

Affordable Strategies to Reduce Heat Stress in Urban Housing

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Session 3, Management Interventions and Mitigation Strategies for Heatwave
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Buildings are our Third Skin

They help us manage our thermal environment



Biological Skin



Cloths



Buildings

Thermal Comfort depends upon

Thermal Comfort is State of Mind



Physiology



Psychology



Behaviour

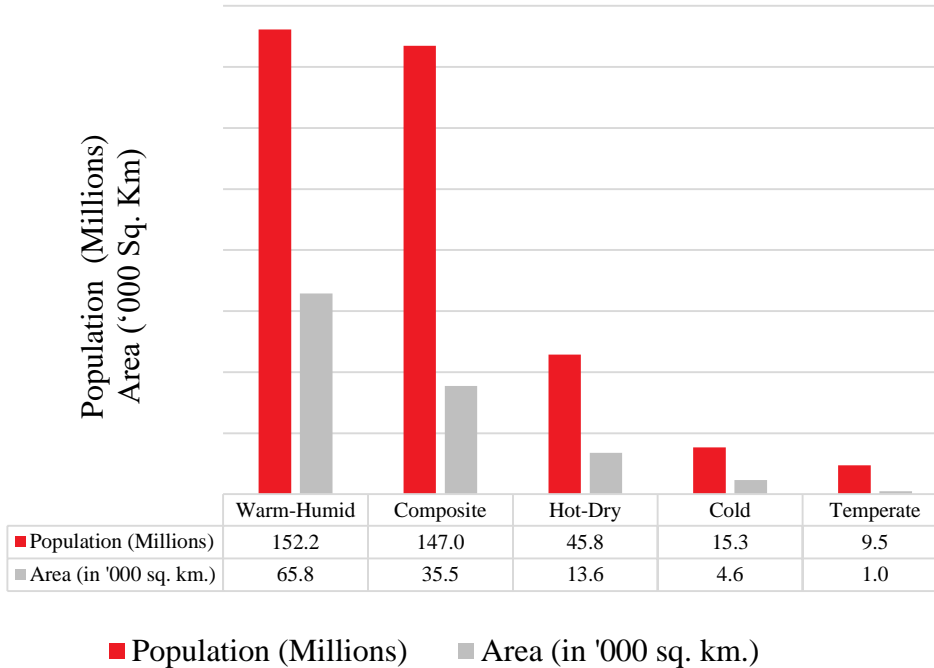
Importance of thermal comfort : Conditioning and Comfort



- Inability to shed excess heat leads to a rise in core body temperature
- Increase in heart rate
- Loss of concentration
- Irritation
- Sickness and Vomiting
- Unconsciousness
- Death

Source: freepik. Tired student [Image]. Retrieved 12 April 2022, from <https://www.freepik.com/photos/tired-student>

Importance of thermal comfort : Conditioning and Comfort



- More than 50% of India lives in a warm and humid climate

- Cooling Degree Days

Kolkata 3360 (19.7 million)

New Delhi 3015 (29.9 million)

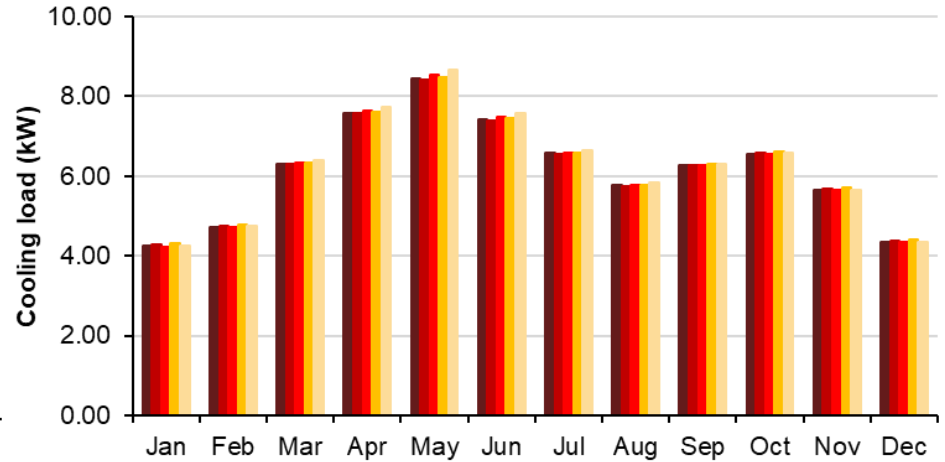
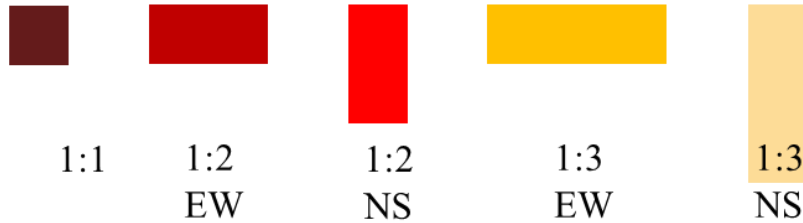
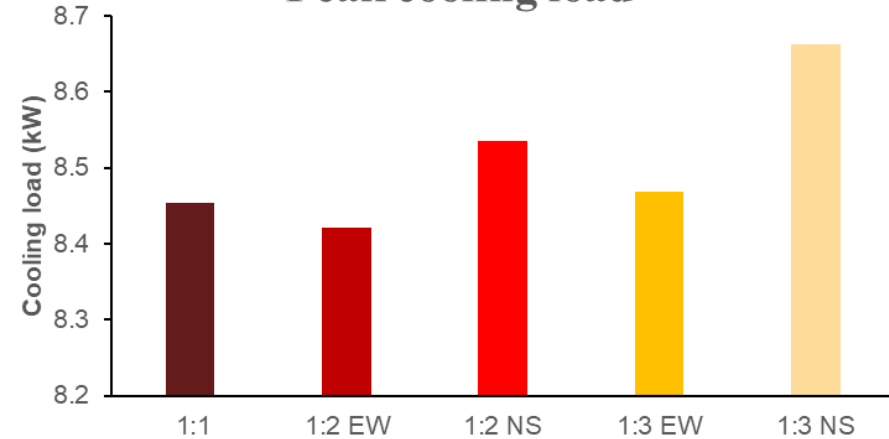
Mumbai 3469 (24.5 million)

