# Building Overheating and Air Quality: Considerations in New Construction

April 28, 2020

BC HOUSING

CITY OF VANCOUVER

BCNPHA

BC Non-Profit Housing Association

# Additional webinars on overheating

| Webinar | Date | Time |
|---|---|---|
| **Building Overheating and Air Quality: Considerations in New Construction** | April 28 | 9-10:30 AM PDT |
| **Addressing Overheating in Buildings for Operational Staff** | May 13 | 9-10:30 AM PDT |
| **Retrofits for Overheating Buildings and Poor Indoor Air Quality** | May 26 | 9-10:30 AM PDT |

bcnpha.ca/education/webinars/

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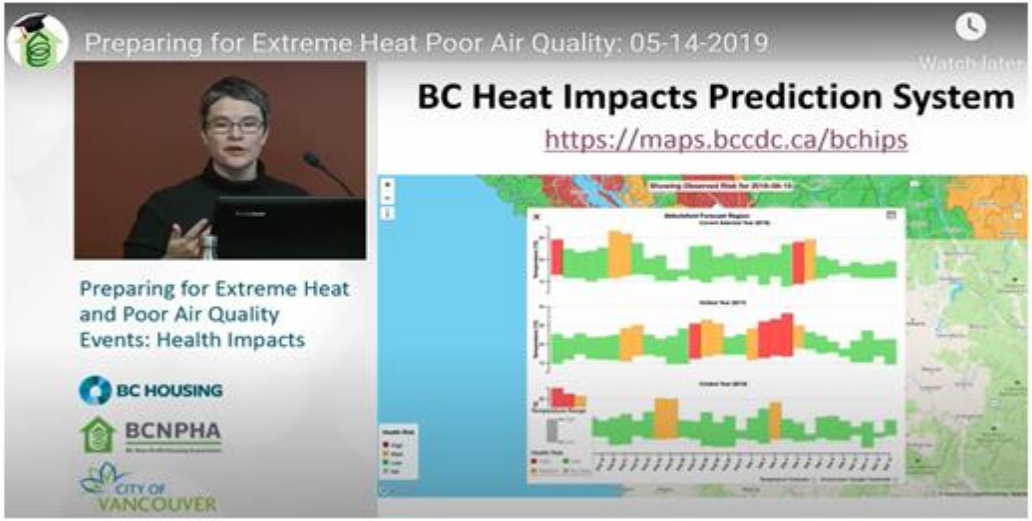
# Previous webinar:
# Health impacts of extreme heat and poor air quality




bcnpha.ca/courses/preparing-for-extreme-heat-and-poor-air-quality-events-health-impacts-webinar/

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# Outline

| | | |
|---|---|---|
| 1. Introduction | Welcome/logistics/introductions | Jackie Kanyuk, BCNPHA |
| 2. Terminology, Context, Resources | • Designing for a changing climate<br>• Implications for housing in BC<br>• Introduction to resilient building design<br>• Overview of resources: MBAR & Design Guide Supplement on Overheating & Air Quality | Lisa Westerhoff, Integral Group |
| 3. BC Housing Design Guidelines | • Overheating in housing<br>• 1st & Clark MBAR case study, modelling for the future<br>• BC Housing Design Guidelines & Construction Standards | Sadia Afrin, BC Housing |
| 4. Passive & Active Design Strategies | • Passive Design Strategies<br>• Active Design Strategies | Chris Doel, Integral Group |
| 5. Questions and Closing remarks | •Audience questions<br>•Closing remarks | Jackie Kanyuk, BCNPHA |

# Resilient Housing for a Future Climate

**Lisa Westerhoff**
Principal
lwesterhoff@integralgroup.com

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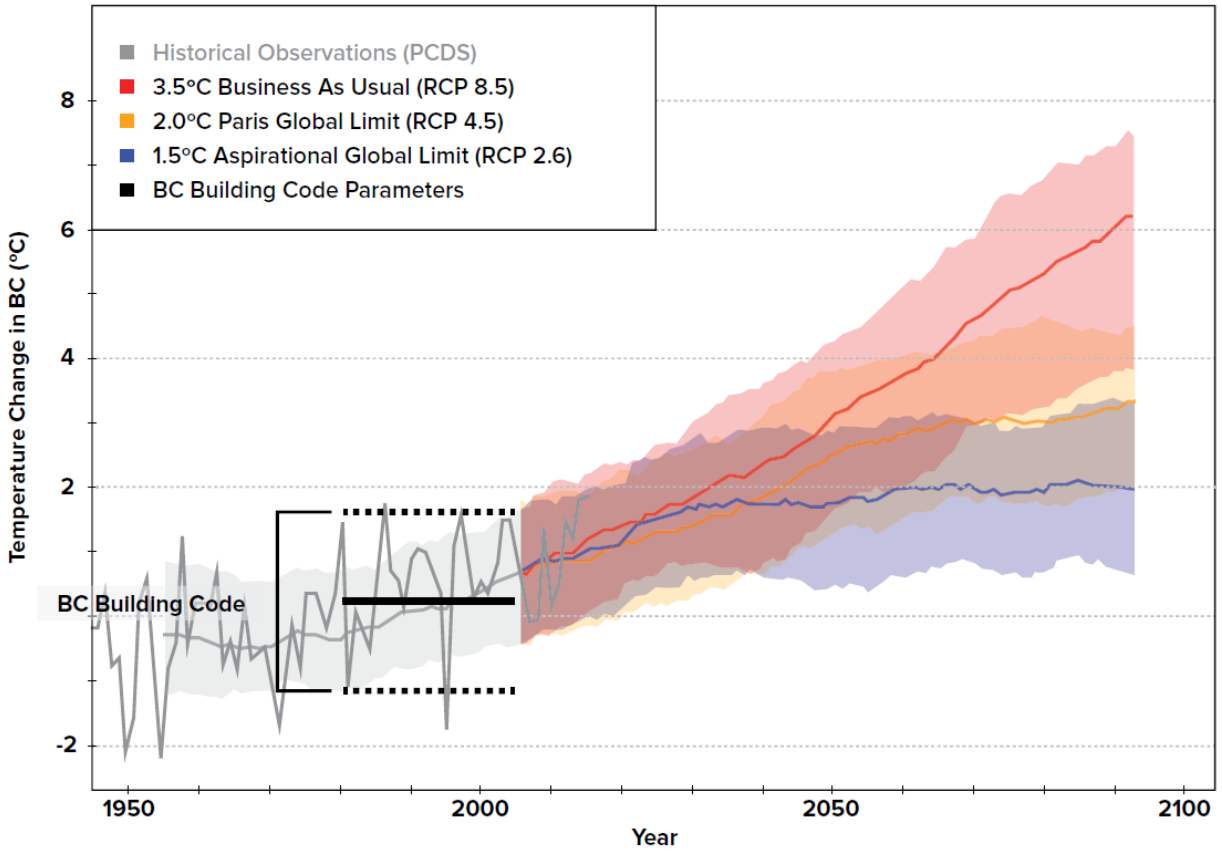
Image Courtesy of Perkins+Will

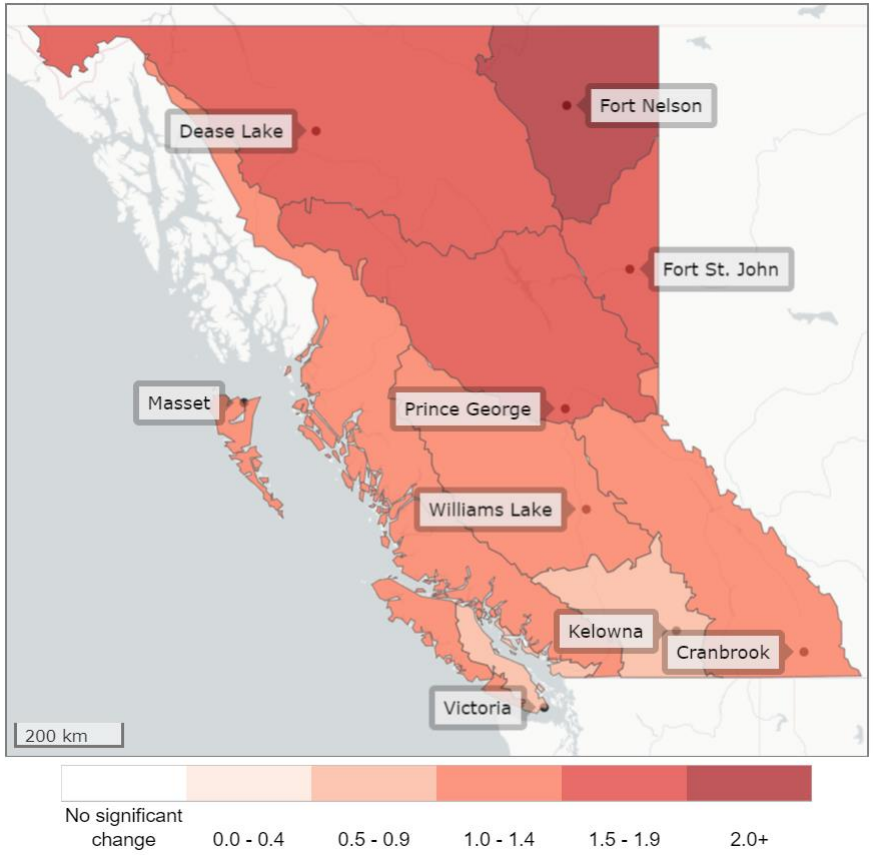
# Overview of Presentation

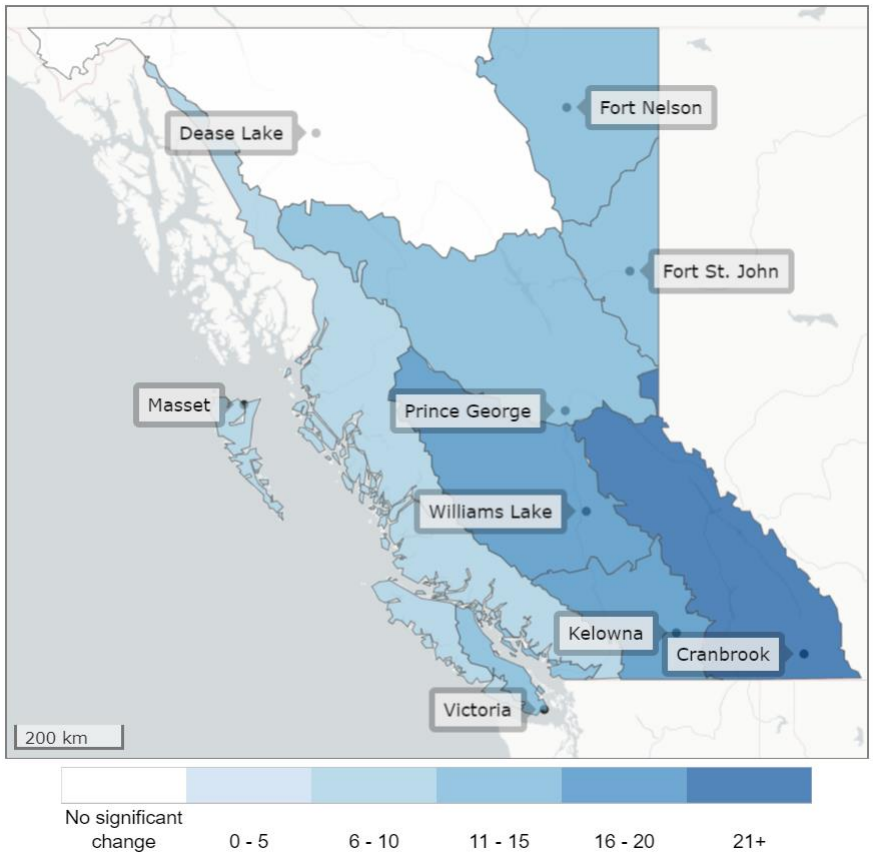
- Designing for a changing climate
- Implications for housing in BC
- Introduction to resilient building design
- Overview of resources

