

# Retrofits for Overheating Buildings and Poor Indoor Air Quality

July 7, 2020



**BC HOUSING**



**BCNPHA**

BC Non-Profit Housing Association



# Outline

1. Introduction	Welcome/logistics/introductions	Jackie Kanyuk, BCNPHA
2. Context & challenges	<ul style="list-style-type: none"><li>• Changing climate</li><li>• Implications for housing</li><li>• Challenges with existing buildings</li></ul>	Jackie Kanyuk, BCNPHA
3. Key scenarios and options	<ul style="list-style-type: none"><li>• Centralized vs. decentralized cooling</li><li>• Options depending on existing systems</li></ul>	Alex Chou, AME Group
4. Overheating in Ontario's Social Housing Buildings	<ul style="list-style-type: none"><li>• Challenges</li><li>• Potential strategies</li></ul>	Marianne Touchie, University of Toronto
5. BC Case Studies	<ul style="list-style-type: none"><li>• Social housing case studies</li><li>• MBAR pilot projects</li></ul>	Owen Philip, BC Housing
6. Questions and closings	<ul style="list-style-type: none"><li>• Audience questions</li><li>• Closing remarks</li></ul>	Jackie Kanyuk, BCNPHA

# A Changing Climate

Hotter, drier summers  
with air quality issues



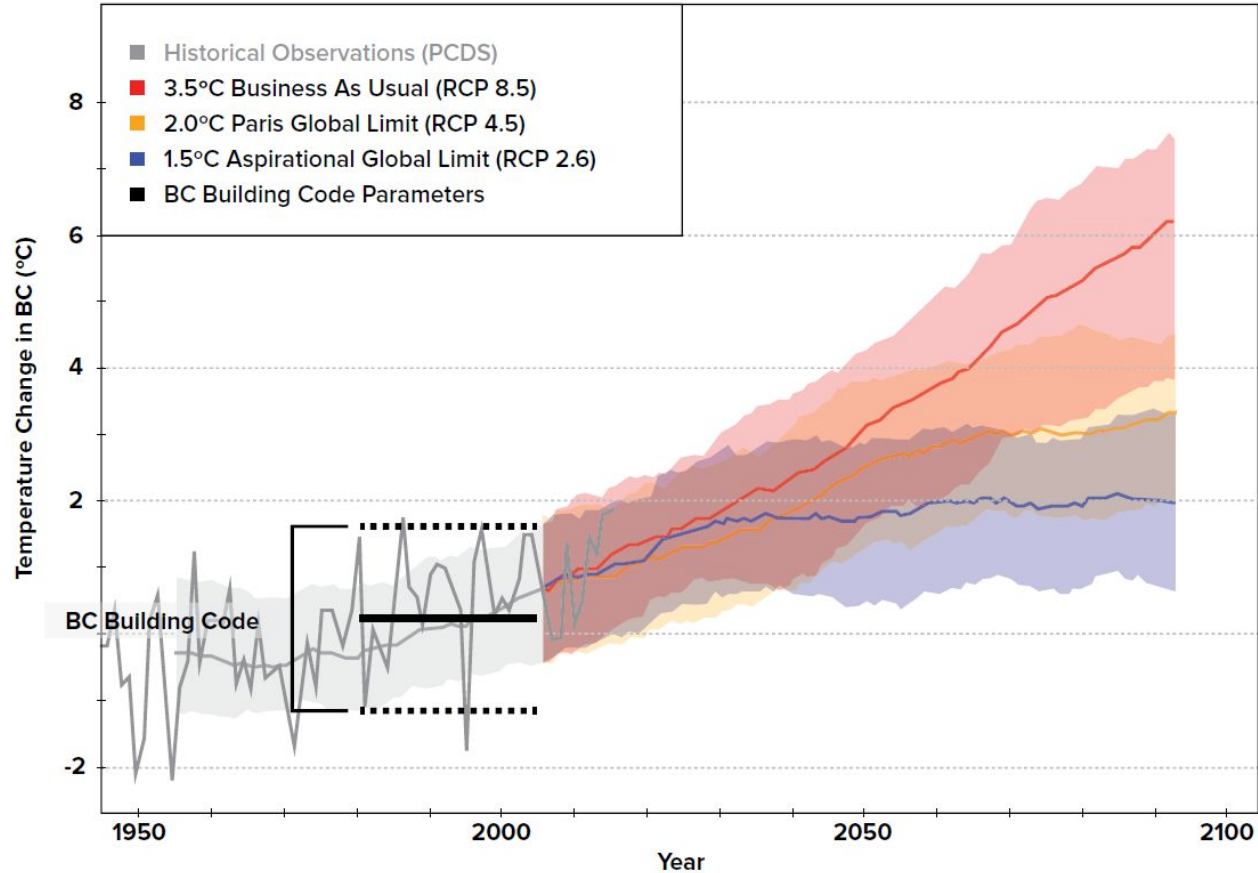
# Record-breaking temperatures

Temperature records broken on August 29, 2018:

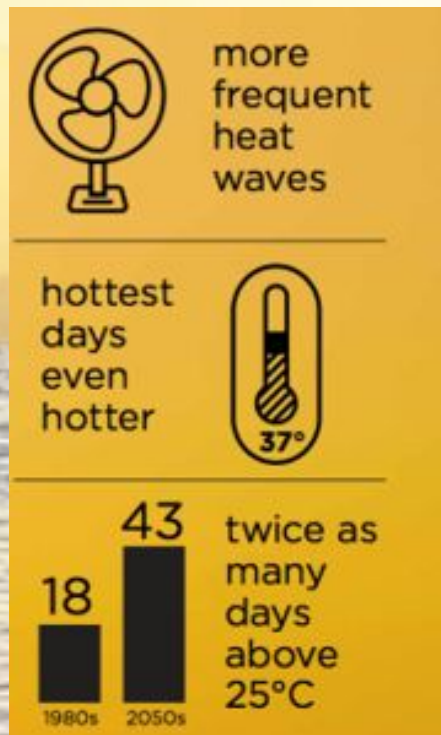
- **Vancouver Harbour 30.5 C (28.9 C in 1967)**
- **Kamloops 38.5 C (35.6 C in 1915)**
- **Princeton 36 C (35 C in 1897)**
- **Sparwood 32.1 C (30.6 C in 1972)**
- **Williams Lake 31.9 C (31.1 C in 1967)**
- **Pemberton 35.1 C (34.4 C in 1974)**
- **Whistler 31.8 C (31.1 C in 1996)**



# BC Climate: Best, moderate and business as usual



# A Changing Climate



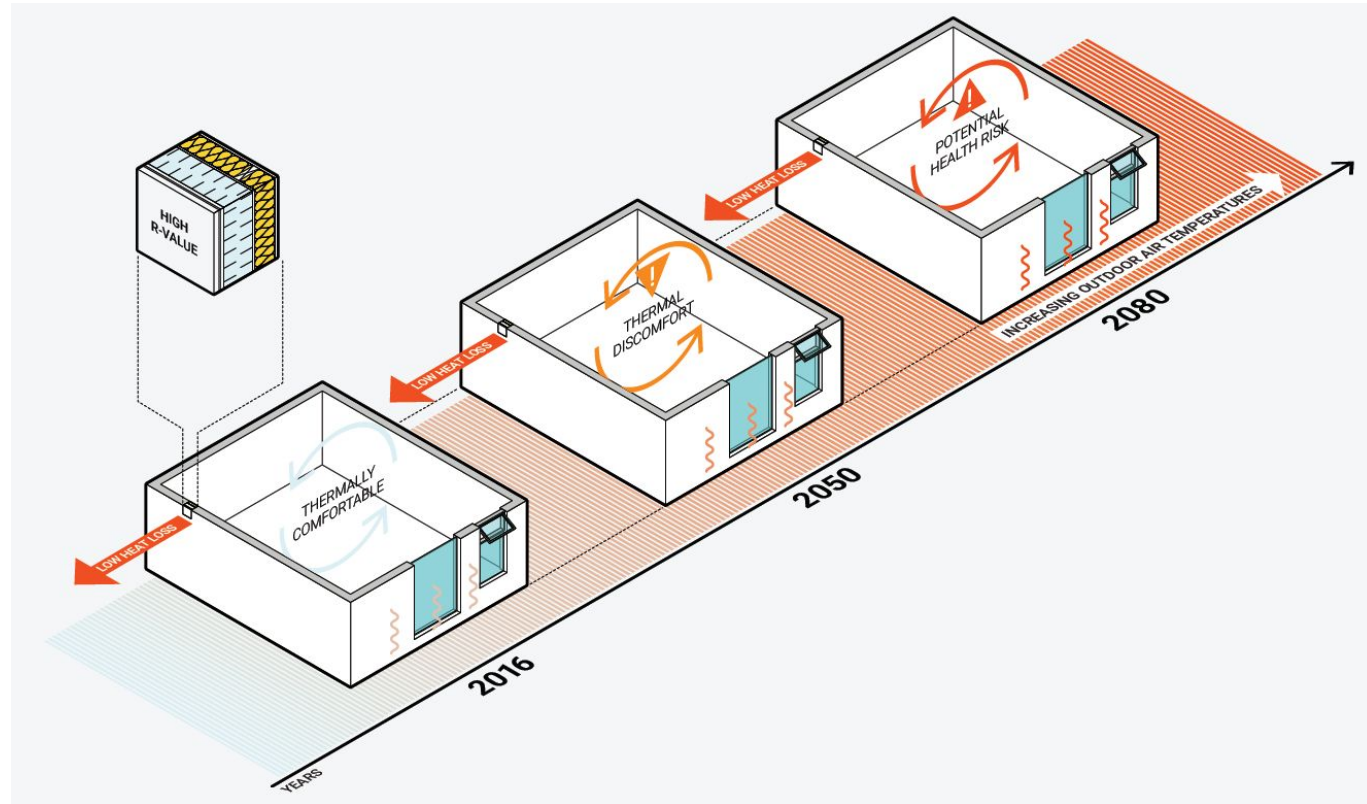
# Hotter climate, hotter buildings

Buildings designed in the past already unsuitable for today's climate

Impacts to **thermal comfort**

Risk of **overheating**

Potential **health risks**



# Retrofit Challenges: rebates and capital

- Mechanical cooling is an *added energy load*
  - Utility rebates for energy savings only
- Half of single-buildings societies have underfunded capital reserves (62% of the sector operating  $\frac{1}{4}$  of units)
- Most Non-Profit Housing built between 1970-2000