Chennai 4108 (10.6 million)

Source: Ministry of Home Affairs, Government of India. Population projection. Census of India. (2011). Retrieved 12 April 2022, from <https://www.censusindia.gov.in/2011census/dchb/DCHB.html>

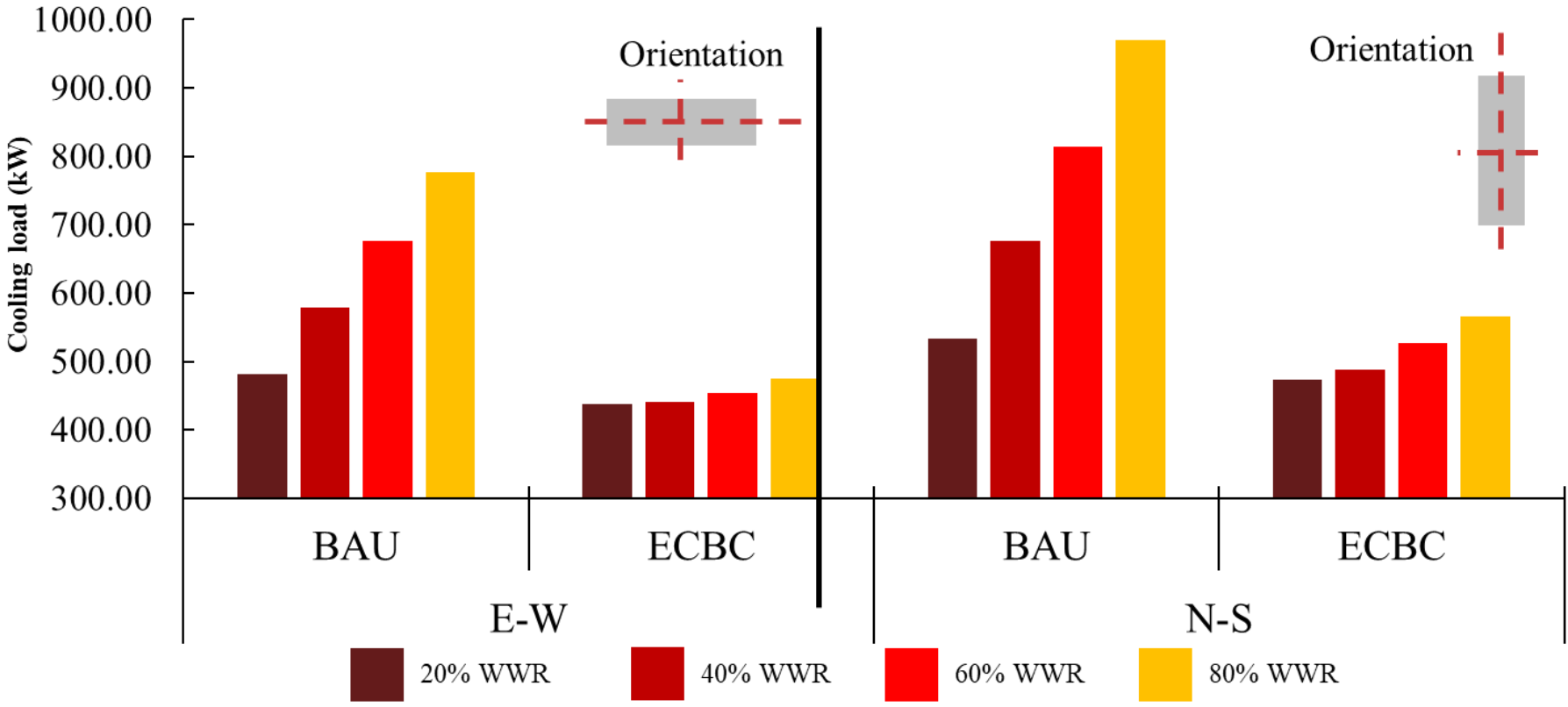
Passive Design: Orientation – Form - Shading

