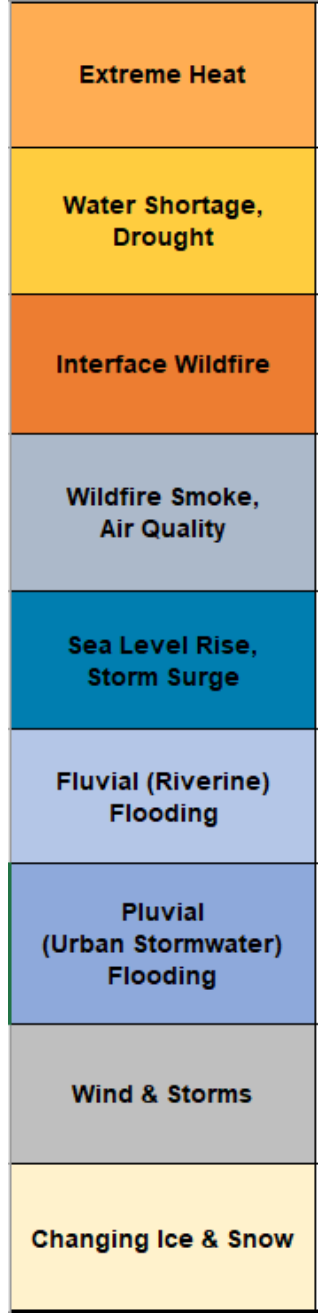



Planning for the future while protecting the future.

https://retooling.ca/climate-change/low-carbon-resilience/#:~:text=Low%20carbon%20resilience%20is%20a,wide%20range%20of%20human%20activities.

# Climate Risk Assessment process

- Step 1: Hazard exposure
  - Identify climate hazards that could affect the project. Rate in level of severity. (with client input).
- Step 2: Climate projections
  - Rate likelihood of that hazard increasing with climate change
- Step 3: Impact and risk
  - Identify consequences of that hazard on the project (with client input). E.g. extreme heat in the summer will affect a long-term care facility differently than a school.
- Step 4: Adaptation
  - Can design strategies be implemented to add resilience?



REFRAMED INITIATIVE

PEMBINA institute

rjc Engineers

cover

AMEGroup consulting mechanical engineers

PwG

lta Consultants Inc

ASK Wellness Society
ASKWELLNESS.CA

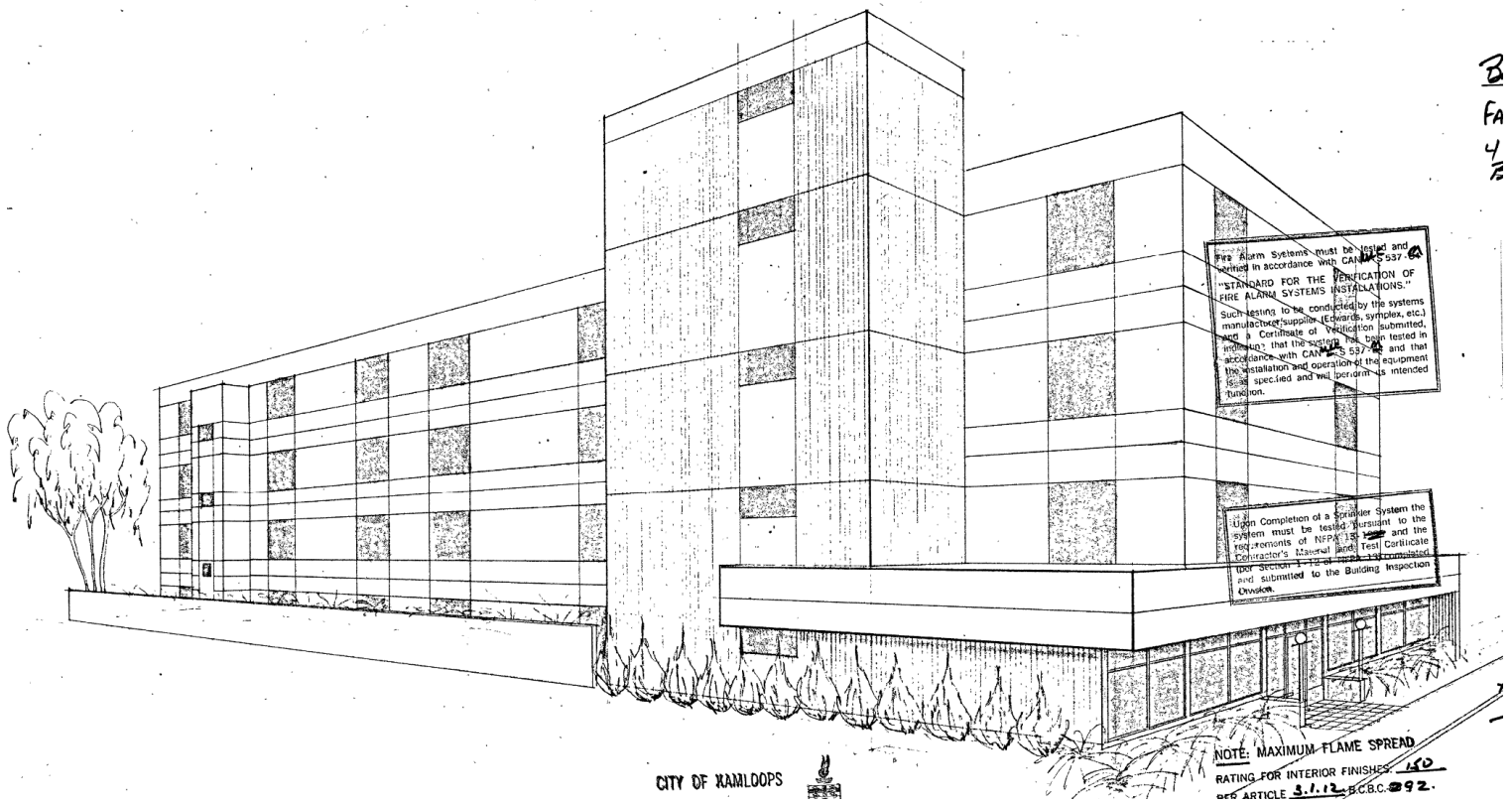
BC HOUSING

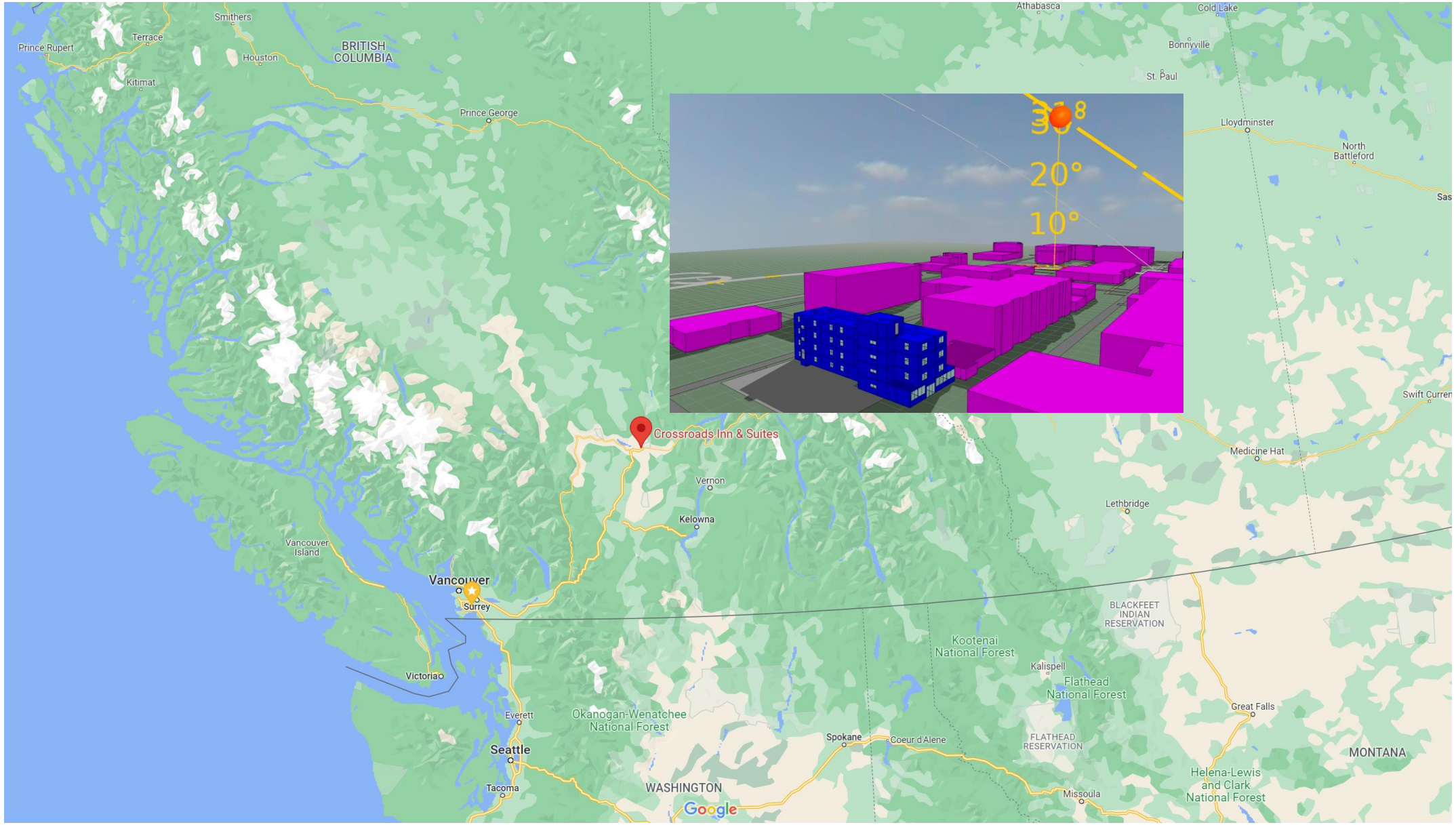
## The building:

- Construction Circa 1993/1994 to 1992 BC Building Code
- Motel/Hotel, changed to Social Housing
- 50 units over Four Floors. 1 Accessible Unit on Ground Floor
- Offices, Amenity

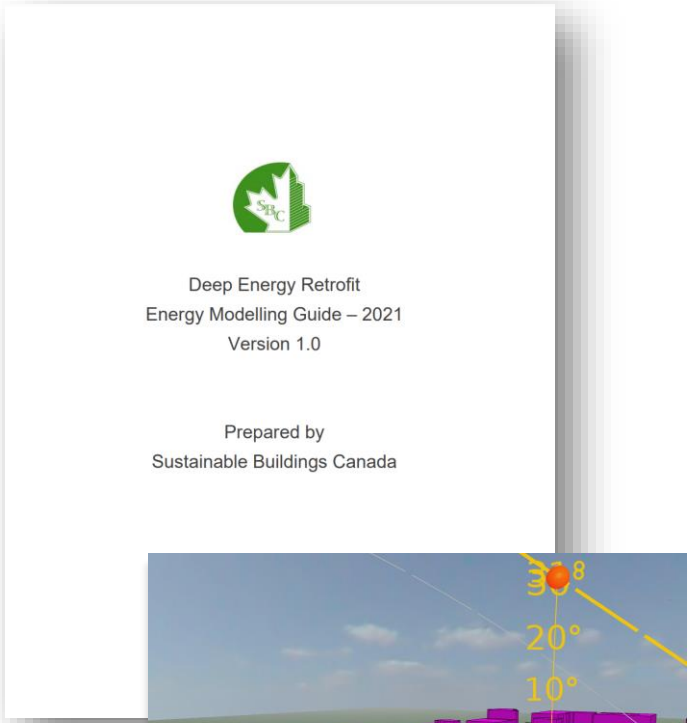
## The initial requirements:

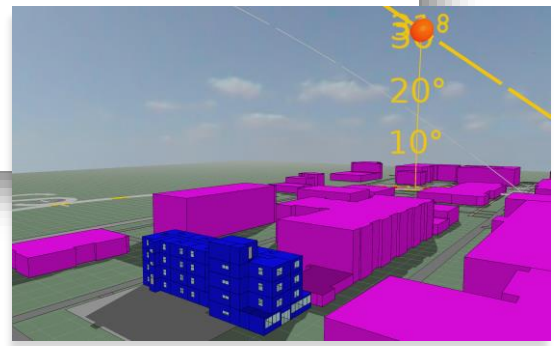
- Light Touch Seismic to Connect stair/elevator cores – Considering Seismic per ReFramed Goals, but not for BC Housing/ASK Wellness



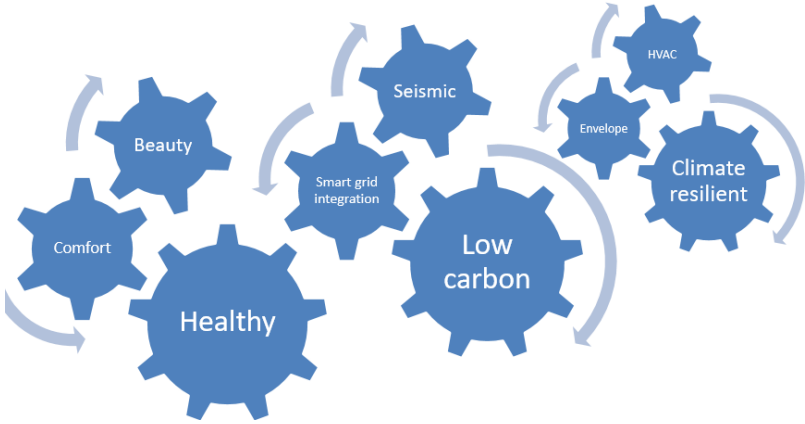

Athabasca
Cold Lake
Smithers
Prince Rupert
Terrace
Houston
BRITISH COLUMBIA
Bonnyville
St. Paul
Kitimat
Prince George
Lloydminster
North Battleford
30°
20°
10°
Crossroads Inn & Suites
Swift Current
Medicine Hat
Vernon
Lethbridge
Kelowna
Vancouver Island
Vancouver
Surrey
BLACKFEET INDIAN RESERVATION
Kootenai National Forest
Kalispell
Flathead National Forest
Victoria
Great Falls
Everett
Okanogan-Wenatchee National Forest
Spokane
Coeur d'Alene
FLATHEAD RESERVATION
Seattle
MONTANA
Tacoma
WASHINGTON
Missoula
Helena-Lewis and Clark National Forest
Google

# Baseline Building Energy Modelling: a step in the path








https://sbcanada.org/wp-content/uploads/2021/07/Deep-Energy-Retrofits-Guide-V1.pdf

# Baseline Building Energy Modelling

- Building assessment

Model inputs

Baseline energy model

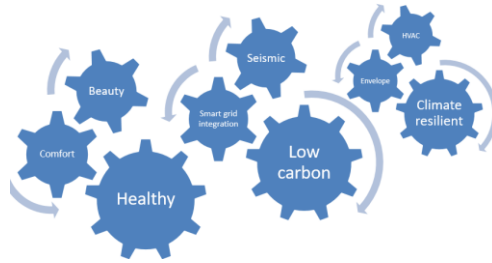
- Weather analysis
- Model calibration
- Utility data

- Low carbon analysis
- Resilience analysis

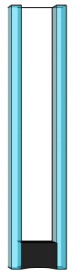
**Retrofits for low carbon resilience**

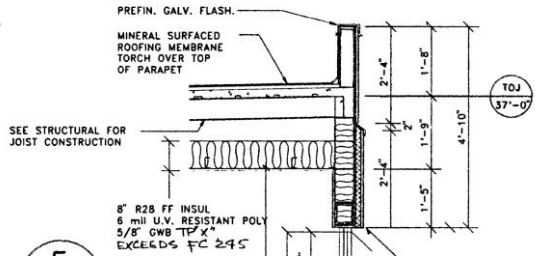
Holistic benefits

Low carbon resilience

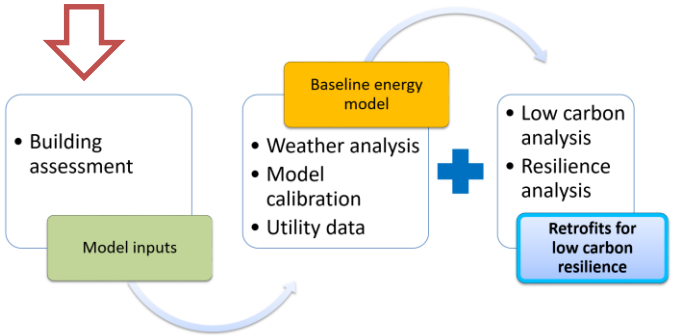


Residential windows:
Vinyl, double glazed, air space
(U0.5 SHGC 0.7)
Replaced in 2012



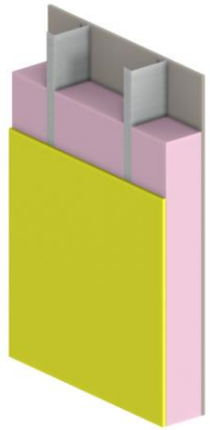



Roof
(R-28 inside steel studs @16” o.c.)



