UNIVERSITY OF TORONTO | Building Energy and Indoor Environment (BEIE) Lab

Improving Thermal Comfort in Mumbai Through Wind Catchers and Solar Chimneys

15th Canadian Conference on Building Science and Technology

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Outline

Introduction → Methodology → Results

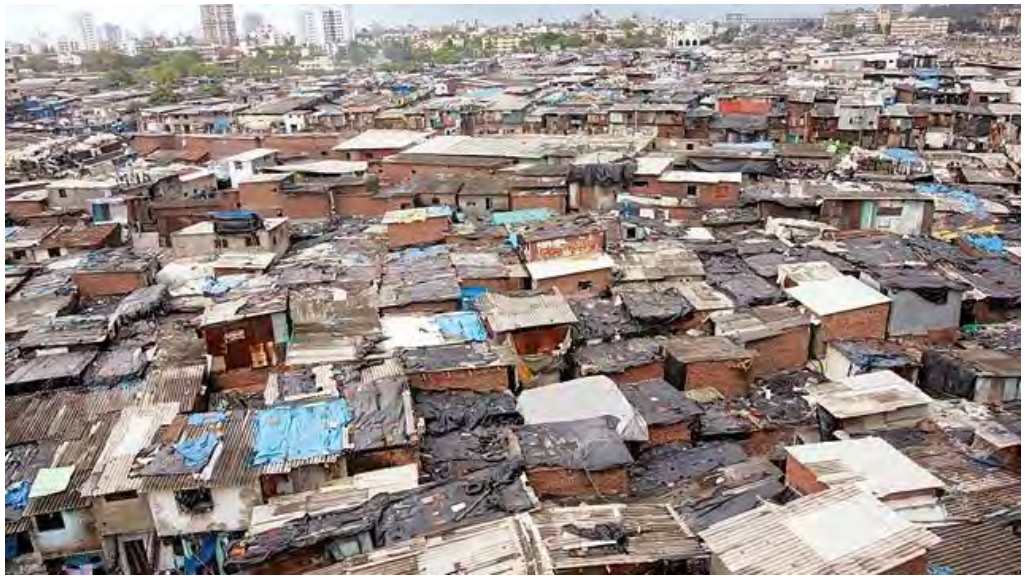
Slum Rehabilitation Redevelopment Project

- Relocate slum residents into new multi-unit residential buildings
- IGUS: redesigning structural and indoor environmental quality of new developments
- Goal: improve thermal comfort

Slum Neighbourhoods

5 Characteristics Defined by UN Habitat (2007):

- Inadequate access to safe water
- Inadequate access to sanitation and infrastructure
- Poor structural quality
- Overcrowding
- Insecure housing status



(Shaikh, 2016)

The Need For Passive Technologies

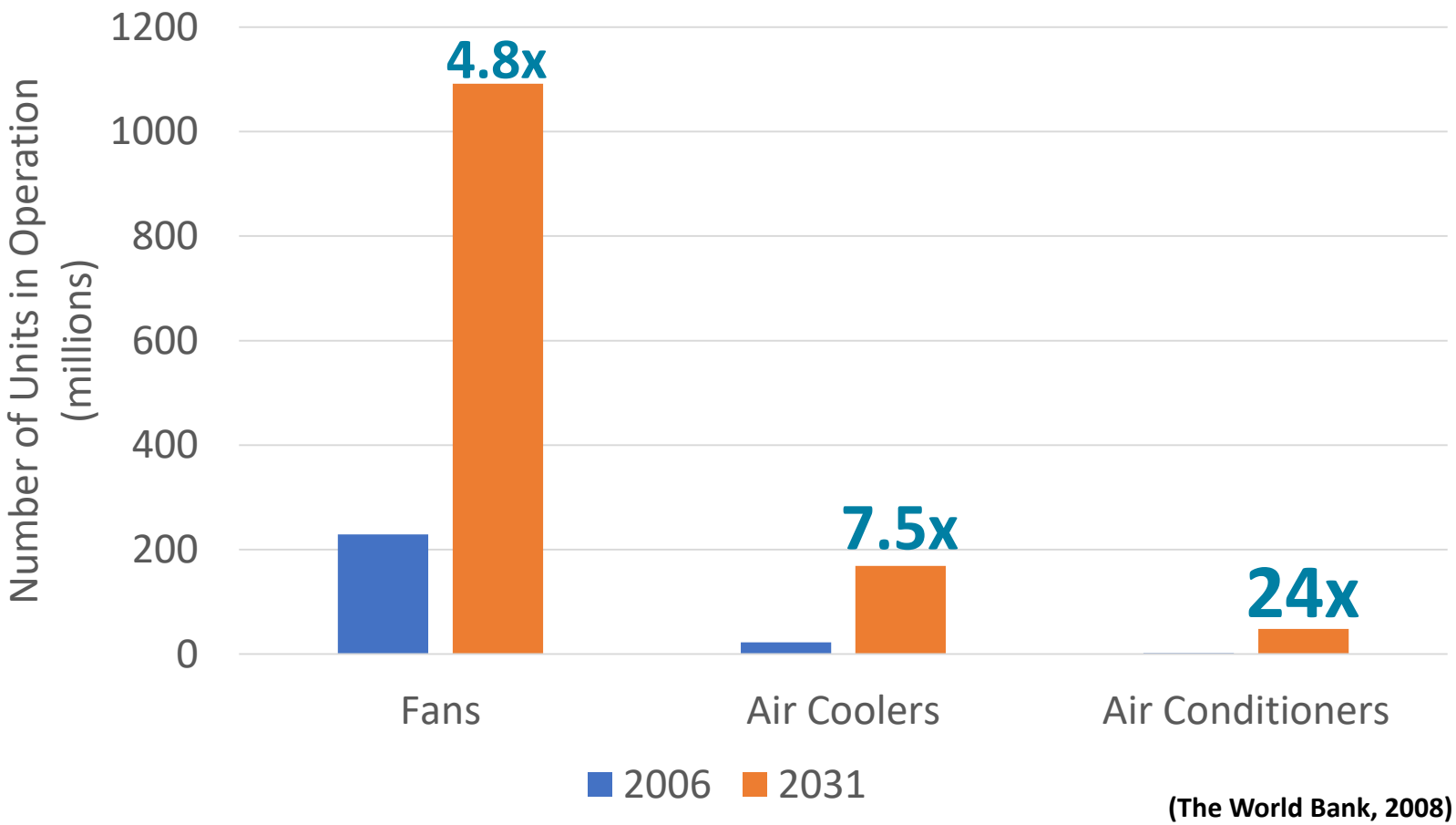
- **Electricity in slum neighborhoods are:**
  - Unreliable
  - Expensive
- **Require substantial investments in future grid networks to meet growing electricity demands**

The Need For Passive Technologies

	Urban	Slum
Percentage of Indian Residential Households with Electricity	95%	63%
Reliability of the Electric Grid	19 hrs per day	13.7 hrs per day

(Aklin, Bayer, Harish, & Urpelainen, 2015)