# Designing for the Past



# Observed Changes, 1900-2013

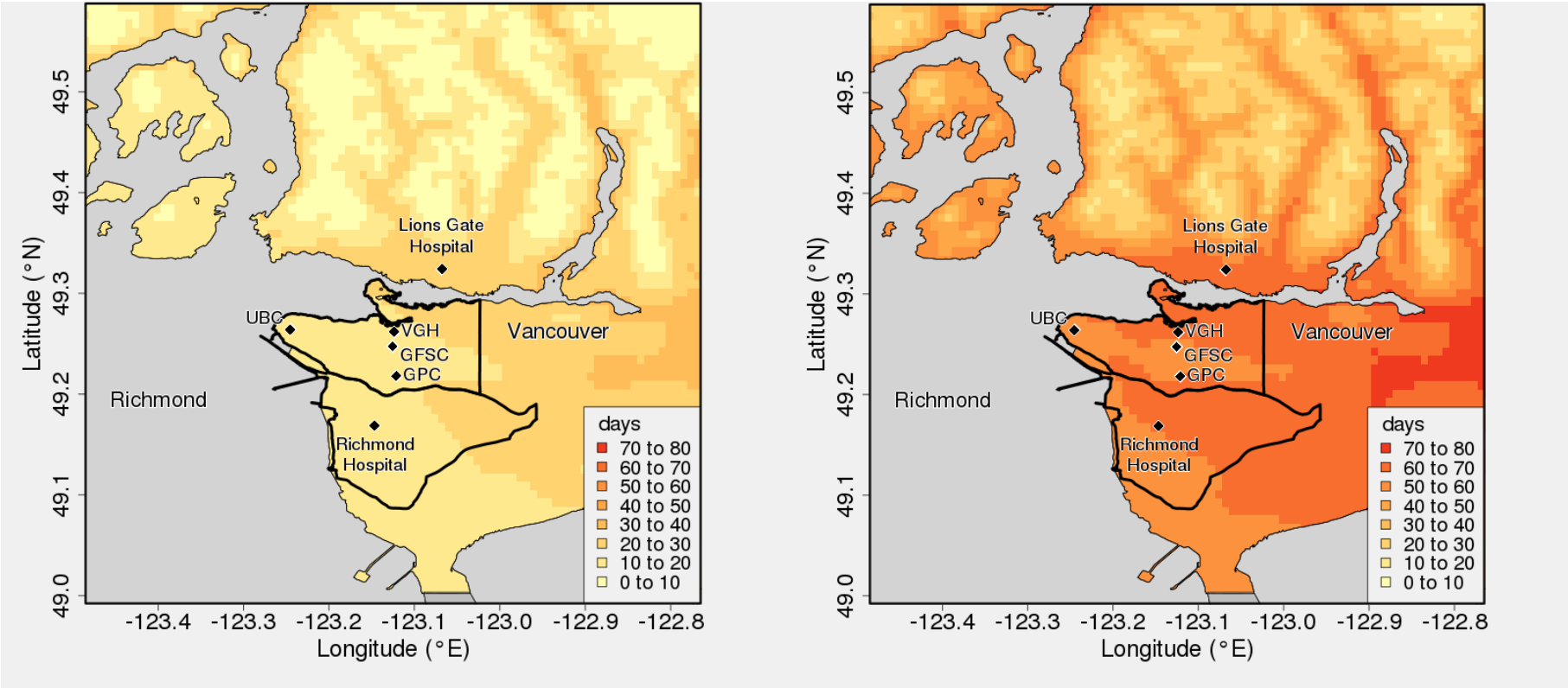




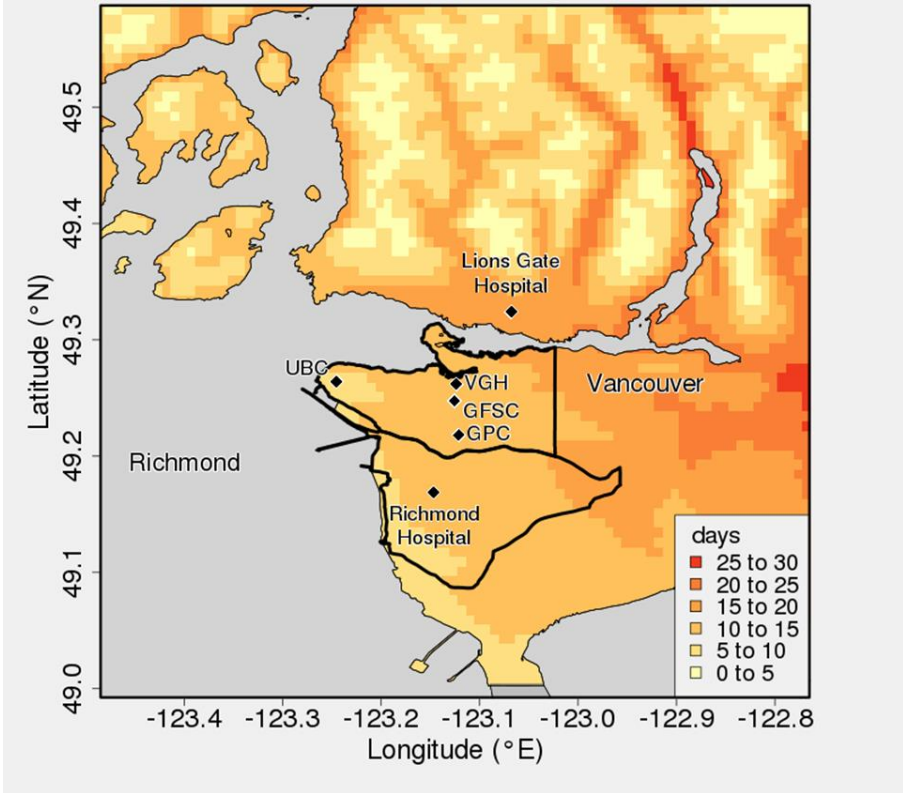

http://www.env.gov.bc.ca/soe/indicators/climate-change/

# Projected Increase in Number of Hot Days




**Days above 25°C:** 17 days for 1971 to 2000 ▯ 51 (36 to 69) days in 2050s

# Projected Increase in Number of VERY Hot Days


**Days above 30°C:** 2 days for 1971 to 2000  12 (6 to 18) days in 2050s

# What Does This Mean for BC?

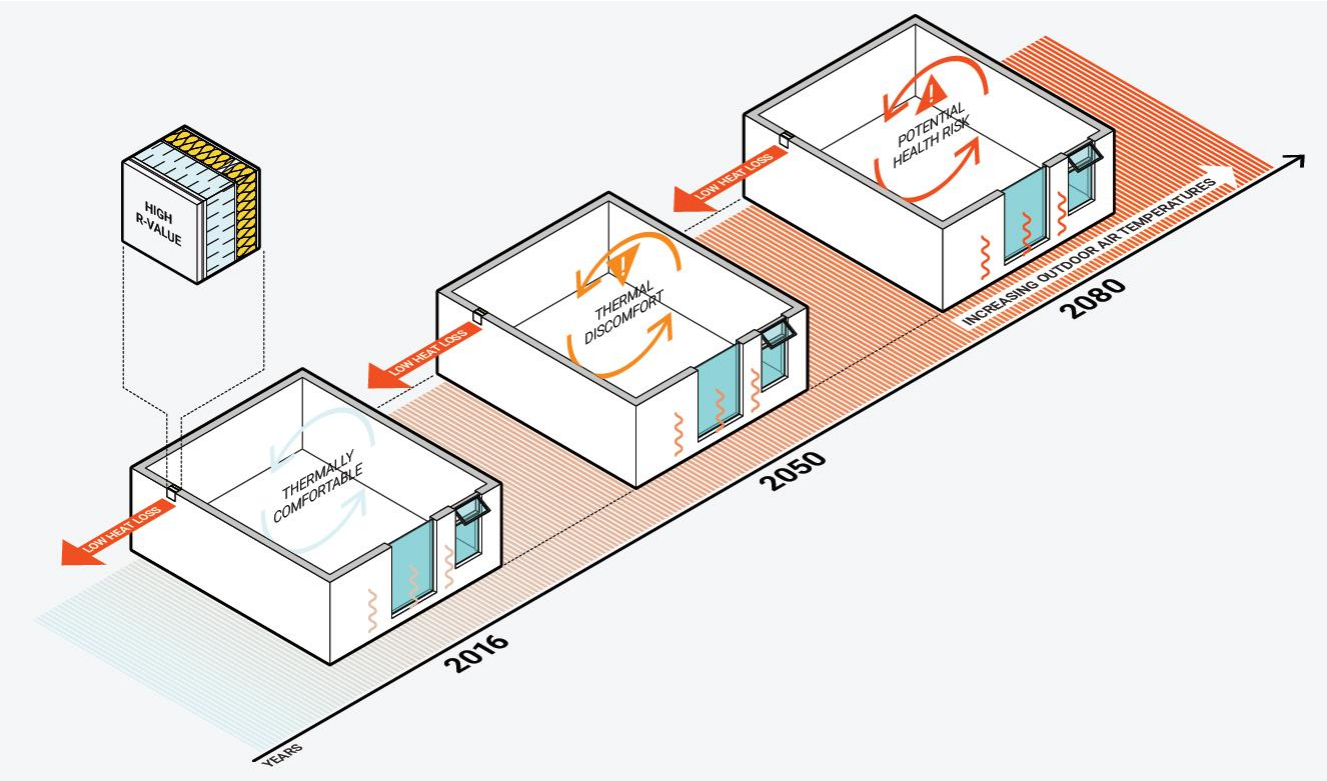
- **Vancouver Island**
  - Similar to Lower Mainland projections
- **Interior and Cariboo:**
  - Hotter and drier with a longer dry season and increased risk of wildfire
- **North:**
  - Increased precipitation in summer but with warmer temperatures