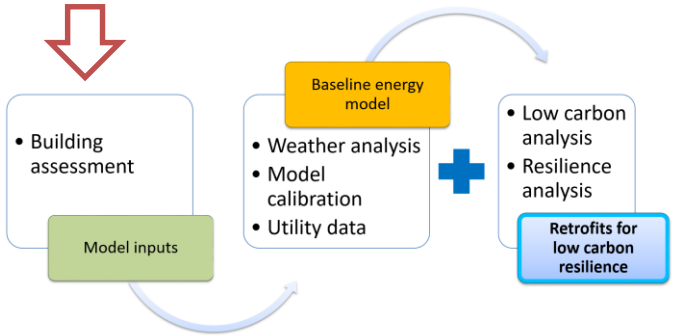

Stairway windows:
Steel, single glazed
(U1.1 SHGC 0.7)

Exterior walls
(R-20 inside steel studs @16” o.c.)




Storefront windows:
Aluminum, non-thermally broken, double glazed
(U1.1 SHGC 0.8)
Original (1993)

# Existing Building: Heating/Cooling

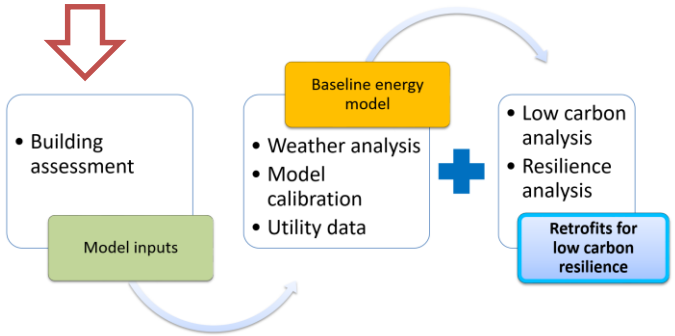



Cooling:
Window mounted AC

Heating:
Hydronic baseboard heater

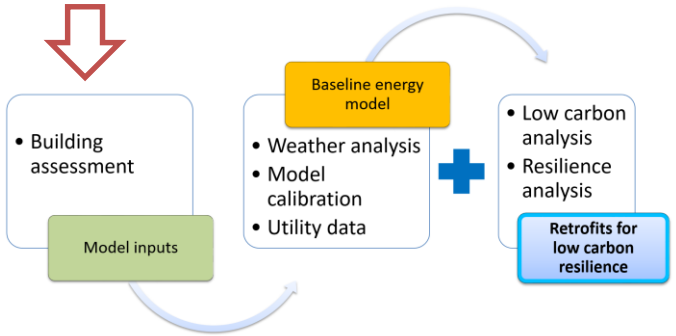
Boiler:
AERCO MLX757H
Condensing 92% $E_t$

# Existing Building: Domestic Hot Water




DHW:
Gas fired atmospheric boiler 80% $E_t$
Two 119 gal storage tanks

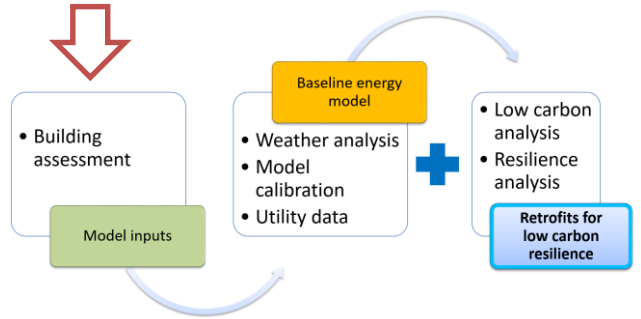
# Existing Building: Ventilation



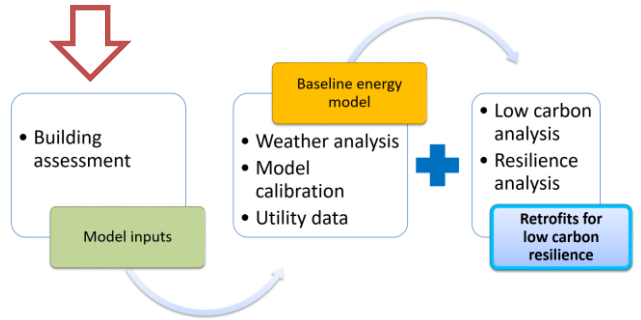

Corridor MUA:
Gas fired (3120cfm)

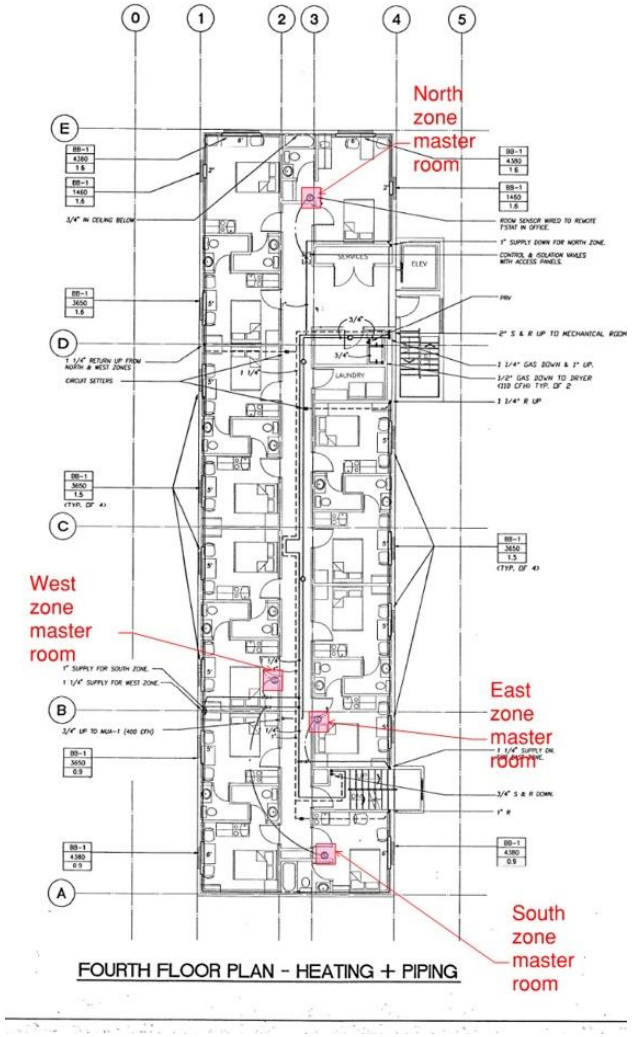
Suite:
Bathroom fans

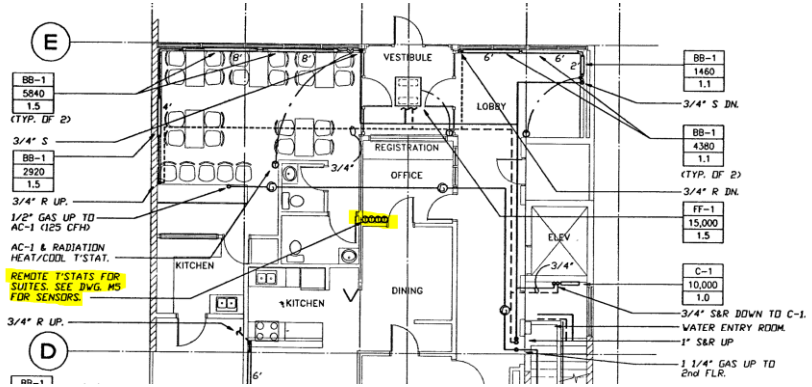
# Existing Building:
# Window Mounted AC: Infiltration Issue




# Existing Building: Thermal Comfort Issues

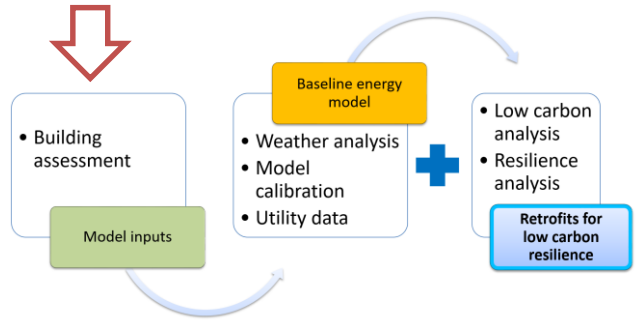



- T'STATS in first floor office
  - Unmet heating hours
- Electric convectors used by occupants
  - High plug loads