Cooling Demand Projection For Space Cooling

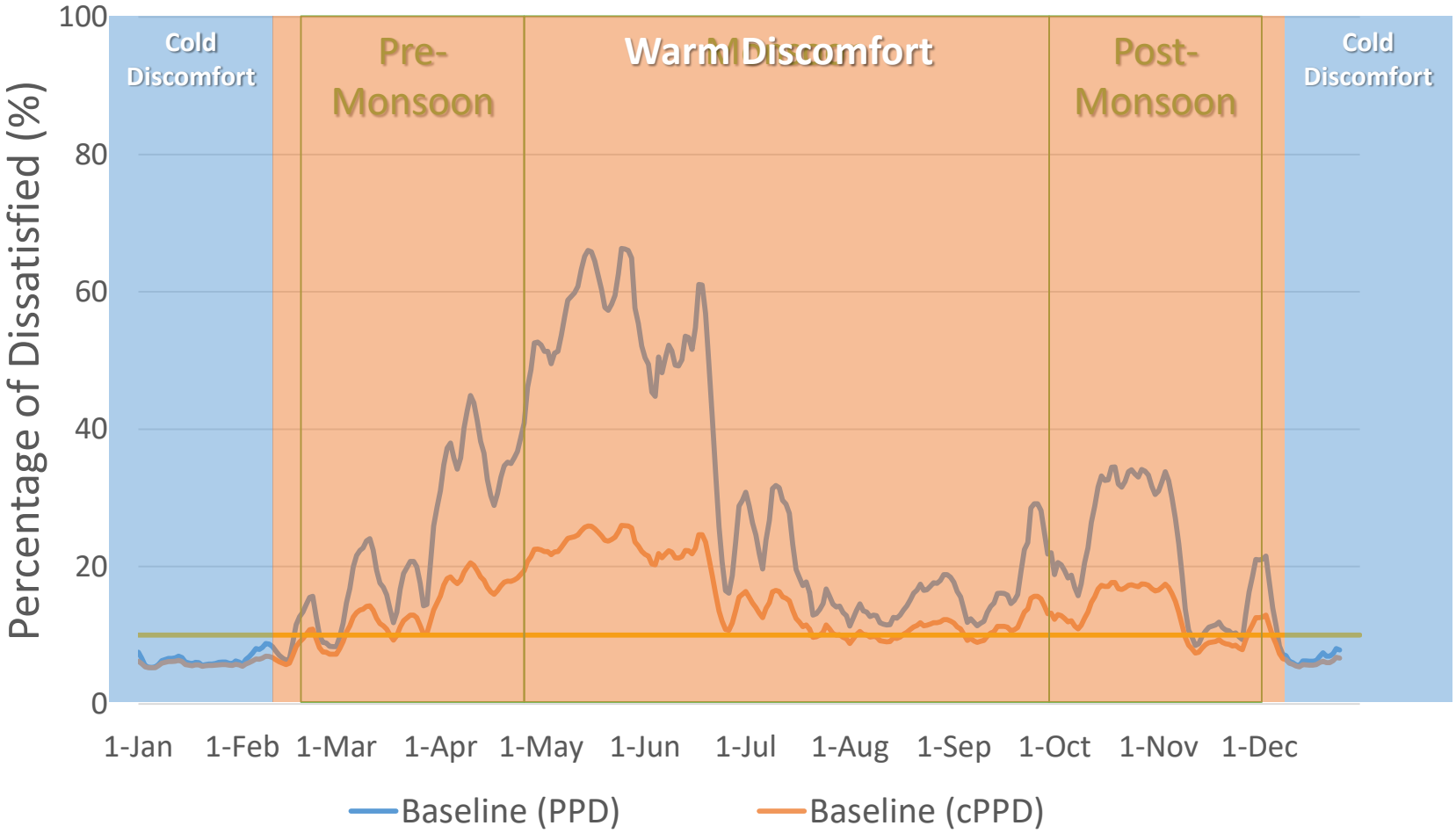


(The World Bank, 2008)

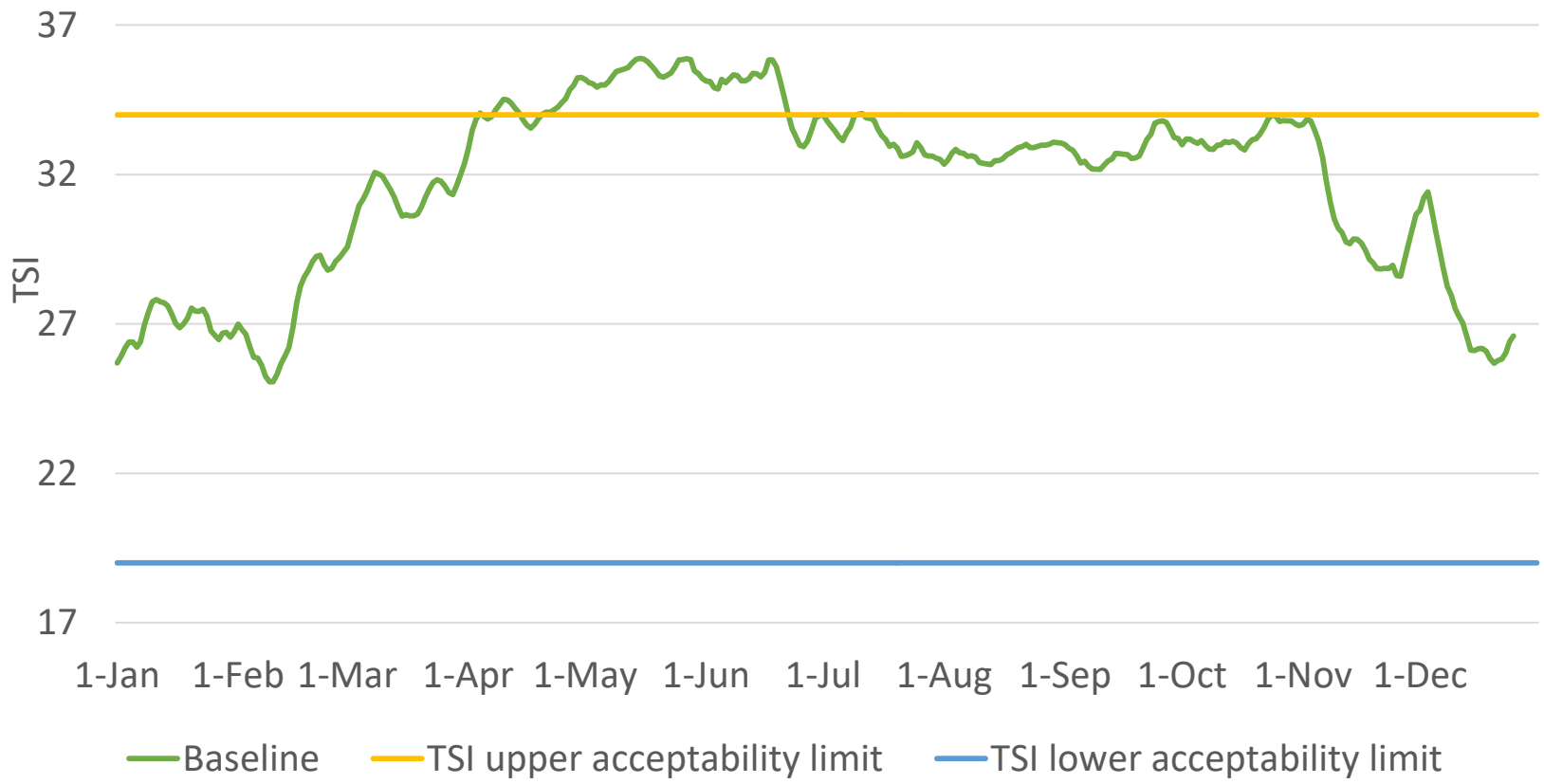
Thermal Comfort Models

- **3 Models:**
  - Predicted Mean Vote (PMV) and Predicted Percentage of Dissatisfied (PPD)
    - ASHRAE
  - Corrected PMV (cPMV)
    - Signh et al. (2011)
  - Tropical Summer Index (TSI)
    - India's National Building Code