Peak cooling load

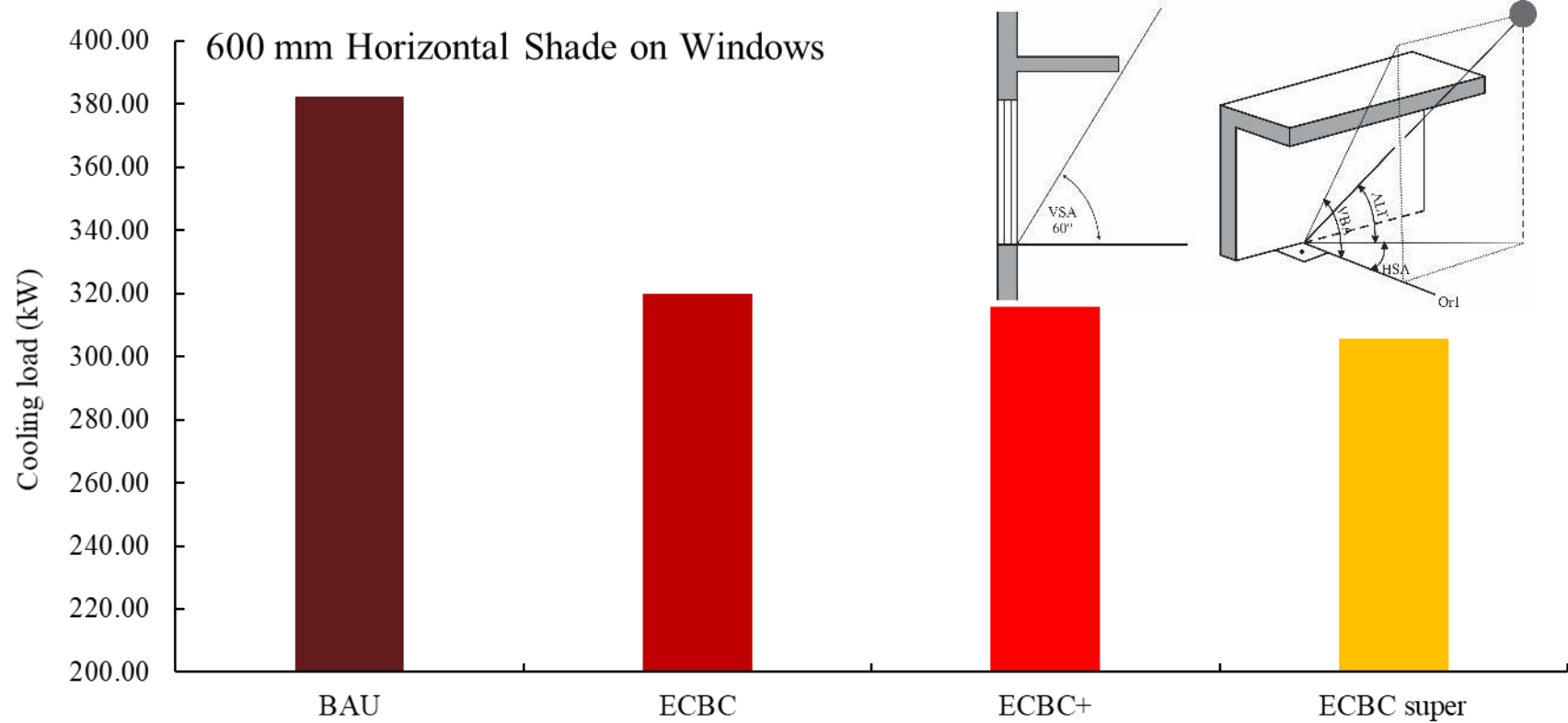


For a Building in Hot-Dry Climate

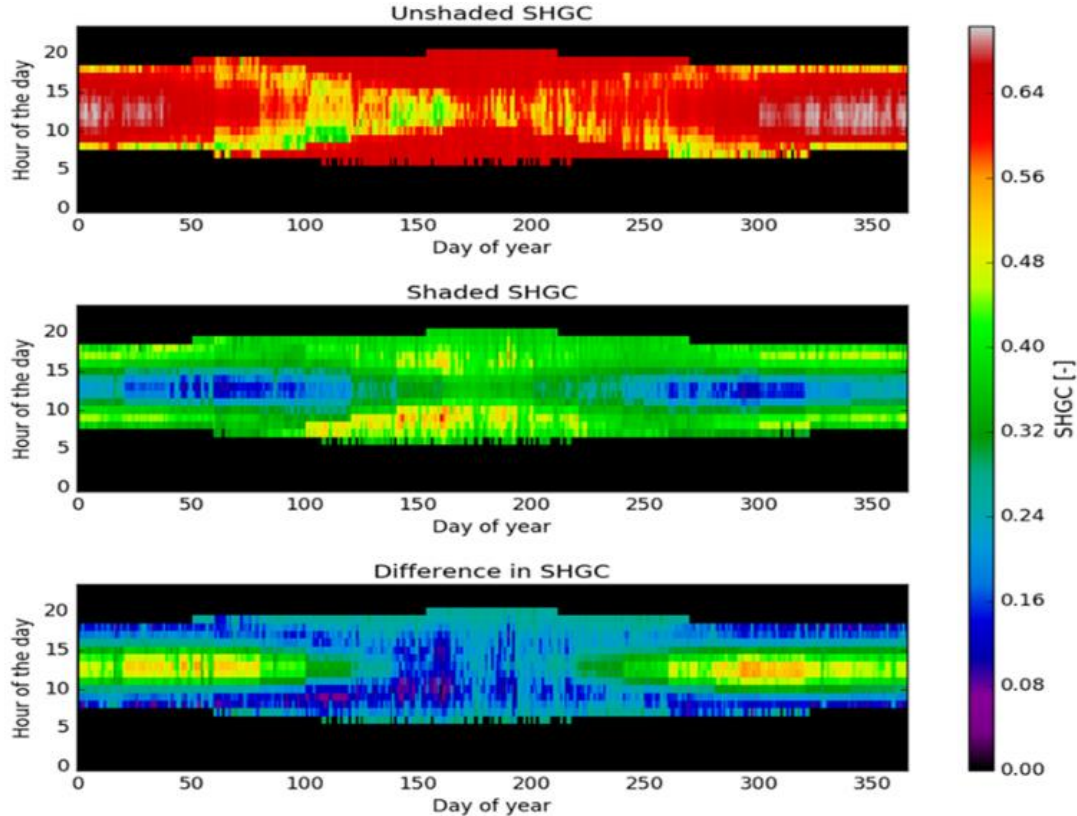
Passive Design: Orientation – Form - Shading