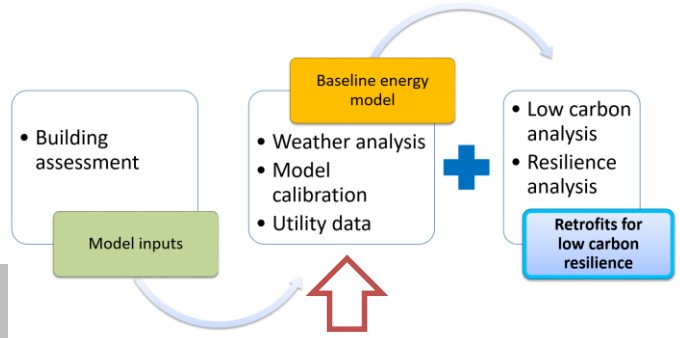
# Existing Building System





| System features *(current state)* | |
|---|---|
| Envelope | Walls Effective R-6 (R20 Batts in Light Gauge Studs)<br>Double Glazed Suite Windows in Vinyl Frames<br>Roof Assembly “bagging” effective R-16<br>Estimated 0.38 L/S/m2 Infiltration |
| Space Heating (suites) | Gas Fired Boiler with Hydronic Baseboard |
| Cooling | In-window units |
| Domestic Hot Water | Gas Fired Water Heater |
| Ventilation | Corridor Pressurization, No HRV |

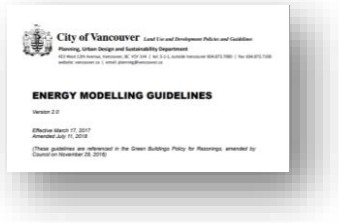
# Landscape of Weather Files




Model Calibration

2006 | 2008 | 2008 | 2010 | 2012 | 2014 | 2016 | 2018 | 2020 | 2022

CWEC- City of Vancouver EMG [2000-2016]