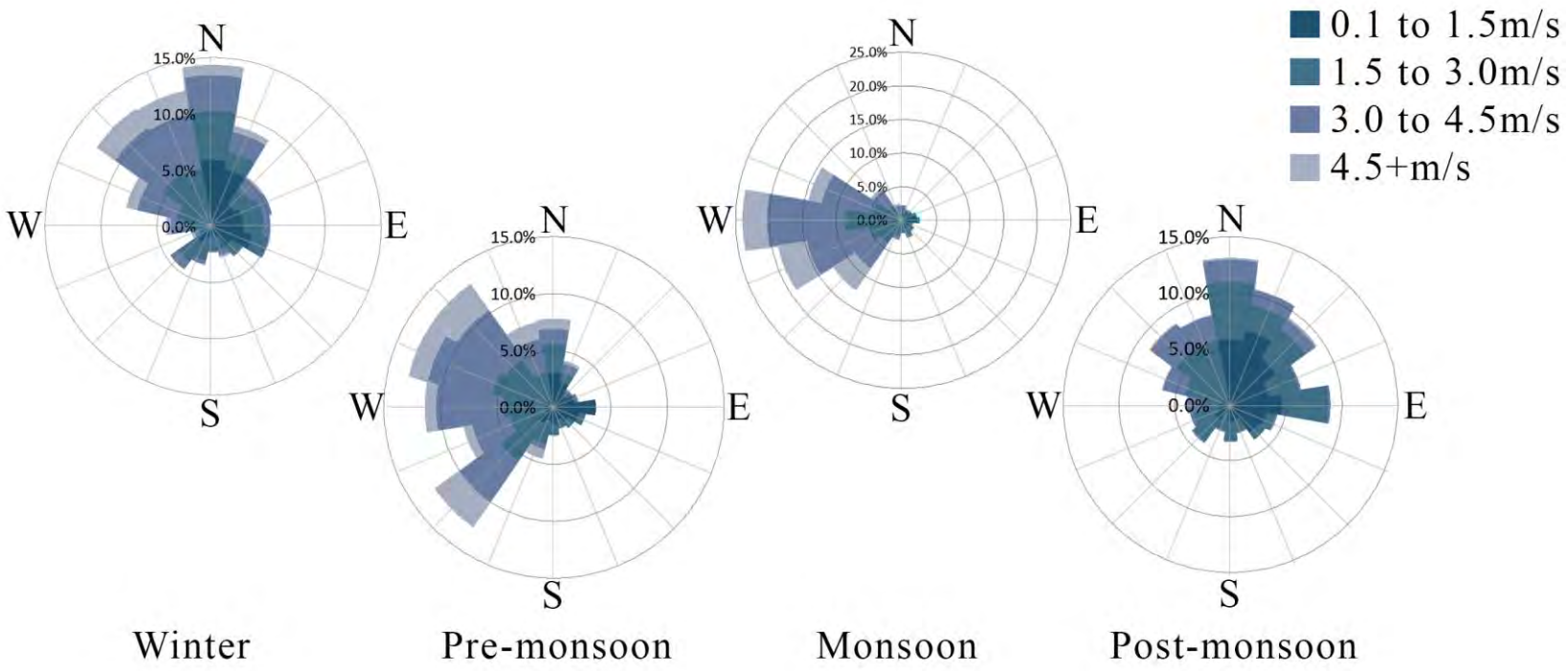
PPD and cPPD (Baseline)



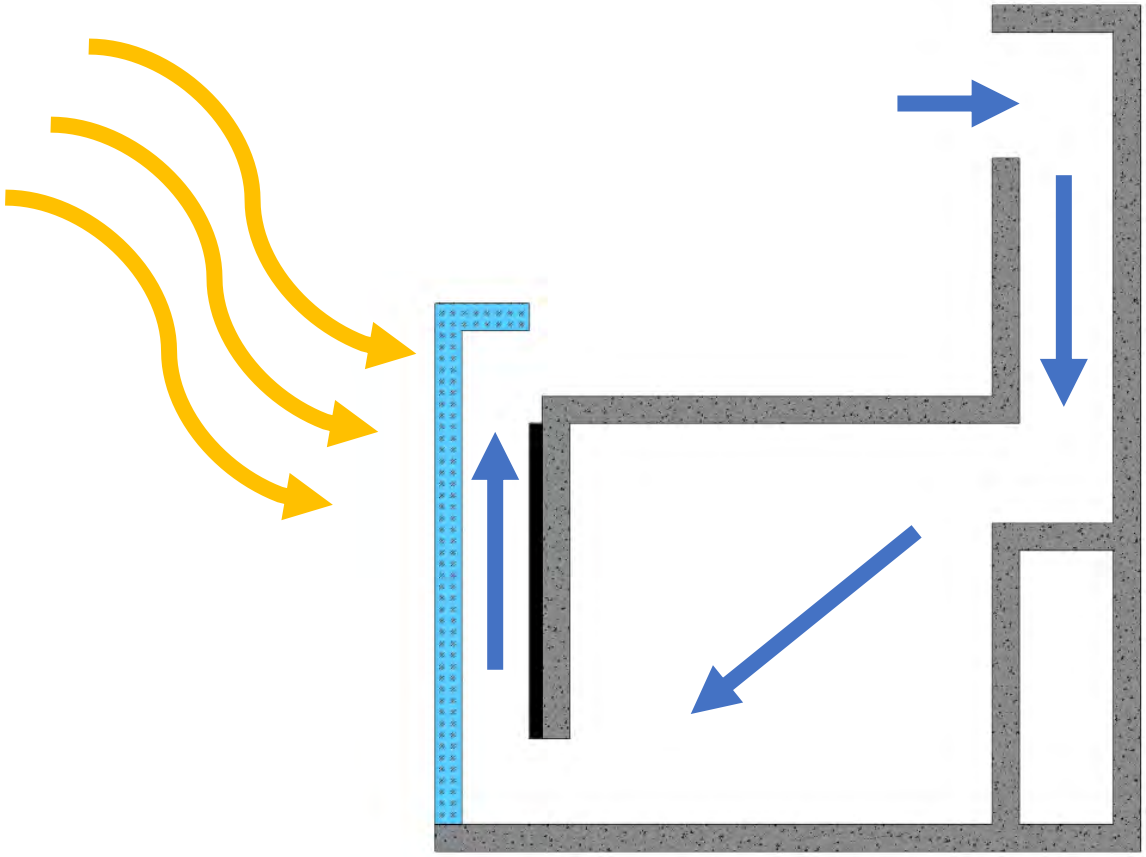
Tropical Summer Index (Baseline)