Passive Design: Orientation – Form - Shading



Heat Transfer in Buildings: Interactions Between Parameters

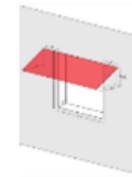


Improved SHGC for the Window

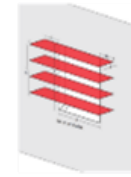
- Shading devices
- Change in Glass Material



Type: 01



Type: 02



Type: 03



Type: 03
angle
input

Extreme Climate Events: Degree Discomfort Hours



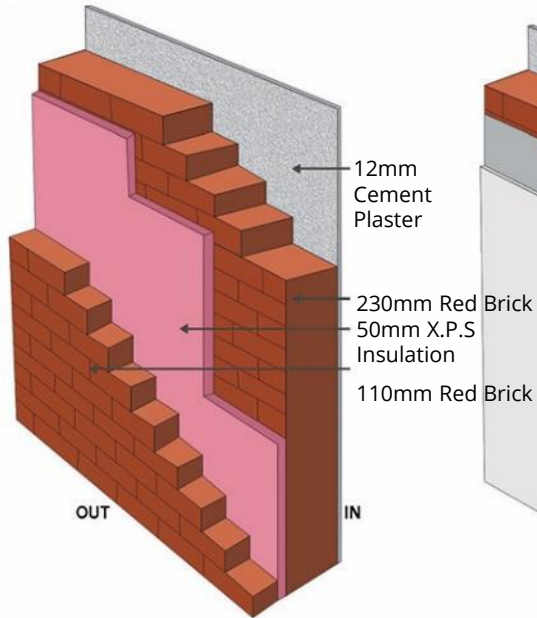
- Measure to understand how many hours are outside comfort hours inside residential units
- And extent / severeness of it.
- Increase discomfort leads to heat stress and health related symptoms

