Practical solutions and implementation strategies for green buildings design and construction

Session 1:
Integrated building performance design for green buildings

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LEED AP, CMVP, CFA&CFA-Sustainable Financing

Chartered Mechanical Engineer (HVAC)

2025.06.05 E-training program for building energy efficiency in Zambia and Mauritius

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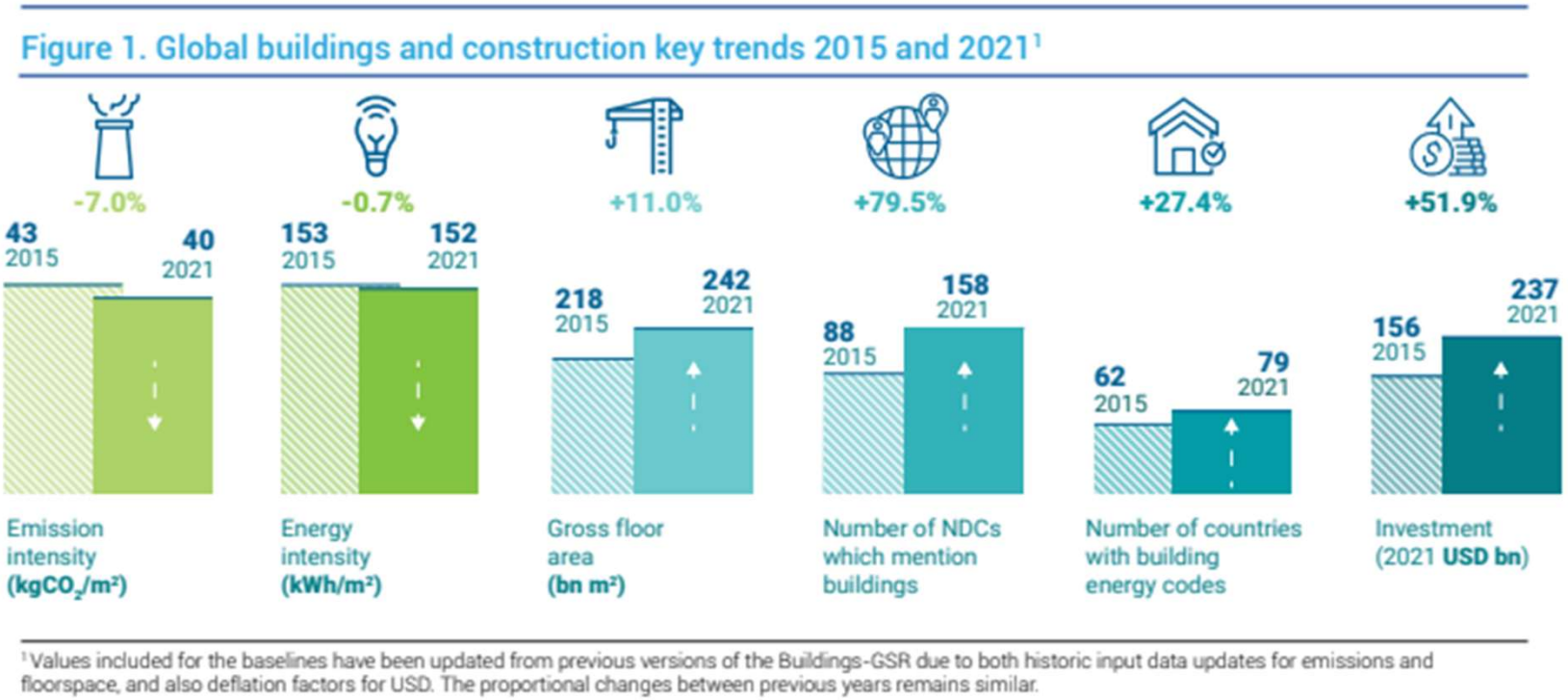
Why do we need green buildings?



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Source: 2022 Global Status Report for Buildings & Construction
https://globalabc.org/news/globalabc-releases-2022-global-status-report-buildings-and-construction

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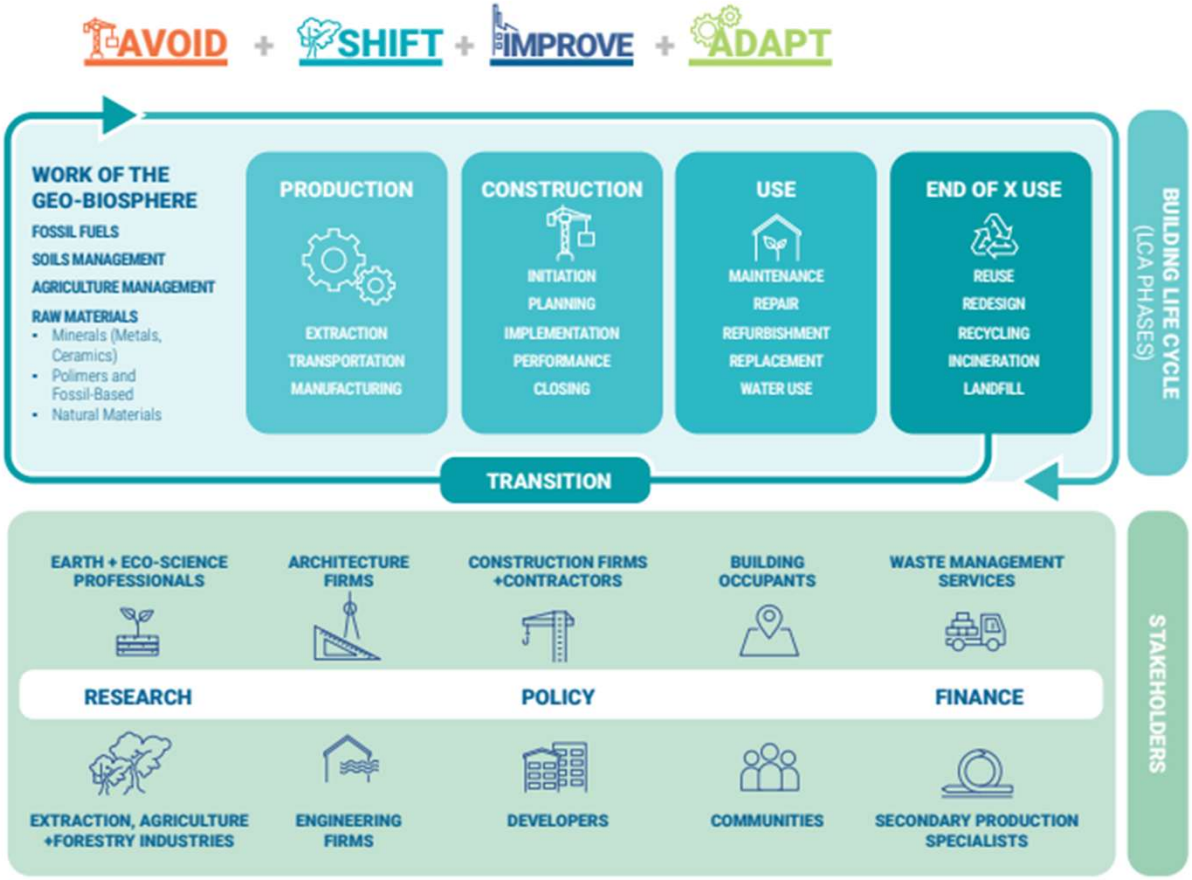

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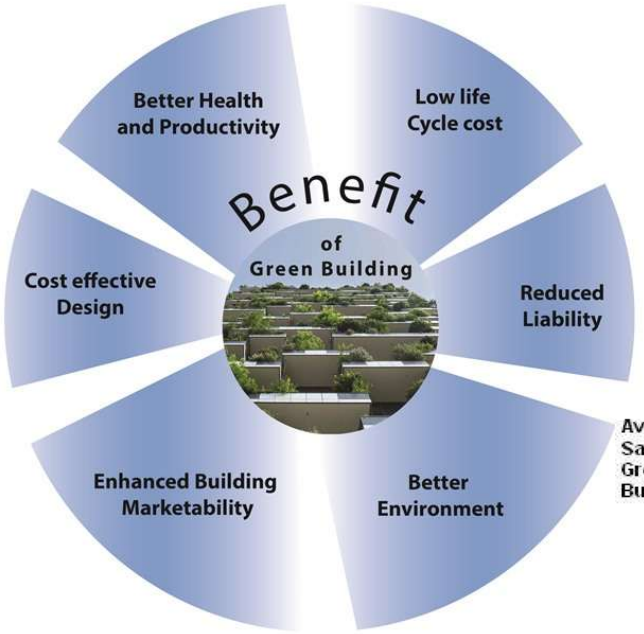
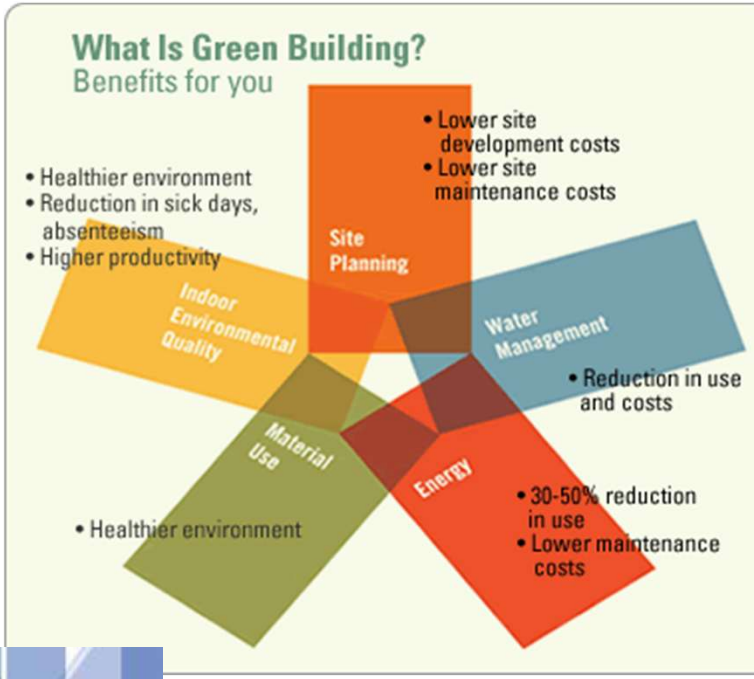
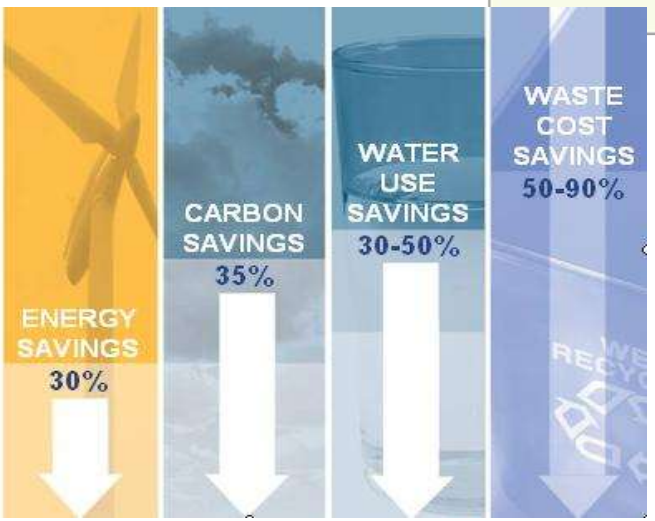