# *Retrofits for Overheating Buildings and Poor Indoor Air Quality*

Alex Chou, P.Eng., LEED AP  
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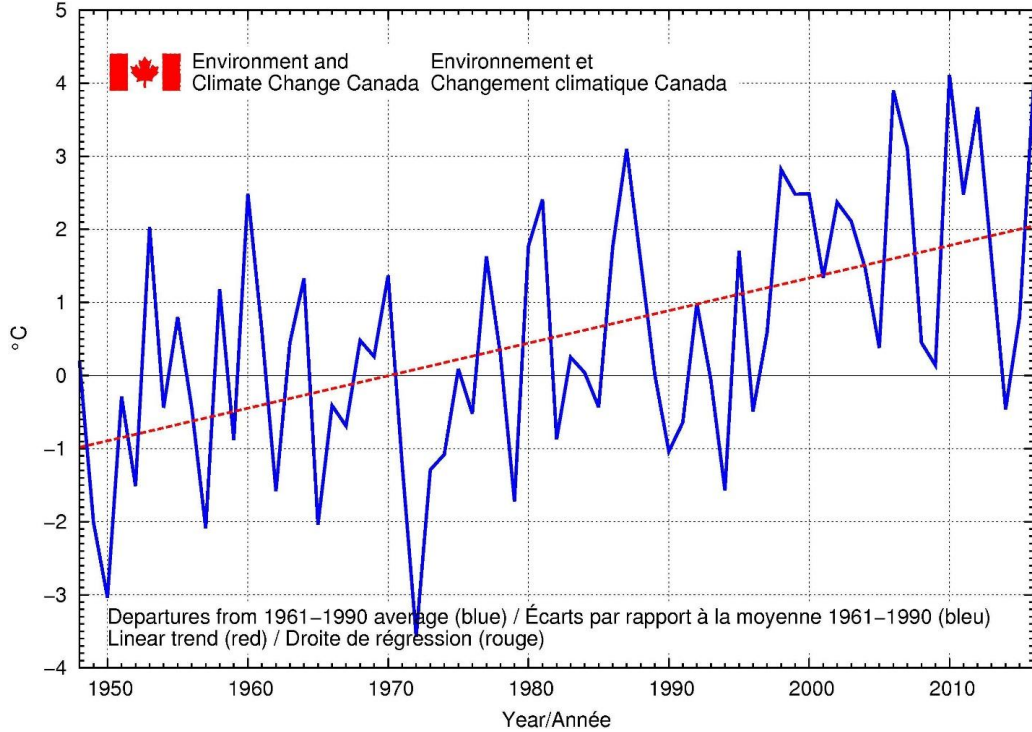
[alexchou@amegroup.ca](mailto:alexchou@amegroup.ca)

July 7, 2020



Why overheating?  
Why it is an issue now?

# Climate Change





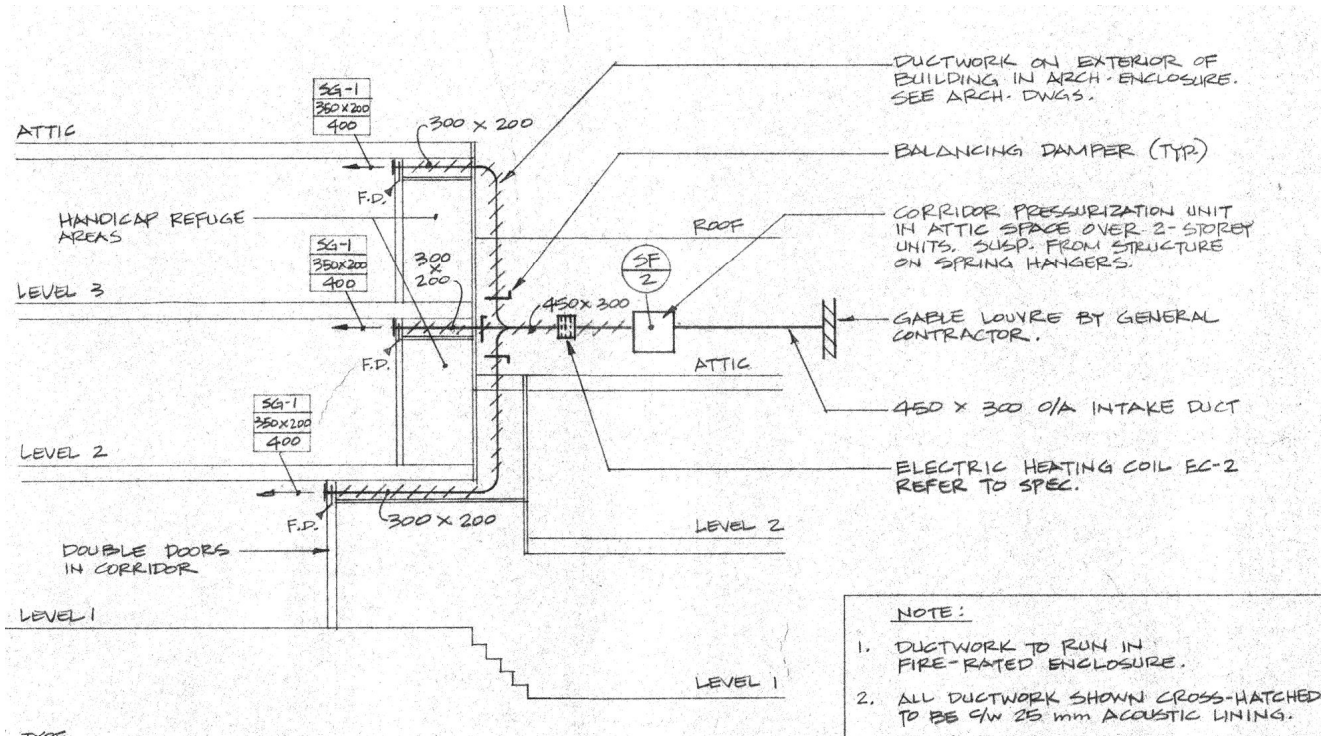


Where is the cooling in the building?

## Typical existing HVAC Systems:

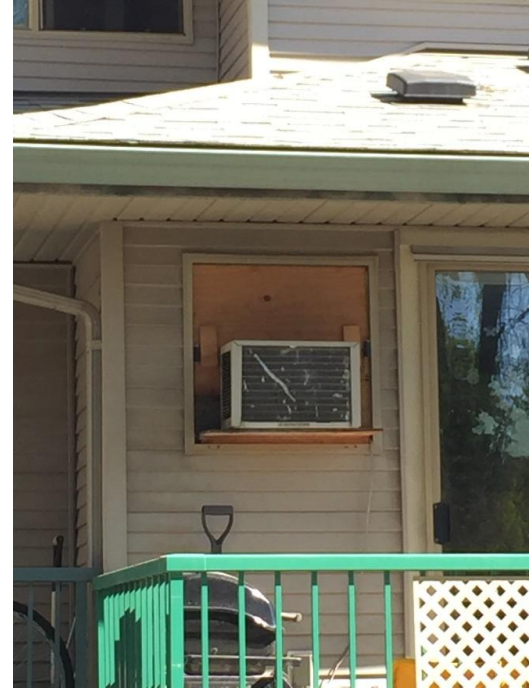
- Rooftop Make-Up Air Unit (heating only)
- Electric baseboard for heating only buildings
- Hydronic system
- Furnace
- Operable Windows











# What Options Are Available?

- 1) Packaged Terminal Air Conditioner (PTAC)
- 2) Refrigerant Based Systems
- 3) Hydronic Based Systems
- 4) Many other systems available







Every Building is Different. No single solution that will be right for all buildings.



The project team need to assess the existing building and review what **PRACTICAL** solutions to be implemented for the project.



Review the limitations

# Space Availability?

# Power Availability?

# Structural Capability?

# New Equipment, New Potential Restrictions

# Typical existing Ventilation Systems in Residential Buildings:

- Rooftop Make-Up Air Unit
- Rooftop Heat Recovery Ventilators
- Duct terminating in closets or behind fridges
- Washroom exhaust fans on time clock or operating 24/7
- Natural ventilation
  - With operable windows





THANK-YOU!