Other Passive Design Strategies: Construction Configuration

3.1 WALL SUPER STRUCTURE

u - VALUE (W/m²)=0.42

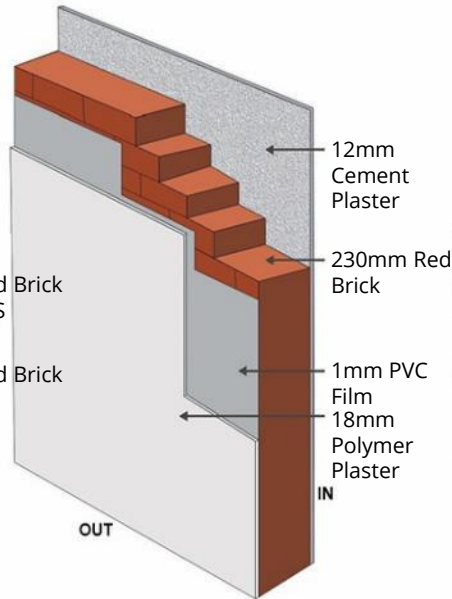
R - VALUE (m².K/W)=2.38



3.2 WALL BASEMENT

u - VALUE (W/m²)=2.01

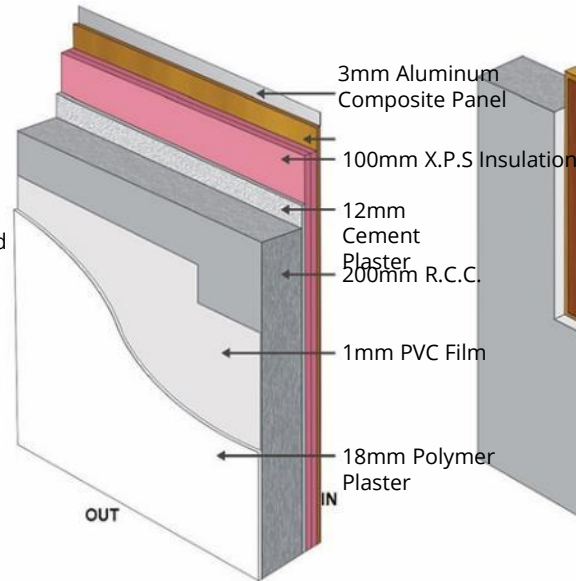
R - VALUE (m².K/W)=0.50



3.3 WALL BASEMENT

u - VALUE (W/m²)=0.28

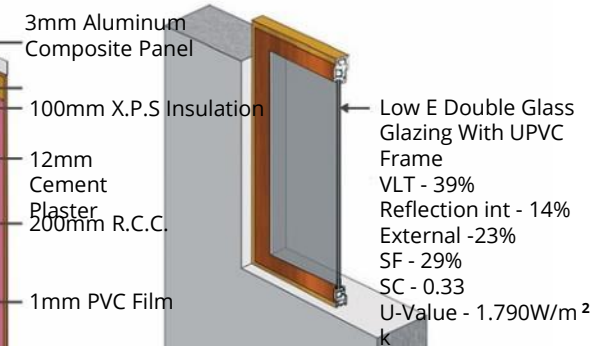
R - VALUE (m².K/W)=3.59



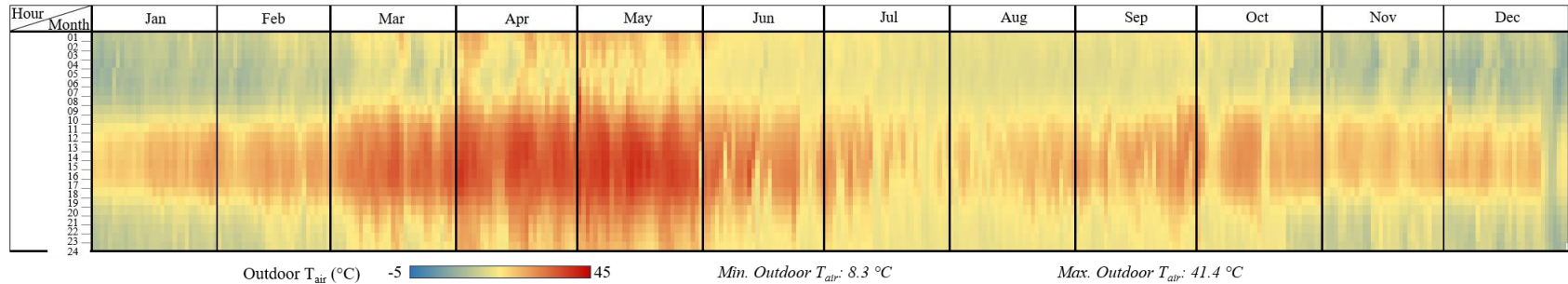
3.4 WINDOW

u - VALUE (W/m²)=1.70

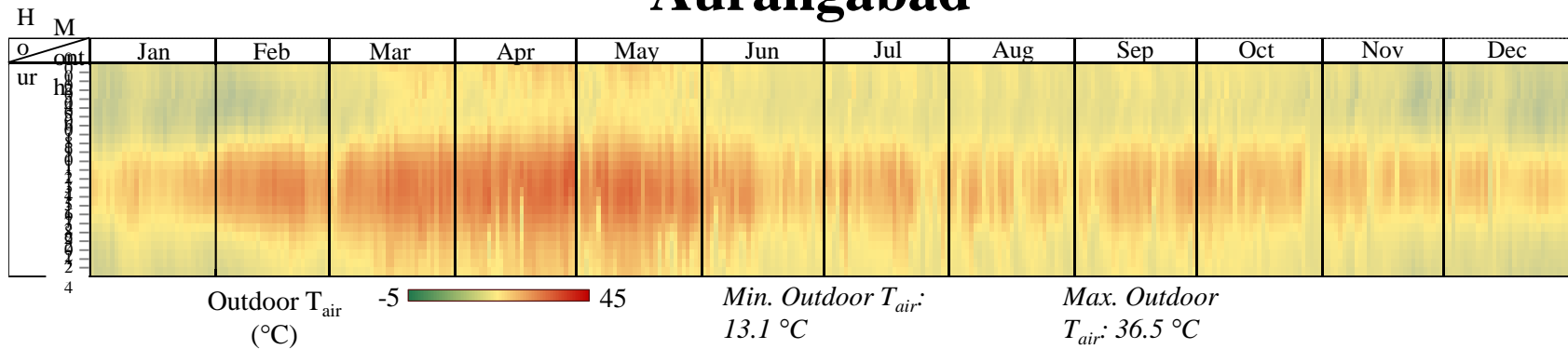