Average Savings of Green Buildings



Source : Capital E

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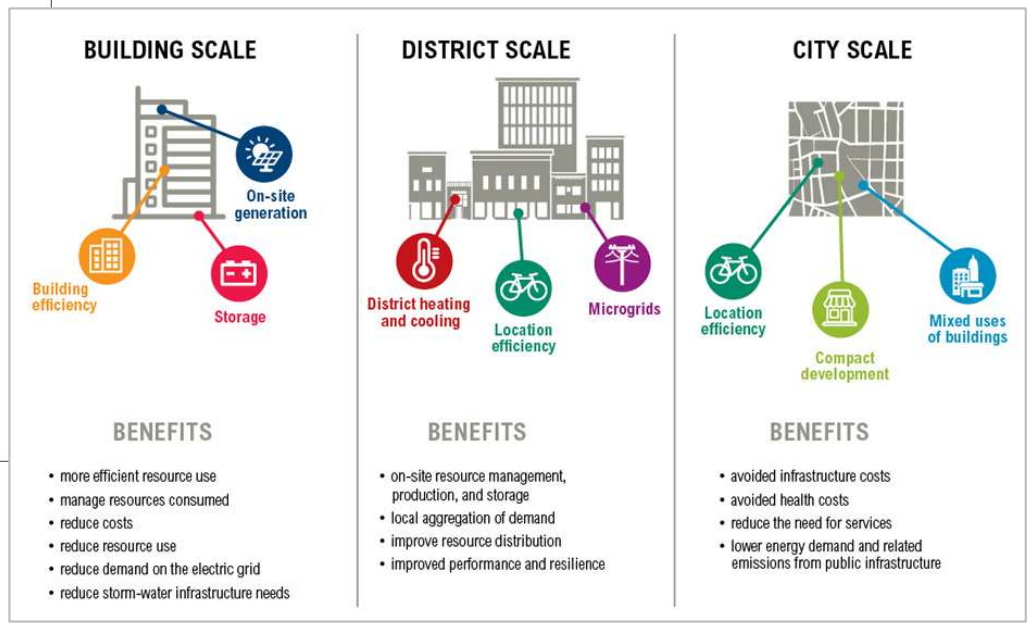

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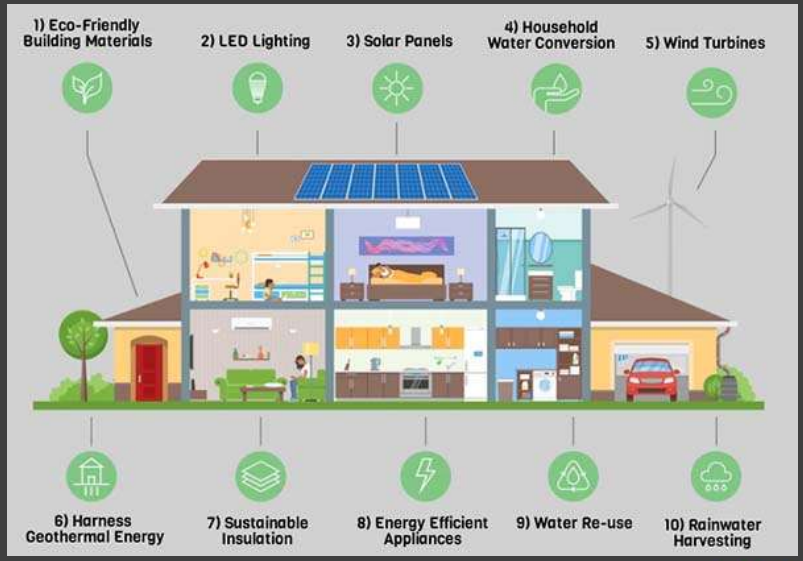
What kind of buildings can be called as green buildings?



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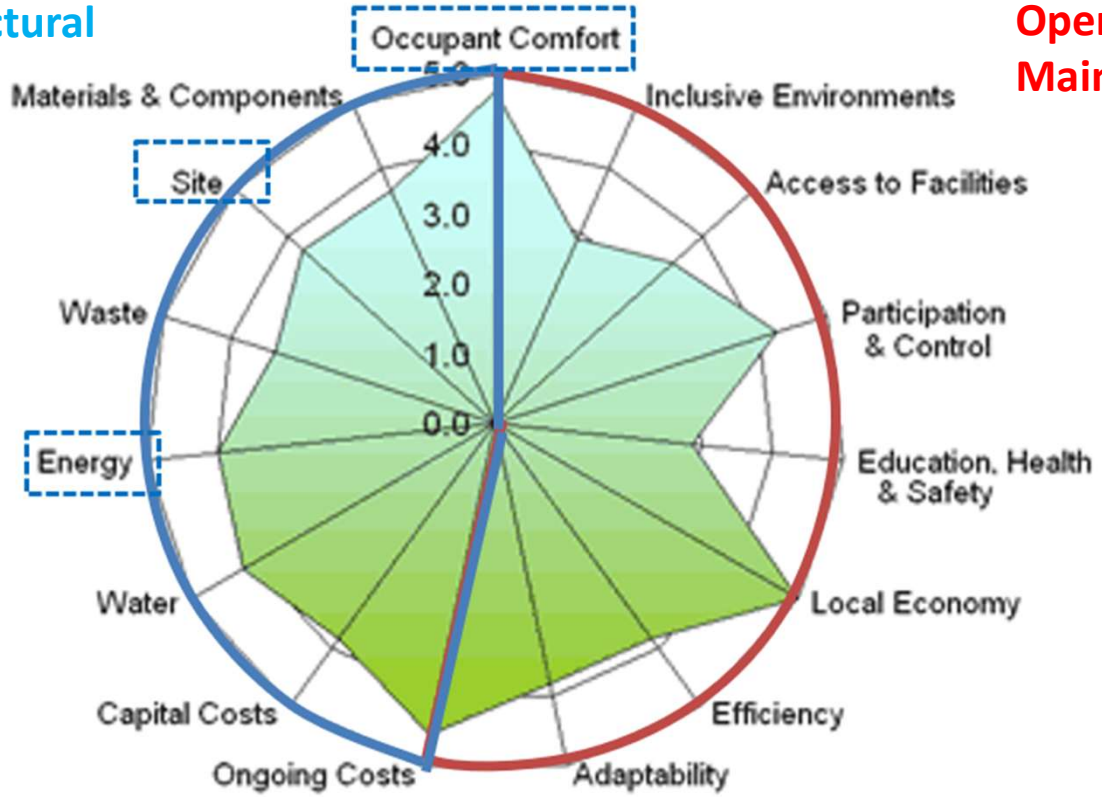
What kind of buildings can be called as green buildings?

Green building rating systems for whole building lifecycle

Urban planning, architectural design & construction

Operation & Maintenance (O&M)



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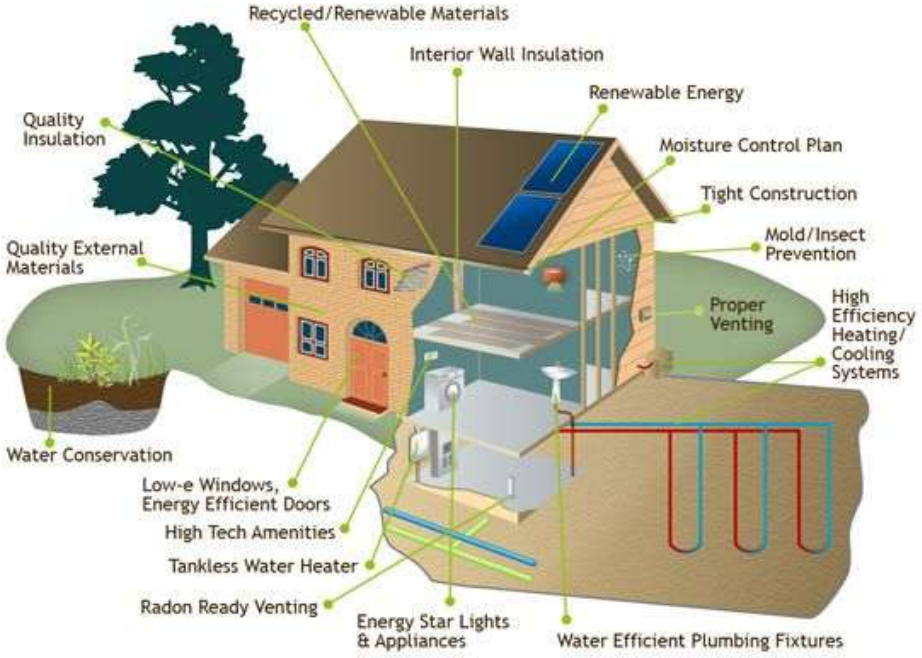

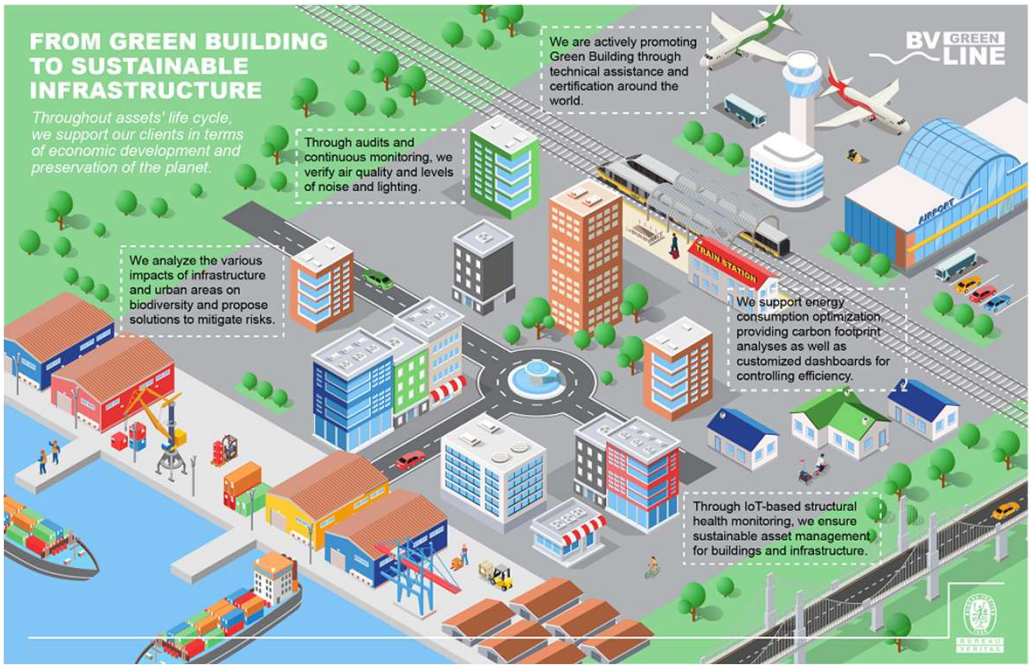

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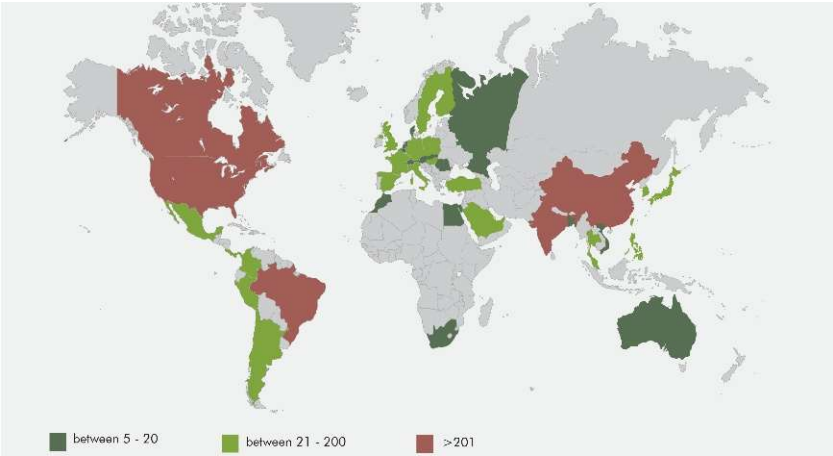
What kind of buildings can be called as green buildings?