# Risks to Thermal Comfort

Buildings designed for today's climate will be unsuitable for tomorrow's

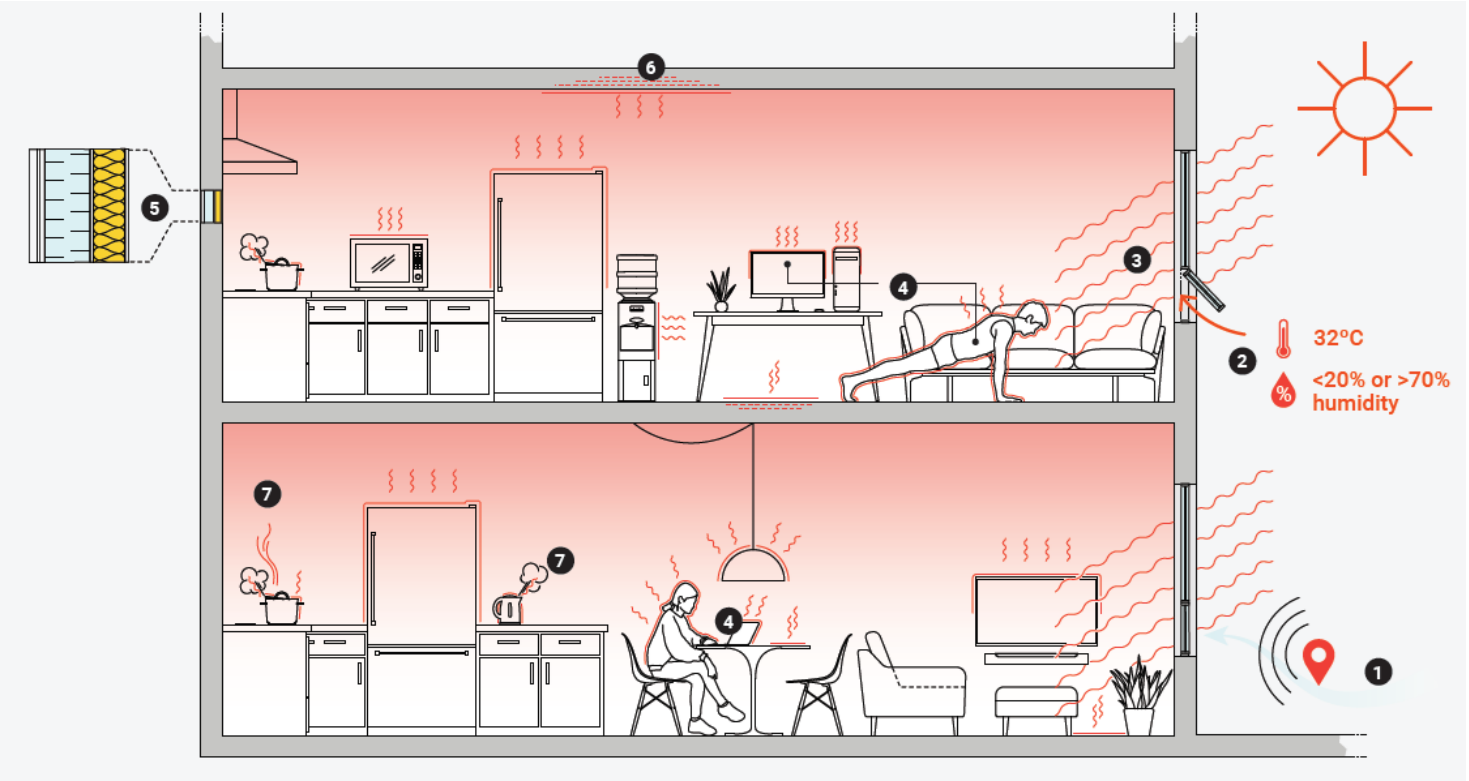
Impacts to **thermal comfort**

Risk of **overheating**

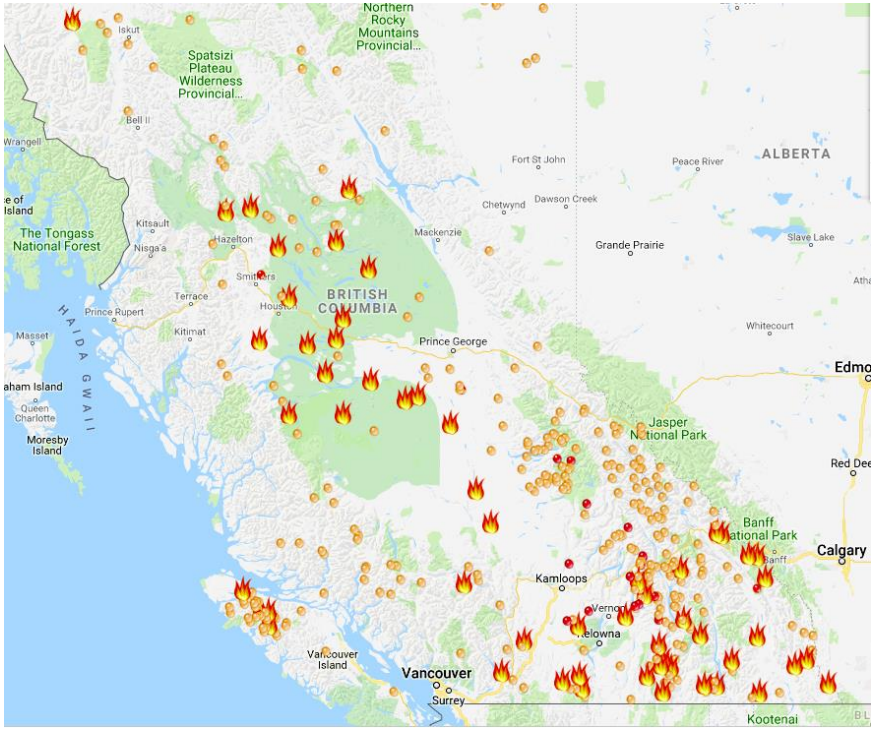


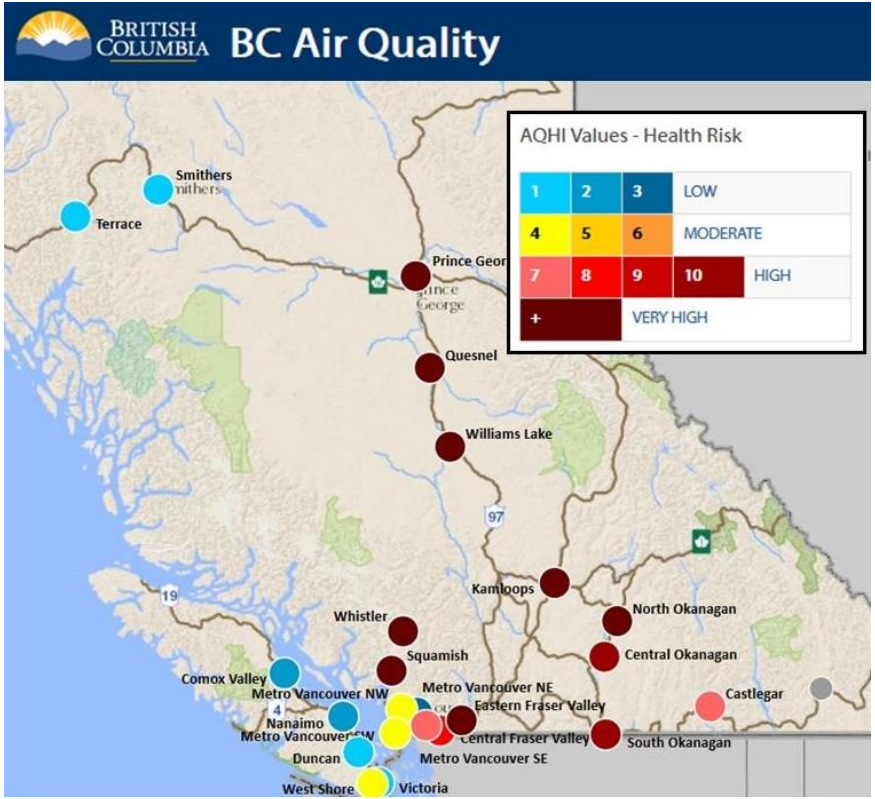
# Factors Contributing to Overheating

1. Outside factors
2. High temps
3. Solar gains
4. Internal gains
5. High insulation
6. Heat absorption
7. Poor ventilation



# Wildfires and Air Quality Advisories



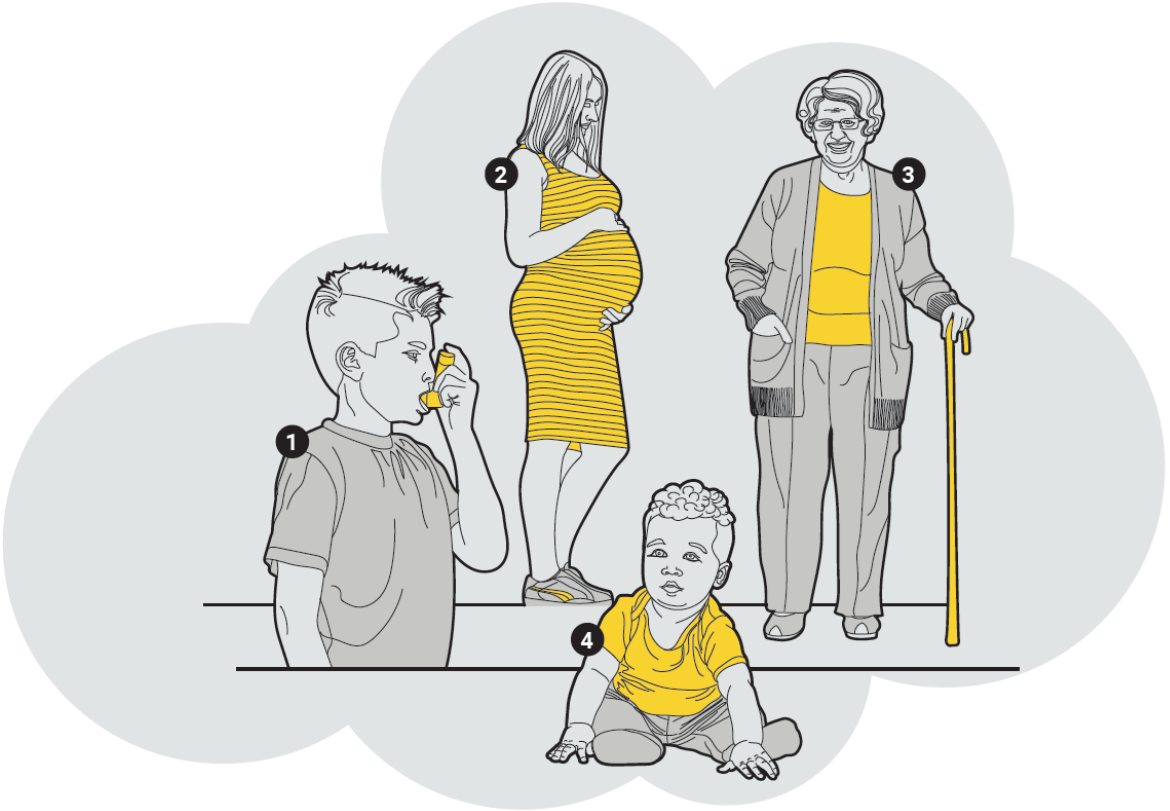
# Wildfire Smoke and Air Quality

- Wildfire smoke can compound with existing sources of air pollution, including emissions from cars and industry
- Pollen is also anticipated to increase with extended growing season

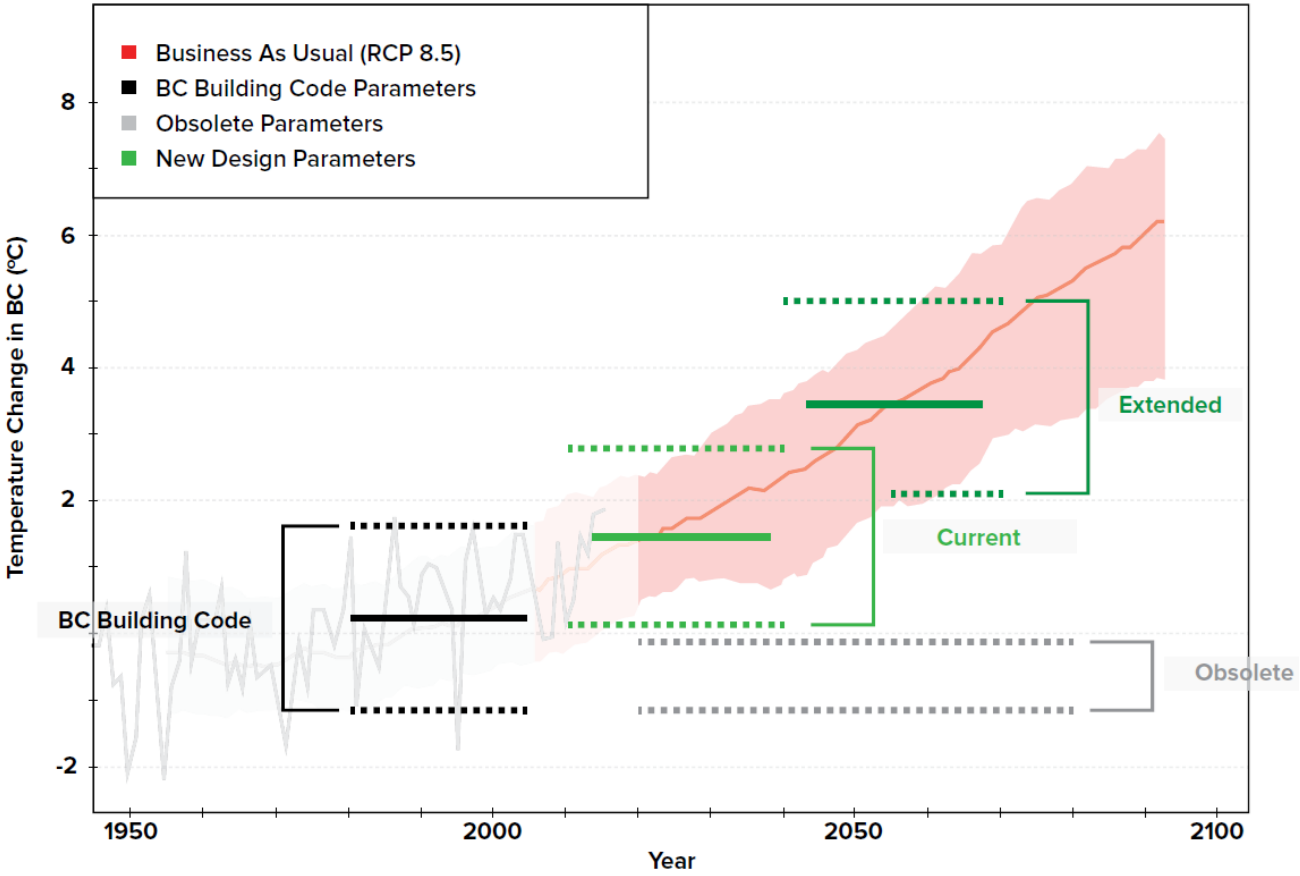
# Impacts to Occupants

**Low-income households** already bear a disproportionate burden of disease

- Face **higher exposure** (e.g. urban heat island effect)
- **More sensitive** to heat-related illness and death (e.g. older populations, people with pre-existing health conditions)
- **Fewer resources** to draw on to cope



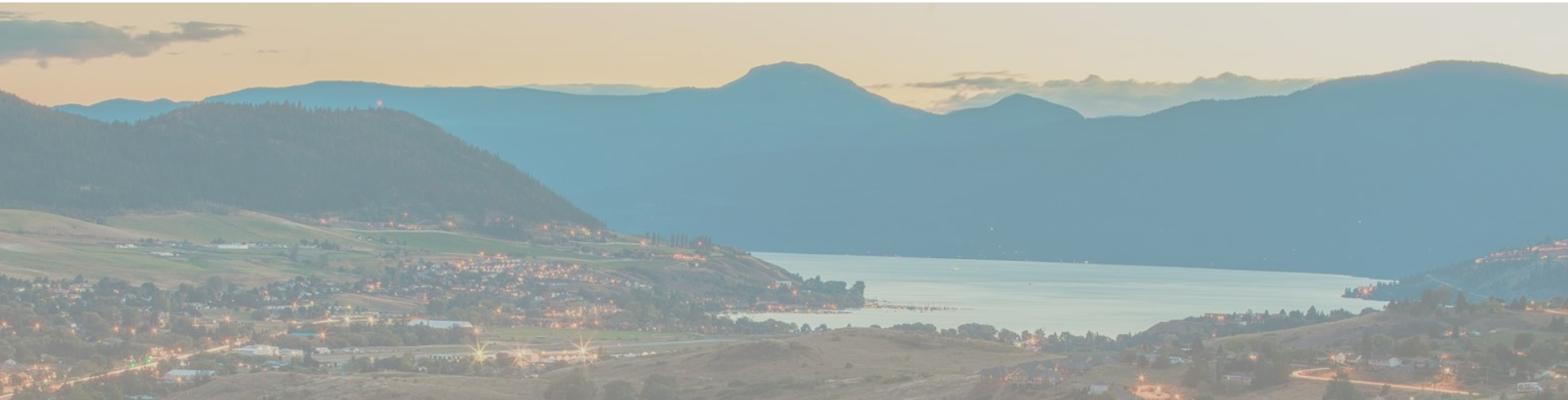
# Designing for the Future



# Adaptation & Resilience

Climate **resilience** or climate **adaptation** is the ability to anticipate, prepare for, and respond to hazardous events, trends, or disturbances related to climate

(and take advantage of opportunities)



# Resilient Housing

**Designed and managed to:**

- Reduce vulnerability to climate-related risks
- Enhance personal safety
- Promote social connectedness
- Maintain affordability for residents
- Enhance resilience through the broader community

# Cost-Benefit of Climate Change Adaptation

## Estimates of $ spent in preparation vs. $ saved in costs (at community scale):

- Global Commission on Adaptation: **$1 spent = $4 saved**
- Federation of Canadian Municipalities: **$1 spent = $6 saved**
- Economist: **$1 spent = $5 saved**