# Overheating in Ontario's Social Housing Buildings: Challenges and potential strategies



Civil Engineering  
UNIVERSITY OF TORONTO

May 26<sup>th</sup> 2020  
Marianne Touchie



Mechanical & Industrial Engineering  
UNIVERSITY OF TORONTO

Image Credit: University of Toronto



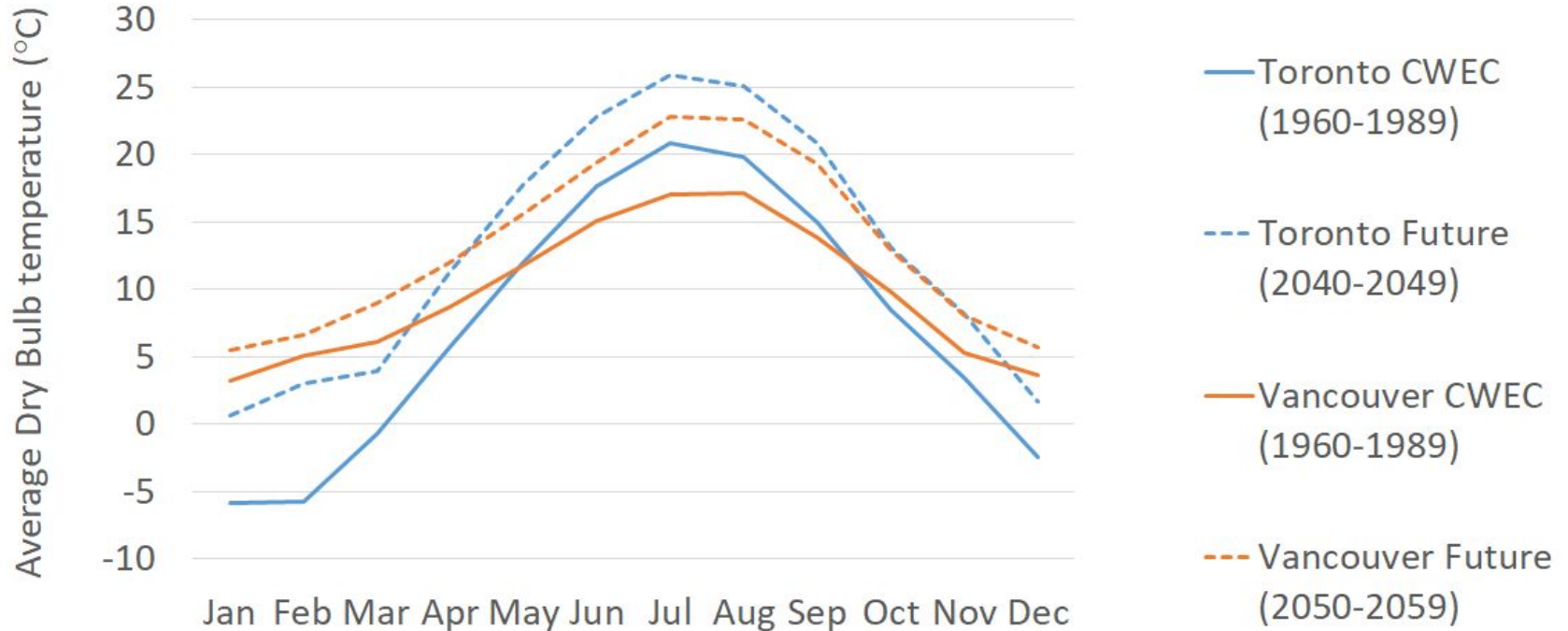
# Outline

- Summertime in Ontario
- Characteristics of our social housing MURBs
- Field study of summertime conditions and retrofits
- Modeling study of potential retrofits
- Where to from here



Image Credit: University of Toronto

# Average temperatures





# Social housing MURBs in Ontario





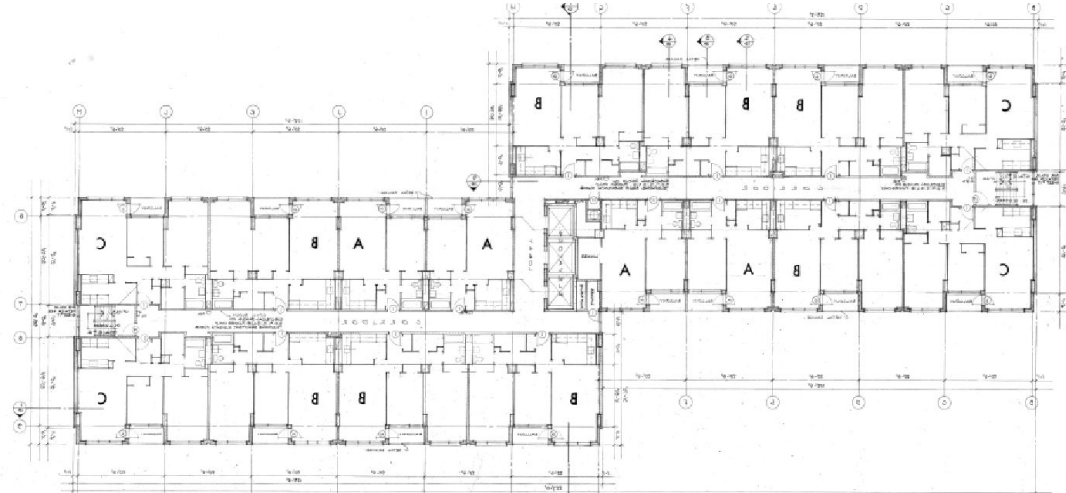
# Features that contribute to overheating

## Architectural

- Little to no solar shading
- Limited window operation
- Thermally massive structure
- Double-loaded corridor
- Often long narrow buildings

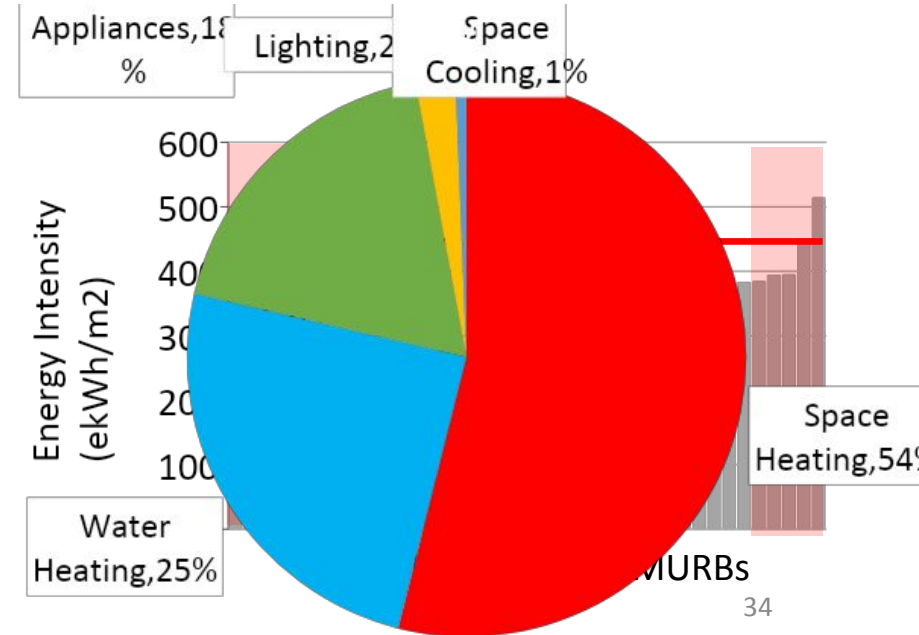
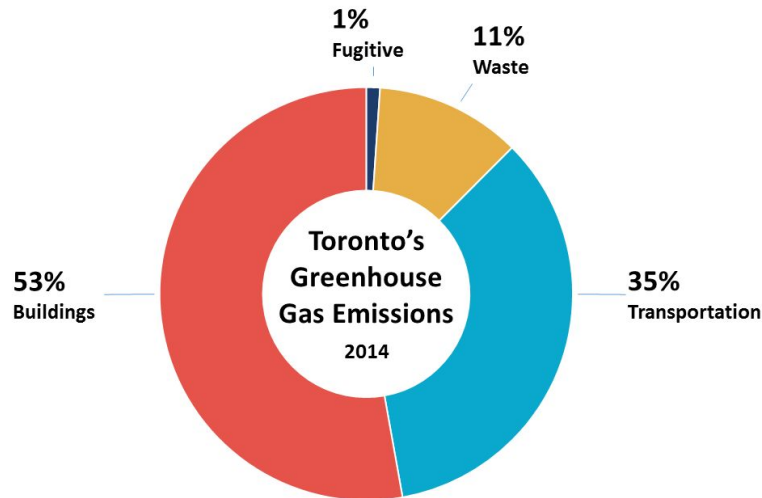
## Mechanical

- No central cooling
- No ceiling fans
- Pressurized corridor ventilation



# Typical Energy use Ontario MURBs

- High variability between buildings
- Mostly space heating energy use
- Almost no cooling energy use



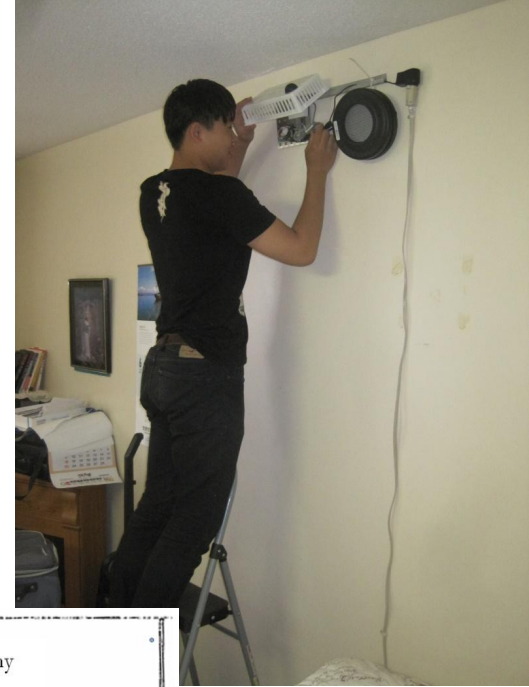
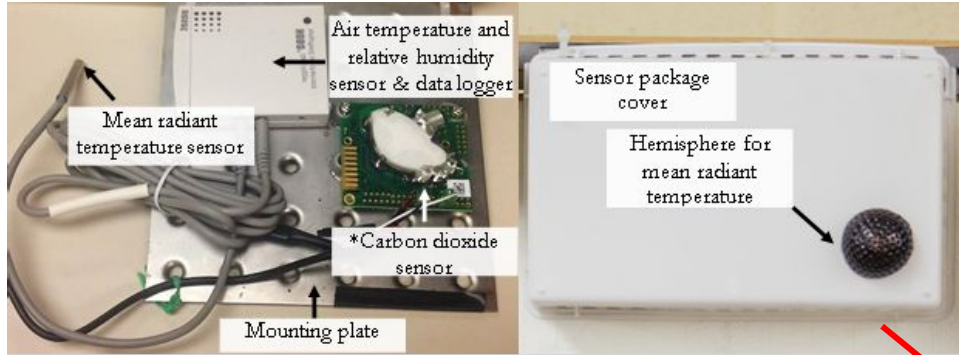
# Field study on IEQ in social housing