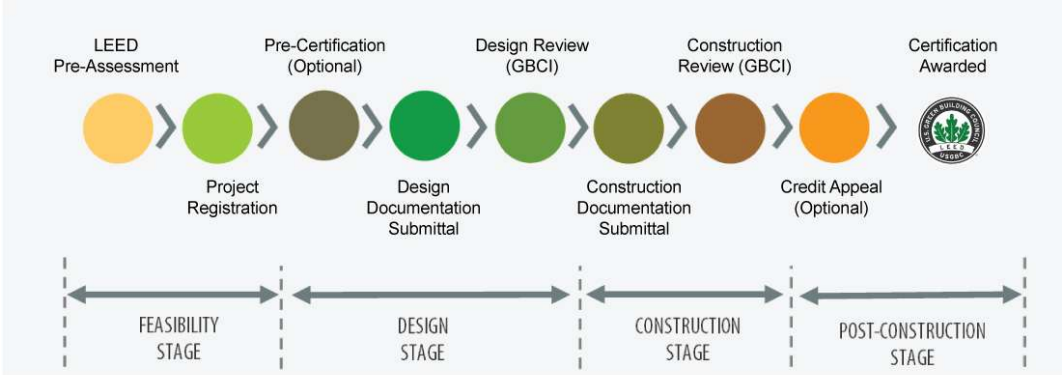
- Green building rating/certification system

What kind of buildings can be called as green buildings?

- LEED system



LEED Certified projects by countries



LEED rating system - Certification process

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What kind of buildings can be called as green buildings?

- LEED system

Certification Levels	Points /Credits Required	Identification Logo/Symbol
LEED® Certified	40 – 49 points	
Silver Level	50 – 59 points	
Gold Level	60 – 79 points	
Platinum Level	80 + points	

Point / Credit Distribution Tables in different categories

Category	Available Points	% of Total
Sustainable Sites	26	23.6%
Water Efficiency	10	9.1%
Energy and Atmosphere	35	31.8%
Materials and Resources	14	12.7%
Indoor Environmental Quality	15	13.6%
Innovation in Design	6	5.5%
Regional Priority	4	3.6%
Total Possible Points	110	100.0%

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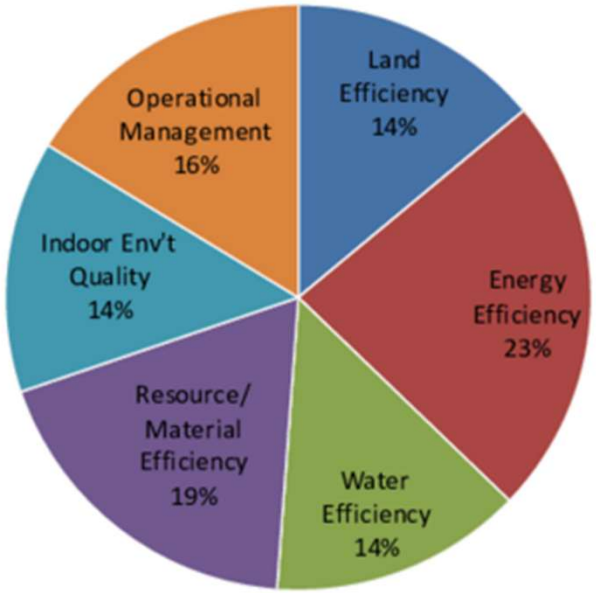
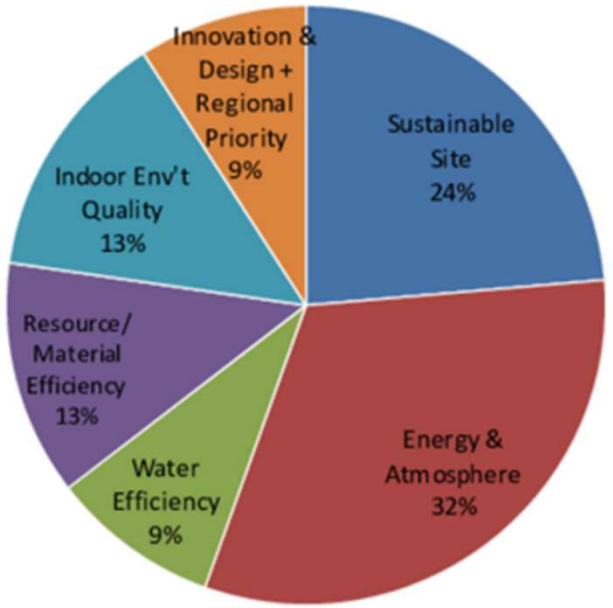
What kind of buildings can be called as green buildings?

China's Three Star Green Building Rating Criteria and Weighting



LEED Rating Criteria and Weighting



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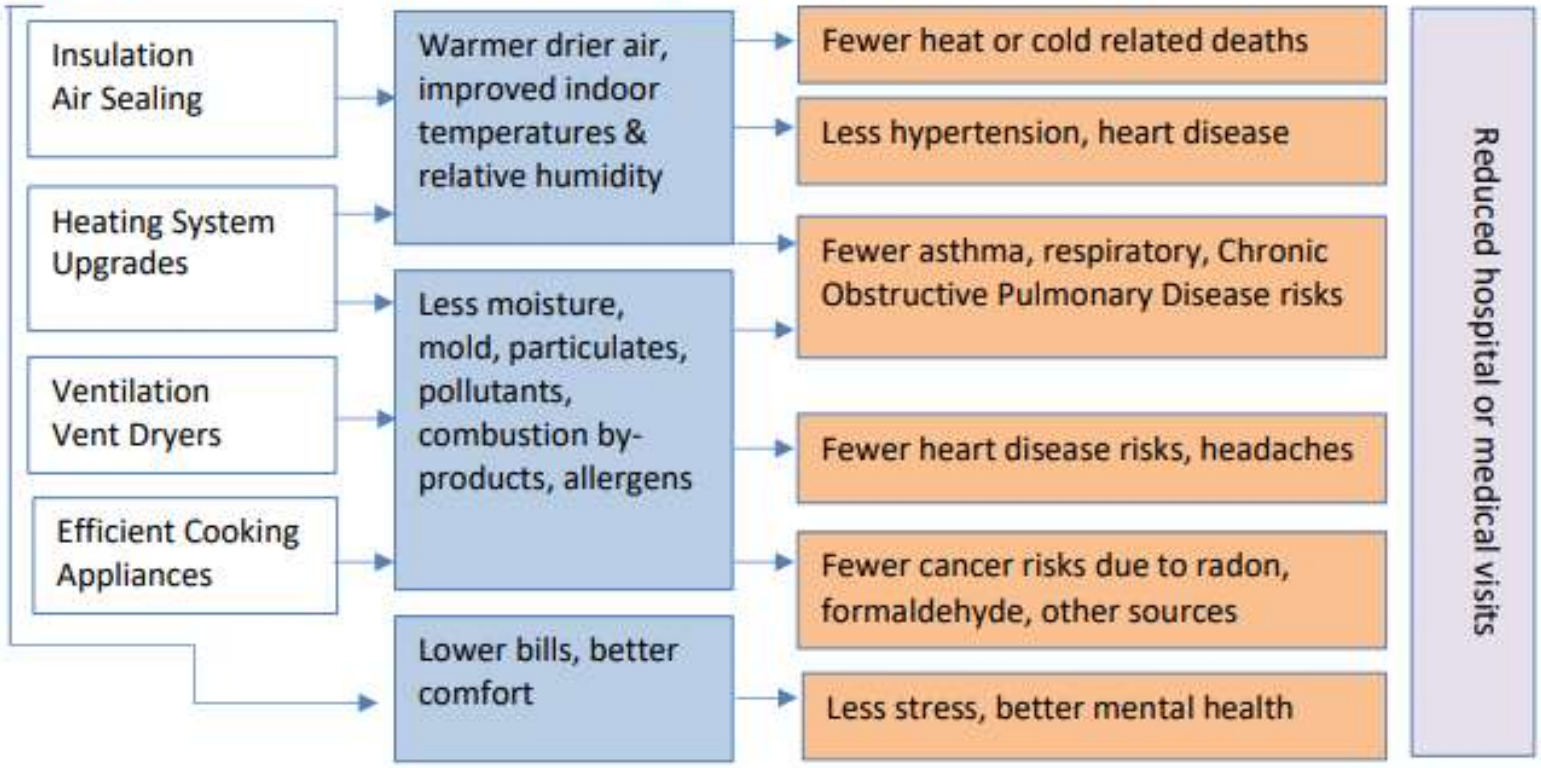
Health & energy efficiency in green buildings

Figure ES1: Occupant Health and Indoor Environmental Benefits of Residential EE



Source: https://neep.org/blog/making-connection-energy-efficiency-health

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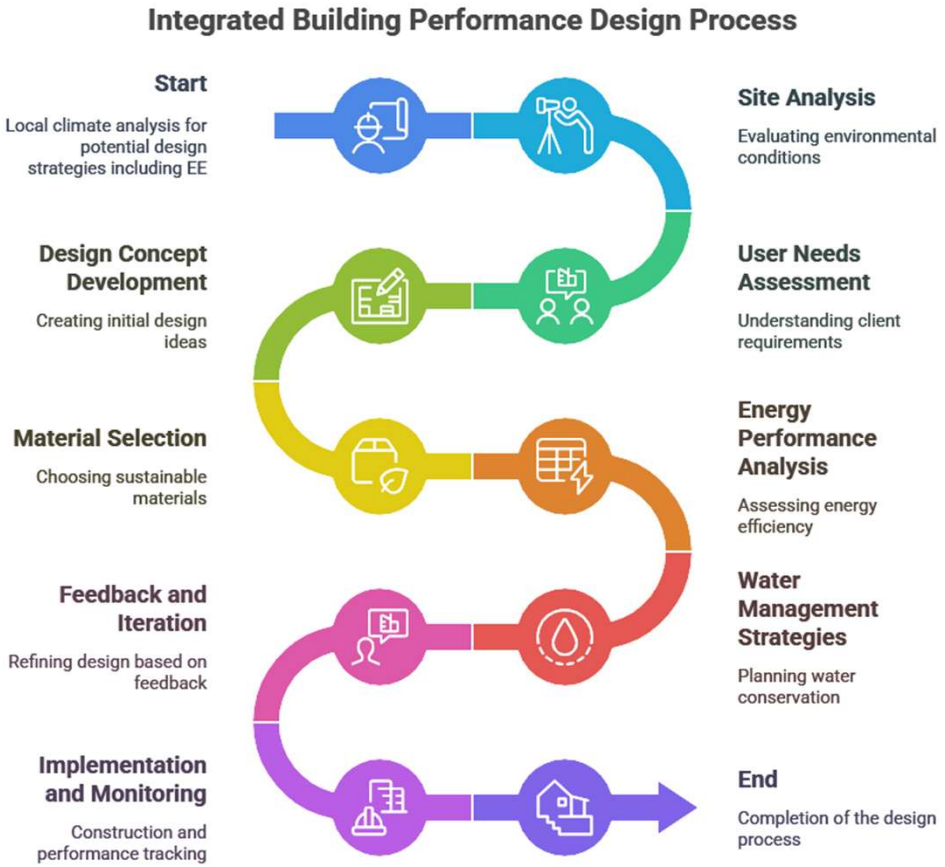
Integrated building performance design process