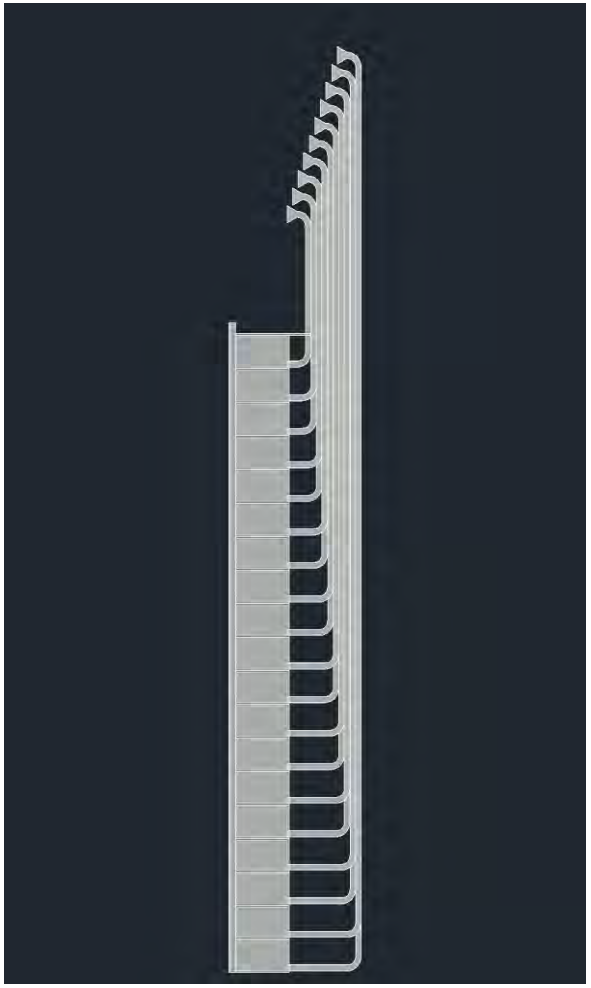
Historical Wind Data (TMY2)



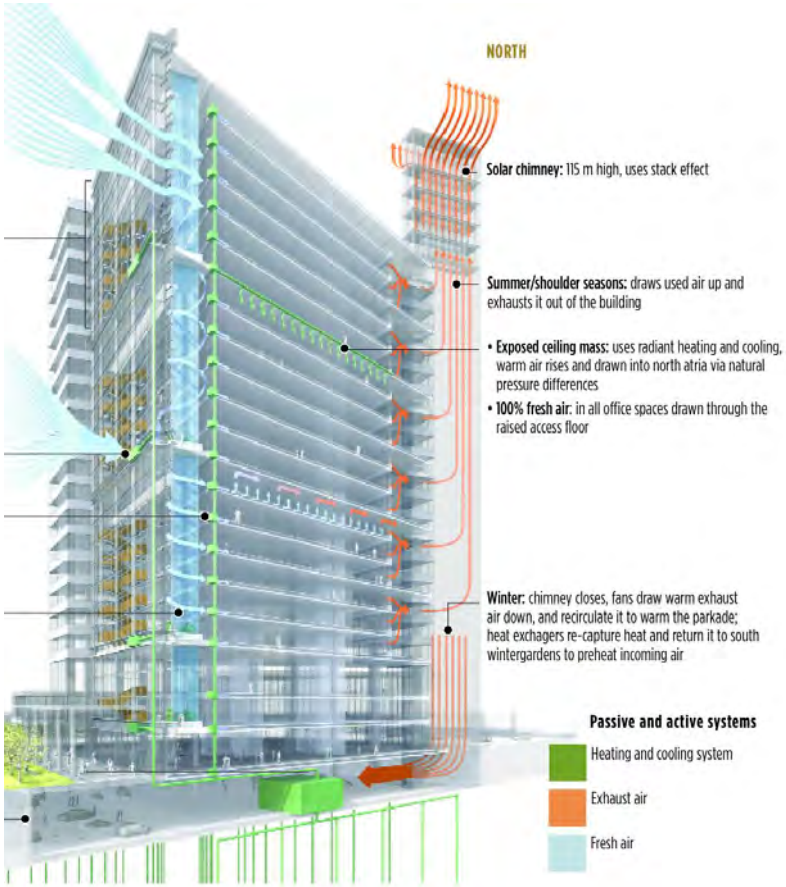
Wind Catcher And Solar Chimney Design



Wind Catcher and Solar Chimney Visualized



Precedents

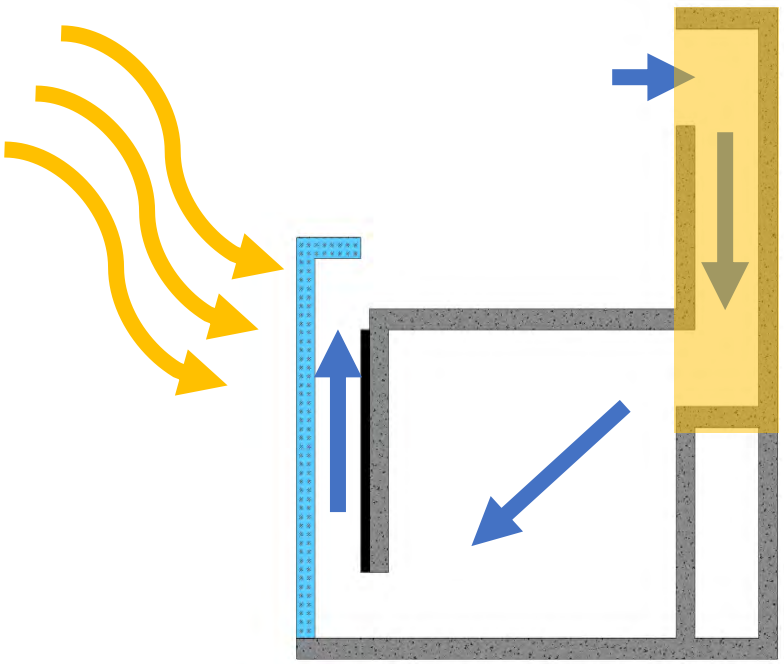


Manitoba Hydro Place (KPMB, 2009)

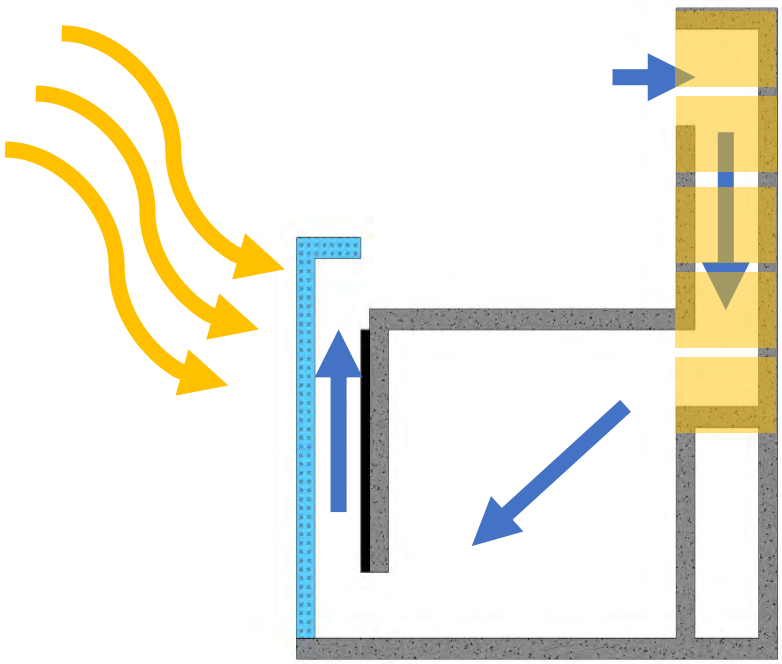
BedZED Ecovillage (Chance, 2007)