- Seven building undergoing energy retrofits

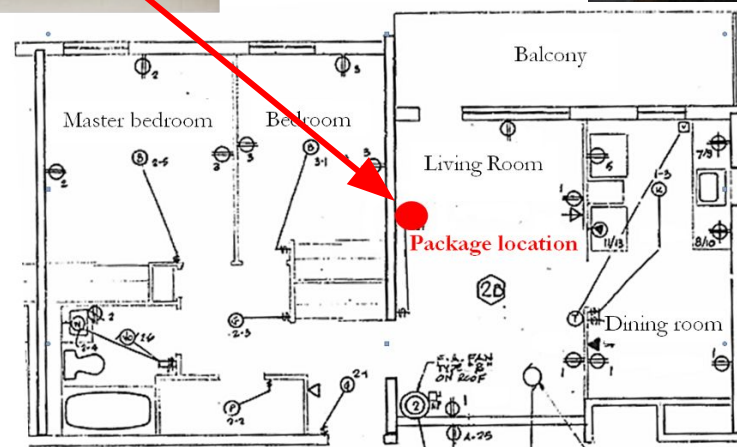
Site	Buildings	Height	# of suites	Occupant type
1	A,B	4 storeys	397	Senior
2	C,D,E	7-11 storeys	471	Bachelor
3	F,G	18-19 storeys	369	Family



# What we measured...



... in 70 suites  
for 3 years



# Resident Surveys – 180 respondents

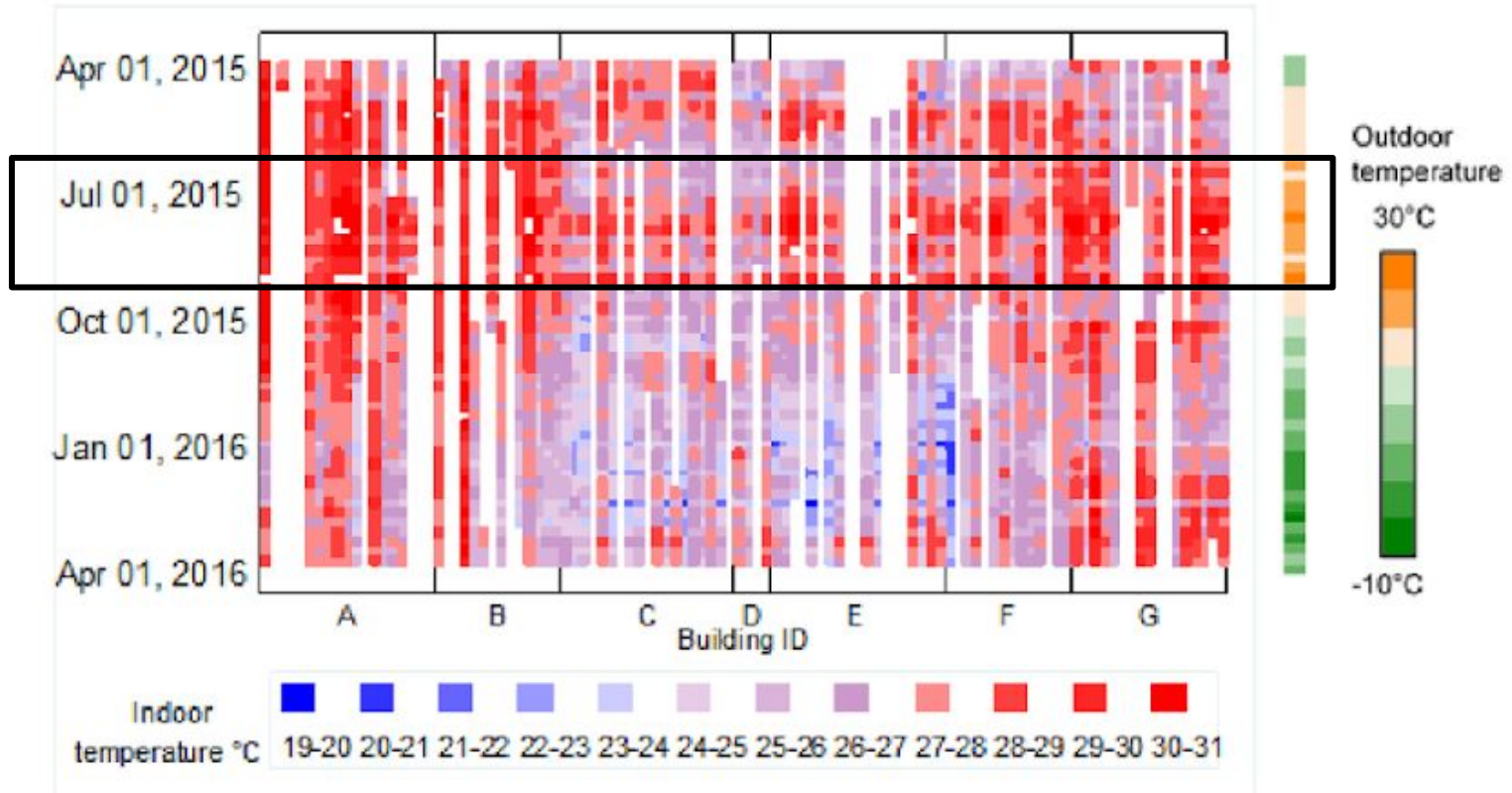
- Demographics
- Perceived comfort in summer and winter
- Behavior in suite



Image Sources: [http://ecx.images-amazon.com/images/I/51FN9837TFL.\\_SL500\\_AA280\\_.jpg](http://ecx.images-amazon.com/images/I/51FN9837TFL._SL500_AA280_.jpg),  
[https://cdn-image.realsimple.com/sites/default/files/styles/rs\\_main\\_image/public/1469163958/retro-table-top-fan.jpg?itok=s0XINRyk](https://cdn-image.realsimple.com/sites/default/files/styles/rs_main_image/public/1469163958/retro-table-top-fan.jpg?itok=s0XINRyk)  
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# Indoor temperatures