City of Vancouver
ENERGY MODELLING GUIDELINES

Calculate Saving

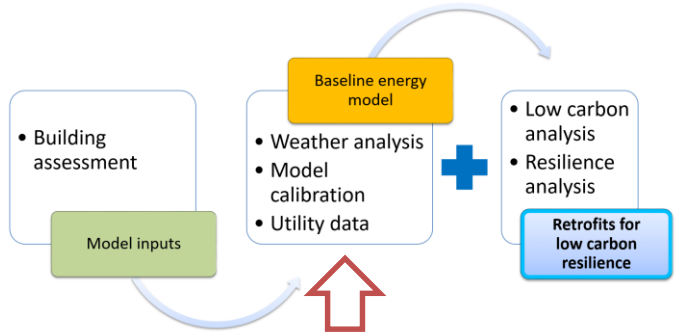
2030, 2050, 2070

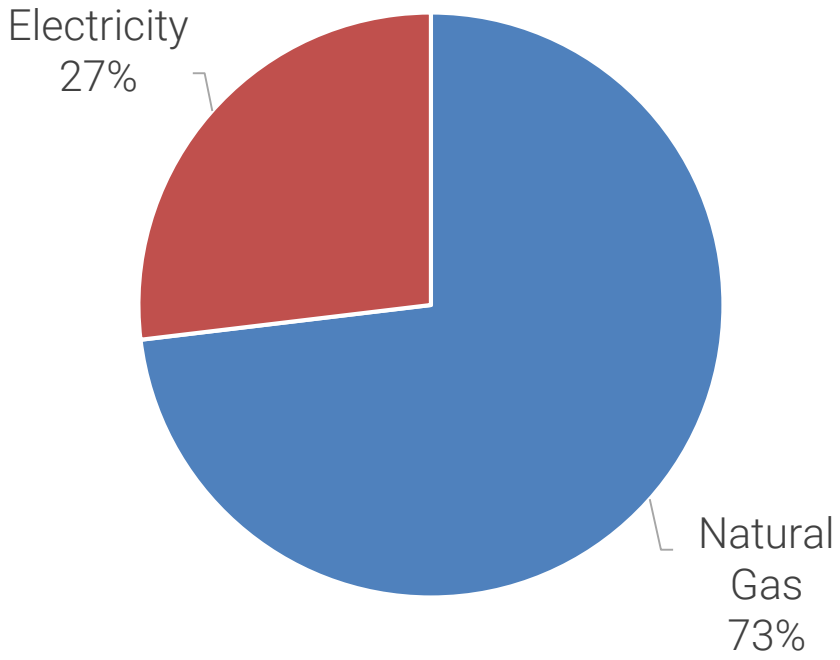
WEATHERSHIFT™

PACIFIC CLIMATE IMPACTS CONSORTIUM

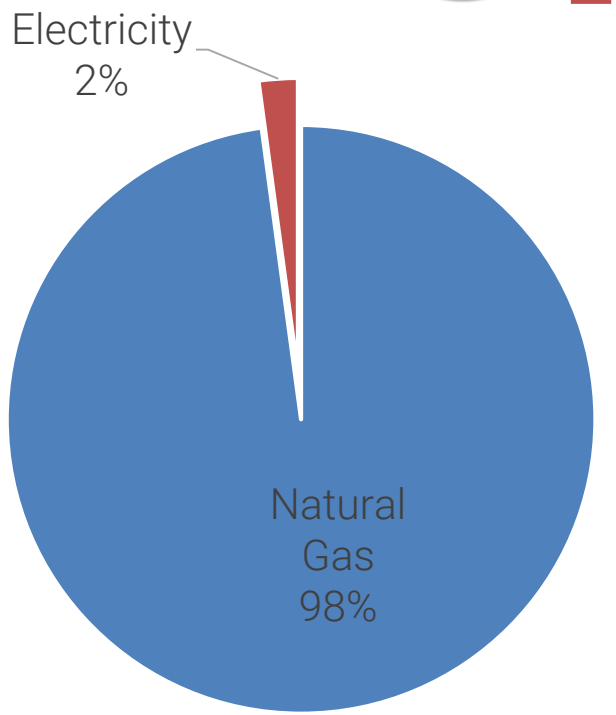
Overheating analysis

# Breakdown of Energy Use & GHG- Utility Data

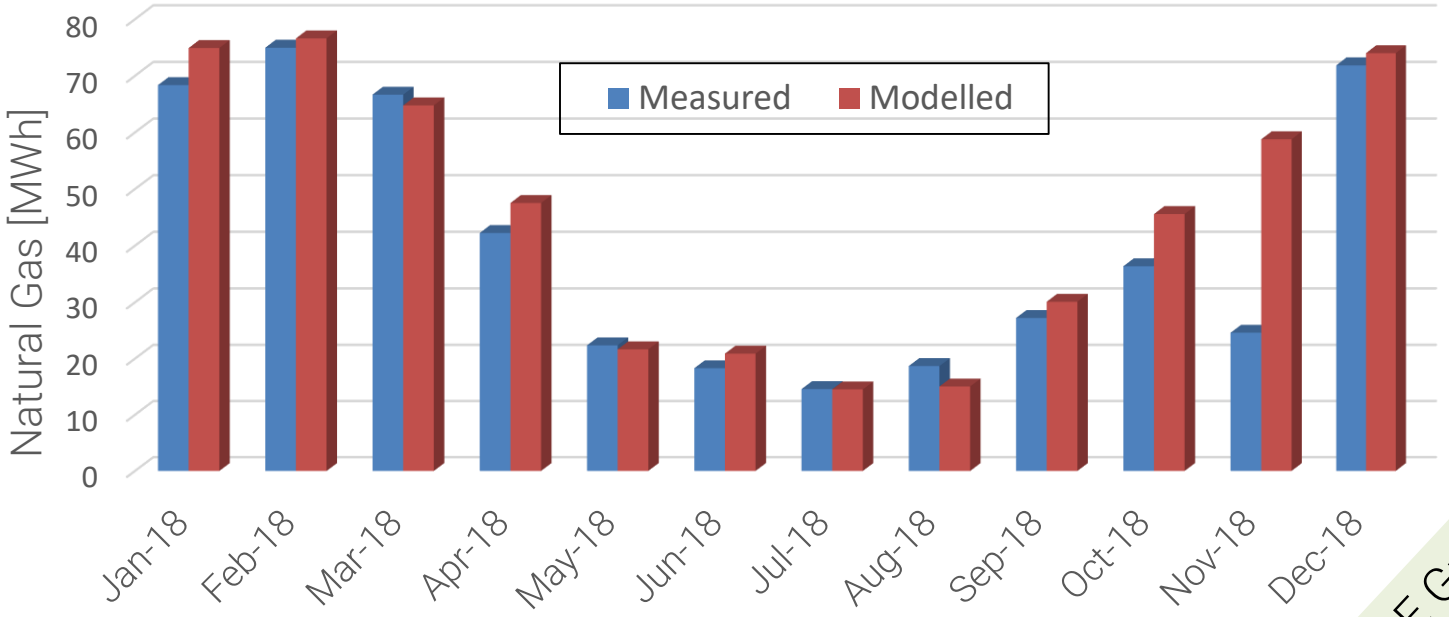


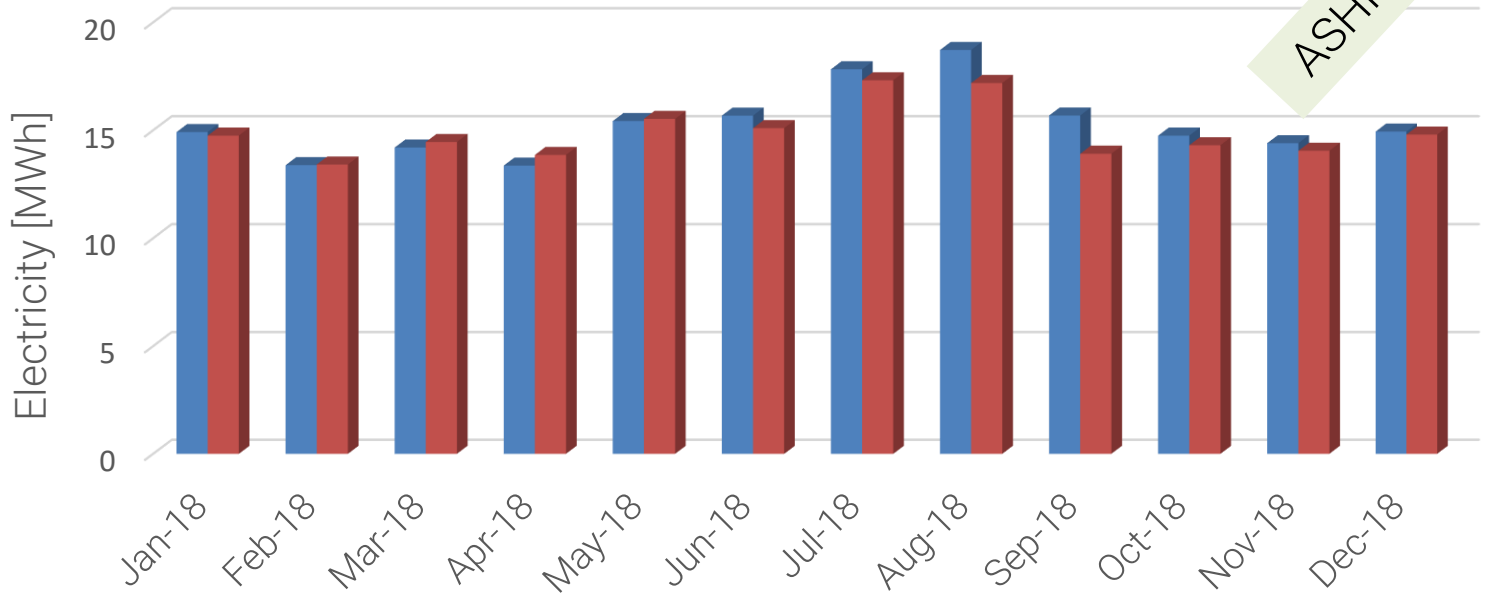




Energy use

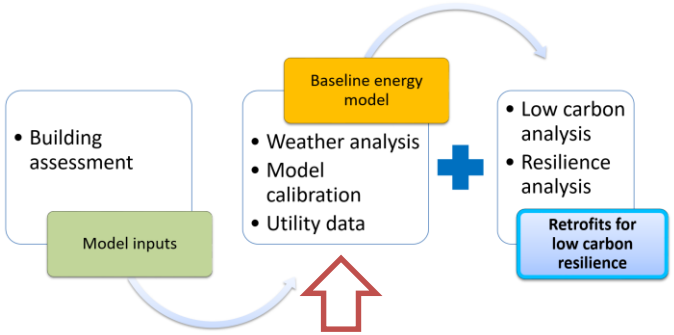



GHG

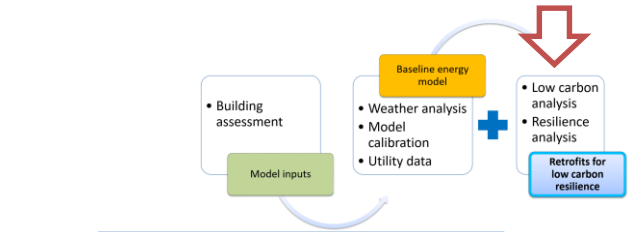



ASHRAE Guideline 14

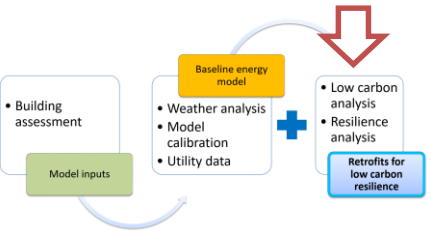


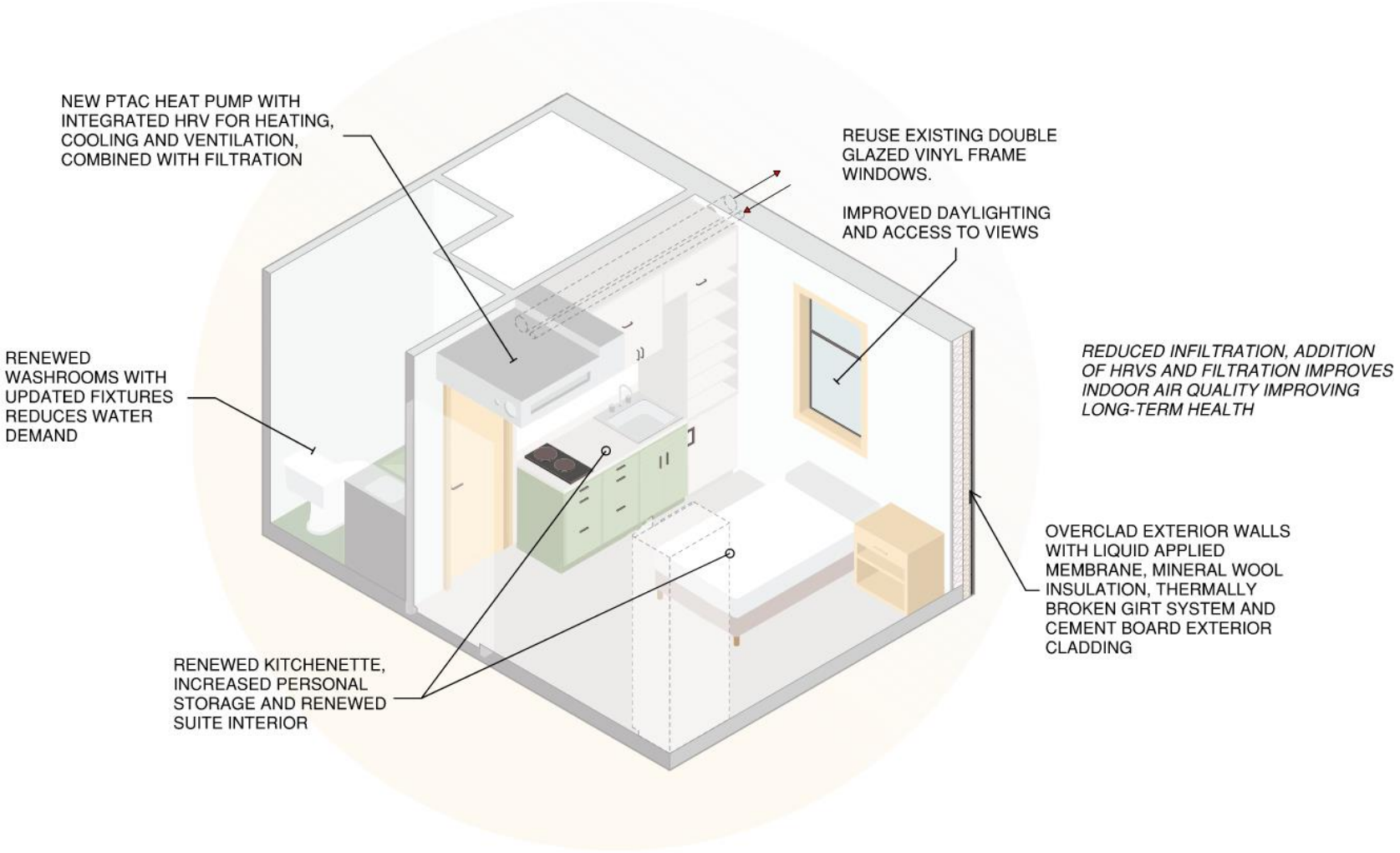
# Proposed Scenarios



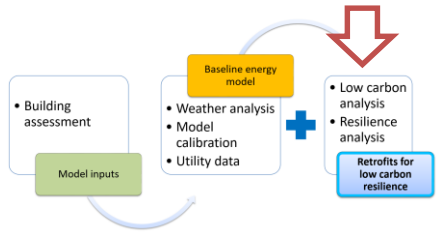

| Component | Bundle 1 | Bundle 2 | Bundle 3 | Bundle 4 | Bundle 3a (Proposed) |
|---|---|---|---|---|---|
| Envelope | Reclad<br>Reroof<br>Reuse Windows | Reclad<br>Reroof<br>Reuse Windows | No Envelope | Reclad<br>Reroof<br>Reuse Windows | Reclad<br>Reroof<br>Reuse Windows |
| Space Heating (in-suite) | Hydronic Baseboard | Hydronic Baseboard | Heat Pumps | Gas Heat Pumps | Heat Pumps |
| Ventilation (common areas) | No change | Electrify MUA | Electrify MUA | Electrify MUA | Re-use Gas Fired |
| Domestic Hot Water | High Eff Gas | Electrify DHW | Electrify DHW | Electrify DHW | Electrify DHW |
| Ventilation (Suites) | ERV | ERV | ERV | ERV | ERV |
| | Only Envelope | Bundle 1+ Electric MUA/DHW | Only Mechanical | Bundle 2+ Gas-Fired HP | Bundle 1+ Bundle 3 |