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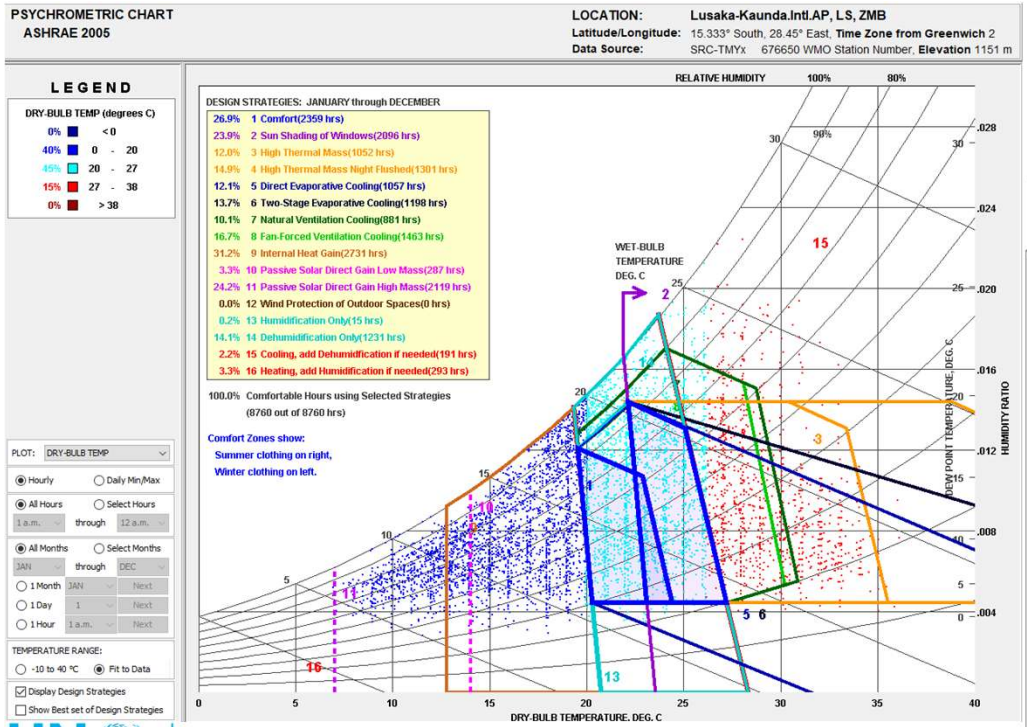
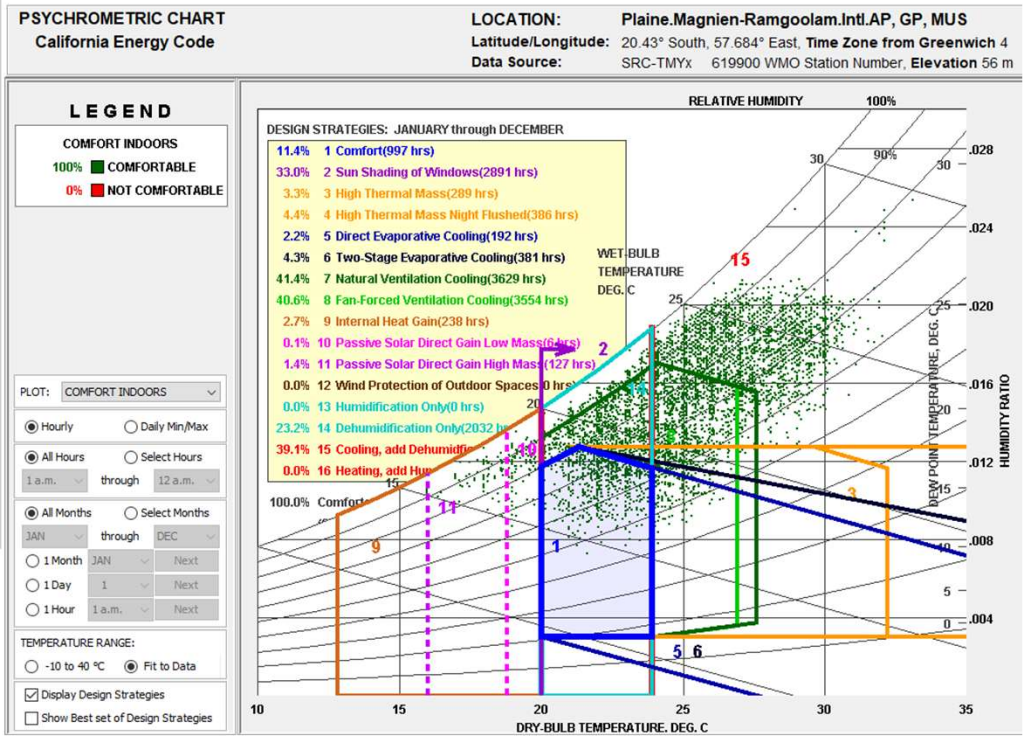
Understand the climate better: find the potential of EE as climate adaptive architectural design strategies





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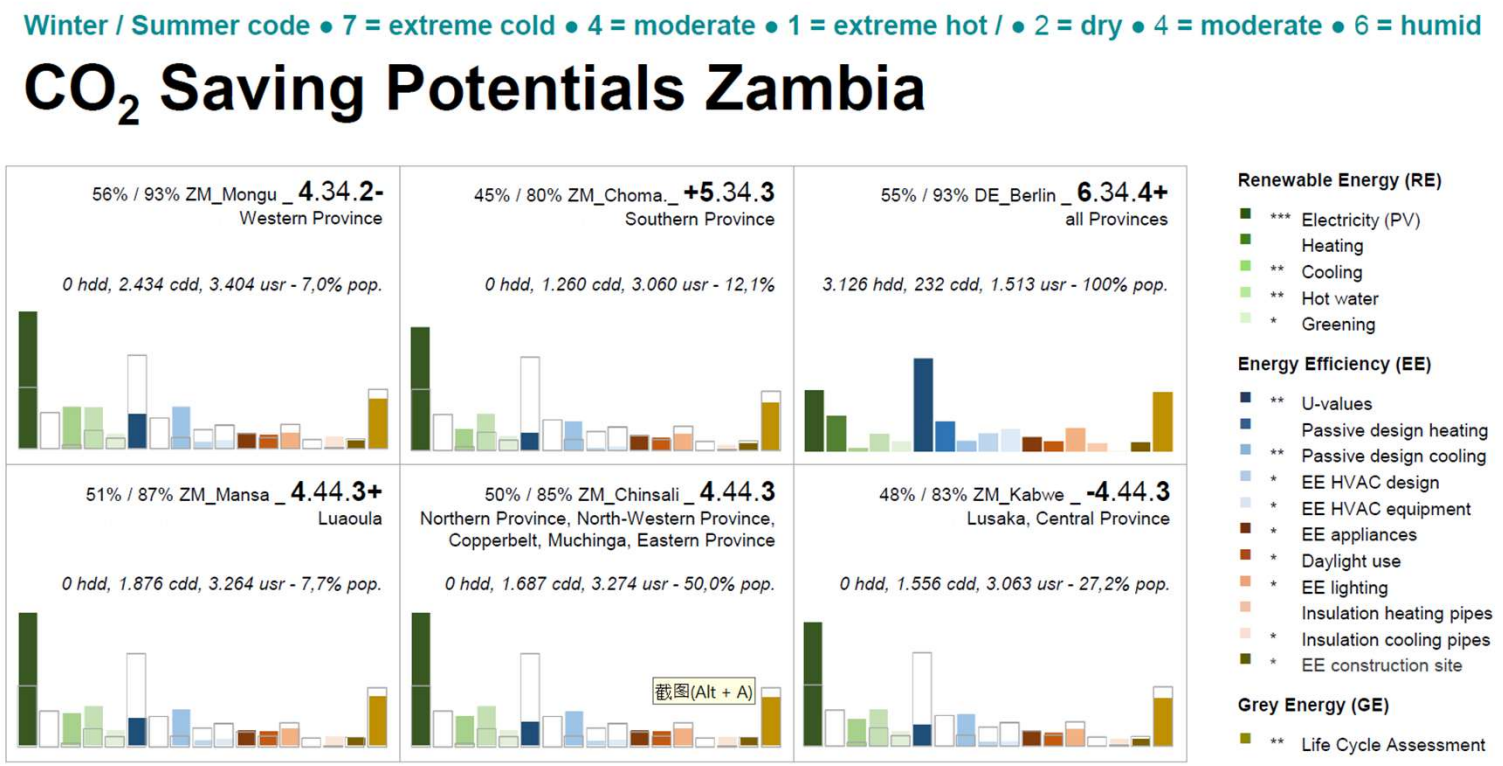

Source: Building decarbonization tool developed by Mr. Thilo Cunz, Germany Energy Agency (dena)

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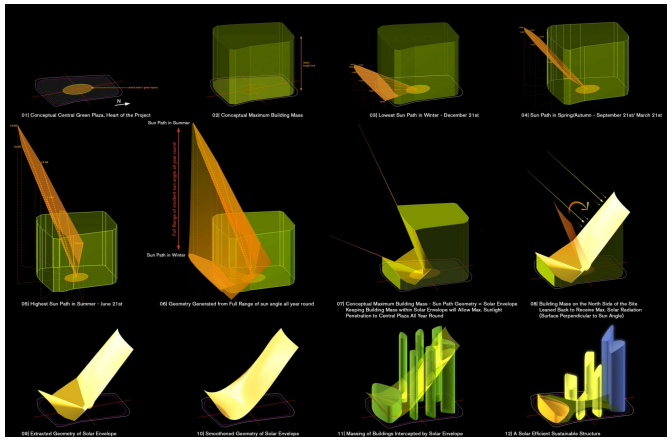

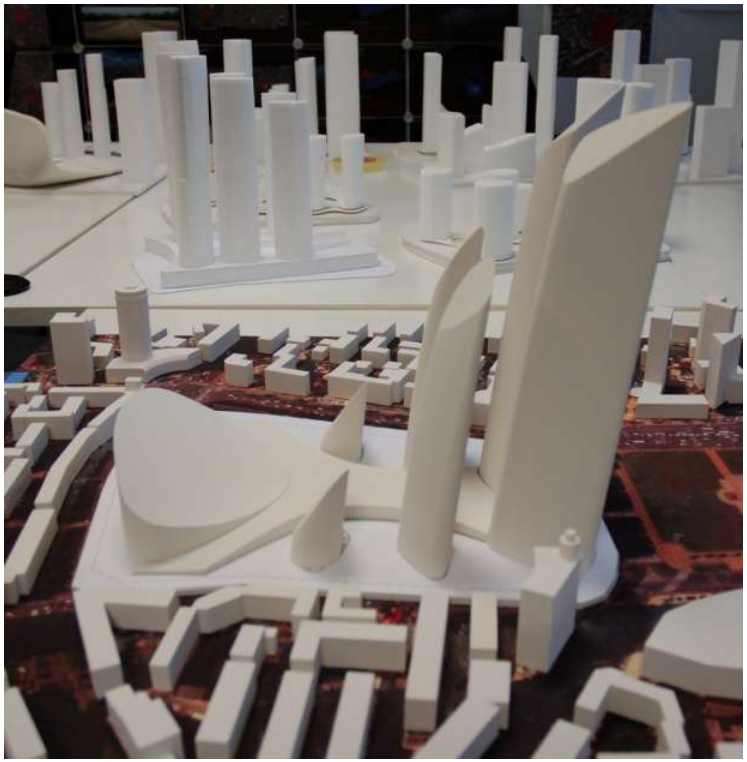

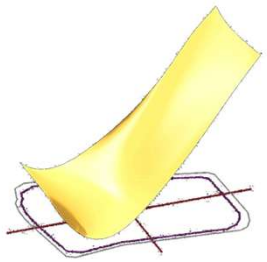

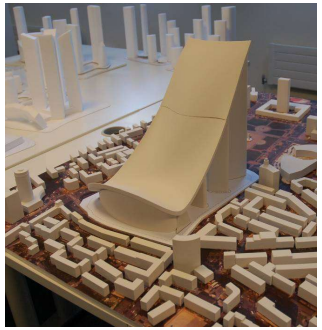

Design for sun: Maximize solar exposure for old people apartments (by Foster + Partners)

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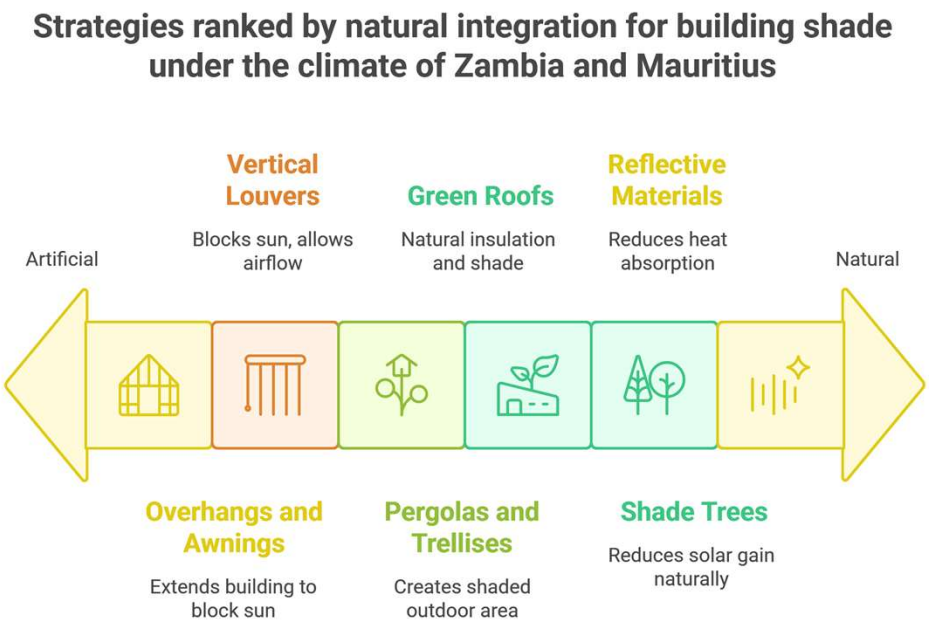
Understand the climate better: find the potential of EE as climate adaptive architectural design strategies