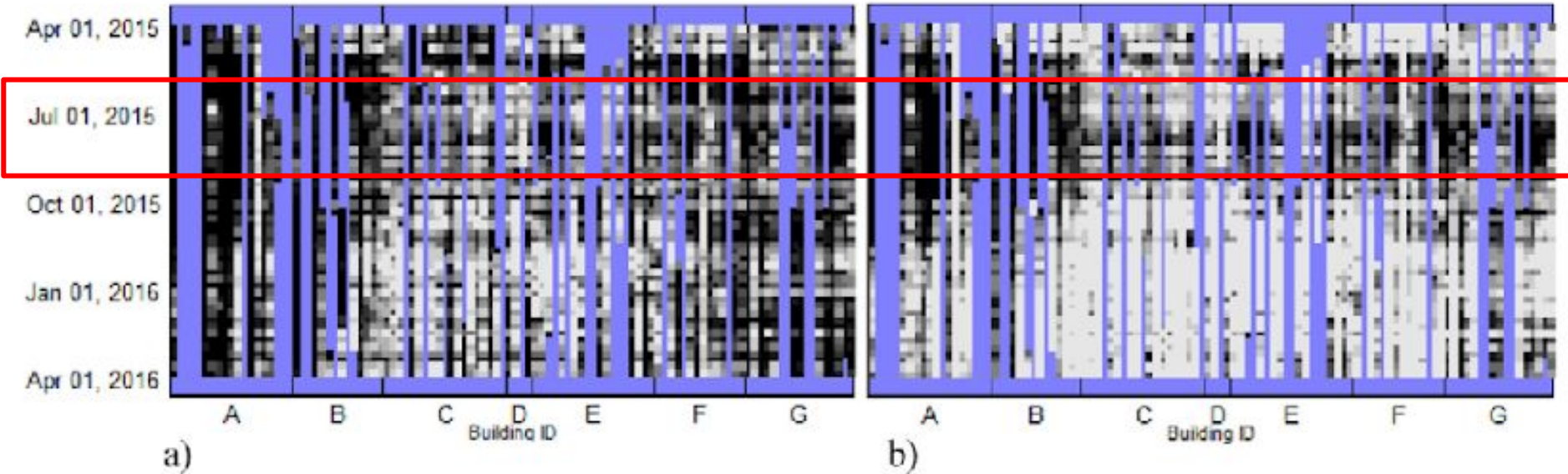




# Occupant Comfort

Fixed Clo level

Variable Clo level

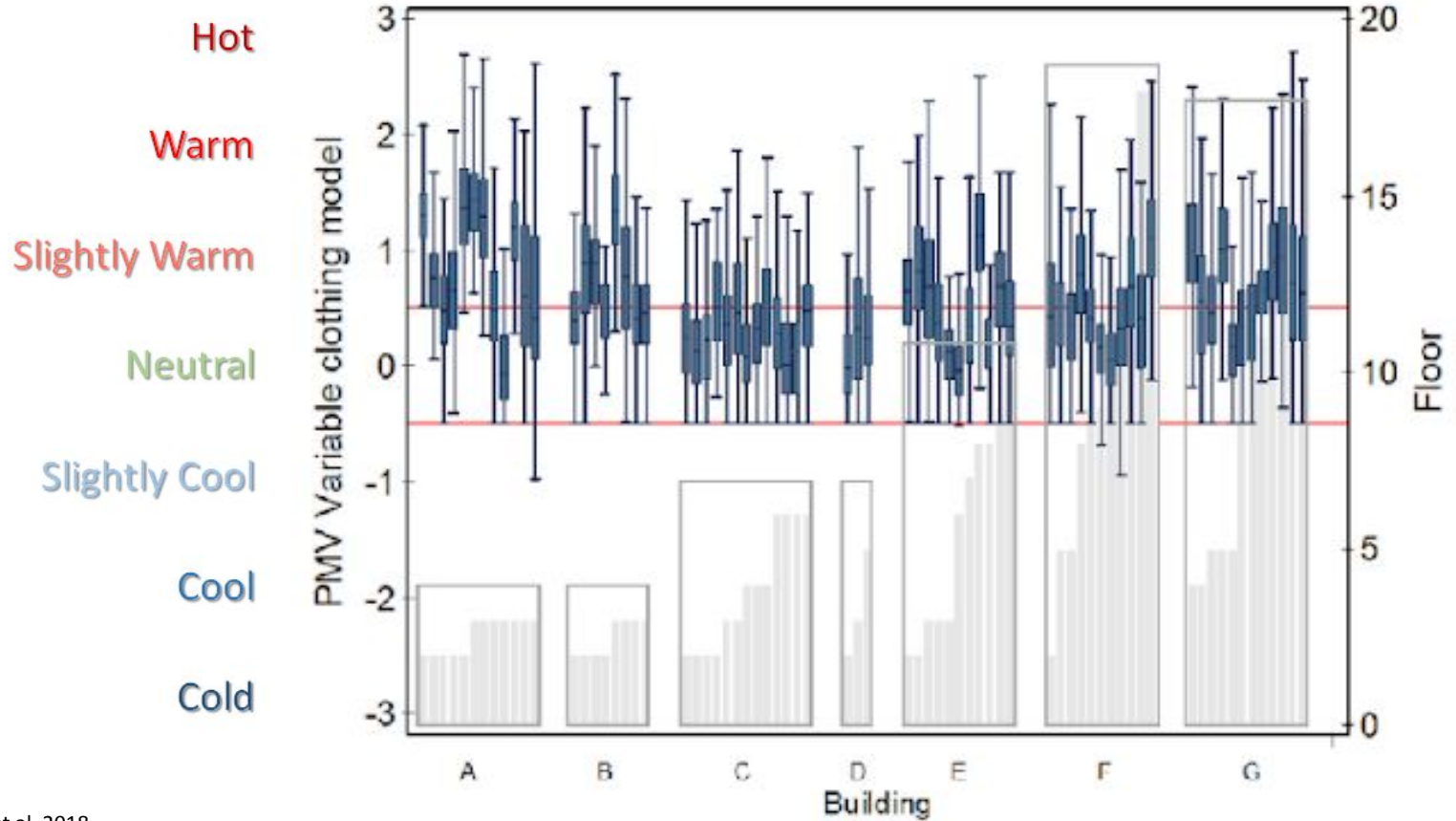


(%) of time  
spent  
comfortable

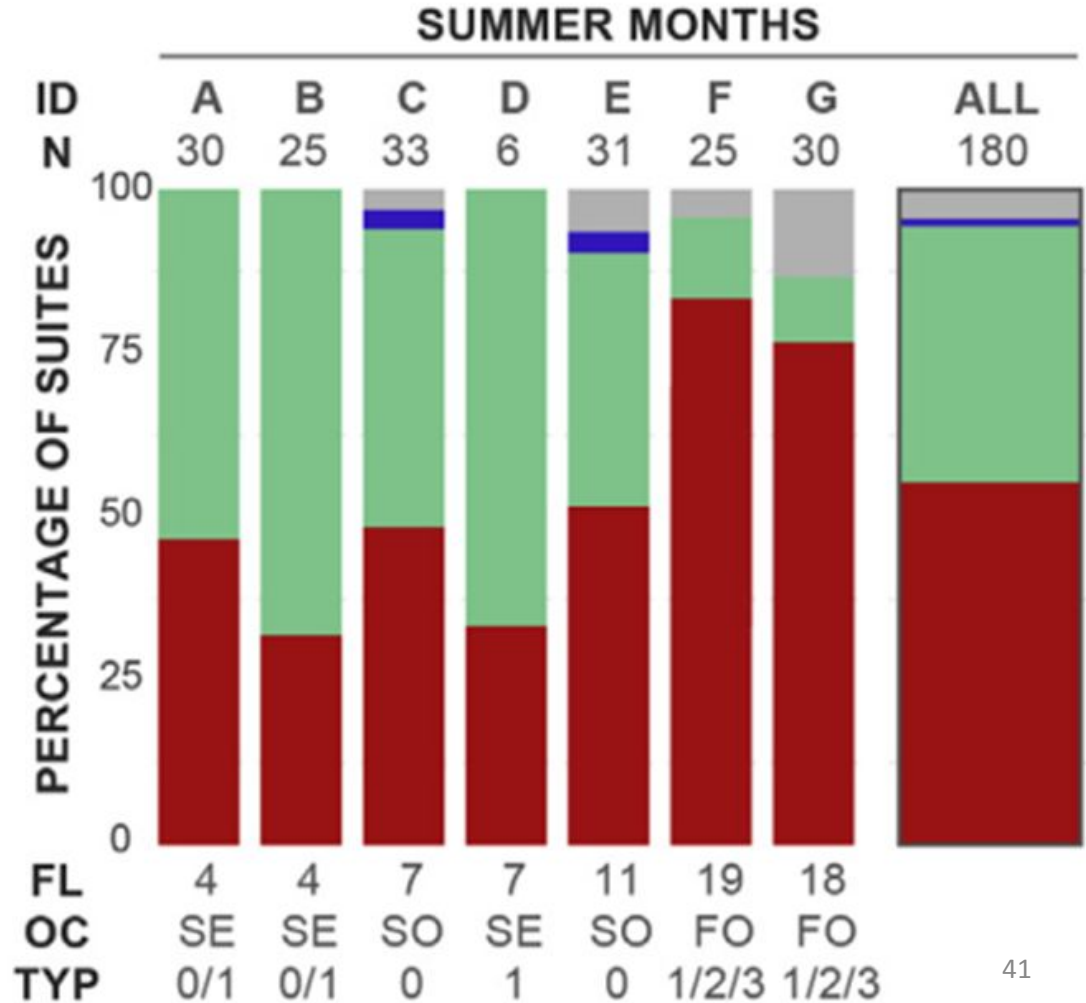


# PMV in Summer

July 2015



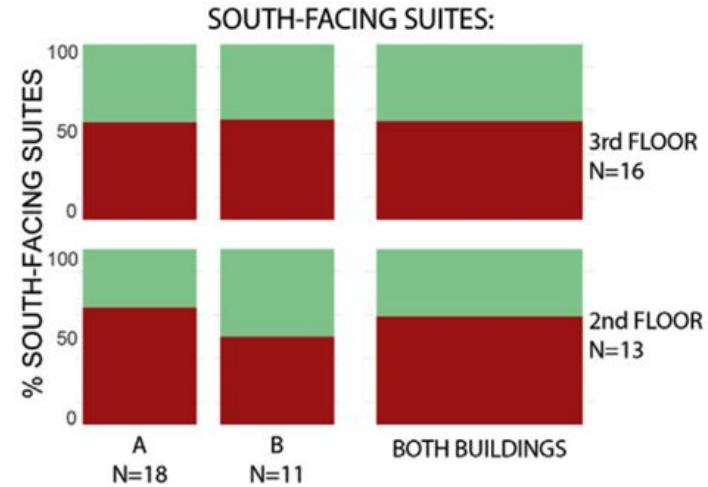
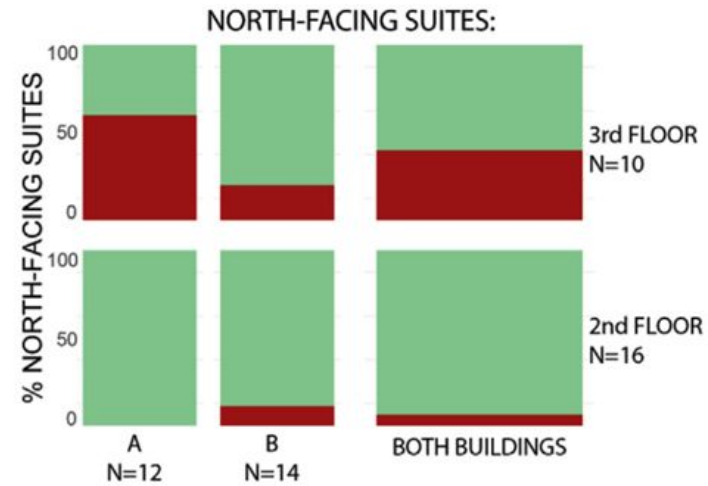
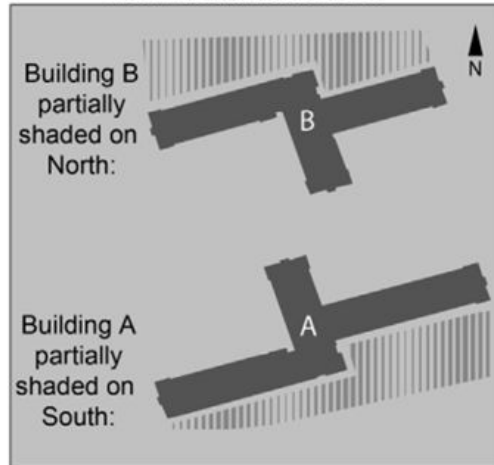
# Reported thermal comfort