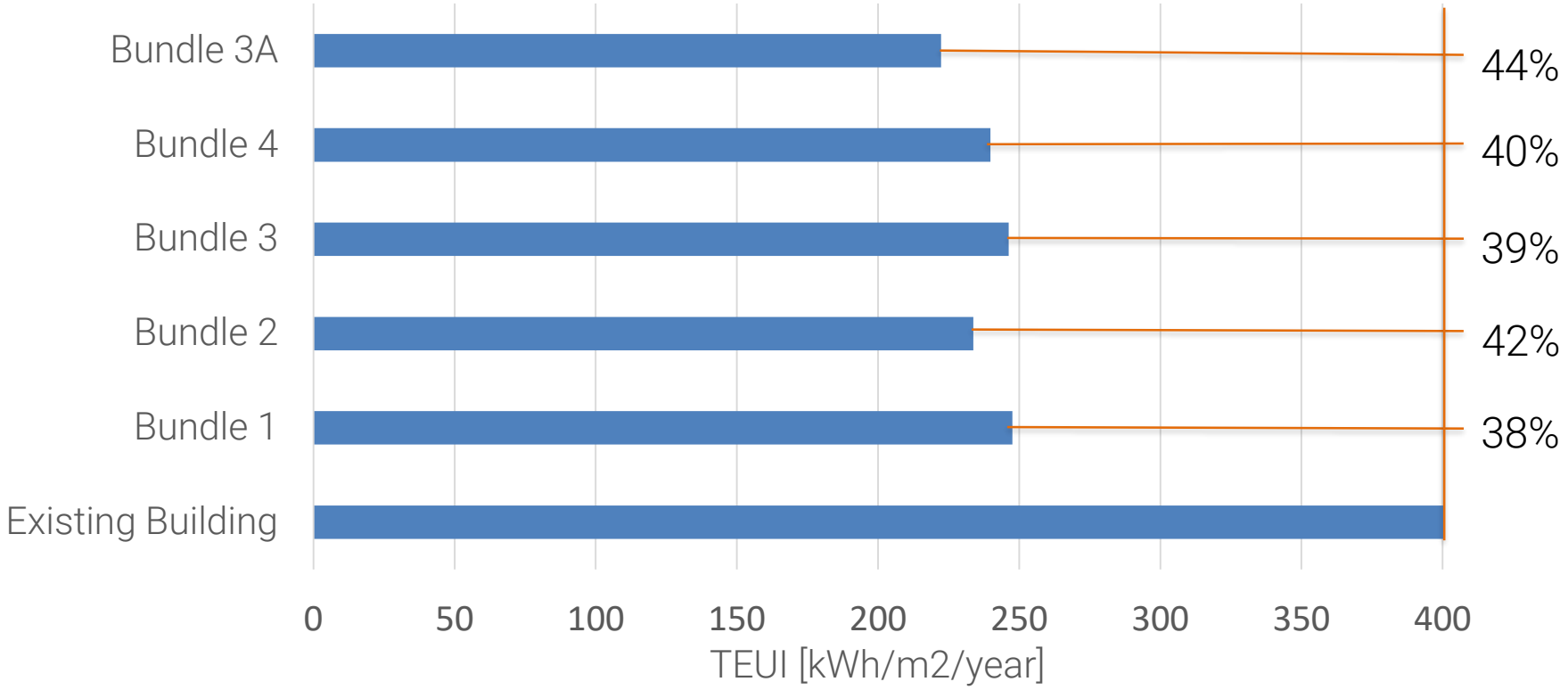
# Bundle 3A- Proposed Scenario



# Energy Saving

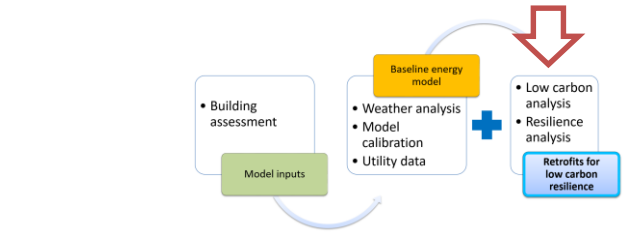


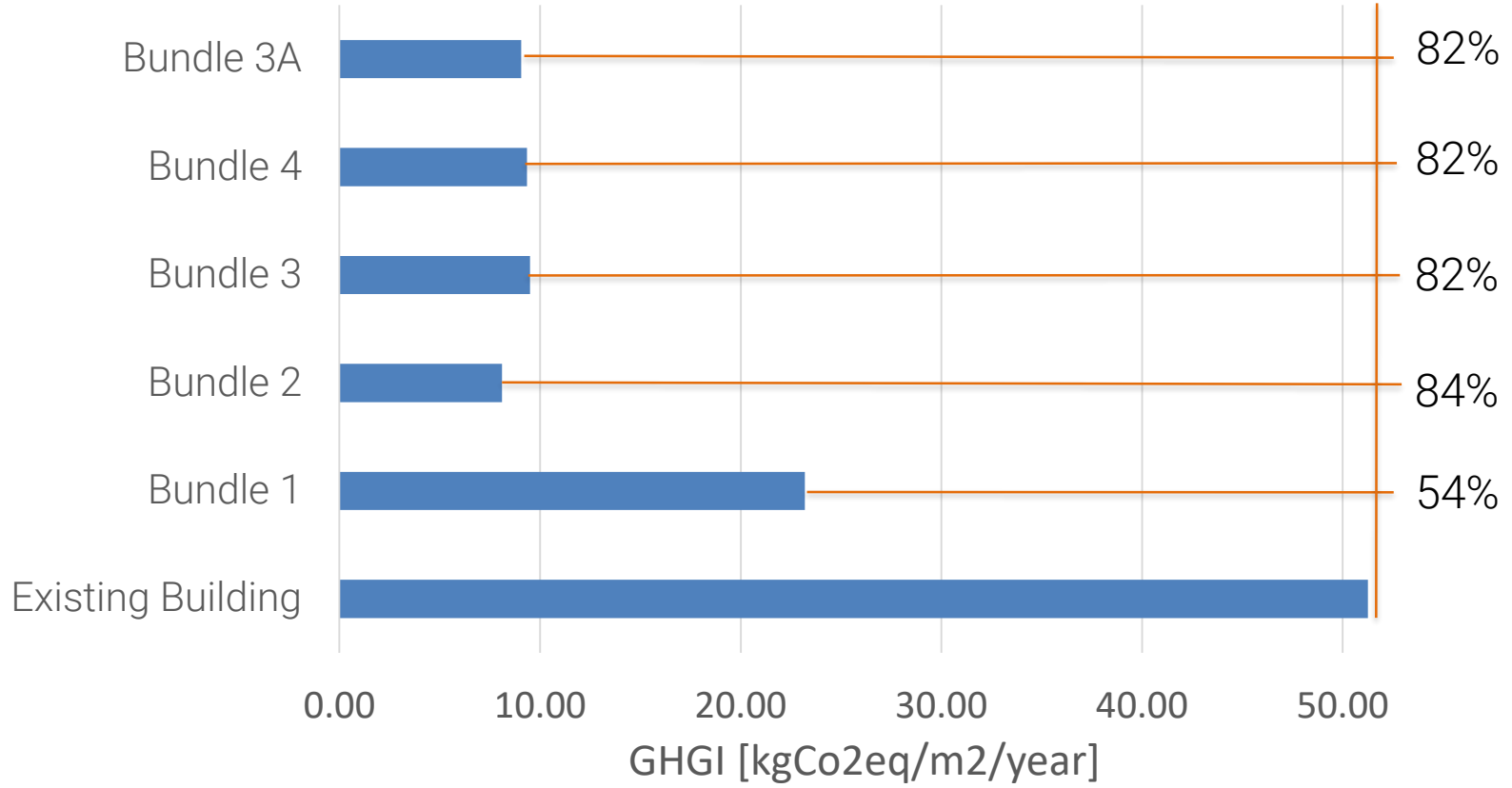




Bundle 1: Only envelope
Bundle 2: Bundle 1+ Electric MUA/DHW

Bundle 3: Only Mechanical (Electric)
Bundle 4: Bundle 2+ Gas Fired Heat Pump
Bundle 3a: Bundle 3 + Bundle 1

# GHG Saving

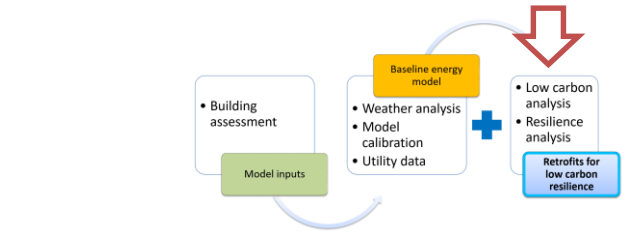



Bundle 1: Only envelope
Bundle 2: Bundle 1+ Electric MUA/DHW

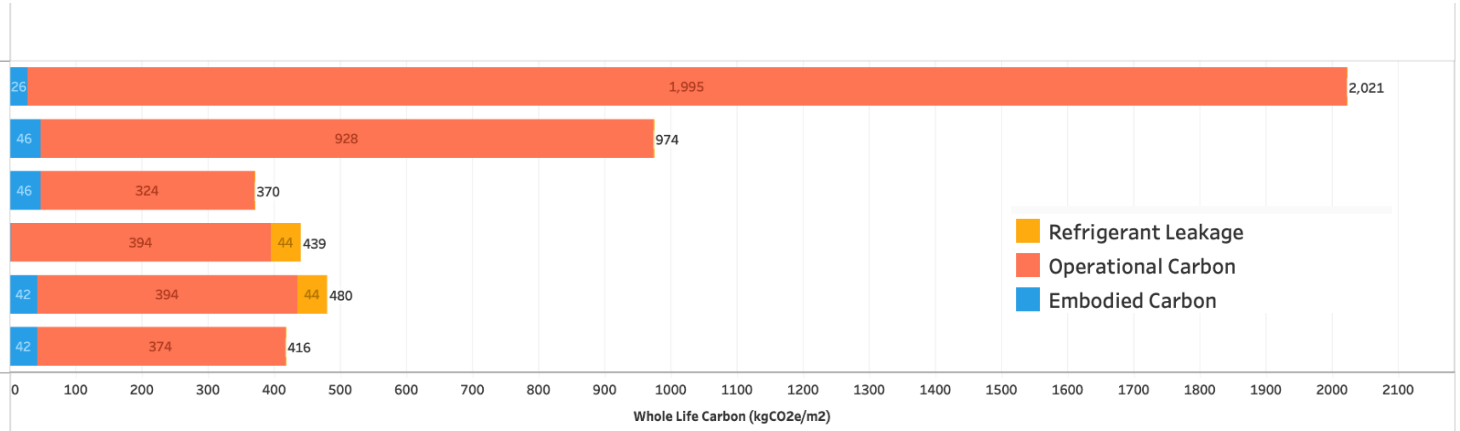
Bundle 3: Only Mechanical (Electric)
Bundle 4: Bundle 2+ Gas Fired Heat Pump
Bundle 3a: Bundle 3 + Bundle 1

# Embodied Carbon – PRIOPTA

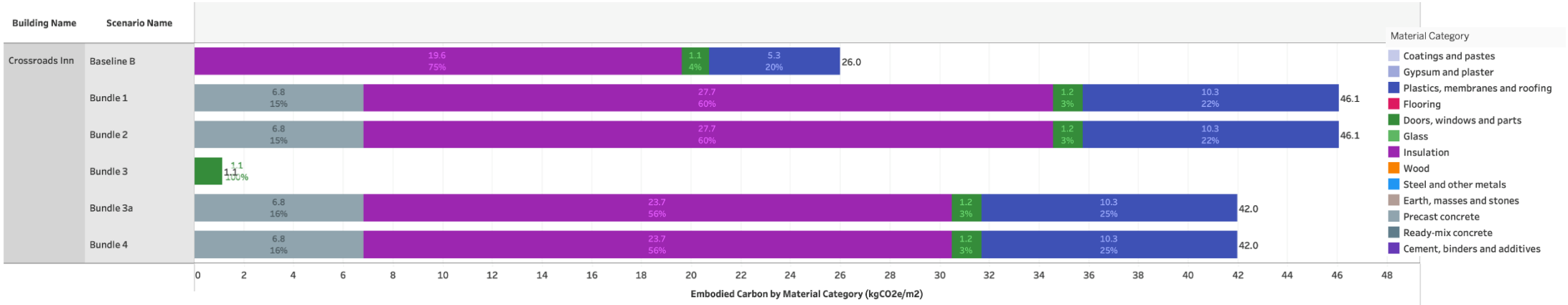



## Whole Life Carbon - 40 years

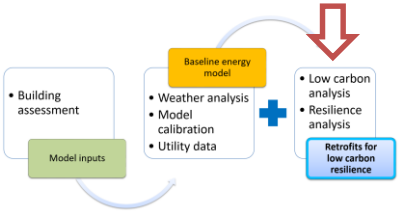
| Building Name | Scenario Name | Embodied Carbon Intensity | Operational GHGI | Refrigerant Leak GHGI |
|---|---|---|---|---|
| Crossroads Inn | Baseline B | 26.0 | 49.9 | Null |
| | Bundle 1 | 46.1 | 23.2 | Null |
| | Bundle 2 | 46.1 | 8.1 | Null |
| | Bundle 3 | 1.1 | 9.8 | 1.11 |
| | Bundle 3a | 42.0 | 9.8 | 1.11 |
| | Bundle 4 | 42.0 | 9.4 | Null |