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Understand the climate better: find the potential of EE as climate adaptive architectural design strategies

External shading in Lusaka, Zambia

External shading in Port Luis, Mauritius

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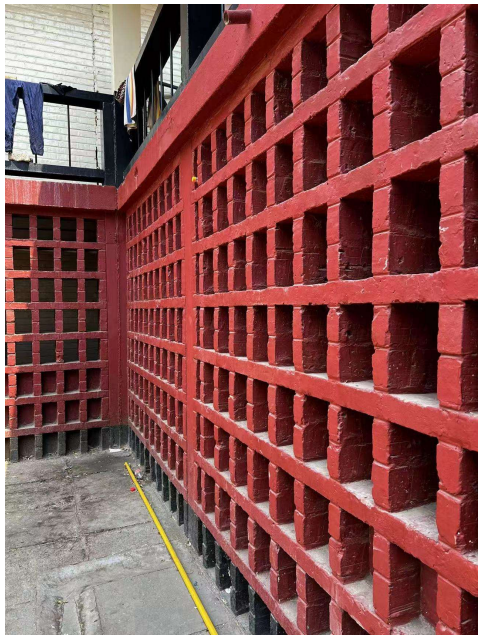
Understand the climate better: find the potential of EE as climate adaptive architectural design strategies

Shading, heavy wall & ventilation enhancement in Lusaka, Zambia



Shading, heavy wall & ventilation enhancement in Port Luis, Mauritius

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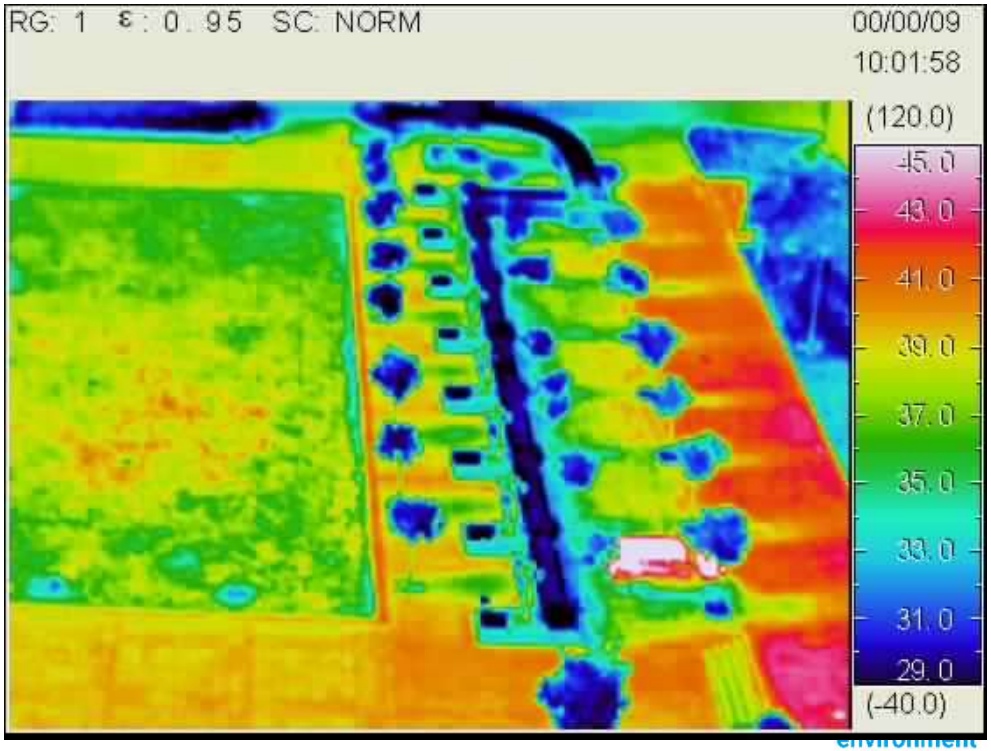
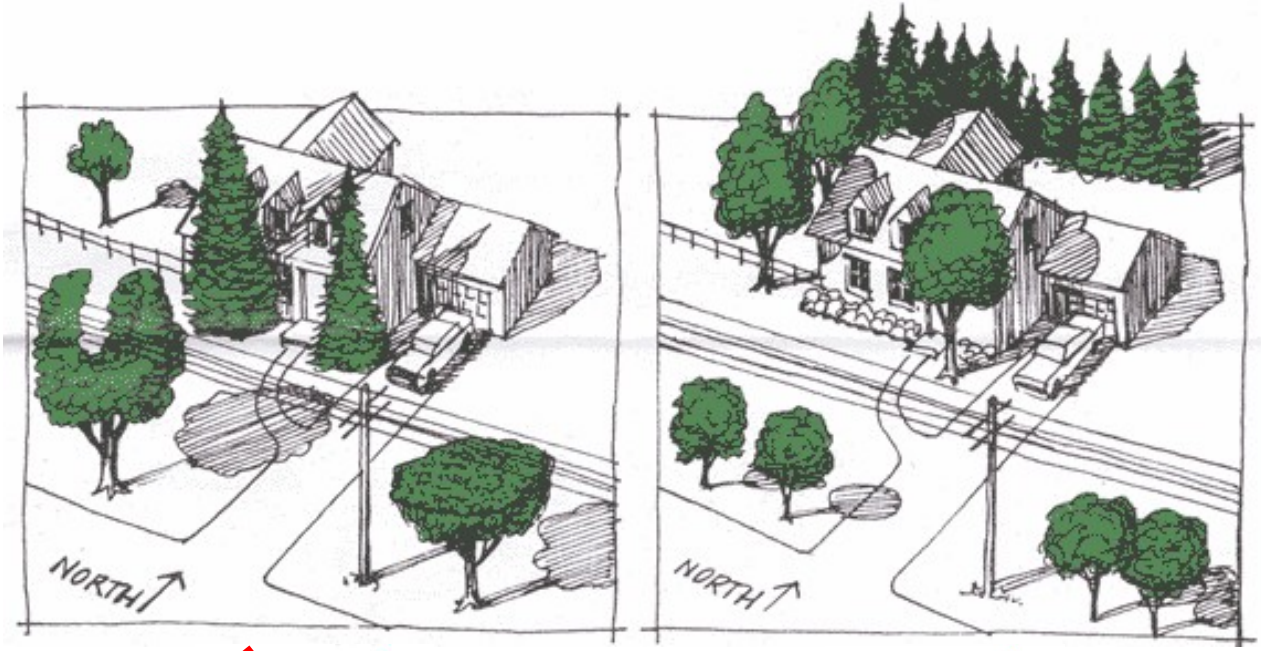
Integrated building performance design: from community-level to building level

- Outdoor thermal environment



Integrated building performance design: from community-level to building level

- Outdoor thermal environment



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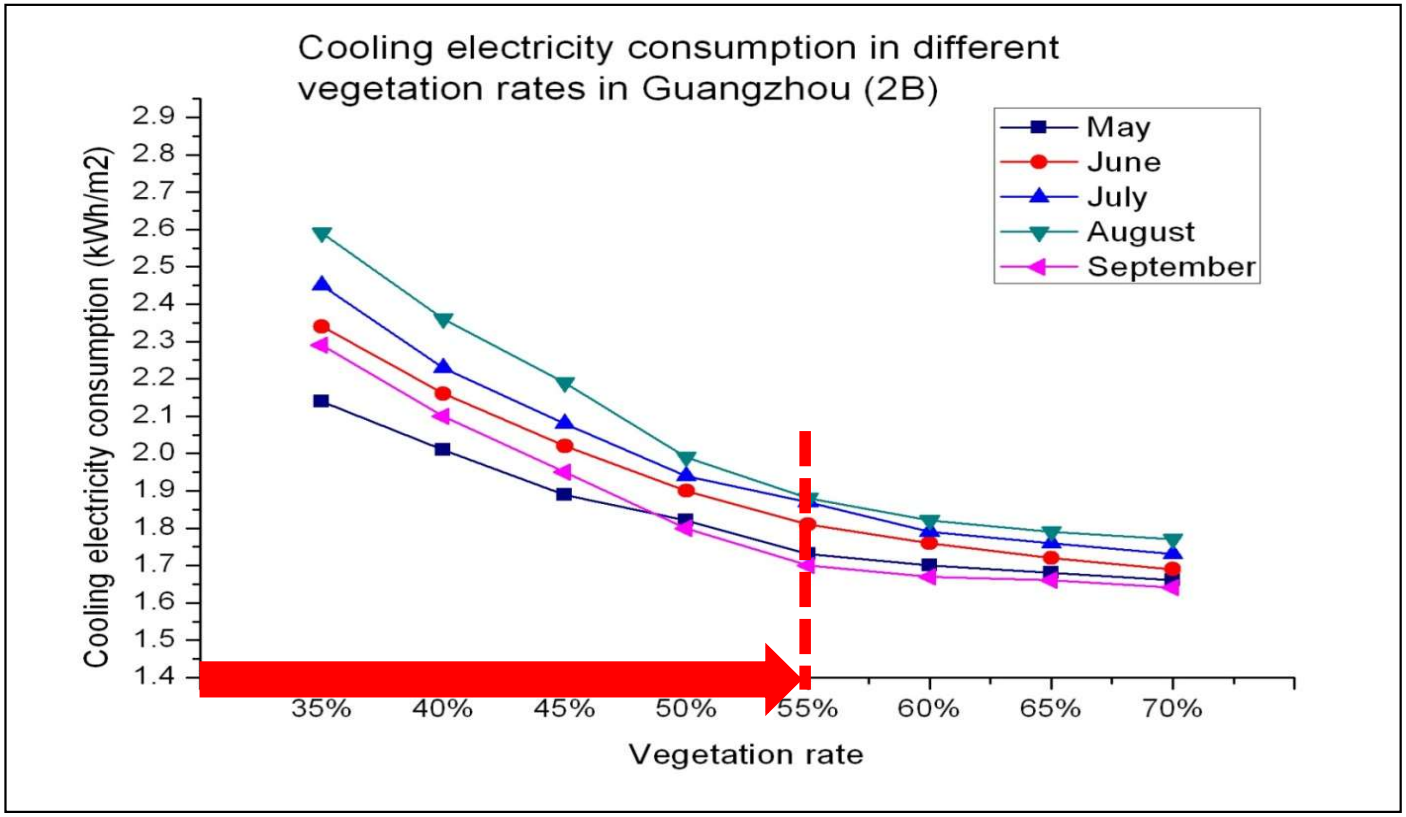
Integrated building performance design: from community-level to building level