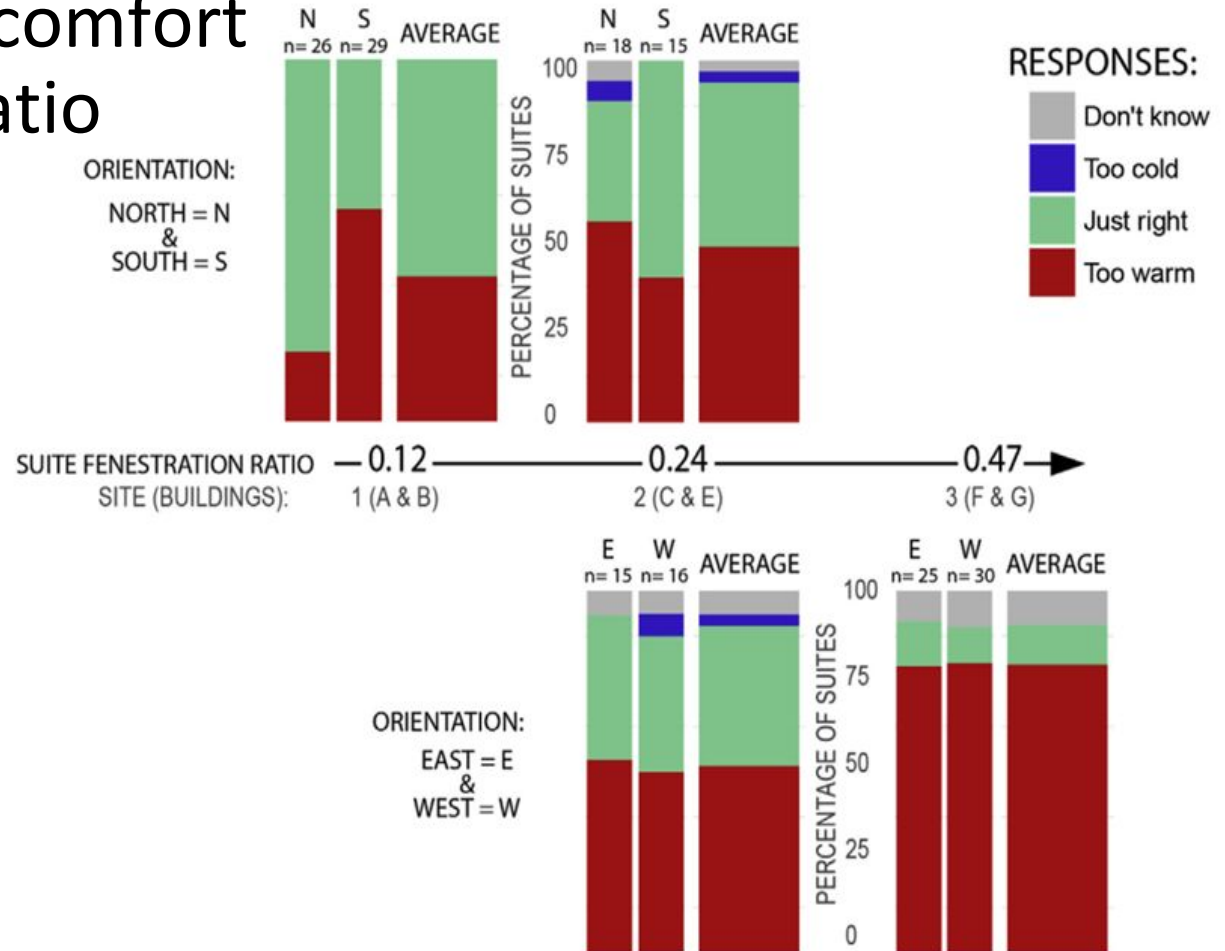
# Reported thermal comfort and orientation



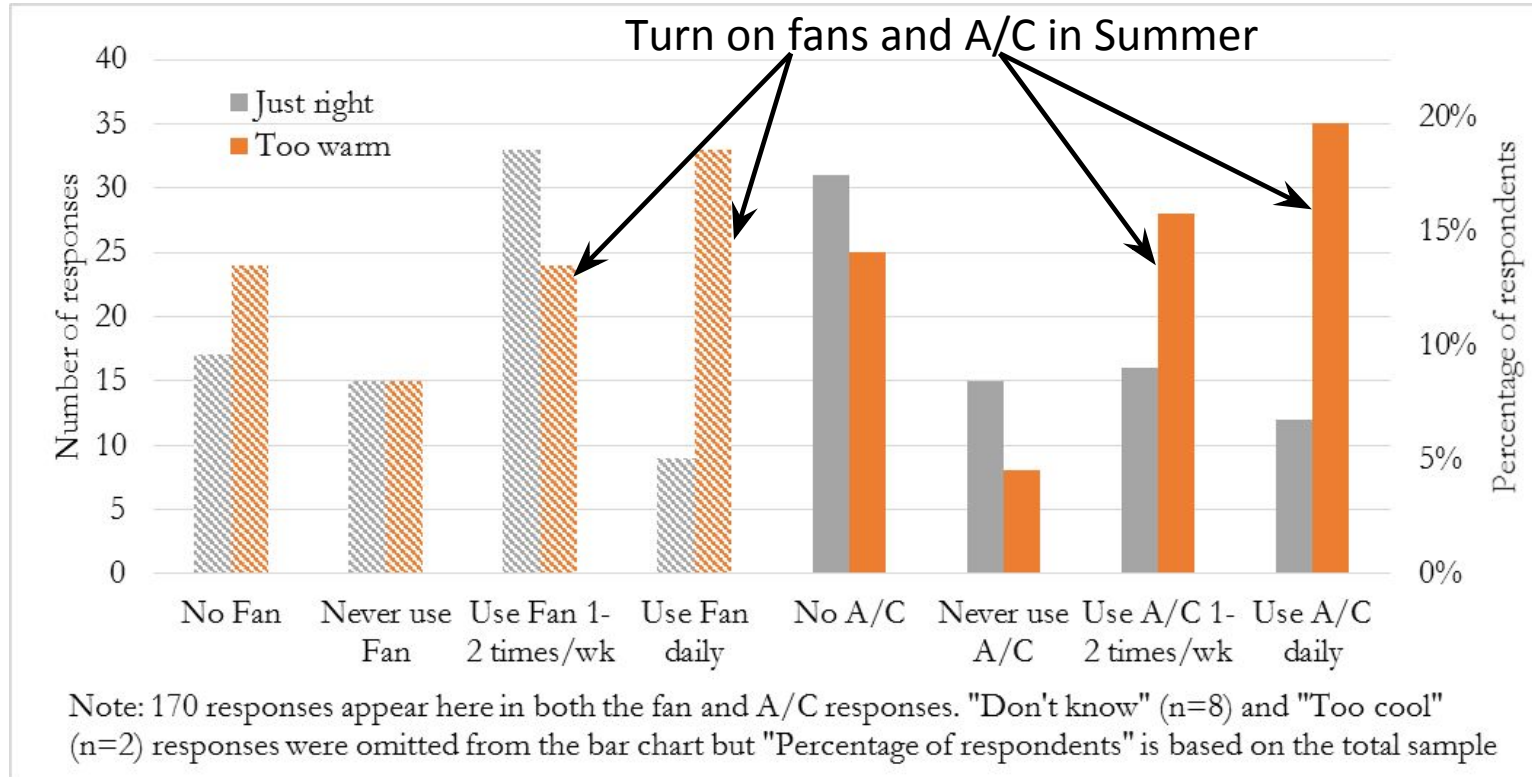
Site 1 map of summer partial shading from deciduous trees



# Reported thermal comfort and fenestration ratio



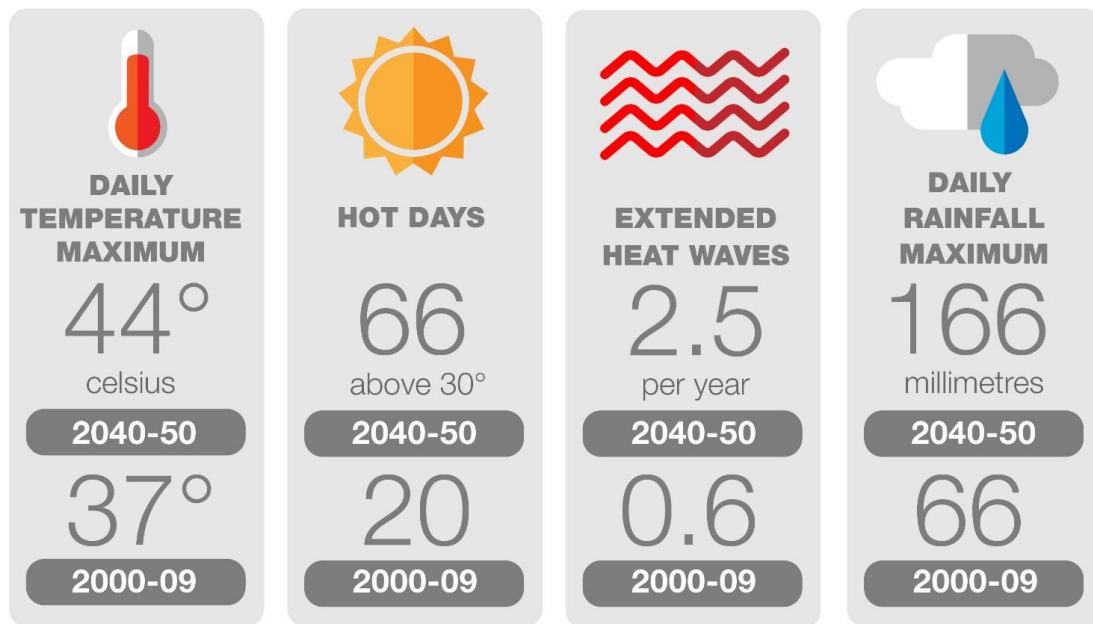
# How do residents cope?