Wind Catcher And Solar Chimney Calculation

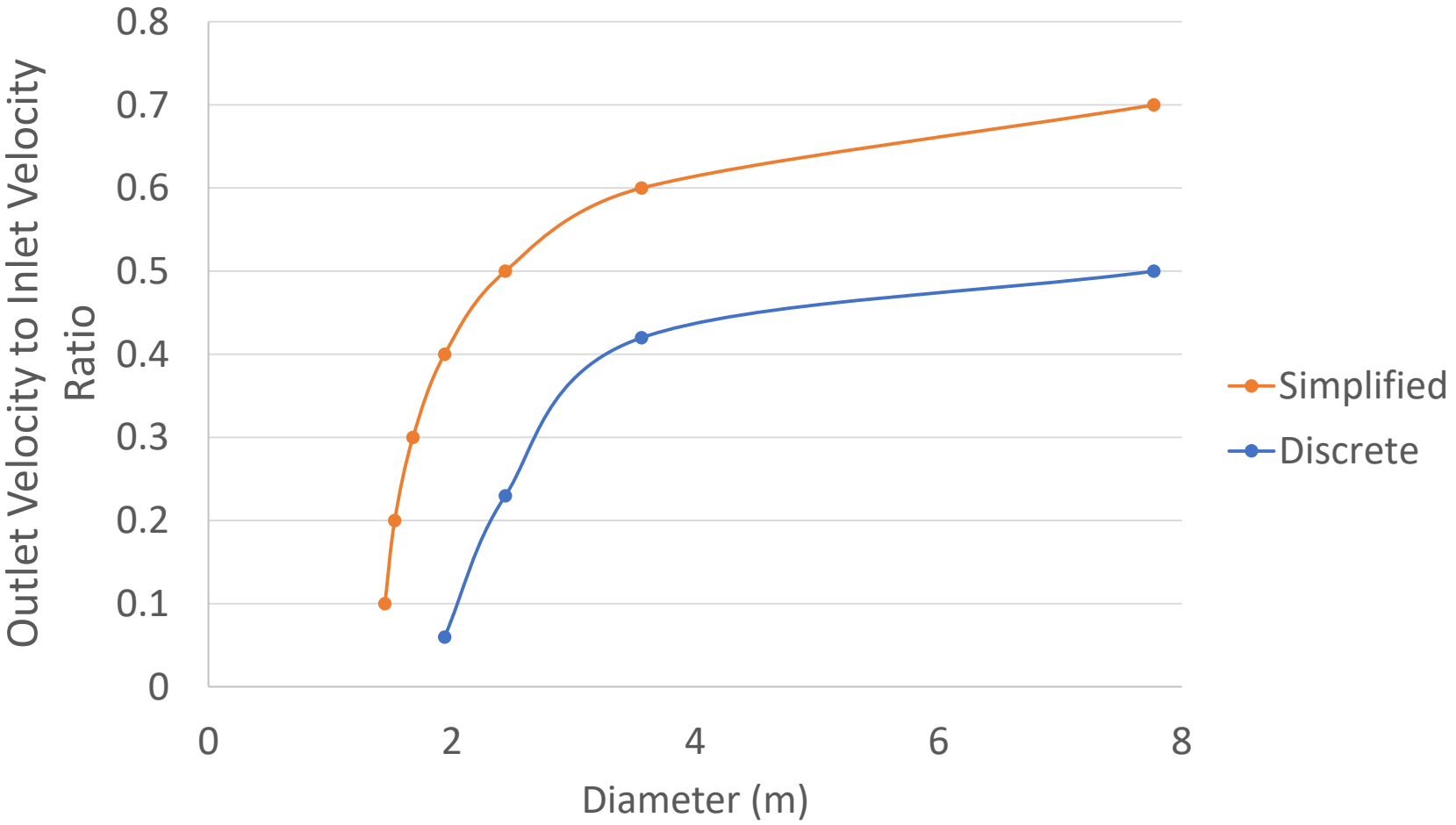
Simplified Method:



Discrete Method:

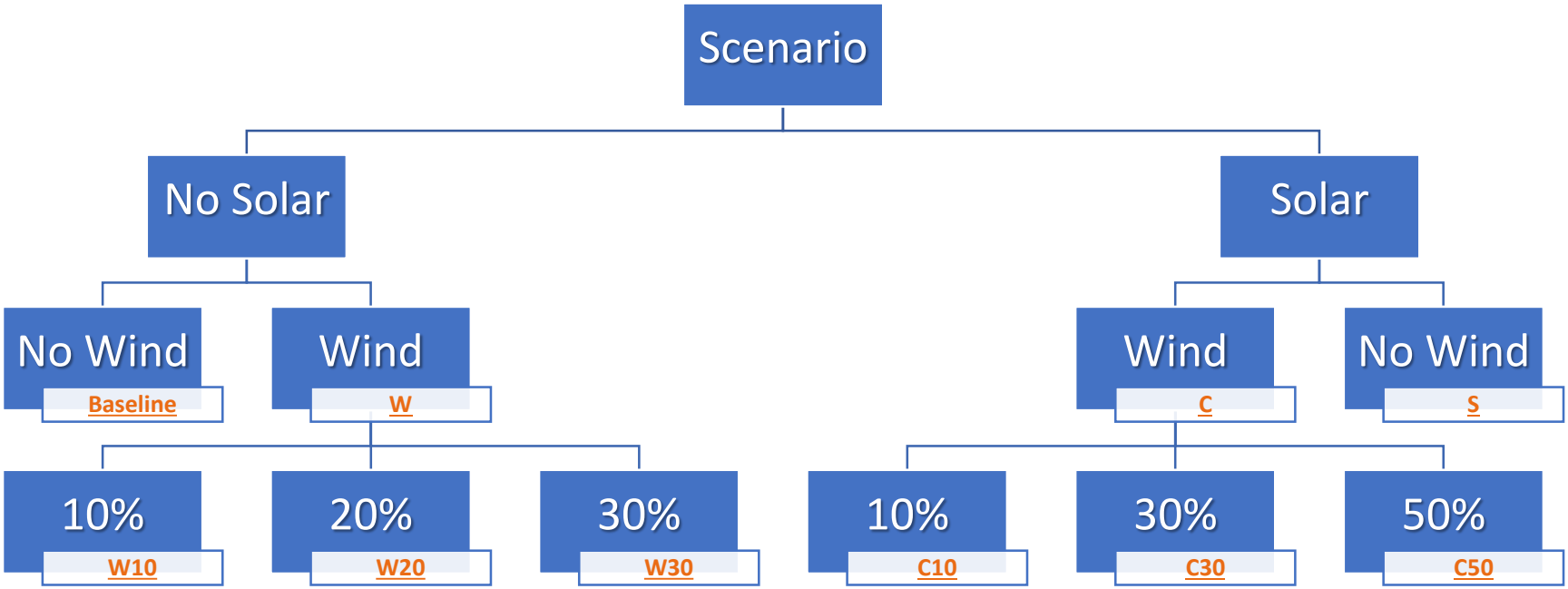


Simplified Method vs Discretized Method

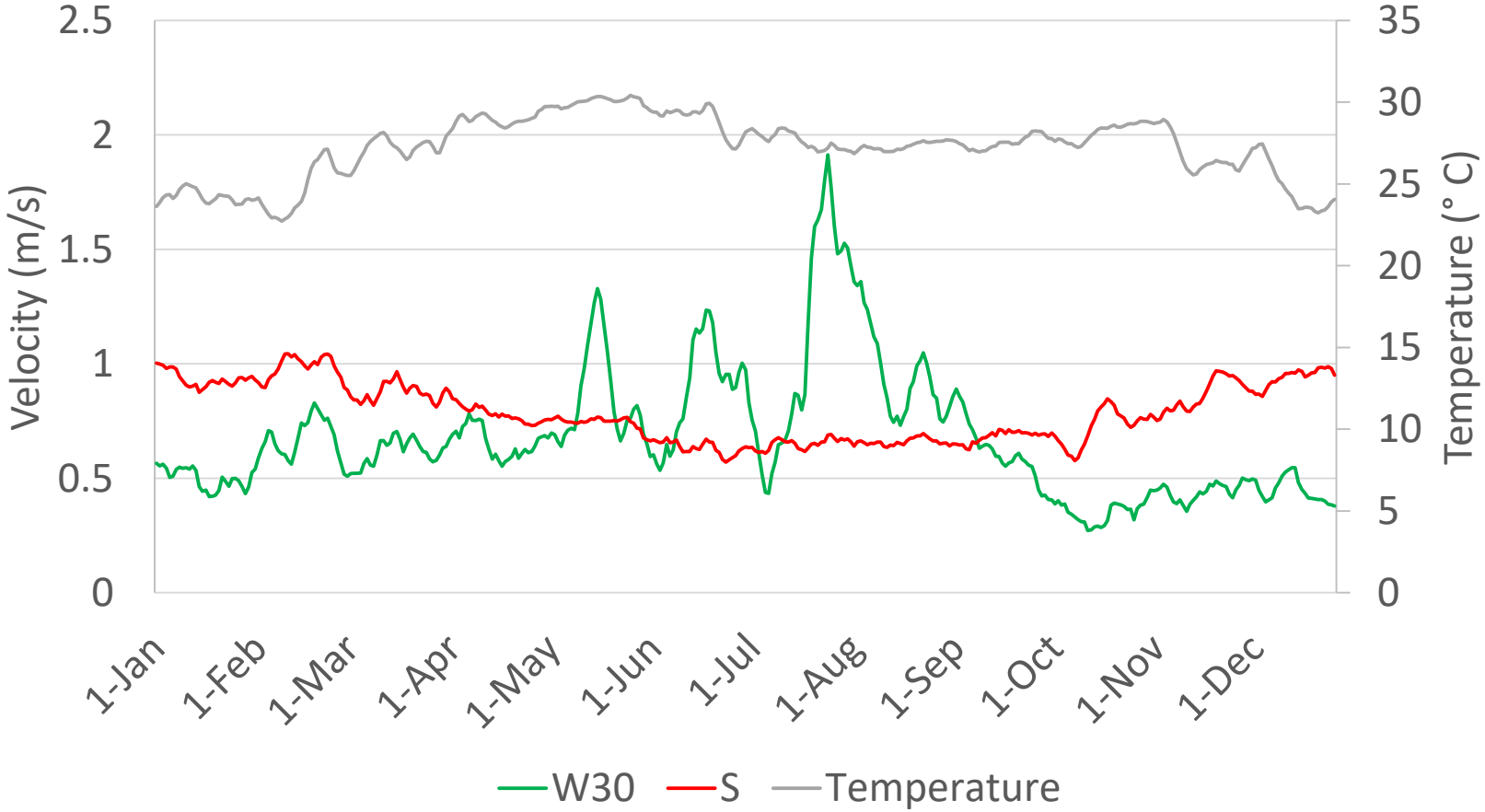


Modeled Scenarios

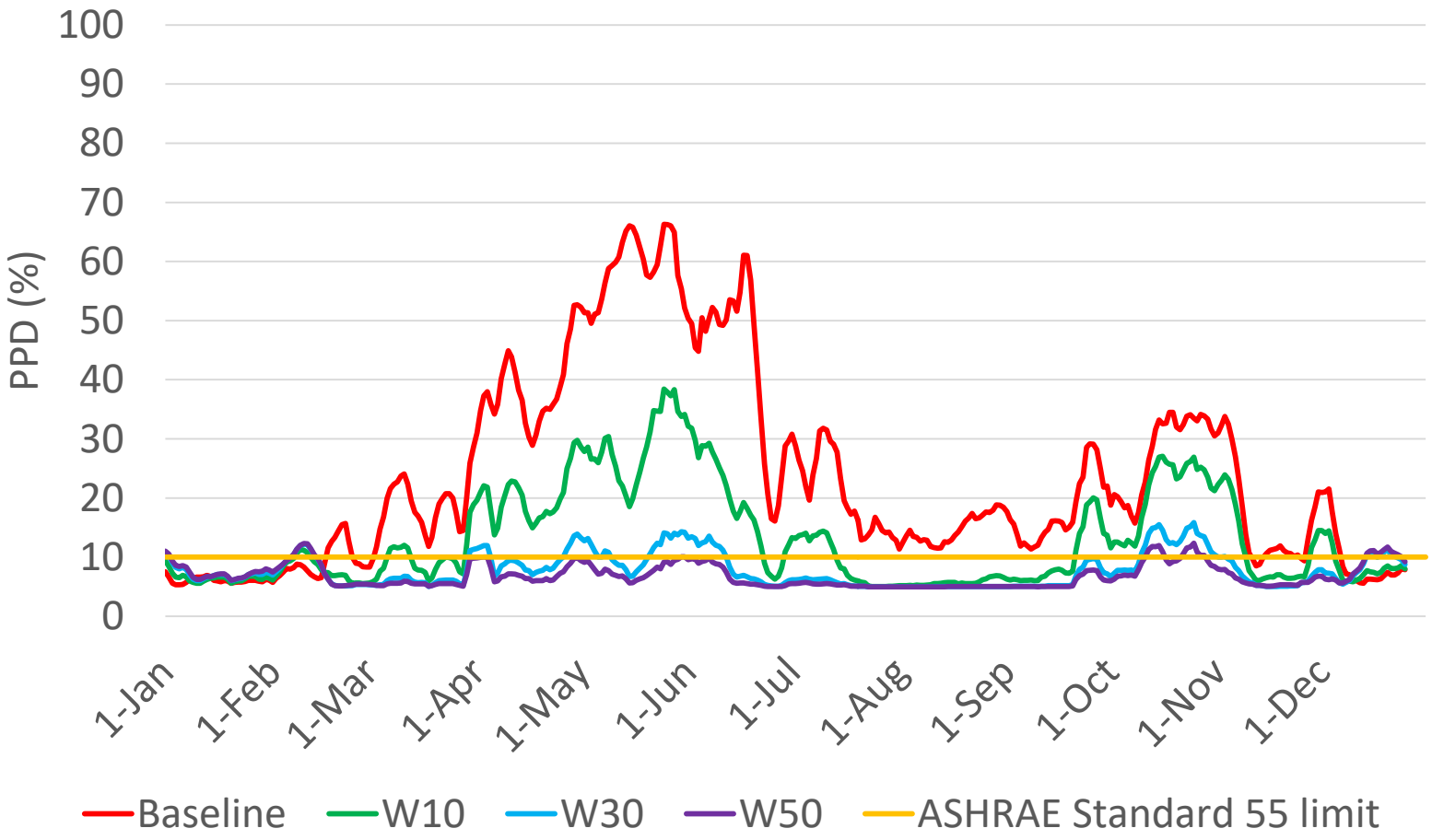
Alterations	None	Wind Catcher			Solar Chimney	Combined		
Scenario	Baseline	W10	W30	W50	S	C10	C30	C50