# Integrating Climate Change Responses

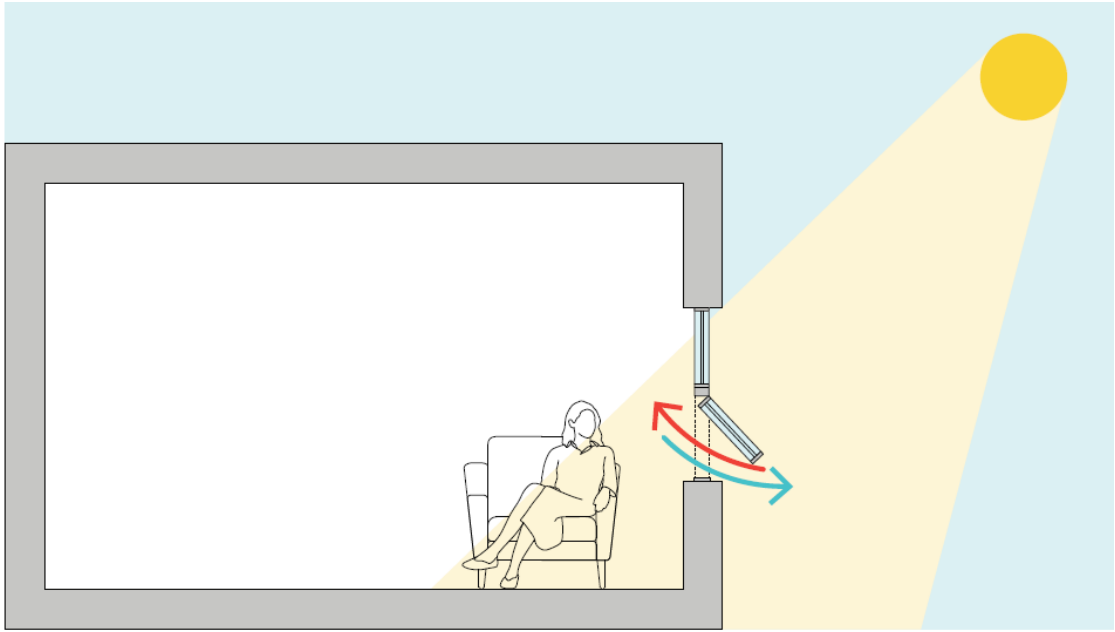
**Improved energy efficiency**

+

**Improved thermal comfort**

+

**Improved indoor air quality**



# The MBAR Project

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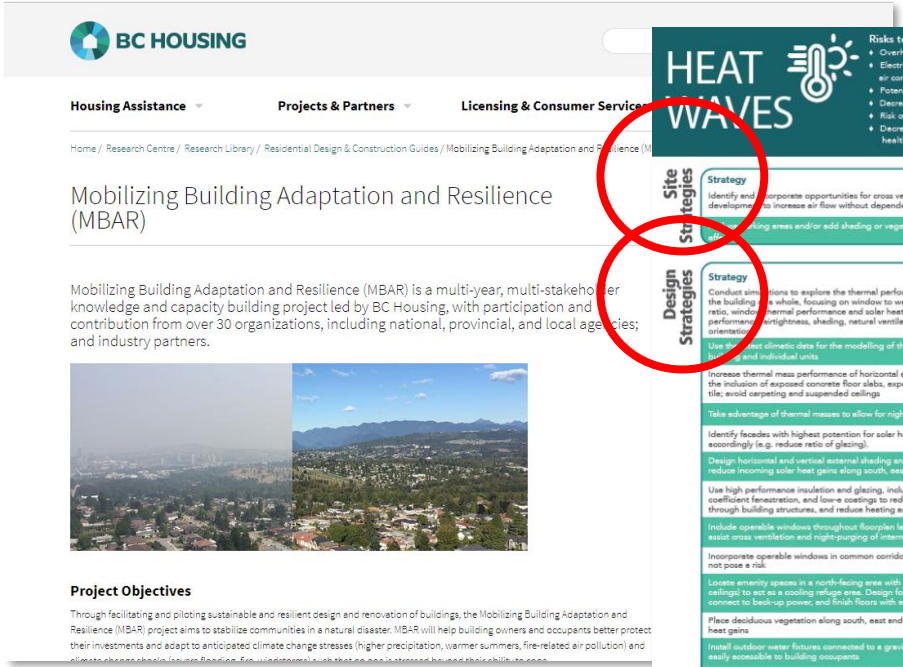
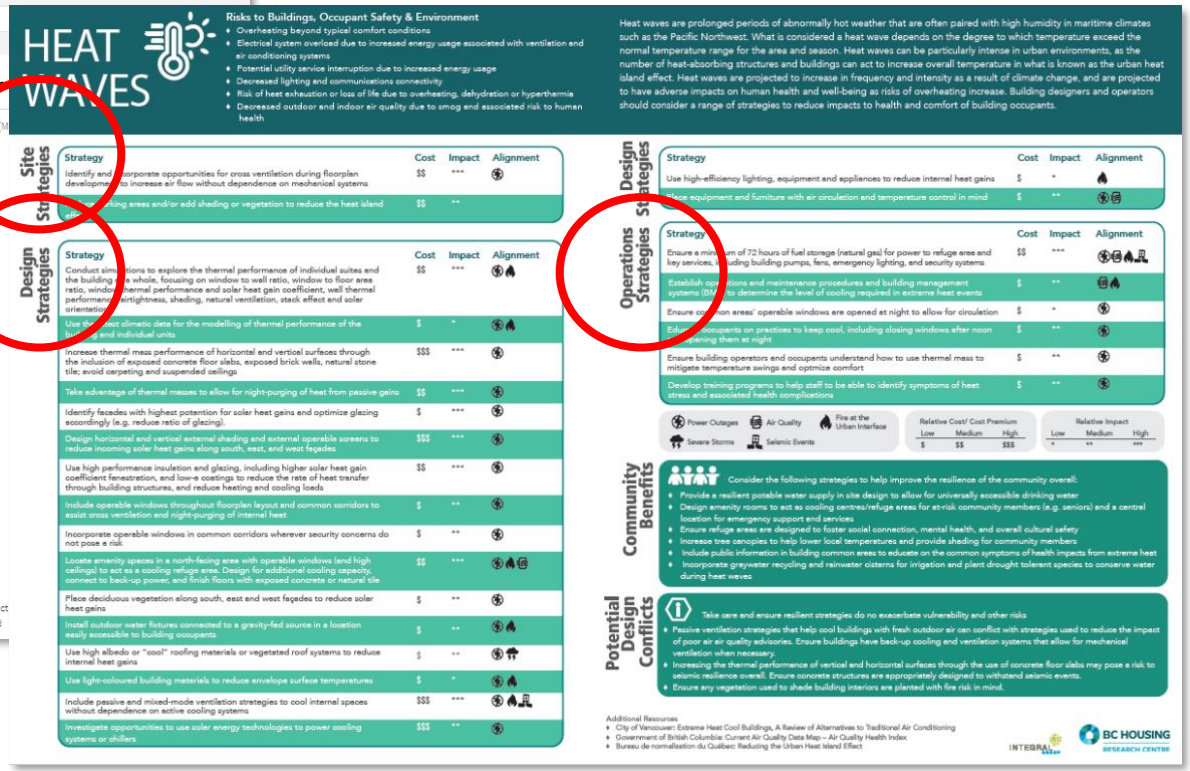
## Mobilizing Building Adaptation and Resilience (MBAR)

- Multi-year, multi-stakeholder knowledge and capacity building project
- Representing over 30 organizations, agencies, and industry partners

# Resilient Building Primers



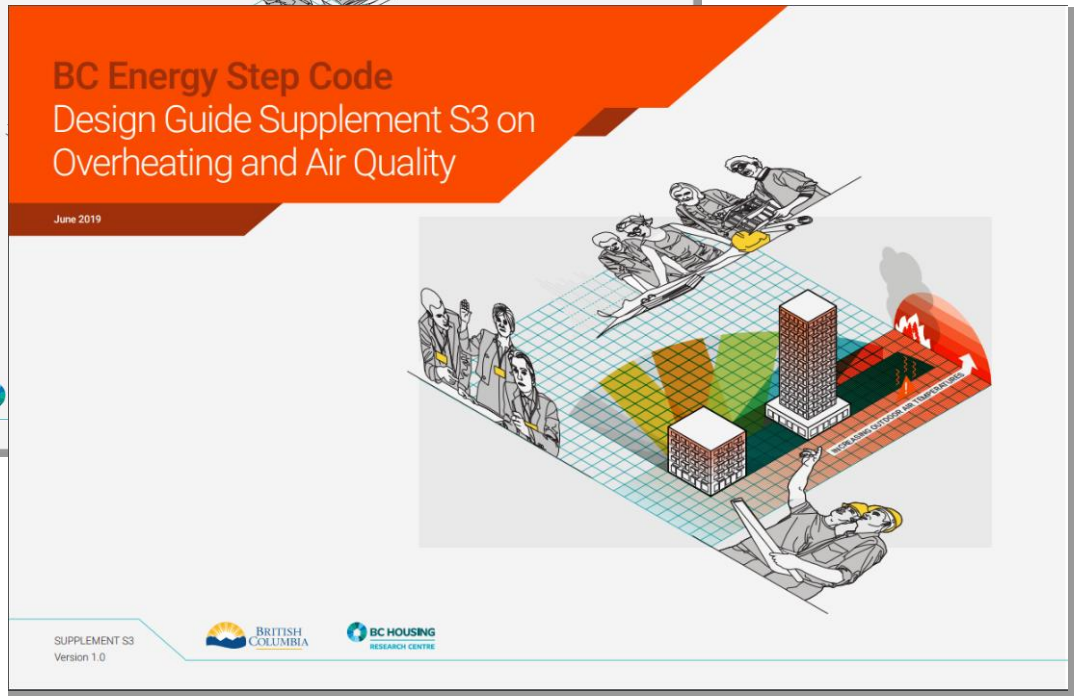



# The BC Energy Step Code Design Guide Supplement

HCMA Architecture + Design

LOCAL GOVERNMENT

ARCHITECTS AND DEVELOPERS

# Thank you!

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Image Courtesy of Perkins+Will

# BC Housing
# Addressing Overheating in New Construction

Sadia Afrin, Sr. Manager - Construction Standards

# Who We Serve

BC HOUSING

We work with about 800 housing providers and help more than 104,000 households in 200 communities across British Columbia

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# Affordable Housing Portfolio

Low-mid rise - Smither's Passive House, Smither


Low rise - Hart Haven, Prince George

High rise - Karis Place, Vancouver

Mid-high rise
BC Hydro, Fort St. John

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# Climate Change and Overheating

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# Overheating in Housing Projects

- Warmer summer
- Buildings becoming more air-tight
- Heavily insulated to retain heat
- Uncontrolled solar gain through windows/glazing
- Conventional timber frame construction
- People, appliances, lighting
- Inadequate or poorly controlled ventilation
- Orientation
- Exposed thermal mass


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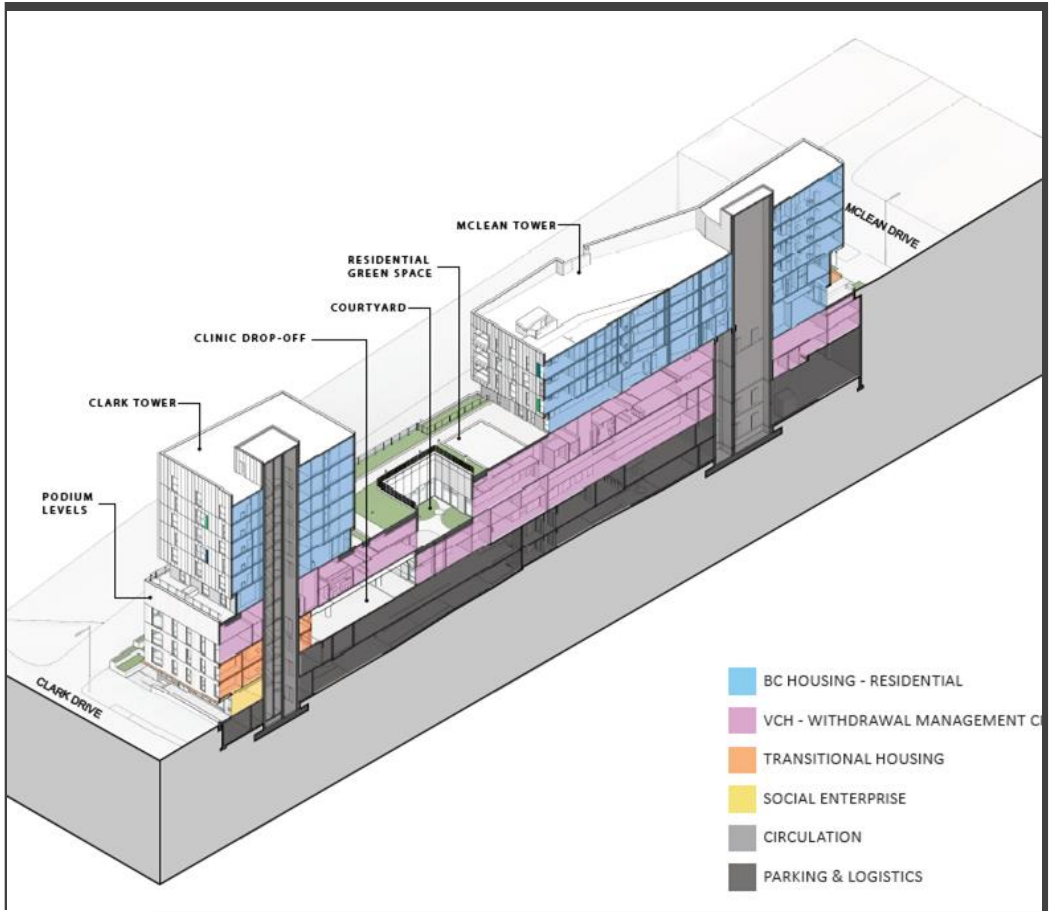
**BC Housing Project: 1st and Clark, Vancouver**

- 97 residential units, 51 withdrawal management beds, 20 transition bed and a Social enterprise for indigenous residents
- DP submission May/2019, Construction starts Aug/2020




## 1st and Clark

## Passive Strategies

- Massing
- Site and Orientation
- Landscape
- Space Planning
- Wall/window Ratio
- Window Design
- ASHRAE 55 – Thermal Comfort

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**1st and Clark**

**Vancouver CWEC 2016 weather file**

**Energy Modelling Guidelines version 2.0**

- R13 concrete / R16 wood walls
- Operable windows
- In suite HRVs
- - LED lighting
- - Low flow fixtures

**Step Code 3**

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# Simulation to Future Projected Data

## A. Future Weather

| Location: Vancouver | CWEC | CWEC 2016 | 2020s | 2050s | 2080s |
|---|---|---|---|---|---|
| *January* | 3.2 | **4.2** | 5.7 | 5.5 | 9.1 |
| *February* | 5.1 | **5.1** | 6.9 | 6.6 | 10.3 |
| *March* | 6.1 | **6.9** | 8.9 | 9 | 12.3 |
| *April* | 8.7 | **9.5** | 11.6 | 12 | 14.7 |
| *May* | 11.8 | **12.4** | 14.6 | 15.6 | 17.4 |
| *June* | 15.1 | **15.4** | 17.3 | 19.4 | 20.5 |
| *July* | 17.0 | **17.9** | 19.6 | 22.8 | 23.4 |
| *August* | 17.1 | **18** | 19.2 | 22.6 | 23.3 |
| *September* | 13.8 | **15.5** | 16.3 | 19.3 | 19.9 |
| *October* | 9.8 | **10.2** | 10.7 | 12.9 | 13.6 |
| *November* | 5.3 | **5.9** | 6.5 | 8.1 | 9.6 |
| *December* | 3.6 | **3.9** | 5 | 5.7 | 8.1 |