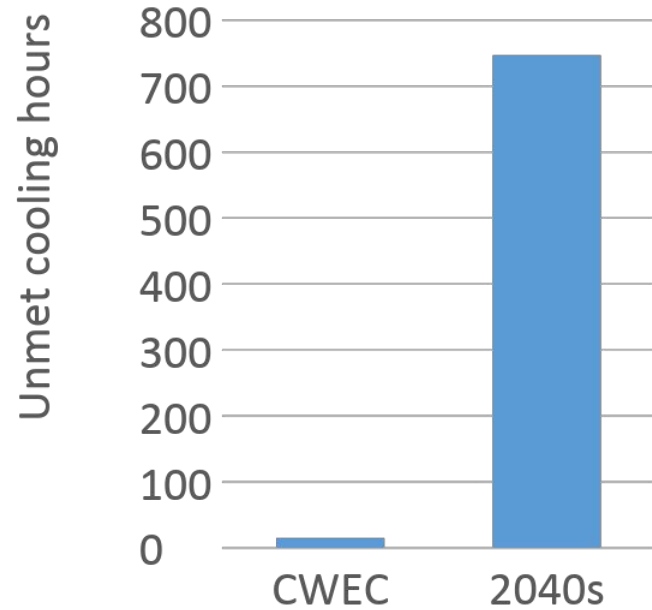
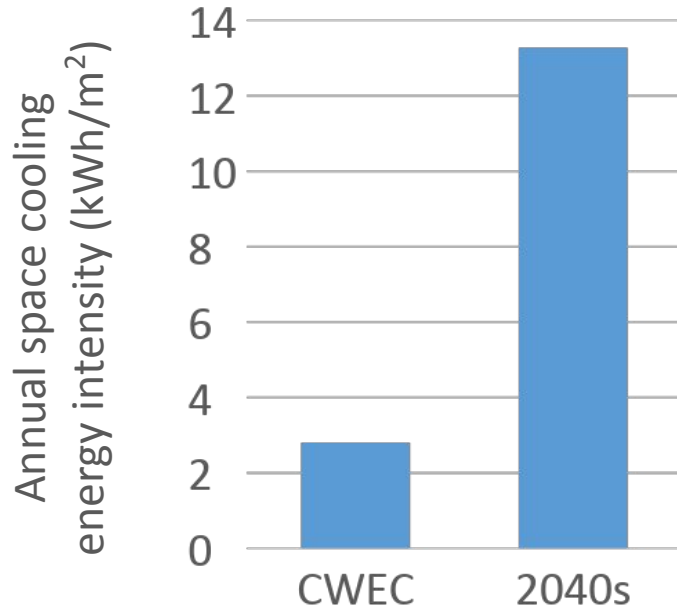
# Increasing threat of overheating

## Toronto's **Future Weather**\*

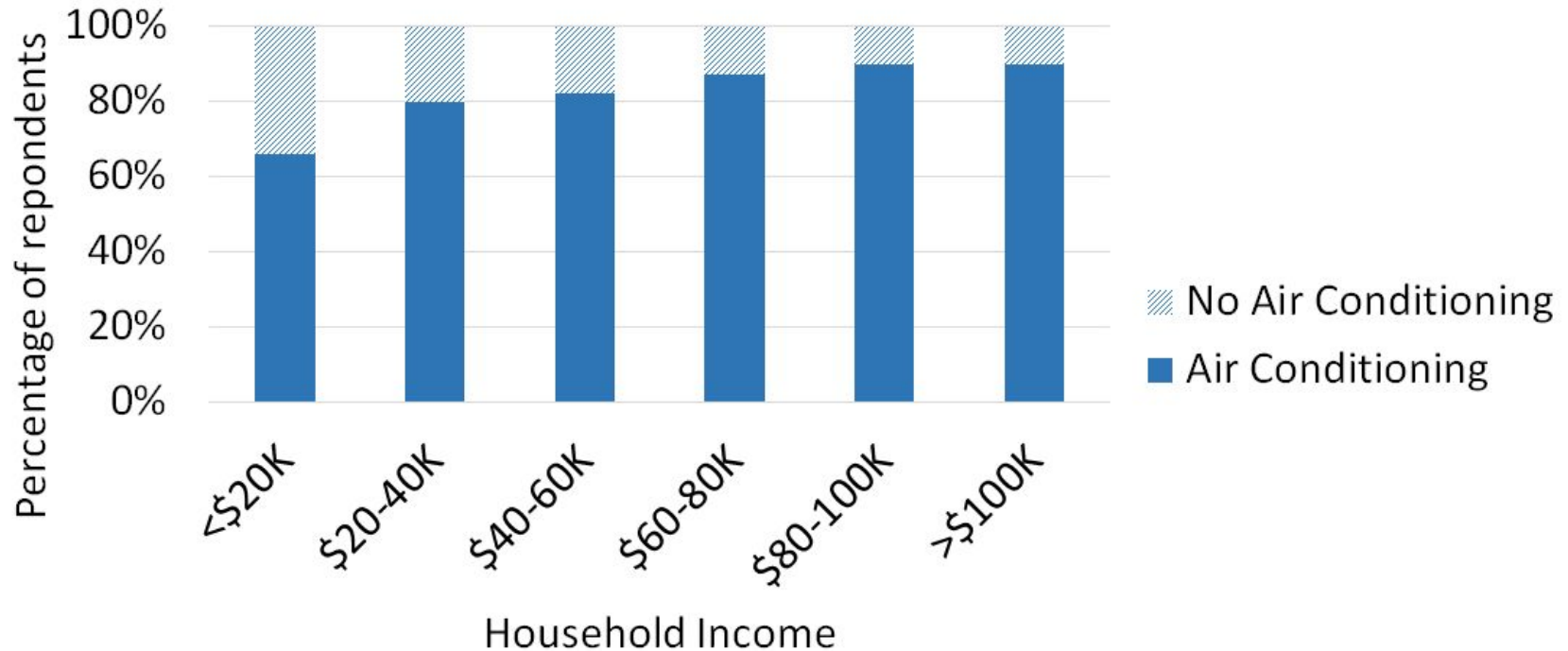


\*Source: Toronto's Future Weather and Climate Driver Study, 2011

# Impact on buildings



# Social housing will be significantly impacted



# Is there a better way?



# Reducing overheating in buildings

- Promote natural ventilation
  - Install grates to prevent falls, allowing window to open fully
  - Replace windows with those that open high up
- Limit solar gains
  - Interior/exterior blinds or shades
  - Window films
- Provide refuge
  - cooling centres
  - shaded green spaces
- Add cooling to corridor air

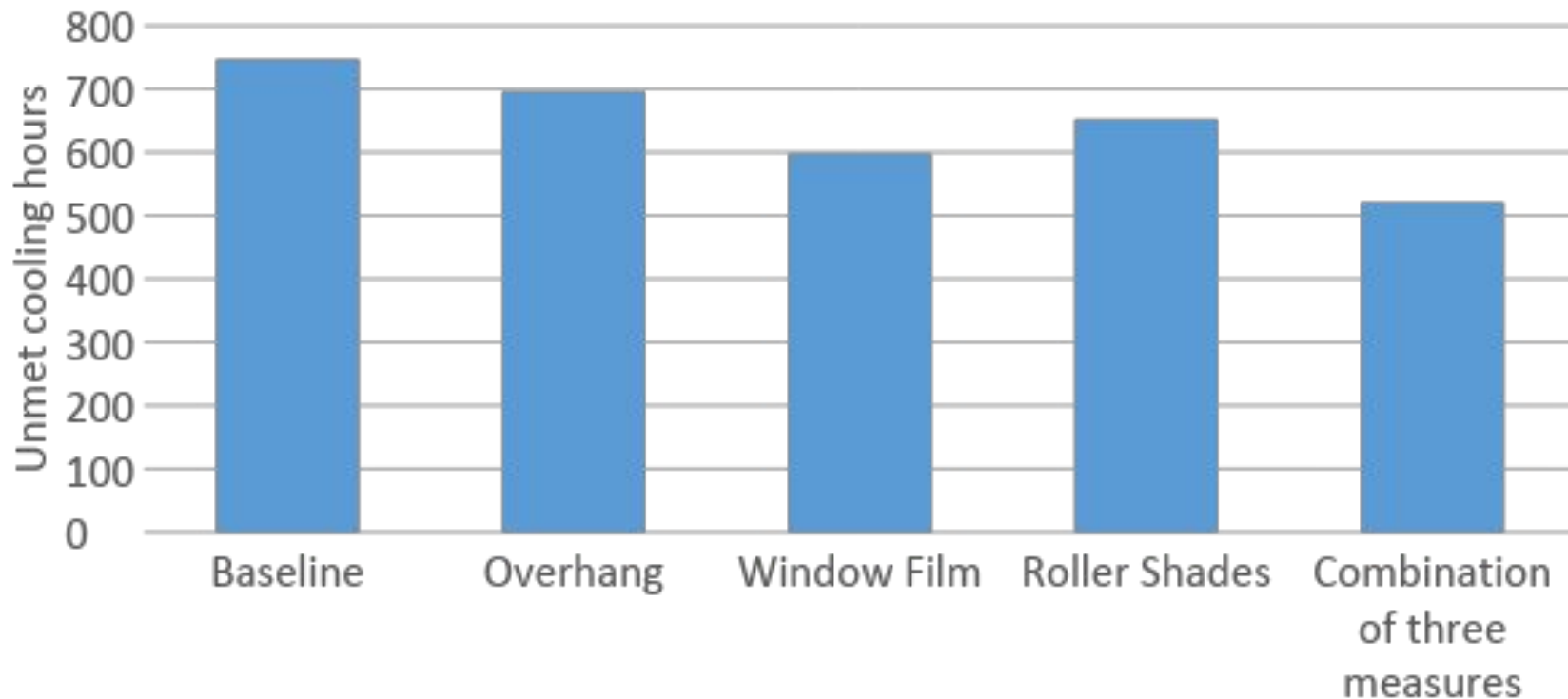


Source: based on discussion at the Extreme Heat in MURBs Roundtable

Image sources: <http://www.onestepahead.com/Health-and-Safety/Guards-and-Protectors/guardian-angel-window-guard-extra-small.pro?fpi=114924&catCd=2I&prefixCode=2I> 49