- Impacts on energy consumption from landscaping design



Integrated building performance design: from community-level to building level

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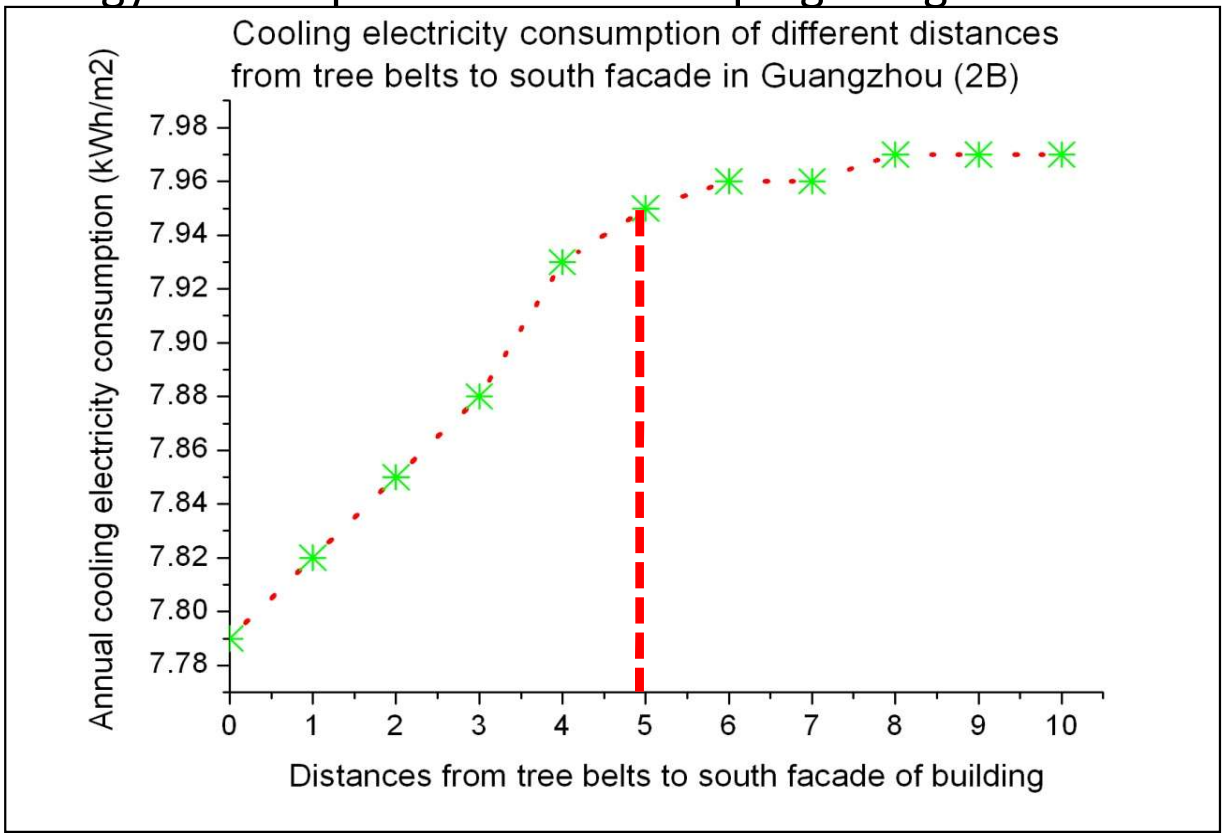


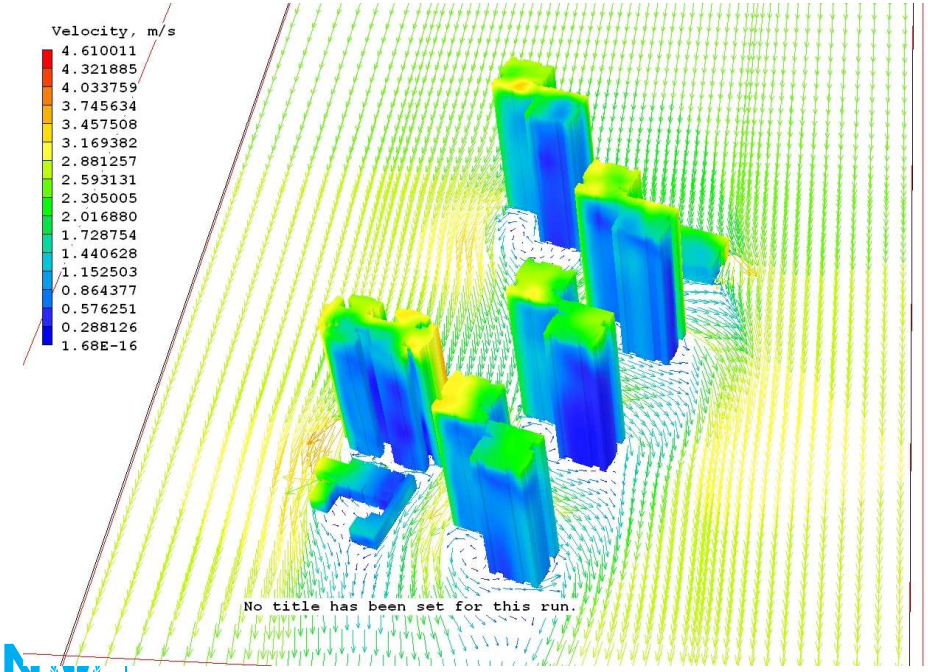
Integrated building performance design: from community-level to building level

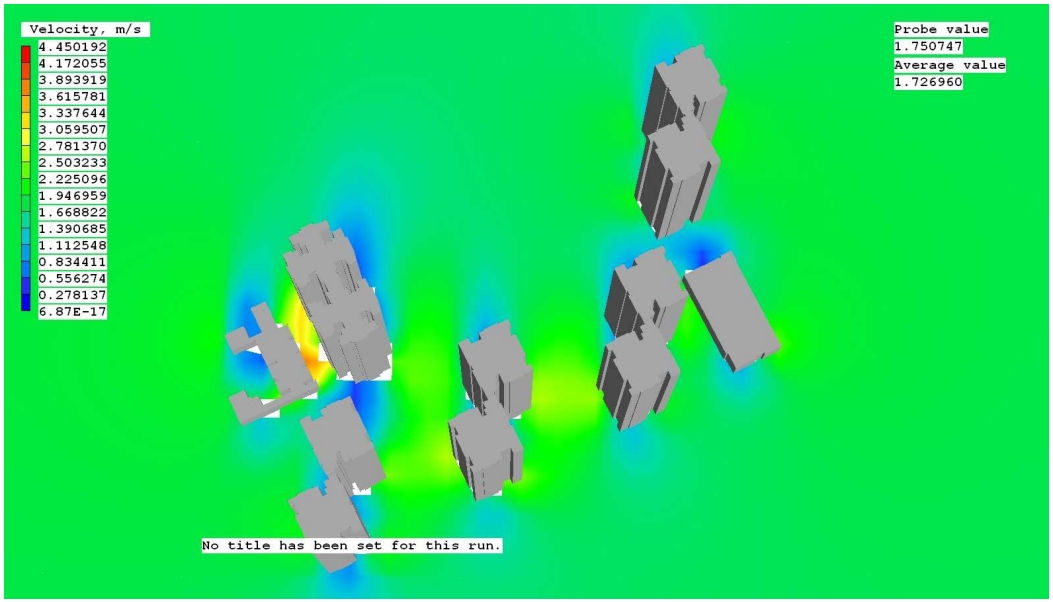
- Wind environment

External wind speed	Human comfort level
V< 5 m/s	Comfortable
5 m/s< V< 10 m/s	Slightly uncomfortable
10 m/s< V< 15 m/s	Extremely uncomfortable
15 m/s< V< 20 m/s	Unbearable
V> 20 m/s	Dangerous

Integrated building performance design: from community-level to building level

- Wind safety in winter VS. Wind comfort in summer





Probe value
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What are the analysis tools available for integrated building performance design?

- Integrated simulation tools

Ecotect, DesignBuilder, IES VE (Virtual Environment)

- Wind environment simulation tools (CFD)

ANSYS, Fluent, PHOENIX

- Building energy simulation tools

EnergyPlus, eQUEST, DeST, ESP-r

- New types of tools: BIM-based (Autodesk Insight 360)

Case Study:

Climate adaptive design in a social housing residential community

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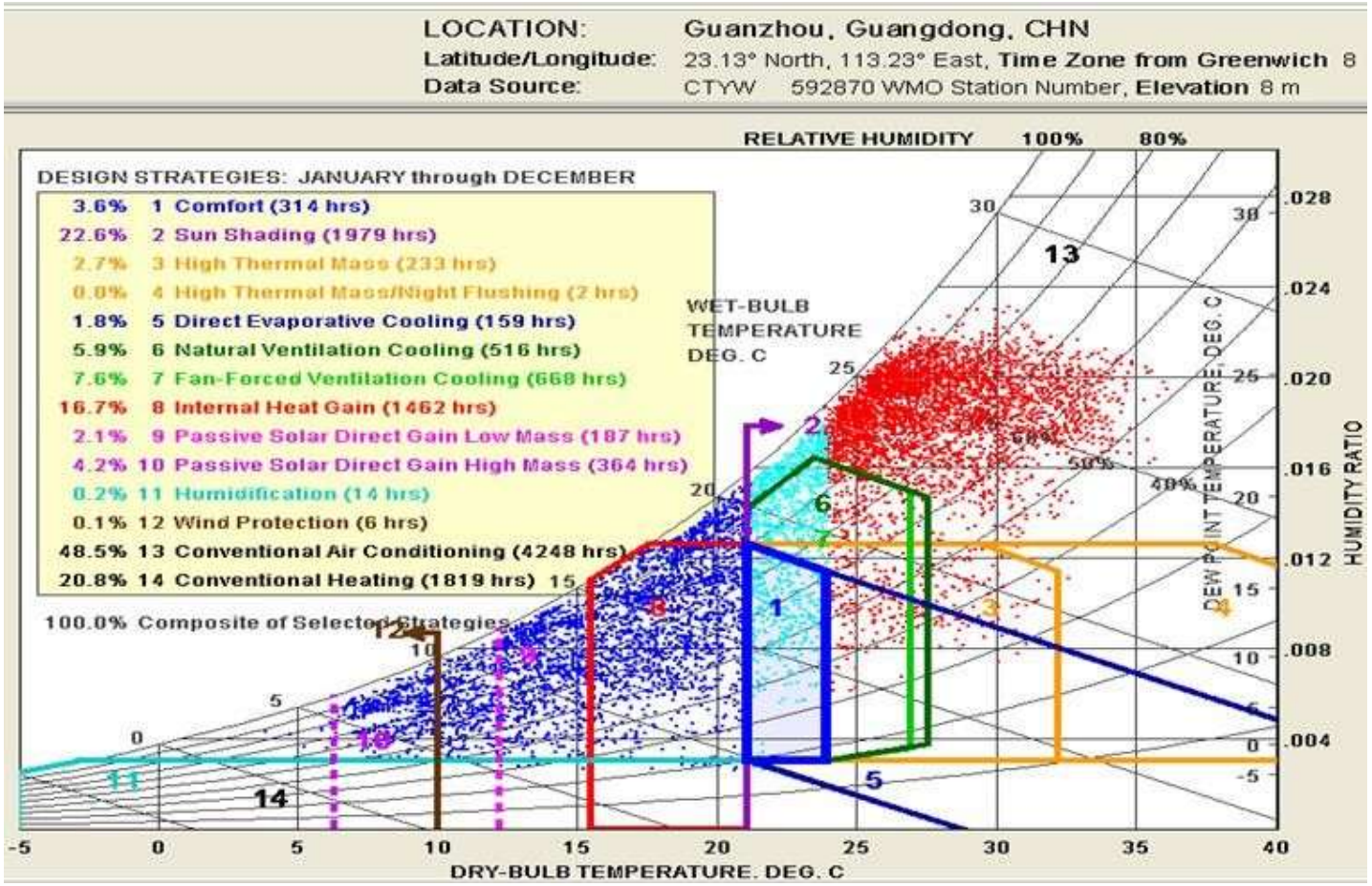
Thermal comfort design strategy in Guangzhou climate



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Integrated climate adaptive design of thermal comfort & EE

- Sino-Singapore Knowledge City in Guangzhou, China

Example: social housing community

1) Dual green building certification
2) Planned: 2005-2006
3) Design: 2007-2008
4) Construction: 2009-2010
5) Voted as one of the best residential communities for living in south China 2015
6) Built-up area: 220,000 sq. meters
7) Land: 57,000 sq. meters

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Integrated climate adaptive design of thermal comfort & EE

- General challenges on balancing thermal safety, thermal comfort/health & EE on the site:
  - How to prevent the big sunshine in summer while keeping the same built-up areas
  - How to have sufficient sunshine in winter for living rooms and bedrooms in the purpose of health, especially for old people
  - How to control the external wind speed in winter under 1.2m/h for safety, especially surrounding primary school and kindergarten
  - How to ensure the wind comfort during the hot-humid summer time in exterior spaces around the buildings and interior spaces inside the buildings

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Integrated climate adaptive design of thermal comfort & EE

- Challenges for master planning:

1) How to locate the 10 high-raising residential buildings as a balance among apartment amount, outdoor/indoor comfort and cooling saving?
2) Where to locate the primary school and the kindergarten regarding higher requirements for thermal/wind safety and comfort?