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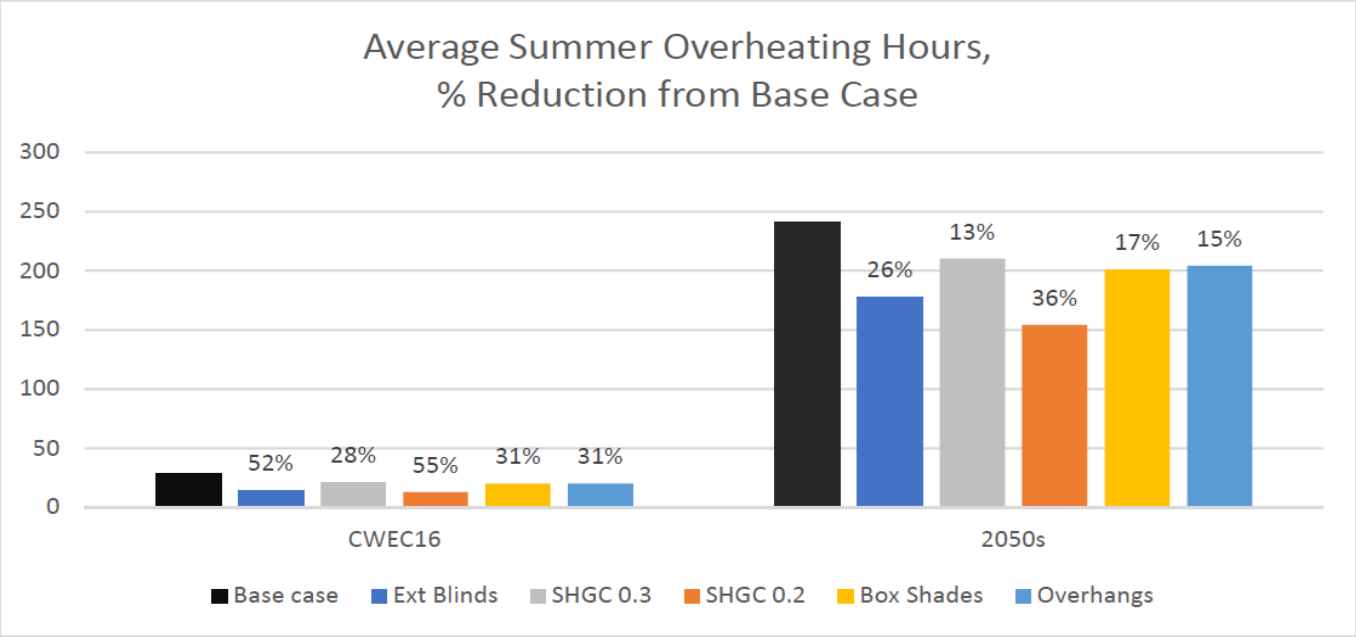
# B. Overheating Mitigation Strategies

## 1. Passive Cooling

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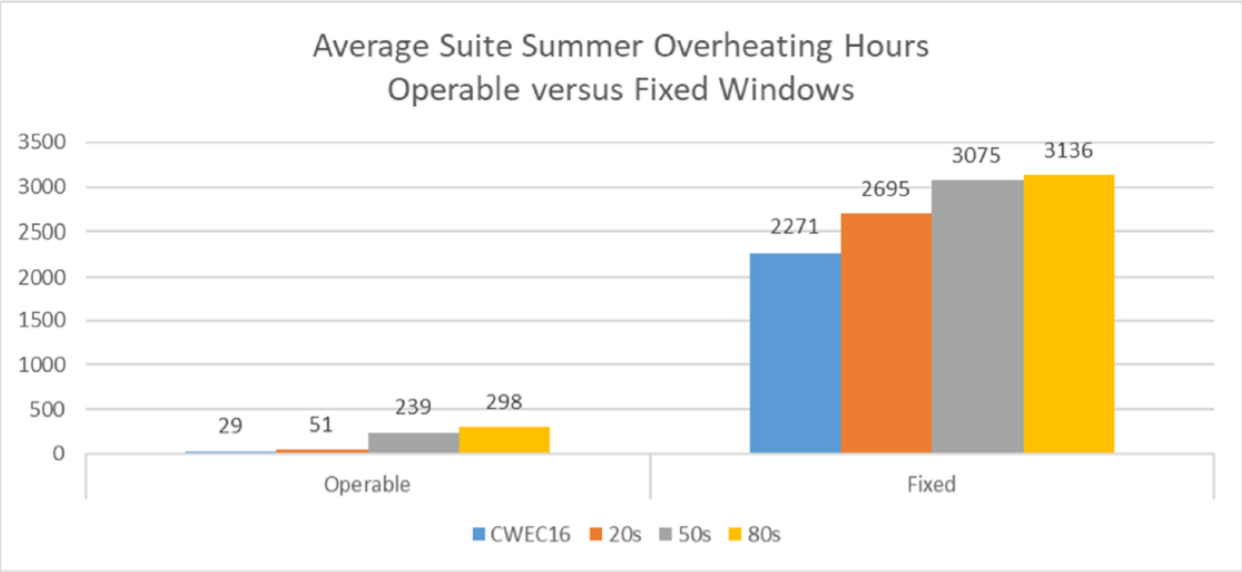
# B. Overheating Mitigation Strategies

## 2. Operable Windows

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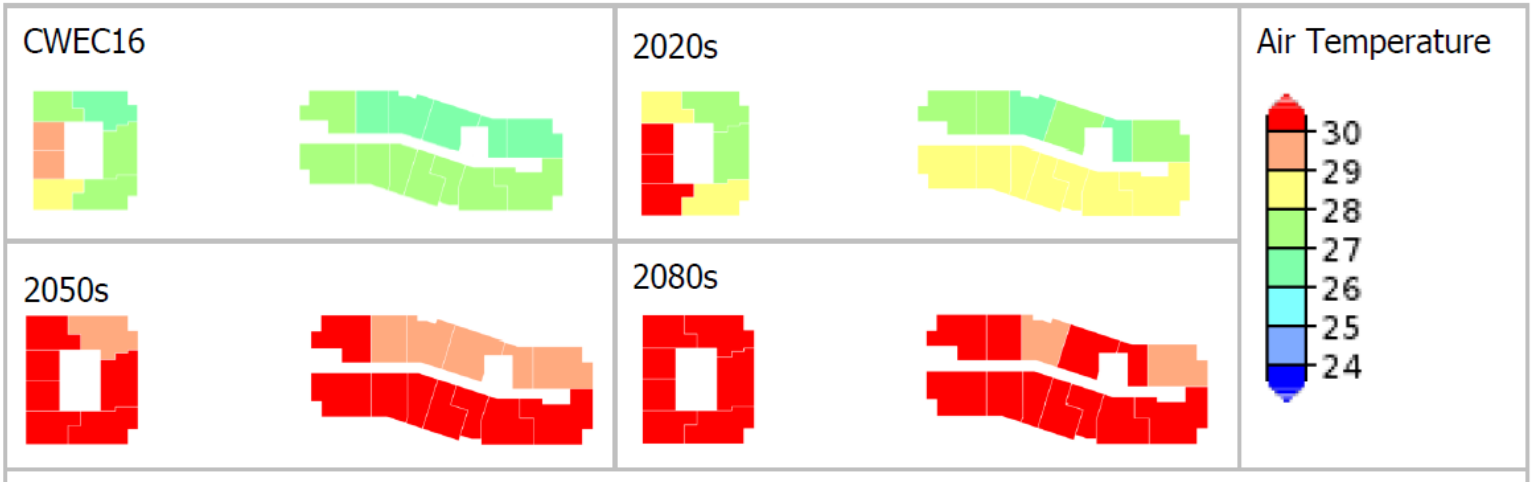
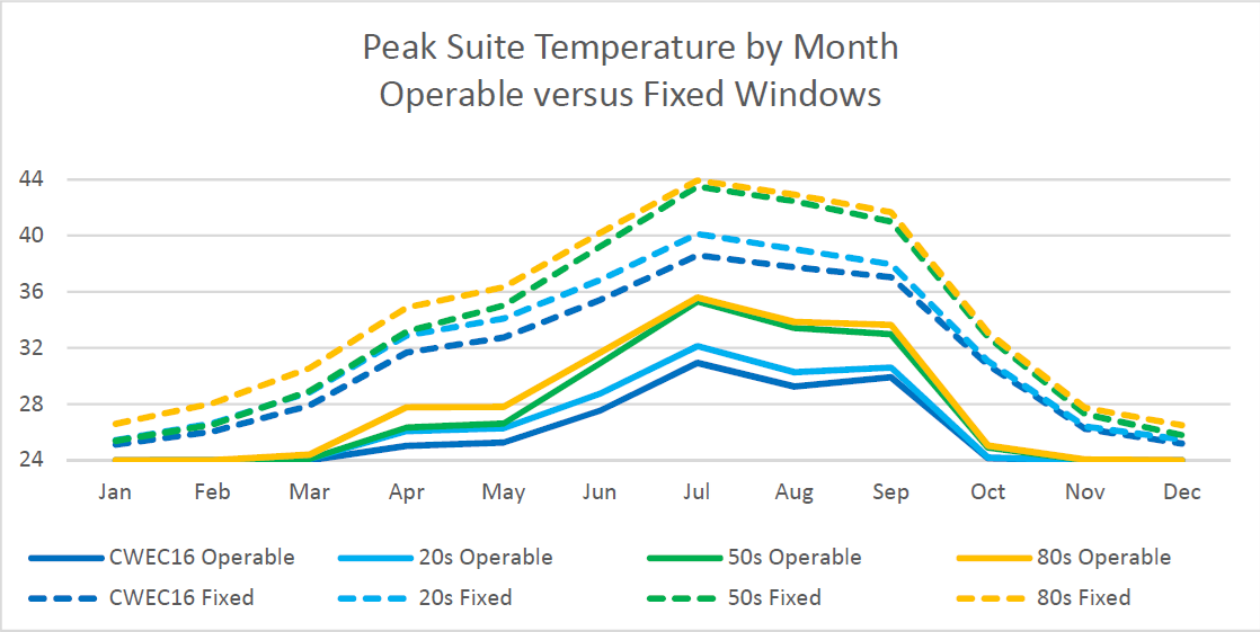
# C. Evaluating Comfort

**1. In-suite Temperature (North)**



# C. Evaluating Comfort

## 2. Operable Windows

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# 1st and Clark: MBAR

**Considerations in Design**

- Passive cooling strategies:
  - glazing with good solar control
  - operable windows

- HVAC Design (Partial cooling):
  - central heat recovery air handling w/DX cooling
  - Ventilation rates
  - MERV-13 filters


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## LESSONS LEARNED

. Microclimate

. Effectiveness of Passive approach

. Active Mechanical Cooling (Full/Partial)

# Moving Forward

- All Amenity, Program and Office areas w/Full Mechanical Cooling
- Overheating Hours < **20 hours** of the 80% acceptability limits ASHRAE Standard 55
- Residential units in Interior w/Full mechanical cooling
- SHGC of Windows **0.27 – 0.33 with VT > 60%**
- Ventilation inside units design in compliance with **Section 9.32**
- Prescribed Ventilation rates
- Partial mechanical cooling provided by central or semi-central Energy Recovery Ventilators (ERVs).



# Mechanical Peer Review

## at Pre-BP

# Commissioning

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**Sadia Afrin, Sr. Manager Construction Services**
BC Housing Management Commission
Email: saafrin@bchousing.org

# Resilient Housing for a Future Climate

# Passive and Active Systems

**Chris Doel** | Managing Principal
cdoel@integralgroup.com

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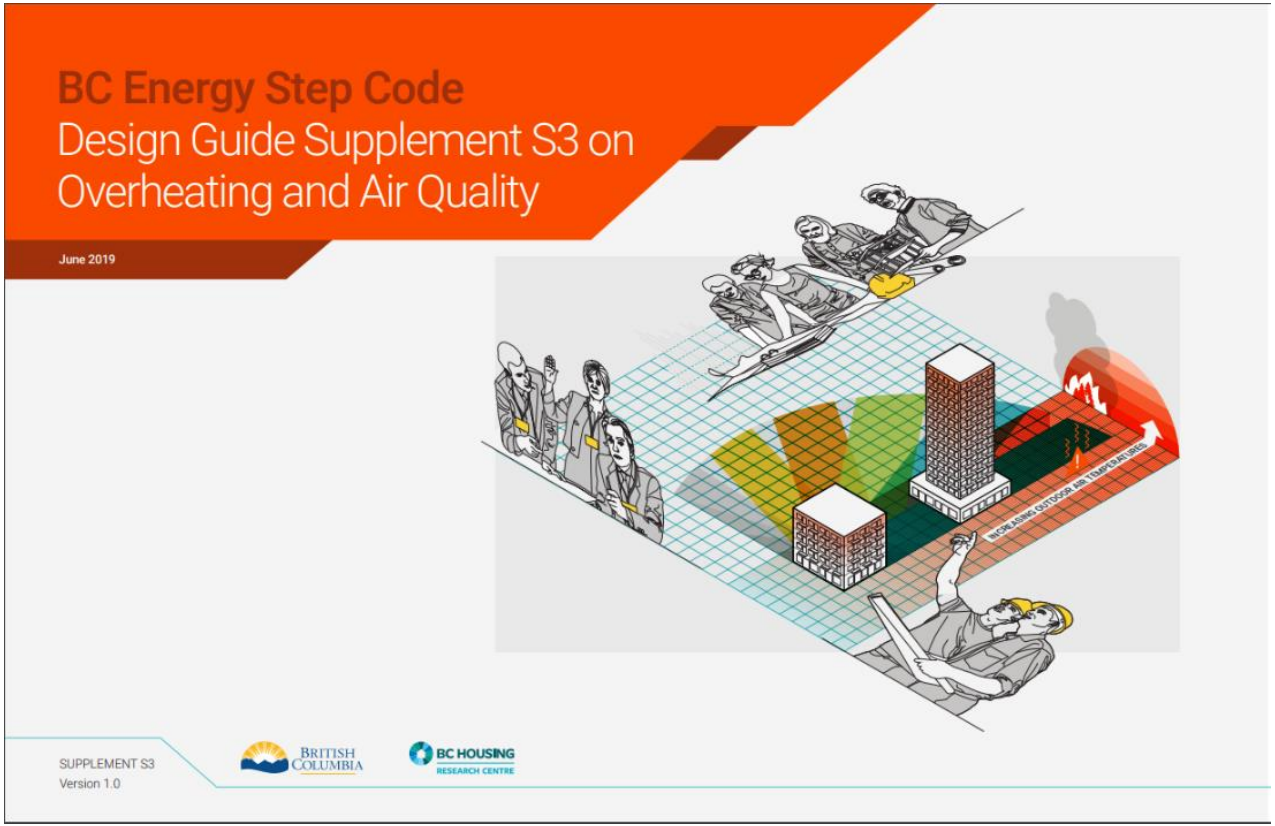
# Overview of Presentation