<http://www.advancedwindow.com/hopper.html>; <http://www.balconyblinds.com/>

# Modeling study on passive features

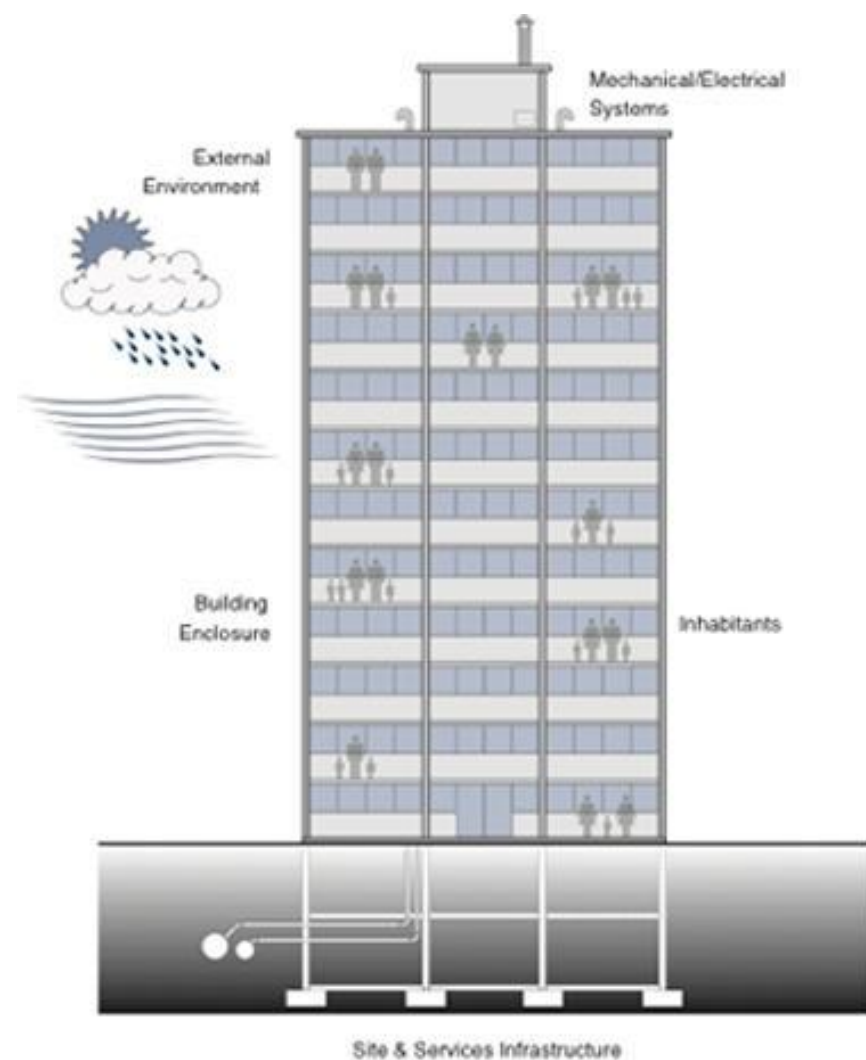




# Other considerations for social housing in retrofits

## “Building as a system”:

- First, address ventilation
- Then, overcladding/window replacement + in-suite heating control
- Finally, boiler replacement (smaller, modular)



# Key Take-aways

- MURB overheating is a growing concern
- Passive measures should be incorporated into retrofits
- Active cooling is likely still required





# Acknowledgements

Thank you to:

- The Atmospheric Fund for providing access to the data used in the studies referenced here
- Natural Resources Canada, the Federation of Canadian Municipalities, Enbridge Gas Distribution, and The Atmospheric Fund for financing of the survey data collection and monitoring program
- the social housing provider, residents and building managers for their cooperation in this study
- Professor Jeffrey Siegel and his team for their assistance with field monitoring

Questions? [marianne.touchie@utoronto.ca](mailto:marianne.touchie@utoronto.ca) or visit [beie.mie.utoronto.ca](http://beie.mie.utoronto.ca)



UNIVERSITY OF  
TORONTO



**NSERC**  
**CRSNG**

# BC Housing Existing Buildings MBAR Pilot Projects

Copper Mountain and  
Campbell Lodge  
Projects

July 7, 2020



**MOBILIZING  
BUILDING ADAPTATION  
AND RESILIENCE**

# MBAR Objectives



Build capacity by **piloting** integrated adaptive and resilient design solutions into building design and renovation projects at the building and neighborhood levels.



Create a training curriculum that is informed by **real-life application** experience based on pilot projects.



Gradually and systematically increase the number of **practitioners** who are aware, informed, educated and experienced.



Experienced practitioners to become **peer trainers**.

# Identified Risks

- Heat waves and overheating
- Wildfires and indoor air quality
- Power outages and emergencies
- Seismic events
- Severe storms, urban flooding, and sea level rise
- Chronic Stressors (e.g. premature & accelerated deterioration of building materials, moisture leading to mould and IAQ issues)
- Social Vulnerability



# Reviewed

- Provincial Priority List for high priority project with potential scope overlap
- Active Project list for projects with potential scope overlap
- Focused on projects with budget capacity and broad enough scope to absorb MBAR recommendations
- Narrowed down to projects that were in early stages (initiation/design development)
- 5 Projects selected for final review by MBAR team
- 2 projects incorporating scope

# Reviewed

- Project Drawings (Architectural, Electrical, Mechanical, Structural)
- Capital Projects Assessment (BE and Drainage)
- Building Condition Assessment Notes
- Historical Prevalence of Hazards
- Future Climate Predictions based on location
- BC Housing Climate Hazard Primers

# Projects

## Copper Mountain

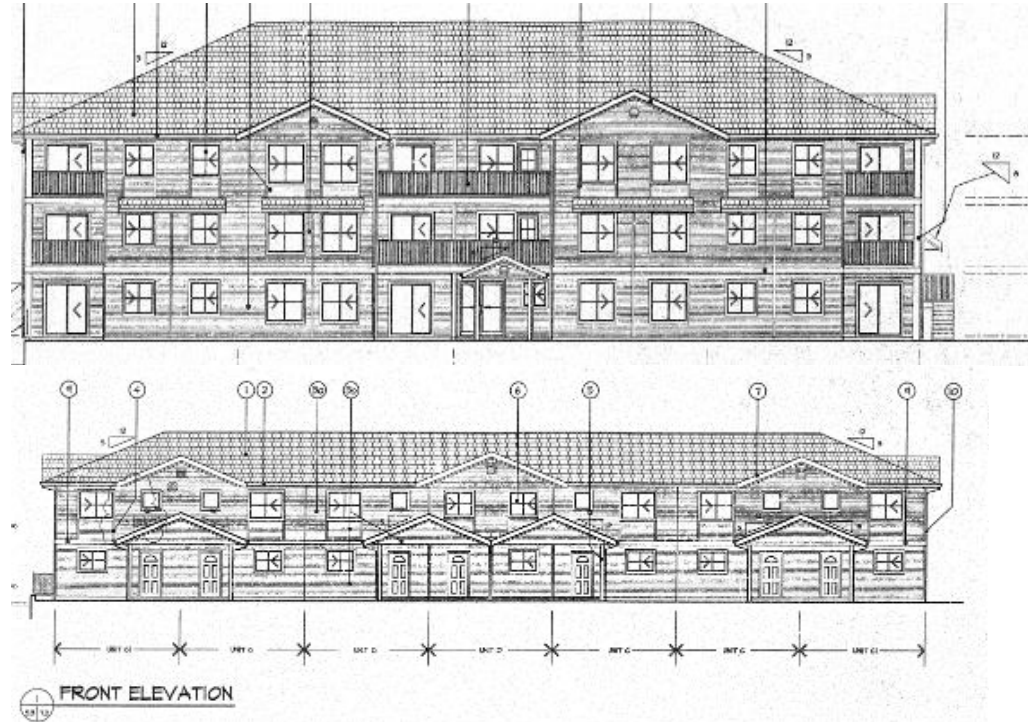
- Nelson, BC
- Retrofits to address drainage problems

## Campbell Lodge

- Victoria BC
- Retrofits to address building envelope deficiencies, structural + mechanical assessments



# COPPER MOUNTAIN



# COPPER MOUNTAIN

## Hazards

- Urban Flooding
- Wildfire
- Air Quality
- Heat Waves/Overheating

# COPPER MOUNTAIN

## Recommendations

- Transform amenity room in apartment building into a cool and clean air refuge space for tenant use.
- Rebuild or replace MUAs, include larger filters or increase filter capacity for MERV 13 and charcoal filters
- Replace Heat Pumps with better sized pumps
- Get specialist in to fix operational issues with the parkade exhaust fan – lots of energy loss
- Approach the city and request the creation of an adequate fire break on the west edge of the property
- Create an outside shaded area for tenants to use

What Happened?

# CAMPBELL LODGE



# CAMPBELL LODGE

## Hazards

- Overheating/Heat Waves
- Seismic Events
- Air Quality

## CAMPBELL LODGE

### Recommendations

- Create a cooling/clean air room in on the ground floor in the common lounge
- Reinforce common room to act as post-disaster shelter
- Ensure that the new building envelope construction has a drainage cavity
- Install reflective glazing on south facing windows to reduce solar heat gain
- Install an operable shade on south windows
- Create a shaded outdoor area for tenants over concrete outside area with a high albedo roof that directs sunlight away from building



What Happened?



HP Unit Inside



Exterior Vents for HP Unit

# MBAR Resources

available at [www.BCHousing.org/mbar](http://www.BCHousing.org/mbar)

1. Design Discussion Primers  
(Heatwaves, Air Quality, Wildfires and others)
2. Overheating Design Guide.  
(Supplement to BC Energy Step Code Guide).
3. More soon!







# Questions?



**BC HOUSING**



**BCNPHA**

BC Non-Profit Housing Association





Thank you for attending  
Contact: [energy@bcnpha.ca](mailto:energy@bcnpha.ca)



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