R - VALUE (m².K/W)=0.588



Extreme Climate Events: Degree Discomfort Hours

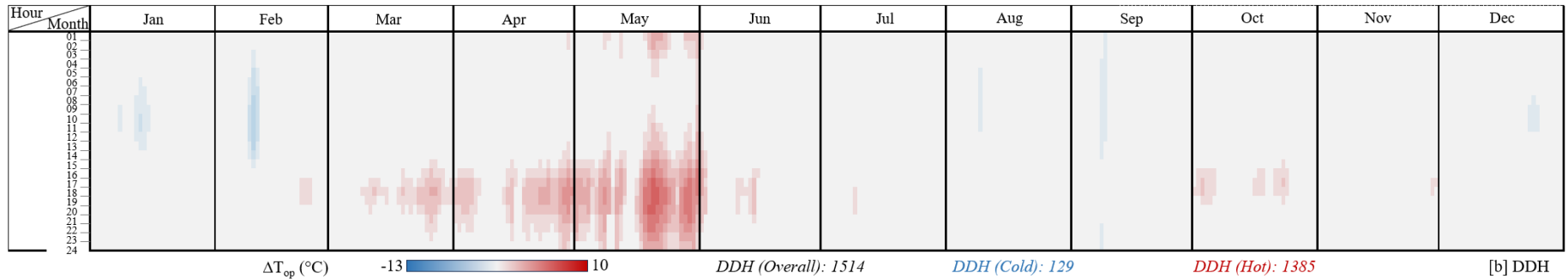


Aurangabad

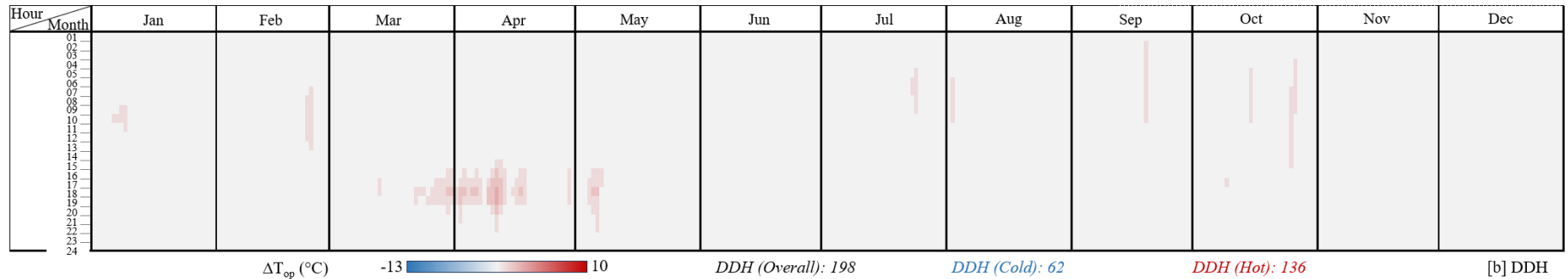


Bangalore

Degree Discomfort Hours Reduction due to Walling Technology

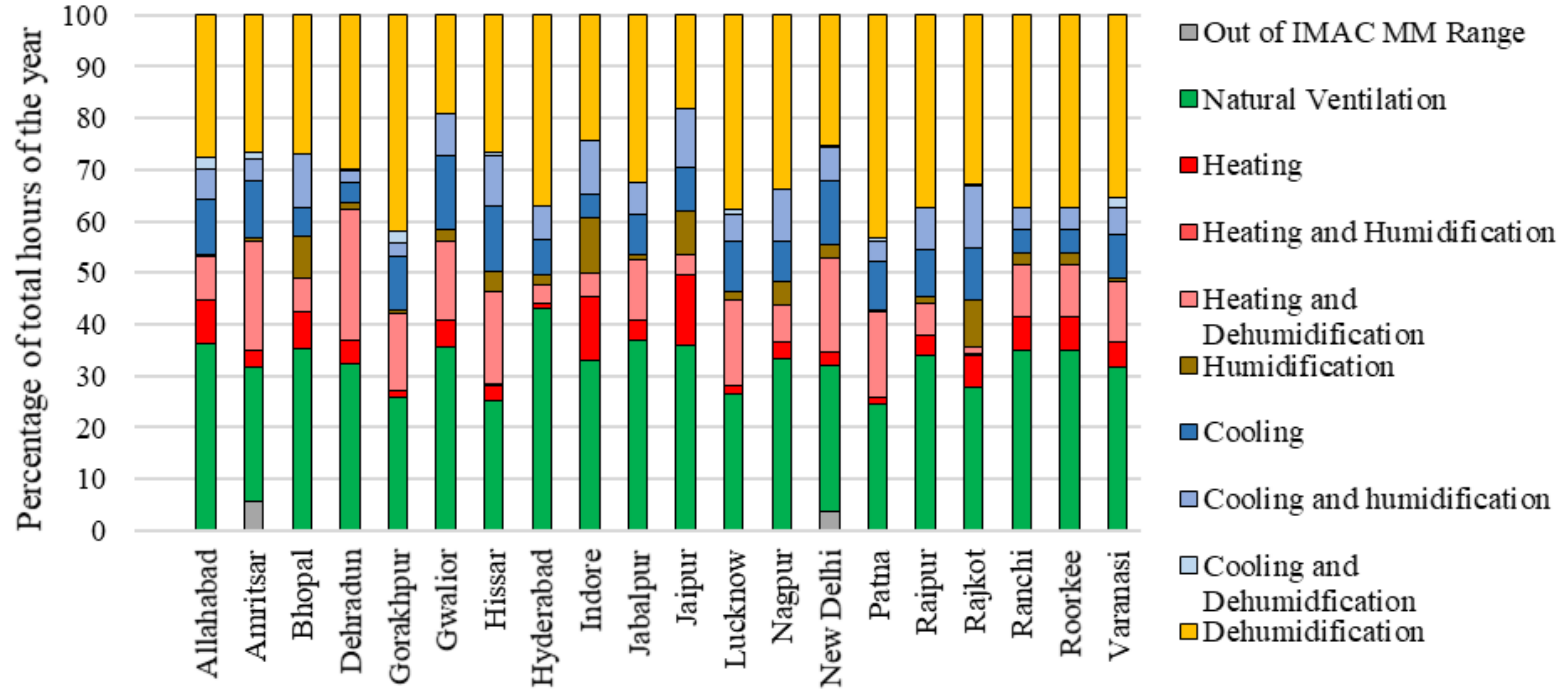


Aurangabad



Bangalore

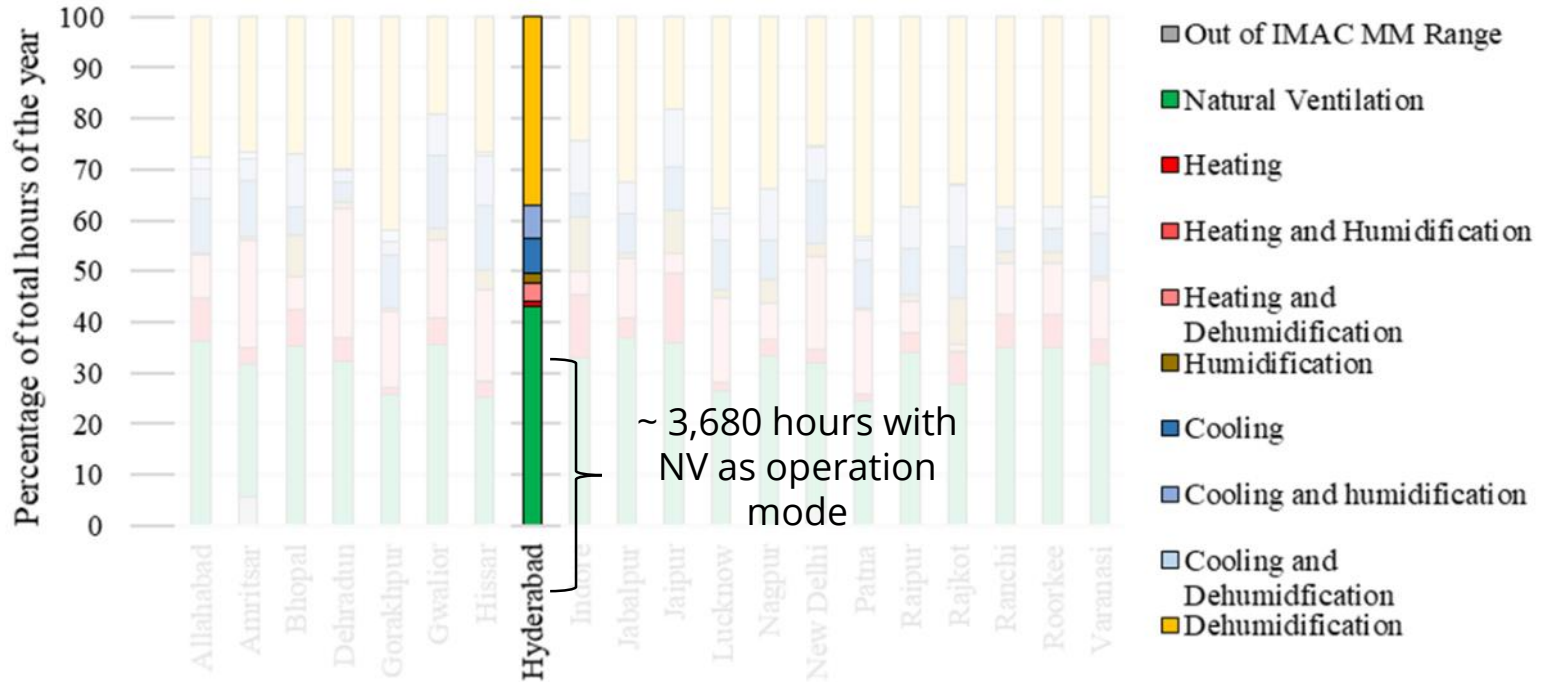
Opportunities to operate buildings with comfort strategies



Summary of comfort hours of different operation modes (NBC - IMAC-MM)