- Overheating and Step Code Targets
- Passive Systems
- Active Systems

# A New Design Guide

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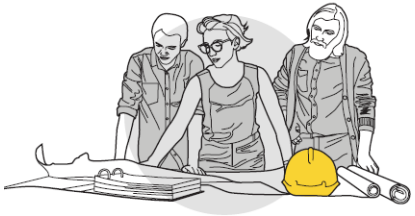



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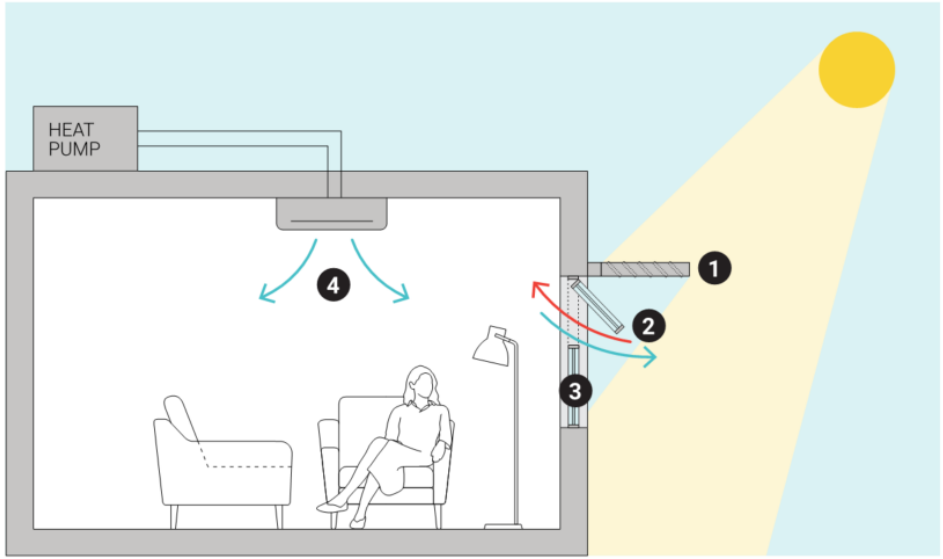
# Balancing Act




① Exterior

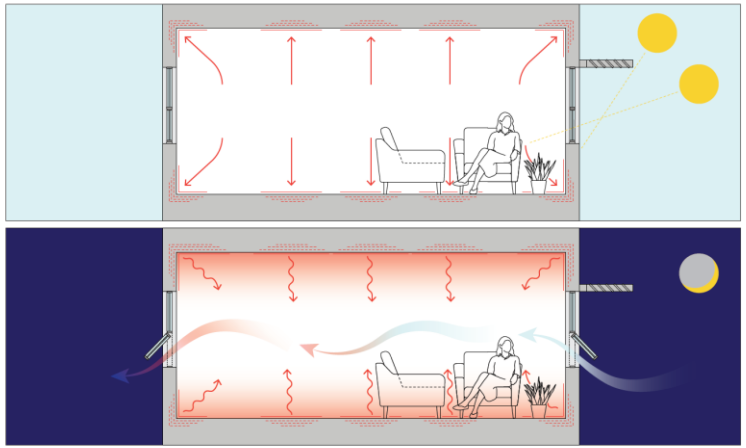
② Operable Windows

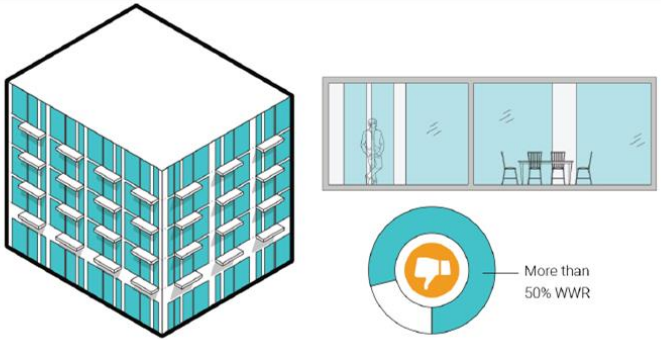
③ Low Solar heat gain glazing

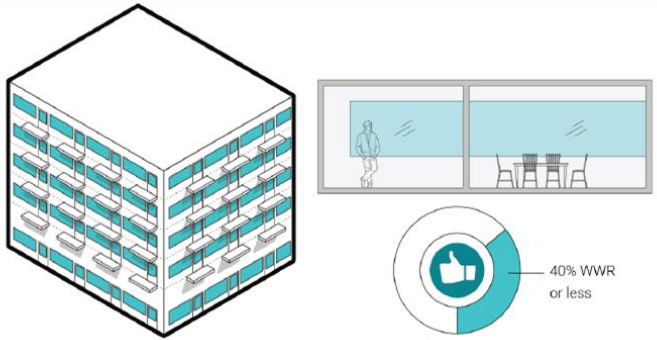
④ Mechanical Cooling

# Passive Systems

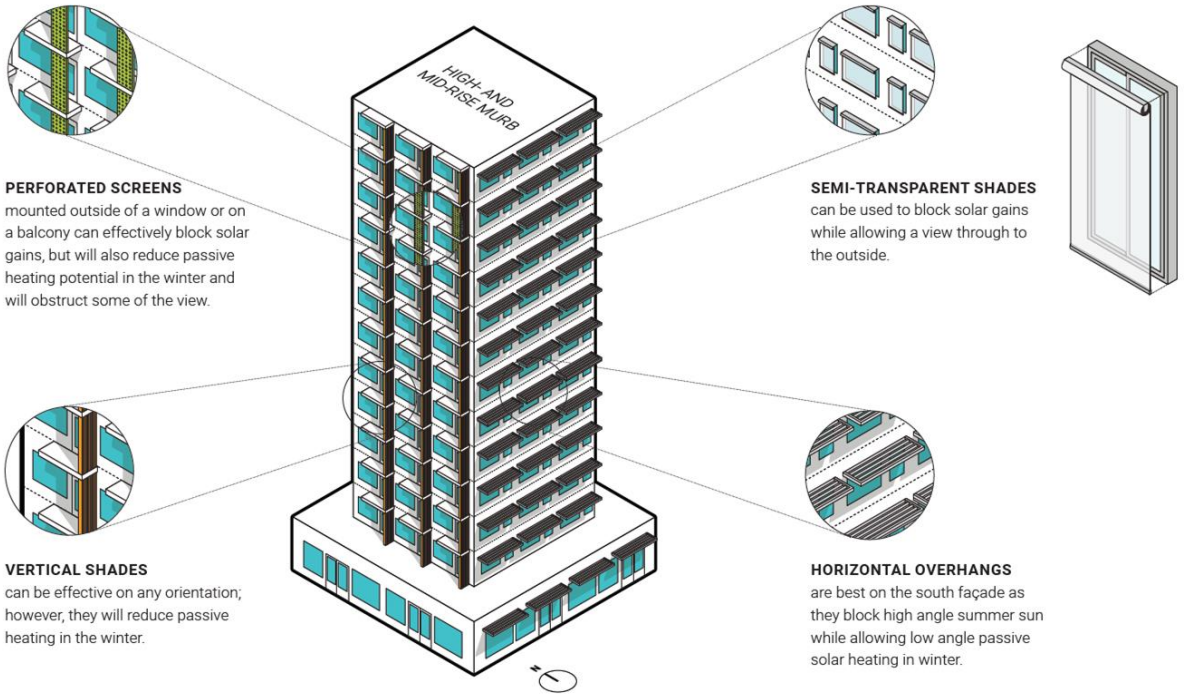
# Start Passively





# Shade Incoming Solar Gains




**PERFORATED SCREENS**
mounted outside of a window or on a balcony can effectively block solar gains, but will also reduce passive heating potential in the winter and will obstruct some of the view.

**SEMI-TRANSPARENT SHADES**
can be used to block solar gains while allowing a view through to the outside.

**VERTICAL SHADES**
can be effective on any orientation; however, they will reduce passive heating in the winter.

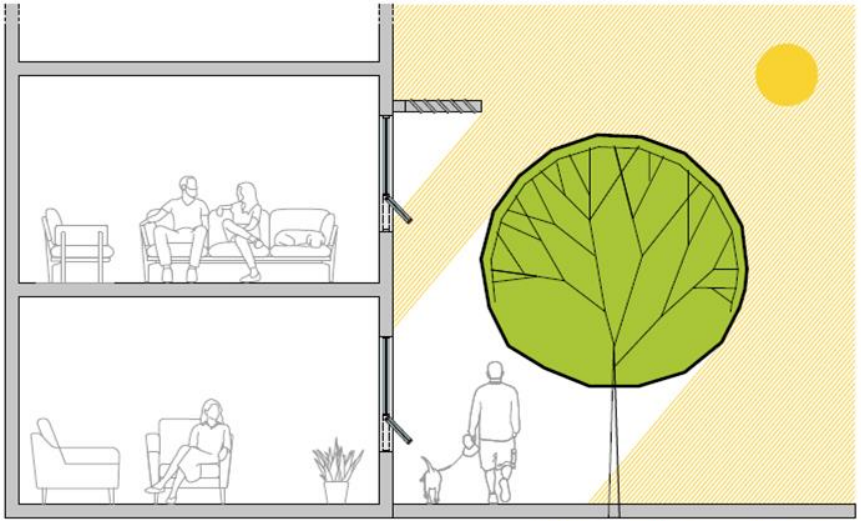
**HORIZONTAL OVERHANGS**
are best on the south façade as they block high angle summer sun while allowing low angle passive solar heating in winter.


Olympic Village


Hornby Island Fire Hall


UBC Arts Student Centre
Image Credit: Leckie Studio Architecture + Design

# Shade Incoming Solar Gains



SUMMER (South/West Facing Facade)

# Shading Strategies

| | Fixed External Shades | Manual Shades | Manual Shades | Vegetation | SHGC Selection | Window Coatings |
|---|---|---|---|---|---|---|
| Livability | 👍👍 | 👍 | | 👍👍 | | |
| Aesthetic | 👍👍 | | | 👍👍 | | |
| No additional maintenance required | | | | | 👍👍 | 👍👍 |
| Controllability | | 👍👍 | 👍 | | | |
| No increase in need for indoor lighting | | | | | 👍* | |
| Glare Control | 👍 | | | 👍 | 👍* | 👍 |

LEGEND 👍 Good 👍👍 Better * Some SHGC reductions may impact visible light transmittance