- Challenges for architectural design:

1) How to design the shape of buildings to provide potential and additional shading in summer while sufficient sunshine in winter?
2) How to make natural ventilation both indoor and outdoor possible in summer while assuring the winter wind velocity in the safe range?

Integrated climate adaptive design of thermal comfort & EE

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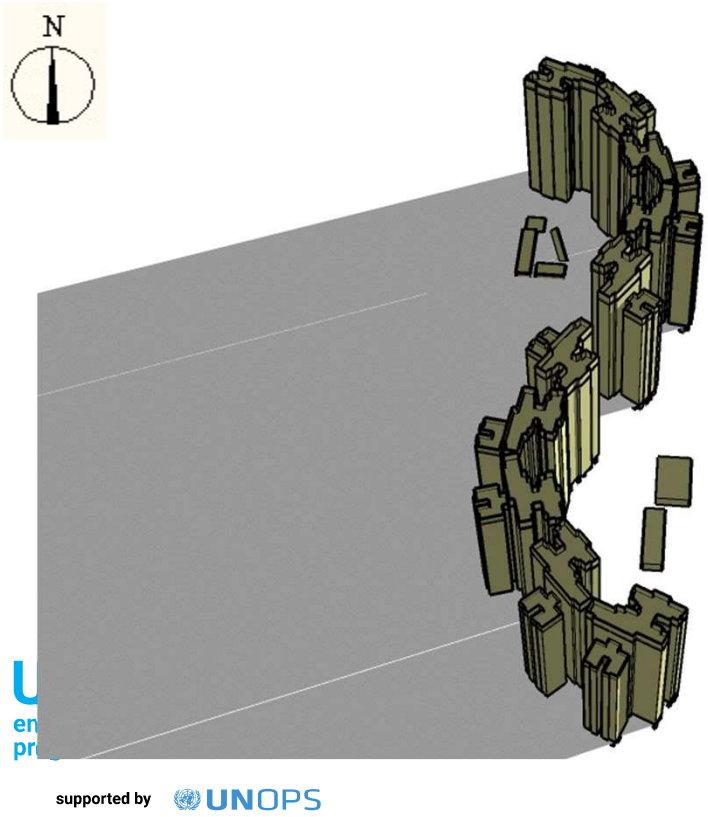
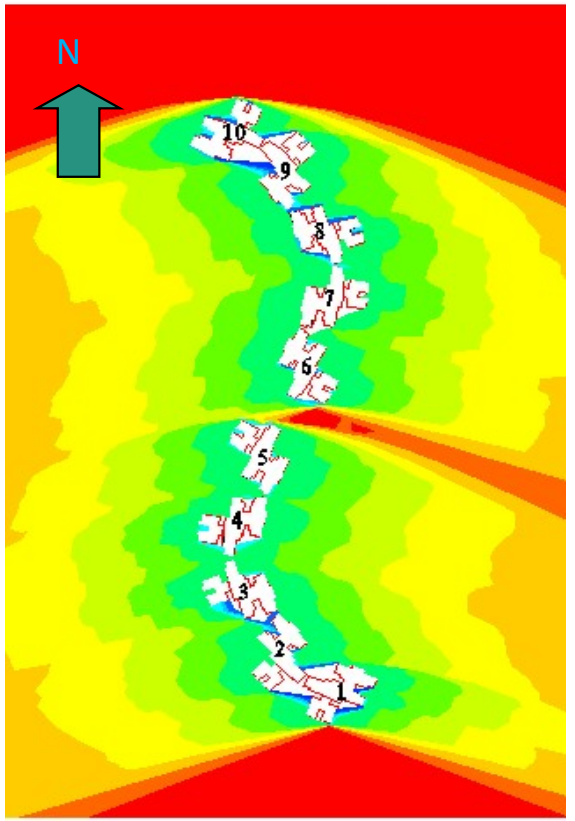
Integrated climate adaptive design of thermal comfort & EE

- Sunshine simulation-Summer





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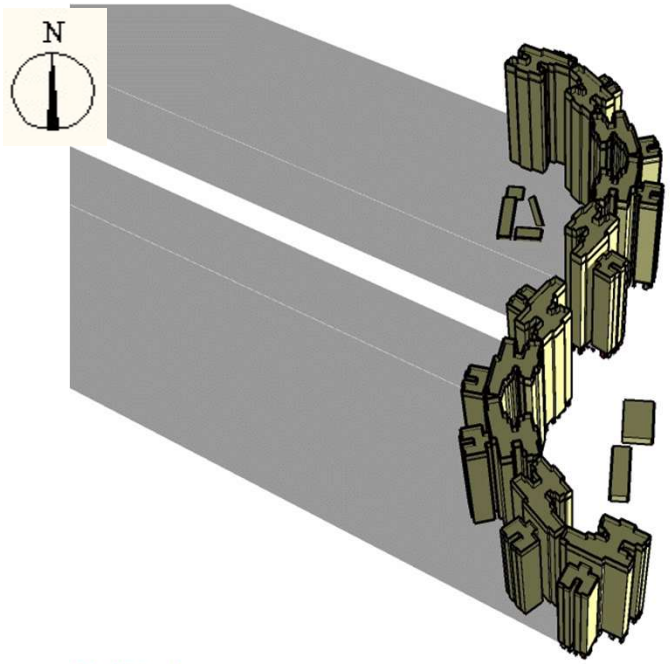
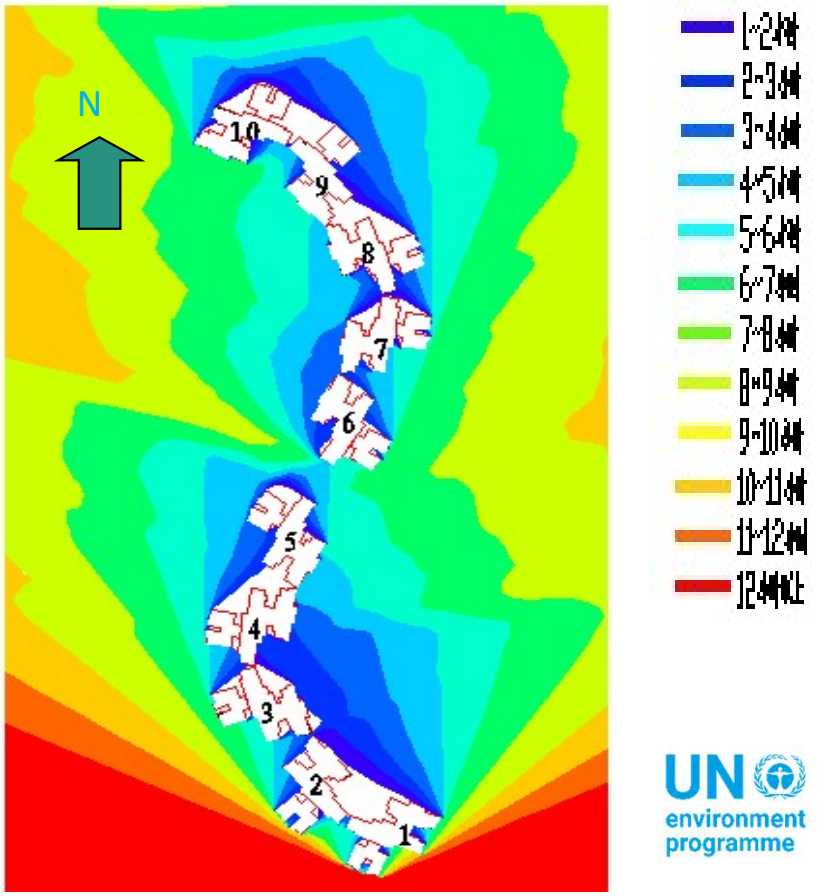
Integrated climate adaptive design of thermal comfort & EE