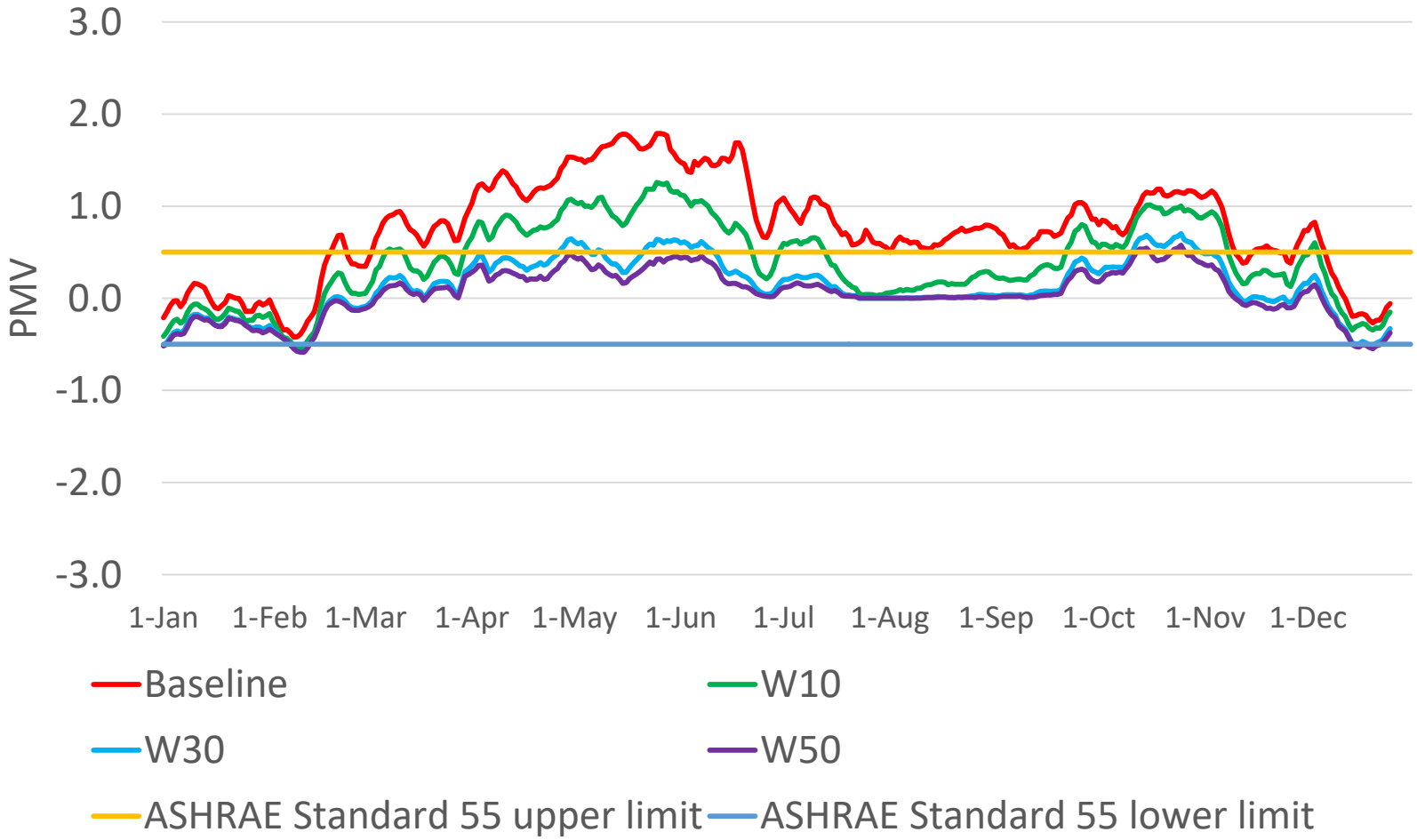
Annual Indoor Wind Velocities And Exterior Temperatures



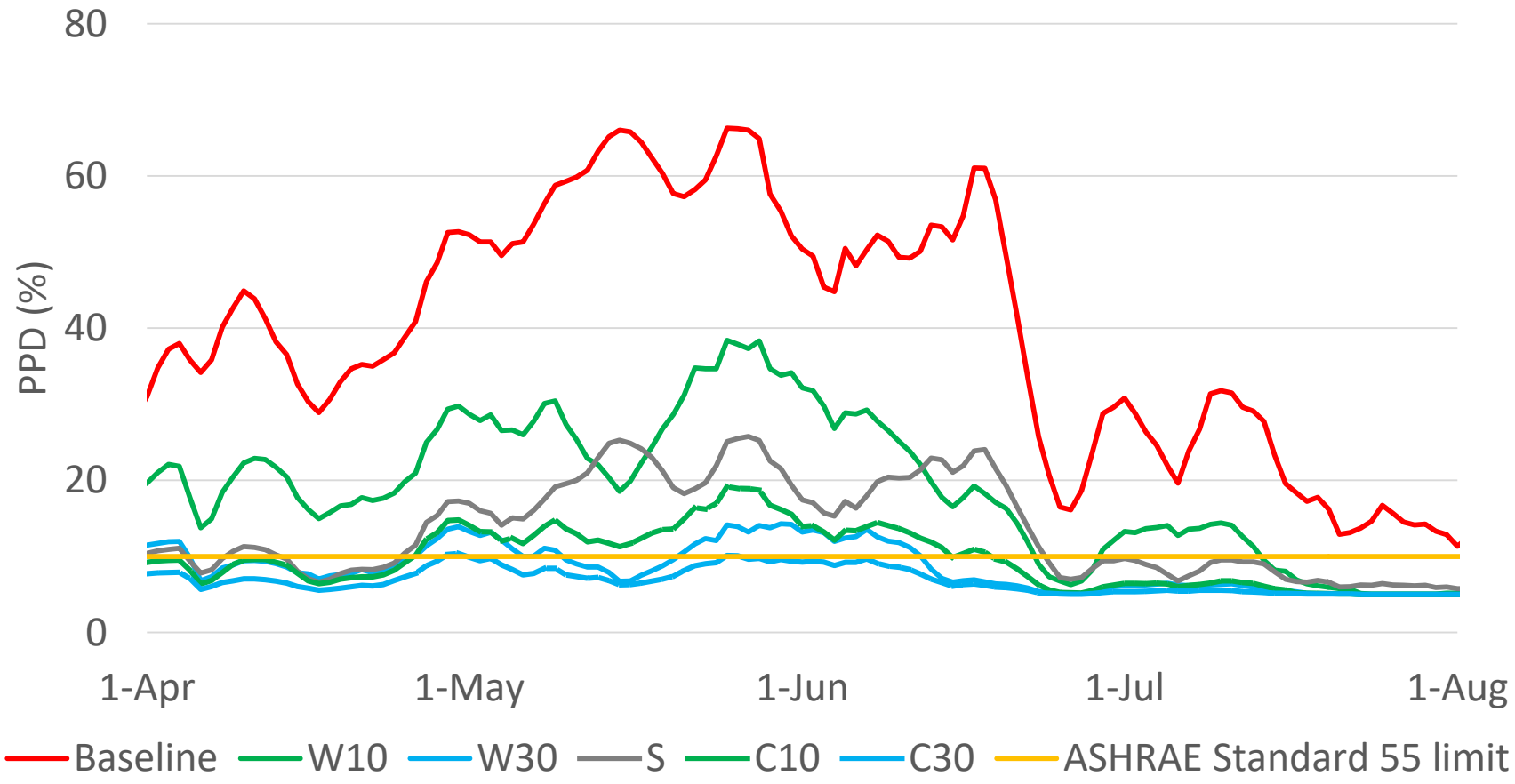
PPD (Wind Catcher Only)