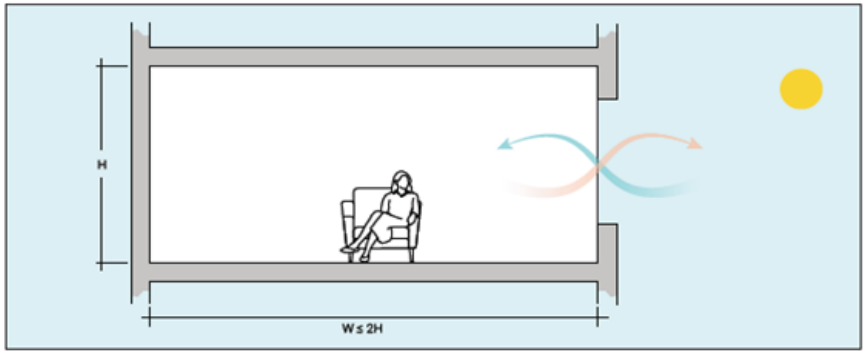

Olympic Village

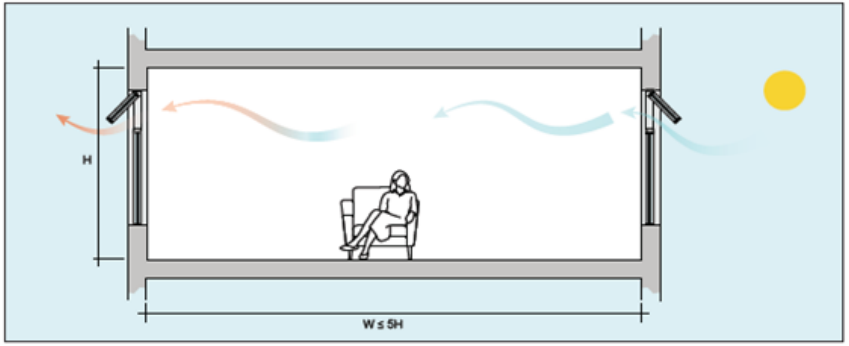

Hornby Island Fire Hall

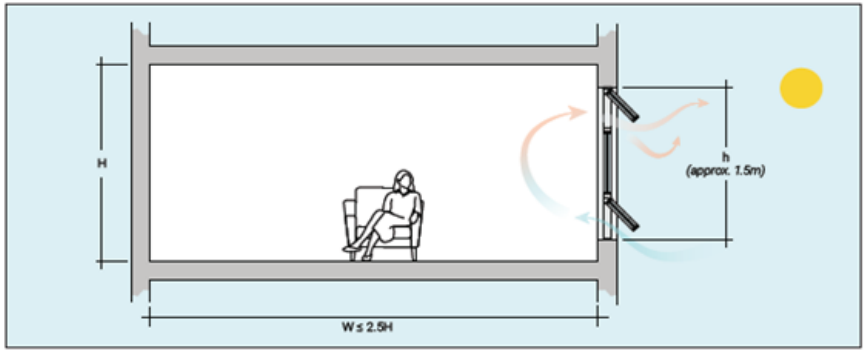

UBC Arts Student Centre

Image Credit: Leckie Studio Architecture + Design

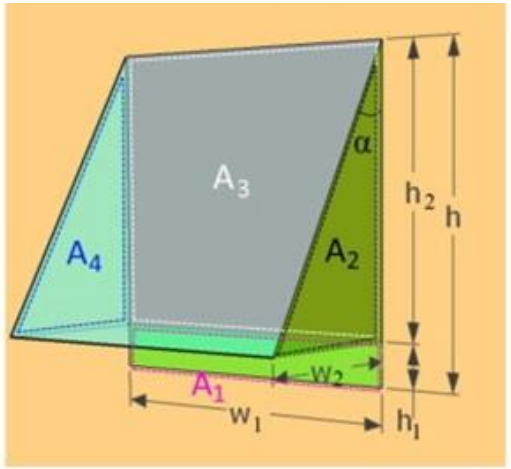
# Passive Cooling



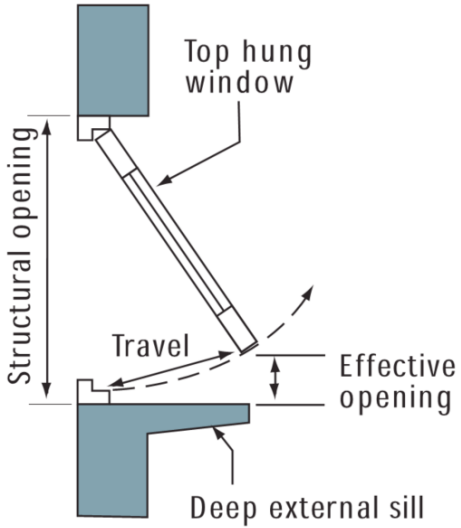



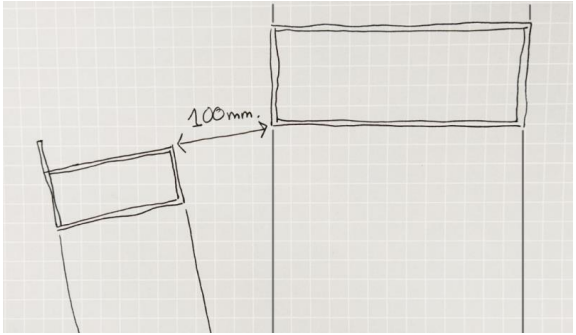
# Openings – Size matters

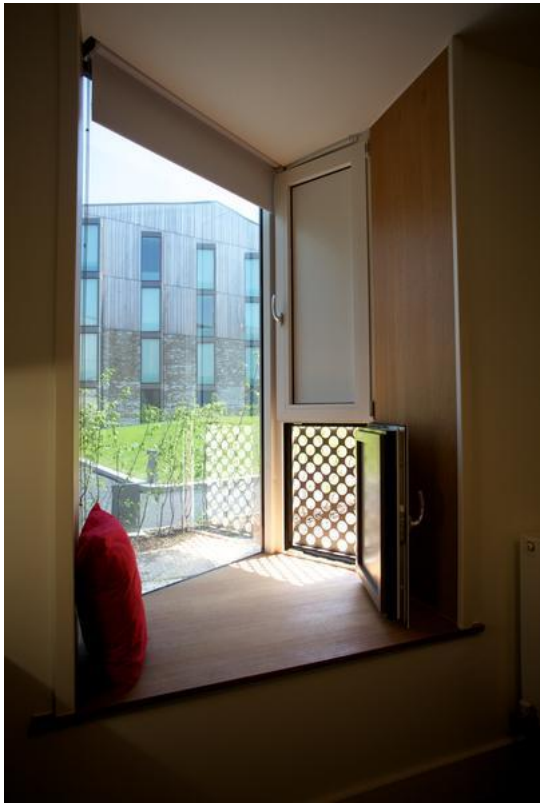




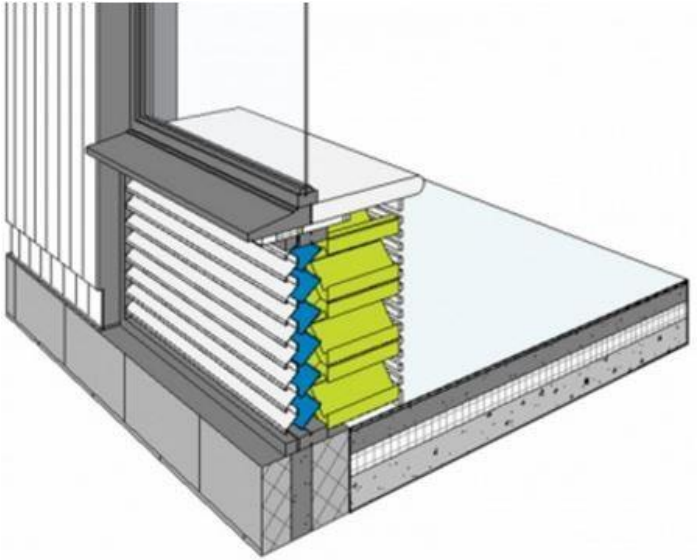


# Openings



# Acoustic Openings



# Ventilation Standards

City of Vancouver *Land Use and Development Policies and Guidelines*

**Planning, Urban Design and Sustainability Department**

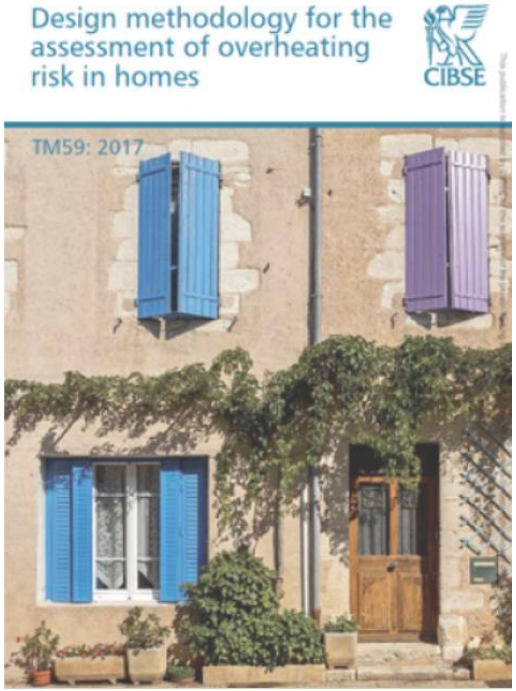
453 West 12th Avenue, Vancouver, BC V5Y 1V4 | tel: 3-1-1, outside Vancouver 604.873.7000 | fax: 604.873.7100
website: vancouver.ca | email: planning@vancouver.ca | app: VanConnect

**ENERGY MODELLING GUIDELINES**

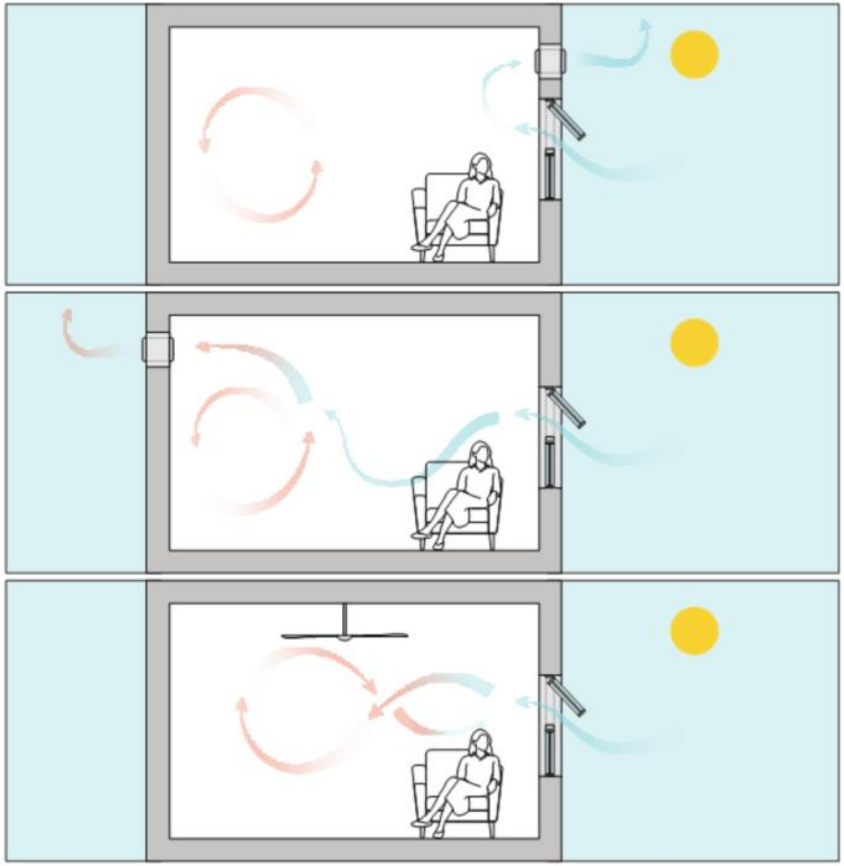
*Version 2.0*

*Effective March 17, 2017*
*Amended July 11, 2018*

*(These guidelines are referenced in the Green Buildings Policy for Rezonings, amended by Council on November 29, 2016)*

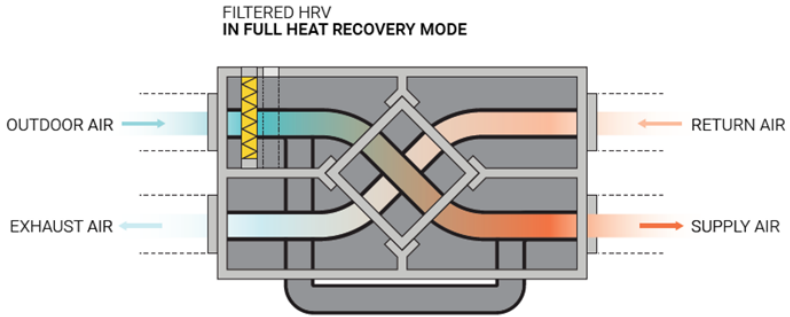
# Fan Assisted Passive Cooling

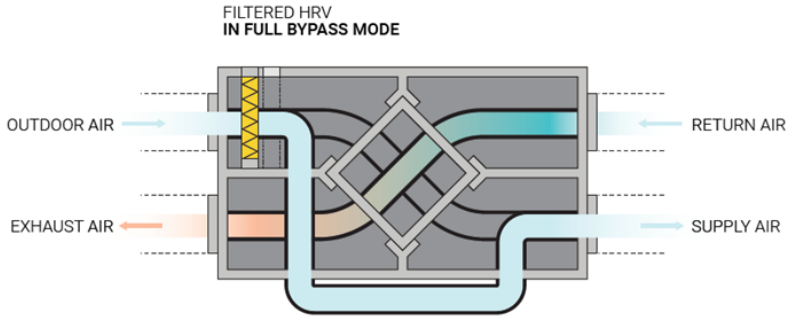


# Active Systems

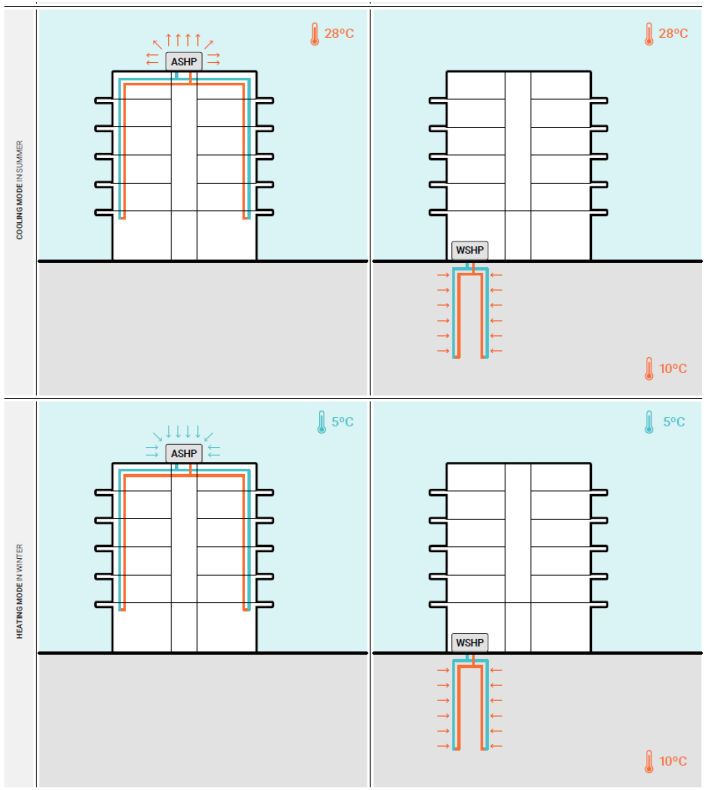
# Consider a Hybrid Cooling System

- Use a bypass in HRVs to reduce heat absorption from exhaust air
- Use supply or exhaust fans to move air
- Outfit central HRVs with a cooling coil