Source: Cook, M., Shulka, Y., Rawal, R., Loveday, D., de Faria, L., Angelopoulos, C. (2020). *Low Energy Cooling and Ventilation in Indian Residences Design Guide*. CEPT Research & Development Foundation & Loughborough University. <http://carbse.org/reports-and-articles/>

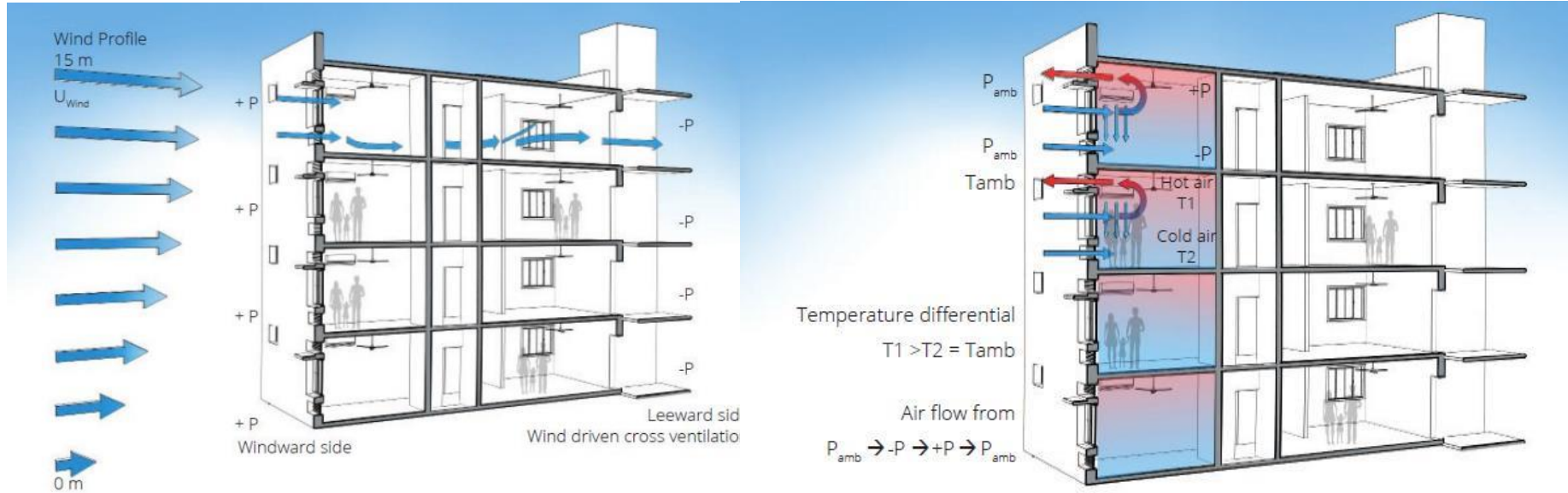
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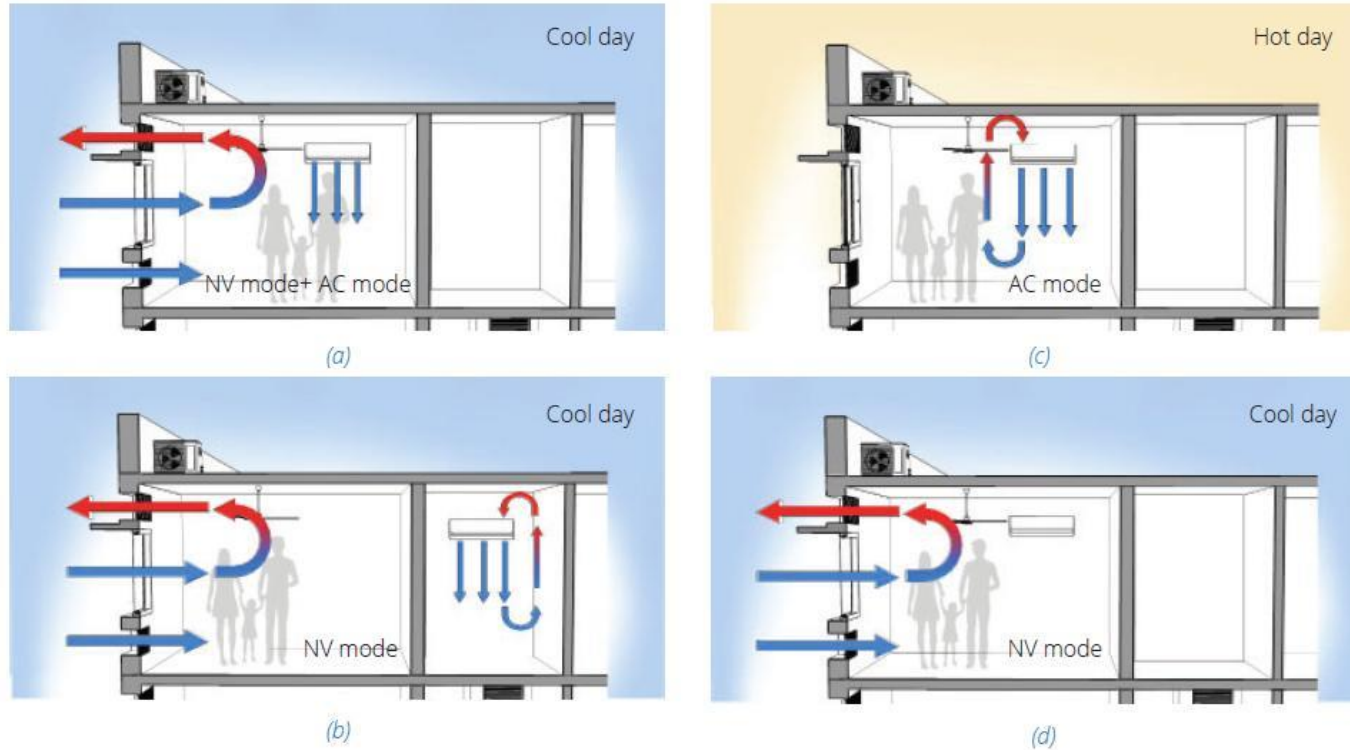
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Harnessing Ventilation for Thermal Comfort