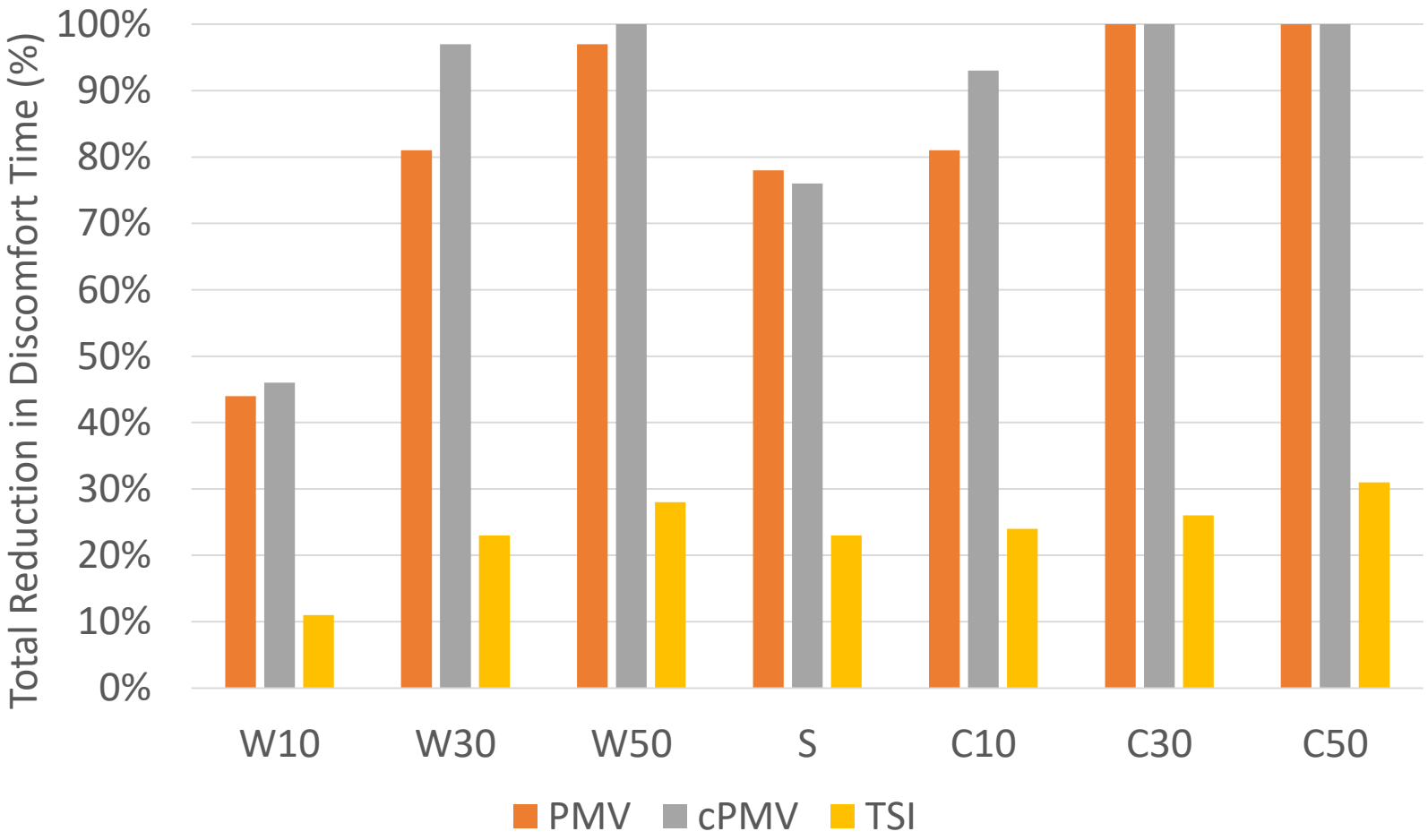
PMV (Wind Catcher Only)



PPD of Cooling Months

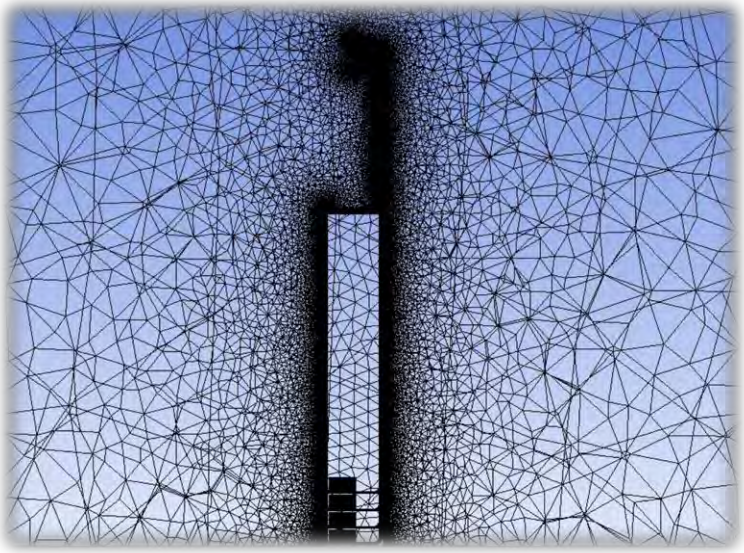


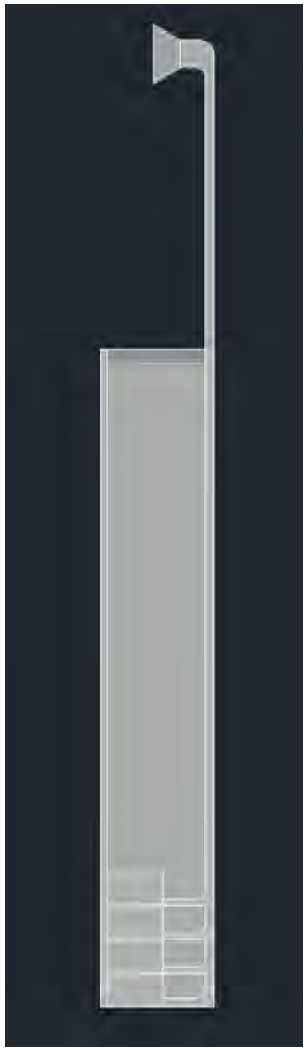
Total Reduction In Annual Discomfort Time



Future research

- **Decrease wind catcher size**
  - Reduce the number of inlets per outlet





Future research

- **Decrease wind catcher size**
  - Reduce the number of inlets per outlet
- **Examine the synergy between the two systems**
  - Velocities within the unit when both systems are operational
- **Examine the effect of the increased air movement on occupants**

Questions?

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