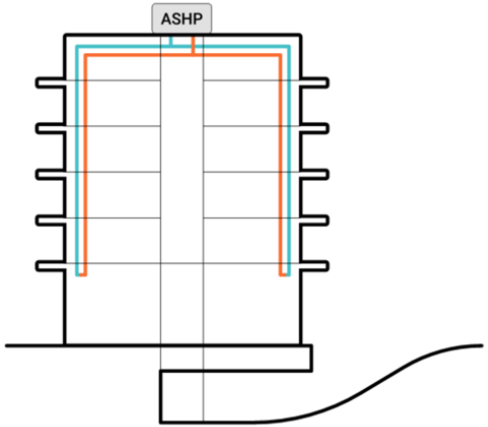



# Add Mechanical Cooling

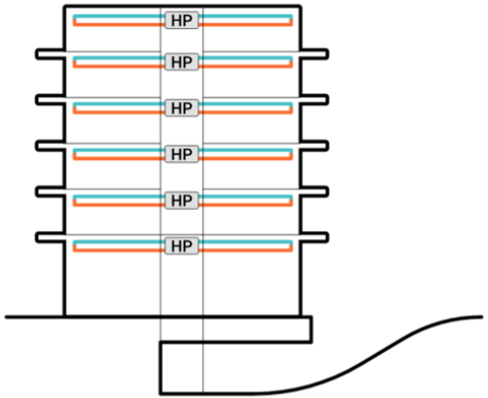



- Air and water heat pumps
- Central or distributed cooling
- VRF systems
- *Roughing in for future cooling*

# Cooling Distribution

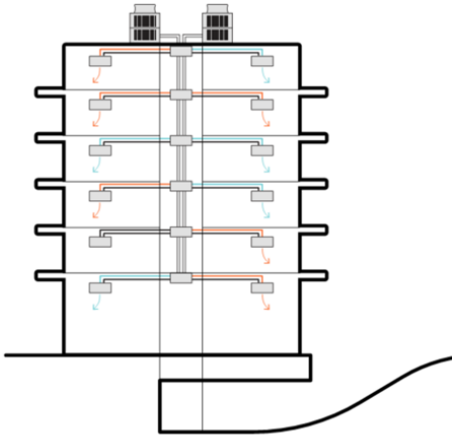



Central




Distributed

Floor by Floor

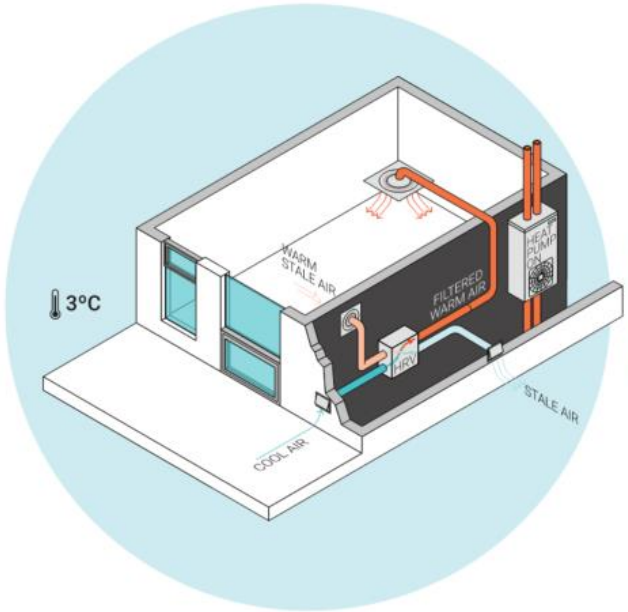


Distributed

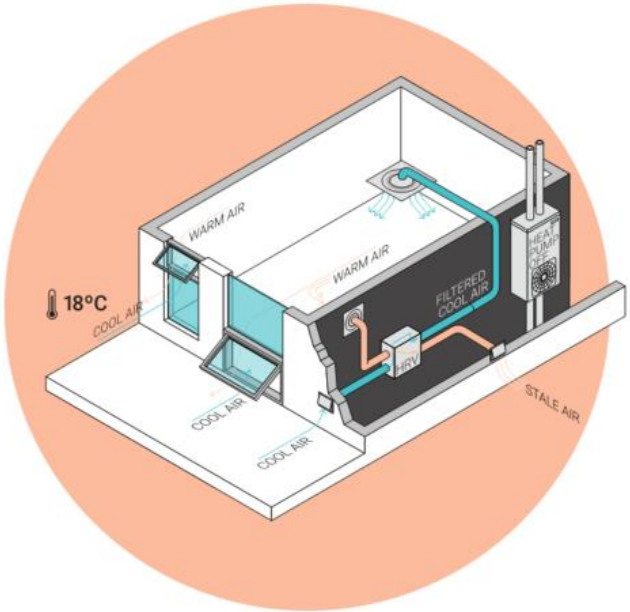
Space by Space

# Mix Your Modes

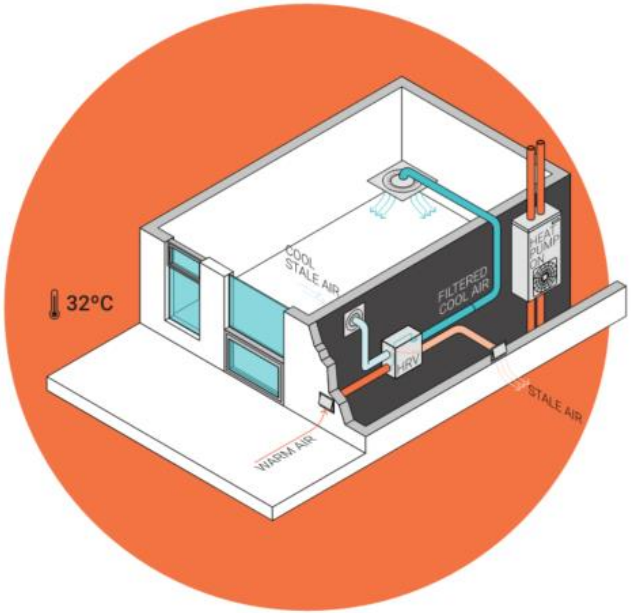
MECHANICAL HEATING
**DURING PEAK WINTER**



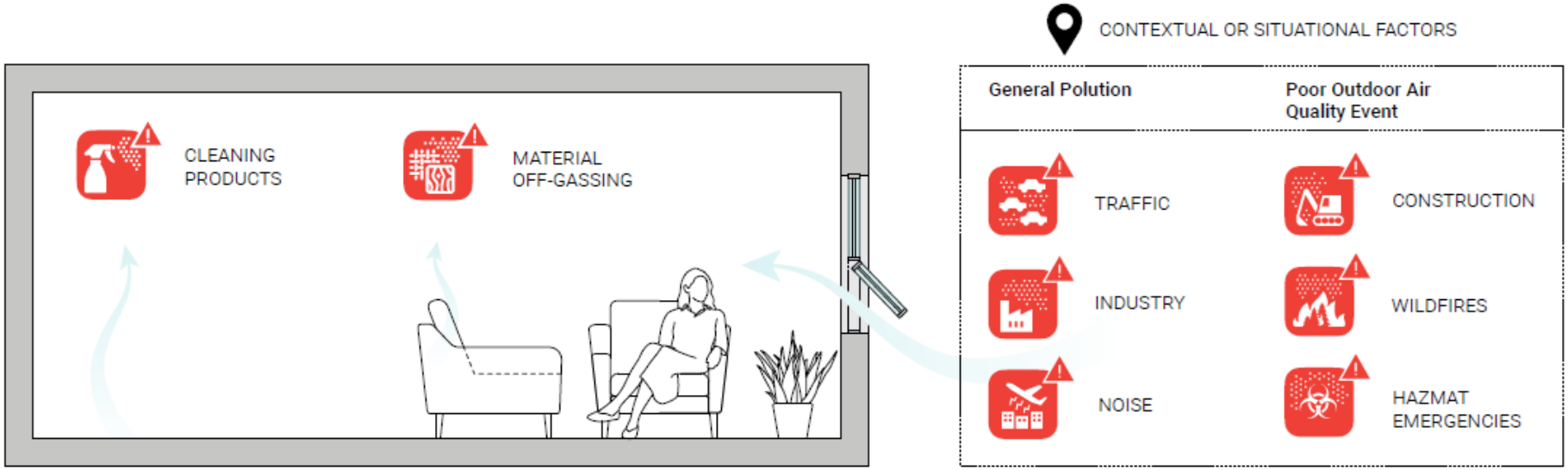

PASSIVE AND MECHANICAL COOLING
**DURING SHOULDER SEASONS**




MECHANICAL COOLING
**DURING PEAK SUMMER**



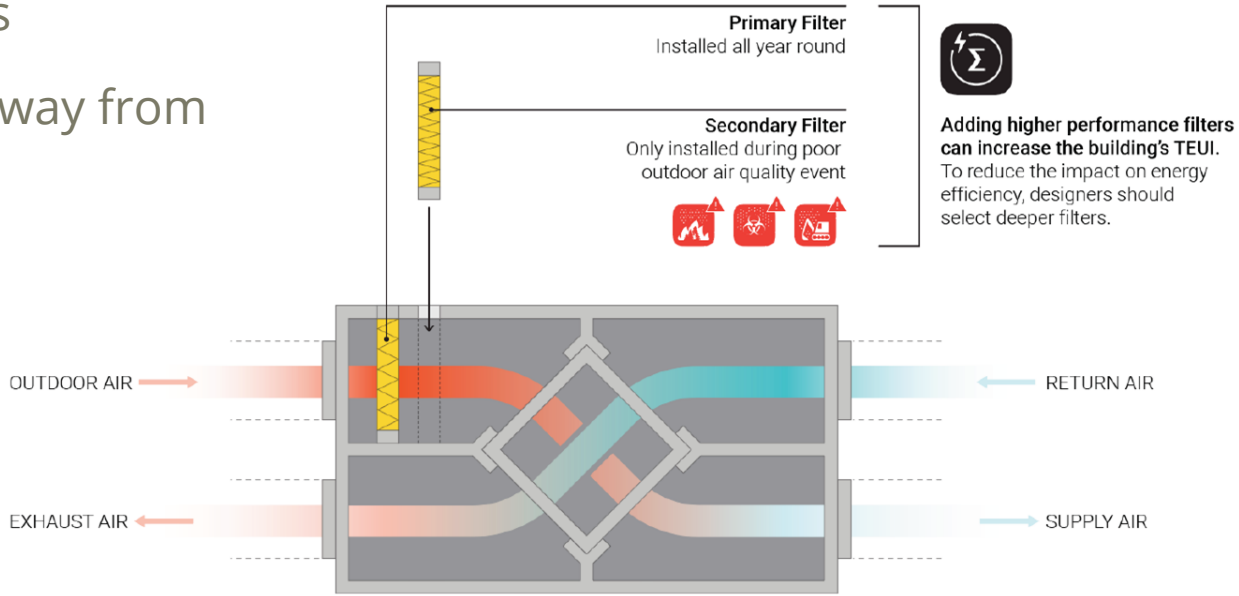
# Improve Indoor Air Quality



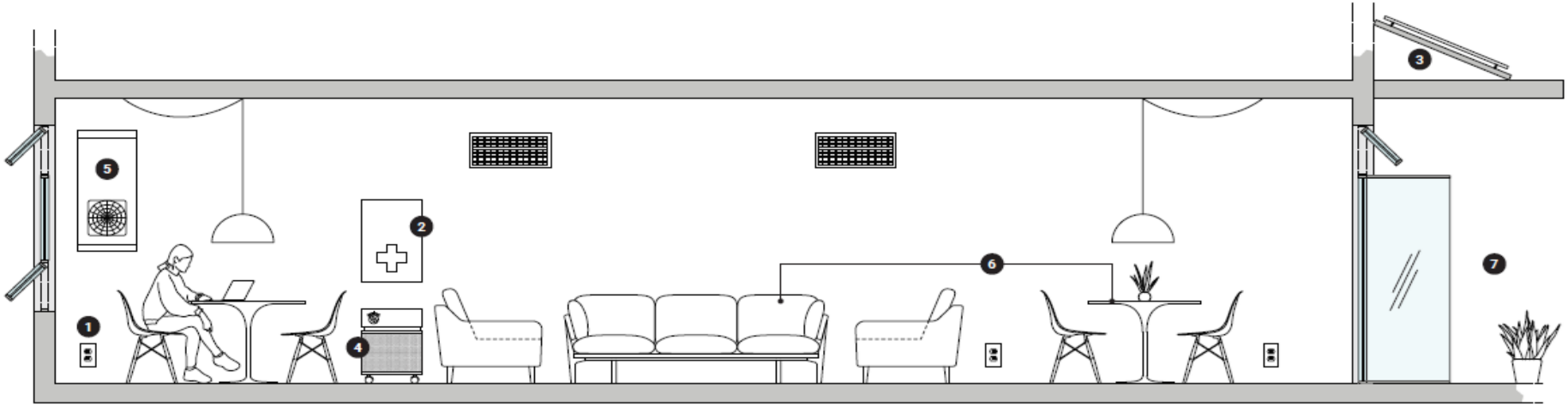

- Identify the number and intensity of local sources of air pollutants
- Refer to BCBC, LEED and WELL Standard

# Improve Indoor Air Quality

- Minimum MERV 13, or activated carbon for high VOCs
- Accommodate additional filters during AQ advisories
- Air intakes located away from pollution sources



# Provide a Refuge



1. Provide mechanical heating and cooling
2. Connect to a source of back-up power
3. Provide amenities and accessibility
4. Provide higher levels of filtration
5. Ensure emergency supplies are provided (food, water)
6. Provide both private and social areas
7. Allow access to outside green space

# Thank you!

**Chris Doel |** Managing Principal
cdoel@integralgroup.com

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