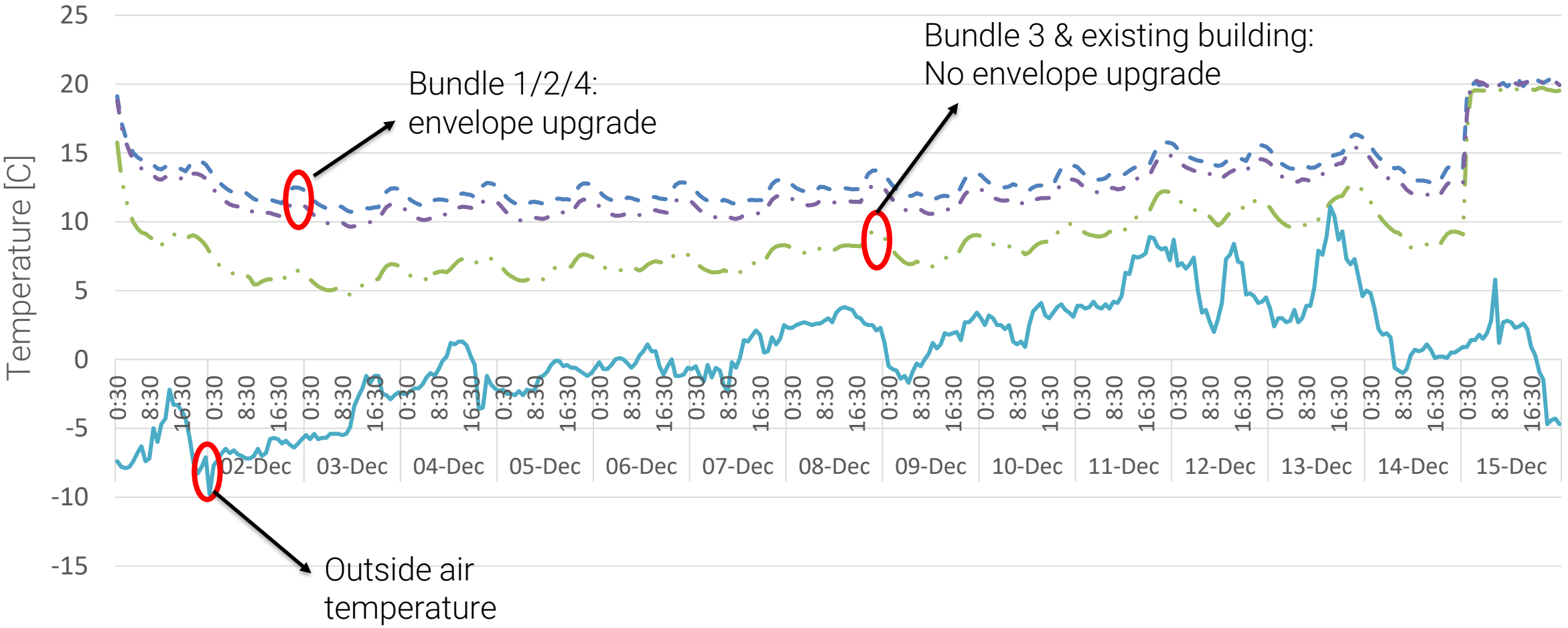



## Material Contribution

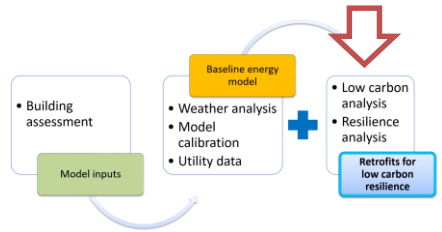


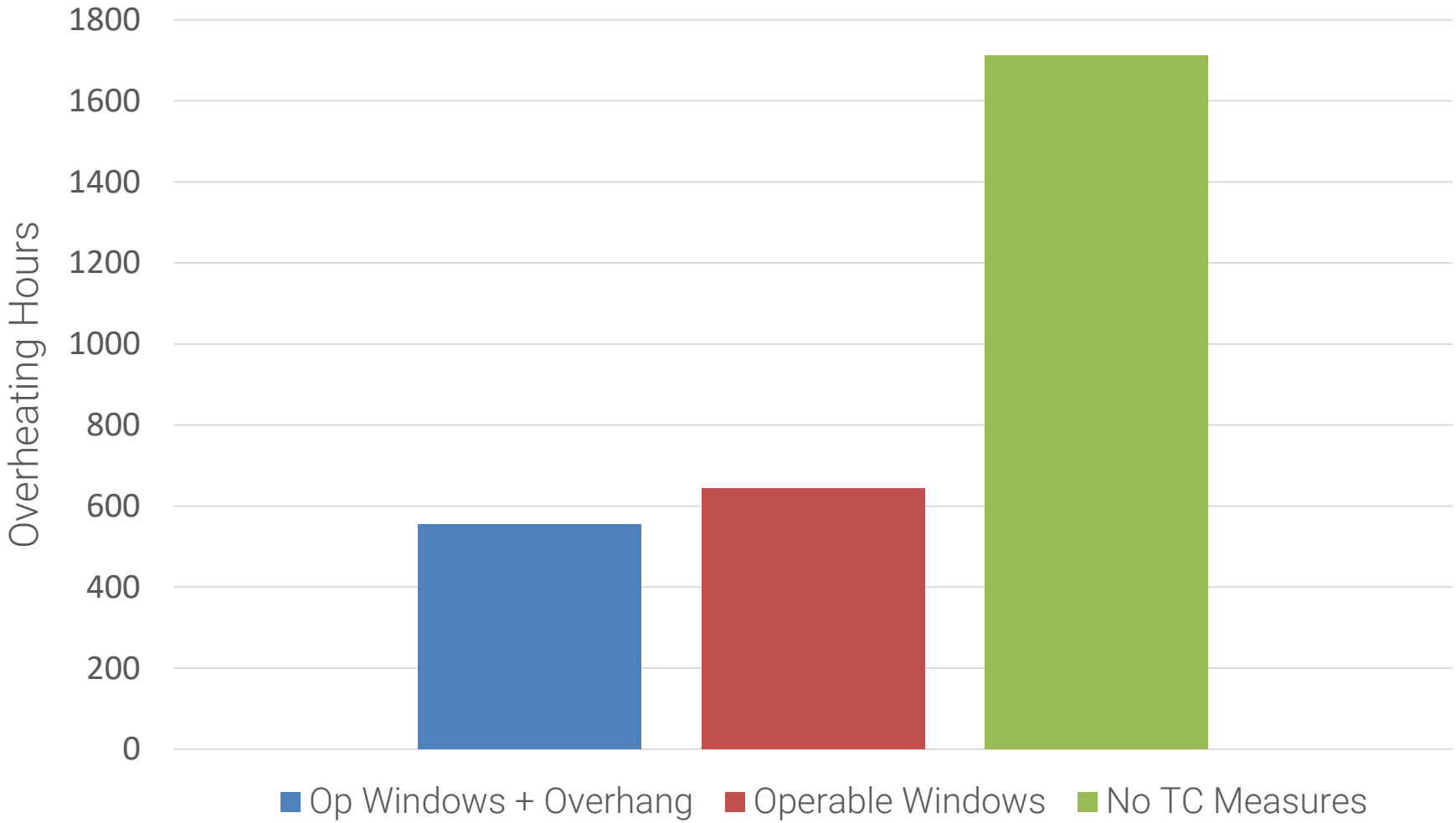
# Power Outage Study-Climate Resilience

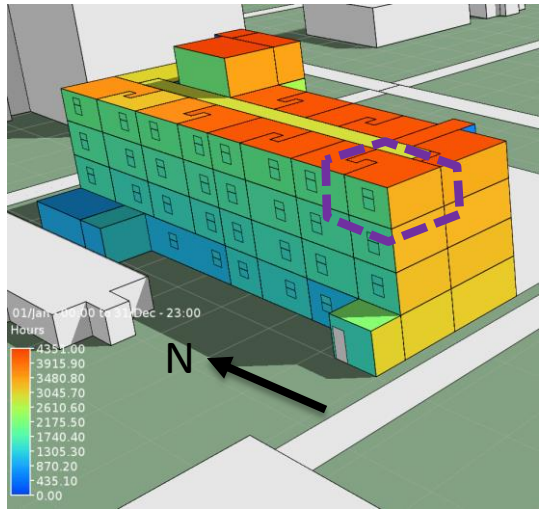


# Thermal Comfort Study- Climate Resilience

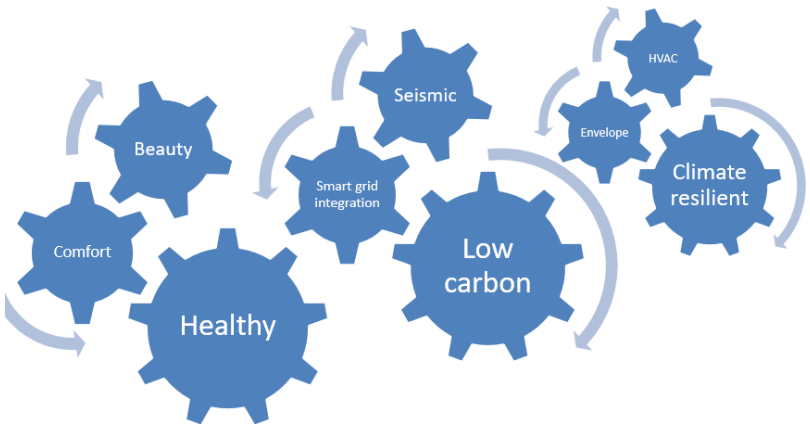



Solar gain on facades

# Non-energy benefits




- Improved Daylighting and Views
- Renewed & Improved Interior
- Improved Thermal Comfort
- Filtering of Wildfire Smoke via HRVs
- Improved accessibility for suites
- Reduced carbon pollution

# Conclusion

- Decarbonization of existing building stock is crucial in order to achieve Canada's GHG target.
- Resilient retrofits should address both adaptation and mitigation. This is called "**Low Carbon Resilience** (LCR)".
- In order to have a holistic view for carbon reduction of retrofit strategies operational carbon, embodied carbon, and refrigerant leakage should be considered.
- A combination of enclosure, electrical, and mechanical retrofits should be taken into account to ensure resilient decarbonization strategies.
- The presented bundles are replicable and can facilitate achieving up to 84% GHG reductions with available and proven technology (even if not all electric).

# Thank you!

# Let’s be in touch…

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