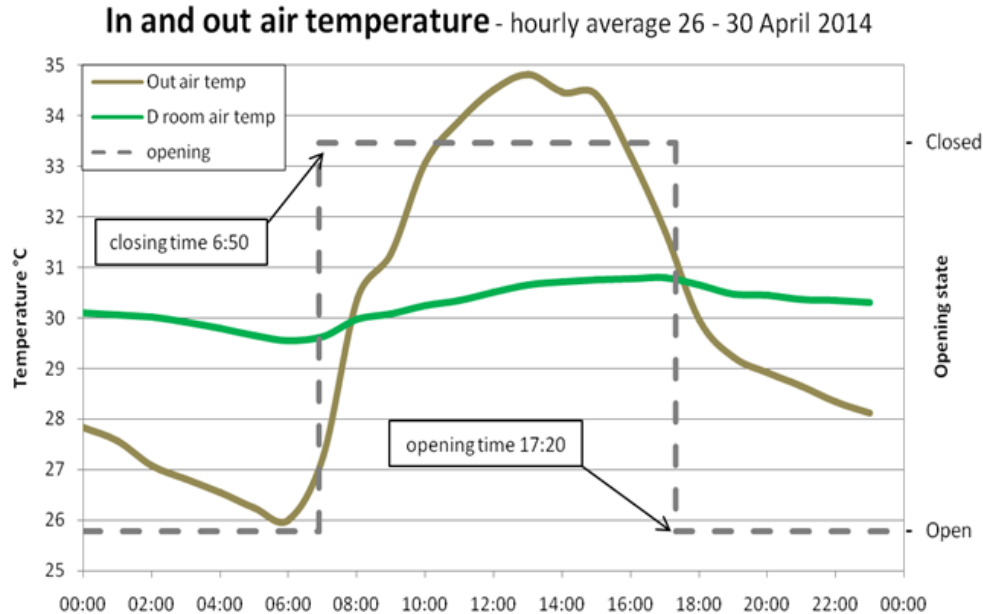
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Ventilation Design using Windows (LECaVIR Guide)



Source: Cook, M., Shulka, Y., Rawal, R., Loveday, D., de Faria, L., Angelopoulos, C. (2020). *Low Energy Cooling and Ventilation in Indian Residences Design Guide*. CEPT Research & Development Foundation & Loughborough University. <http://carbse.org/reports-and-articles/>

Operation of the Buildings Equally Important



- Balancing Thermal Mass and Insulation
- NV operation with controlled Ventilation
- Warm Humid Climate

Day shutting and nighttime comfort strategy show good results in preventing excessive temperature rise in the building

Source: Doctor-Pingel, M., Vardhan, V., Manu, S., Brager, G., & Rawal, R. (2019). A study of indoor thermal parameters for naturally ventilated occupied buildings in the warm-humid climate of southern India. *Building and Environment*, 151, 1–14. <https://doi.org/10.1016/j.buildenv.2019.01.026>



Thank You



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