- Sunshine simulation- Winter





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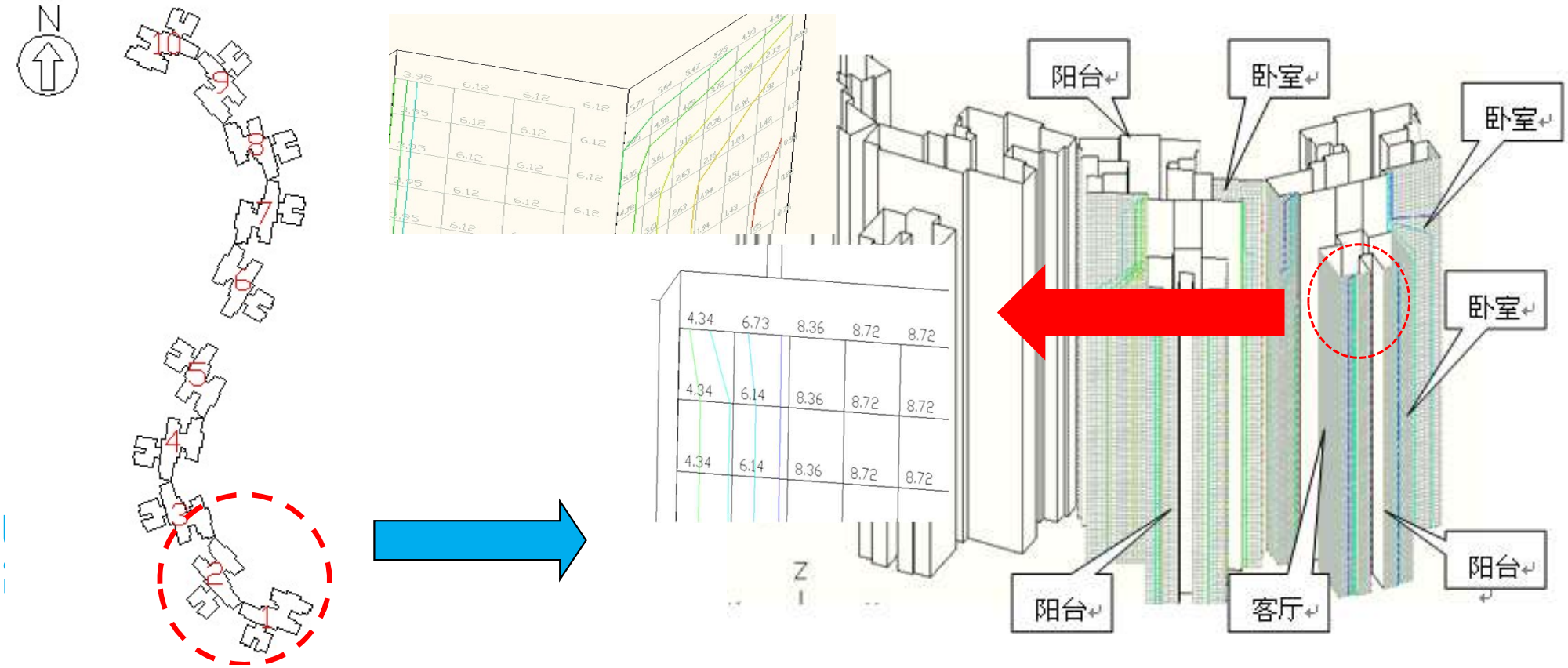
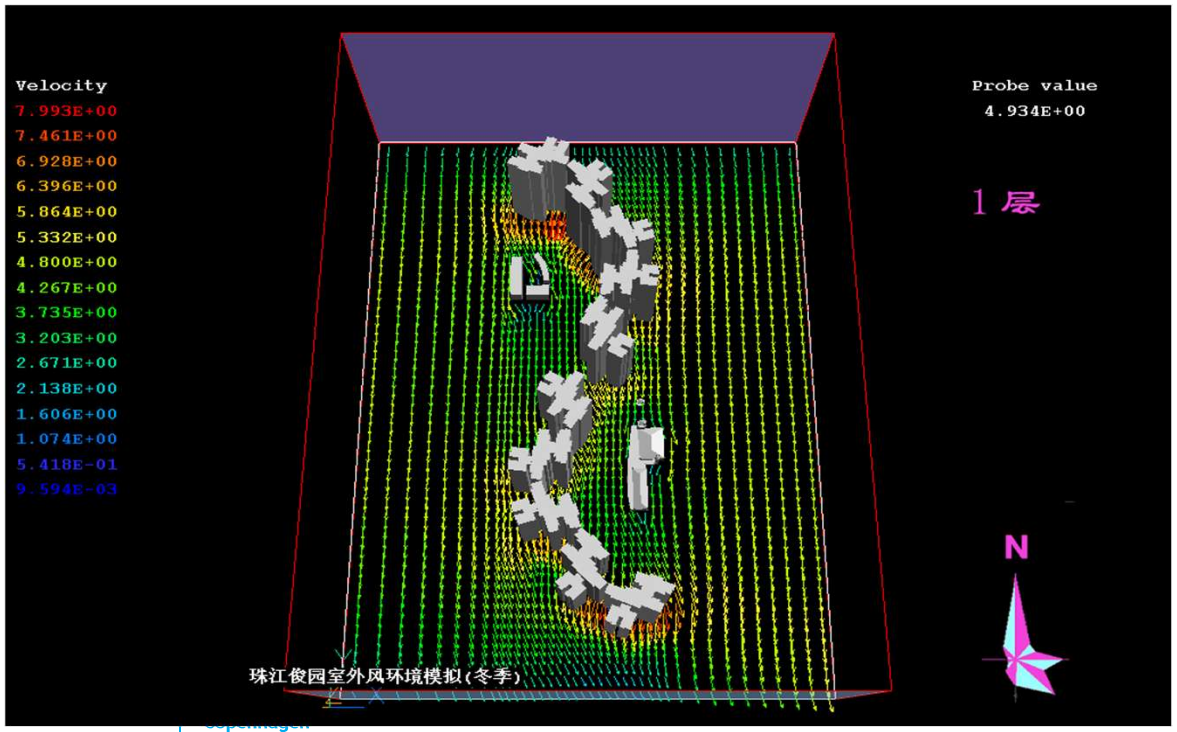
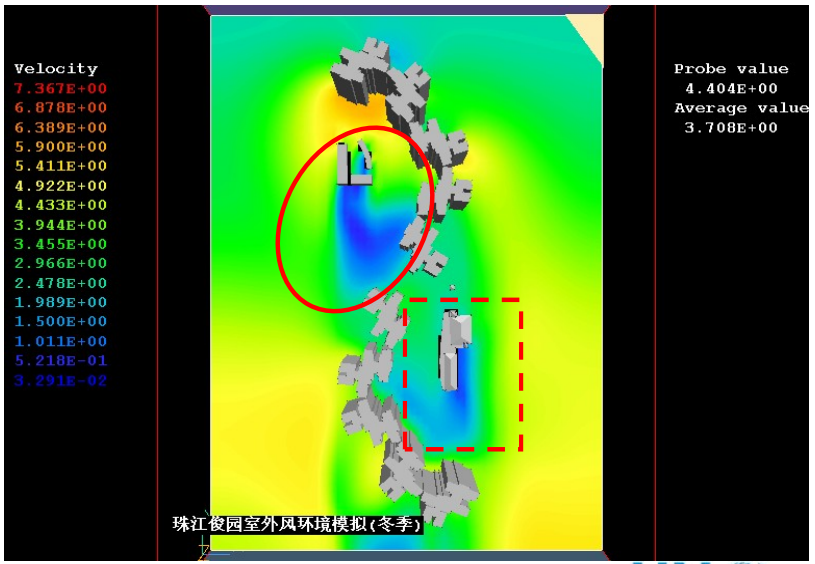


Integrated climate adaptive design of thermal comfort & EE

- Exterior wind environment simulation-Winter





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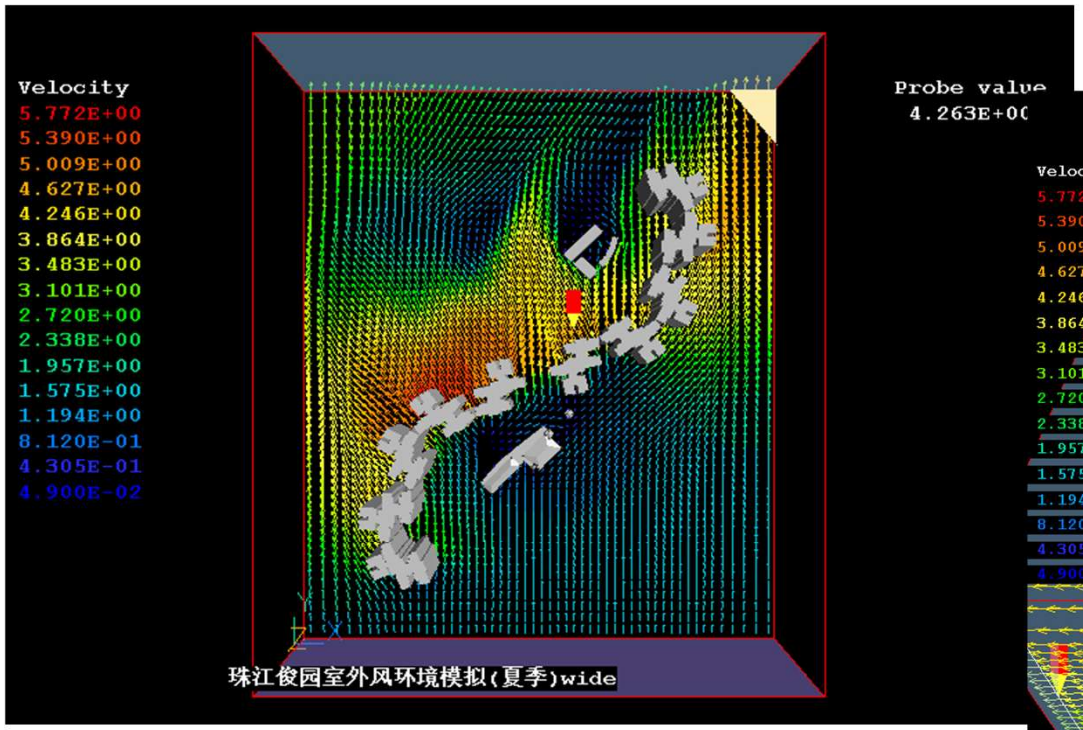
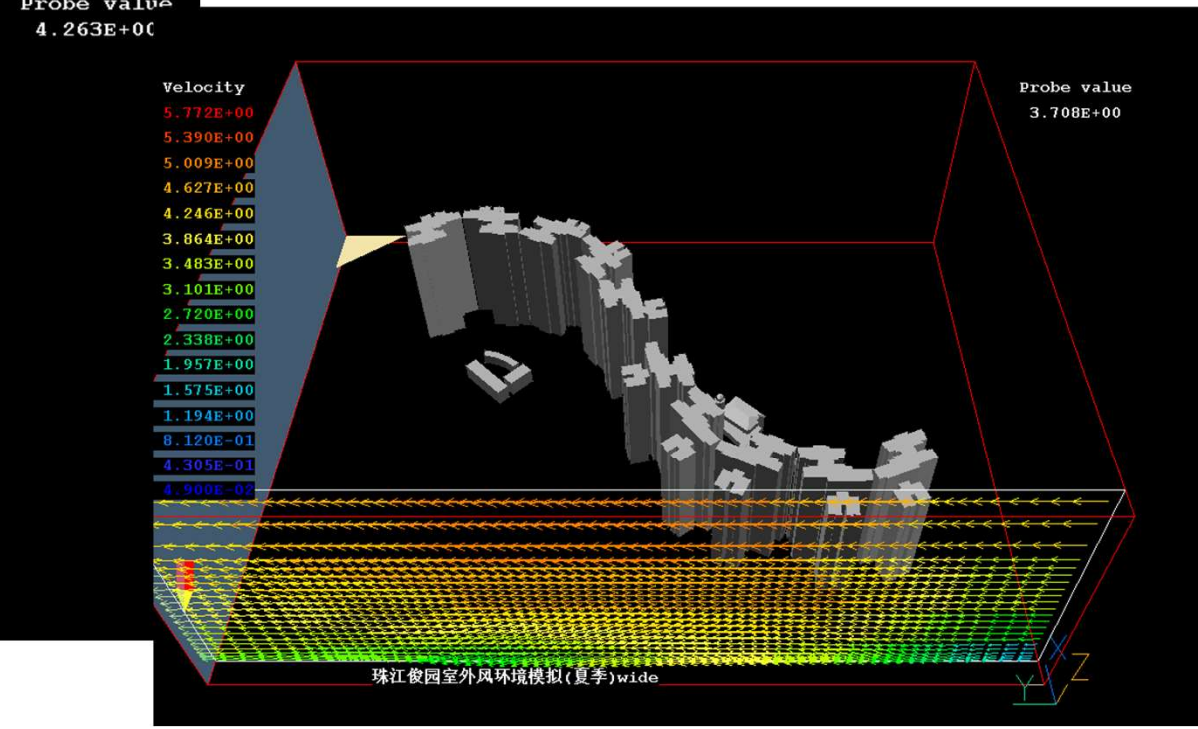
Integrated climate adaptive design of thermal comfort & EE

- Exterior wind environment simulation-Summer





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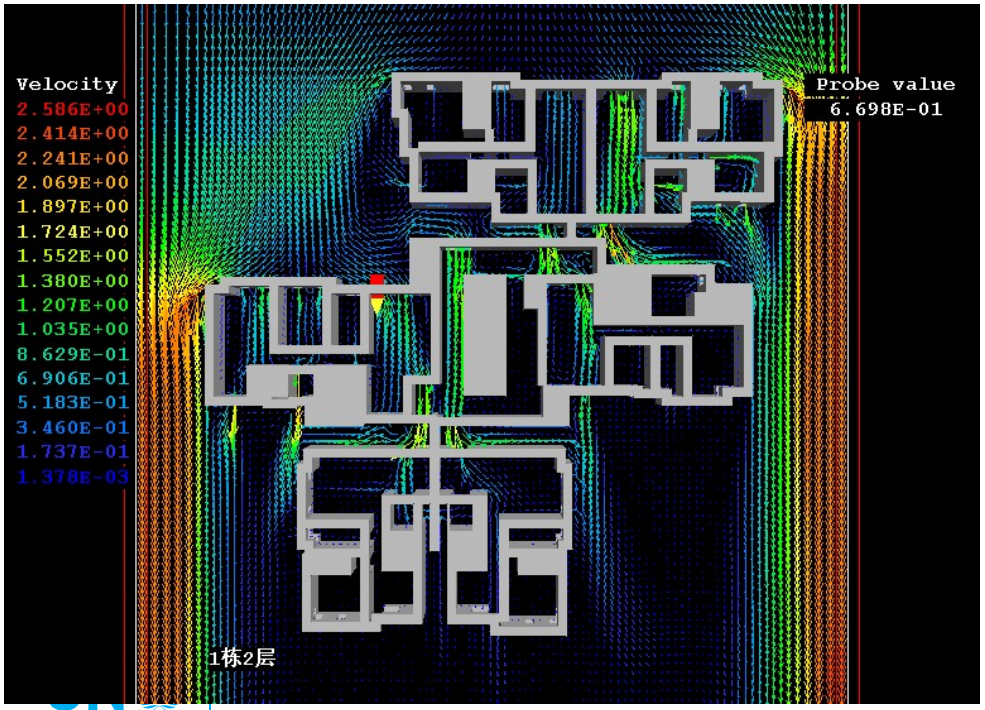
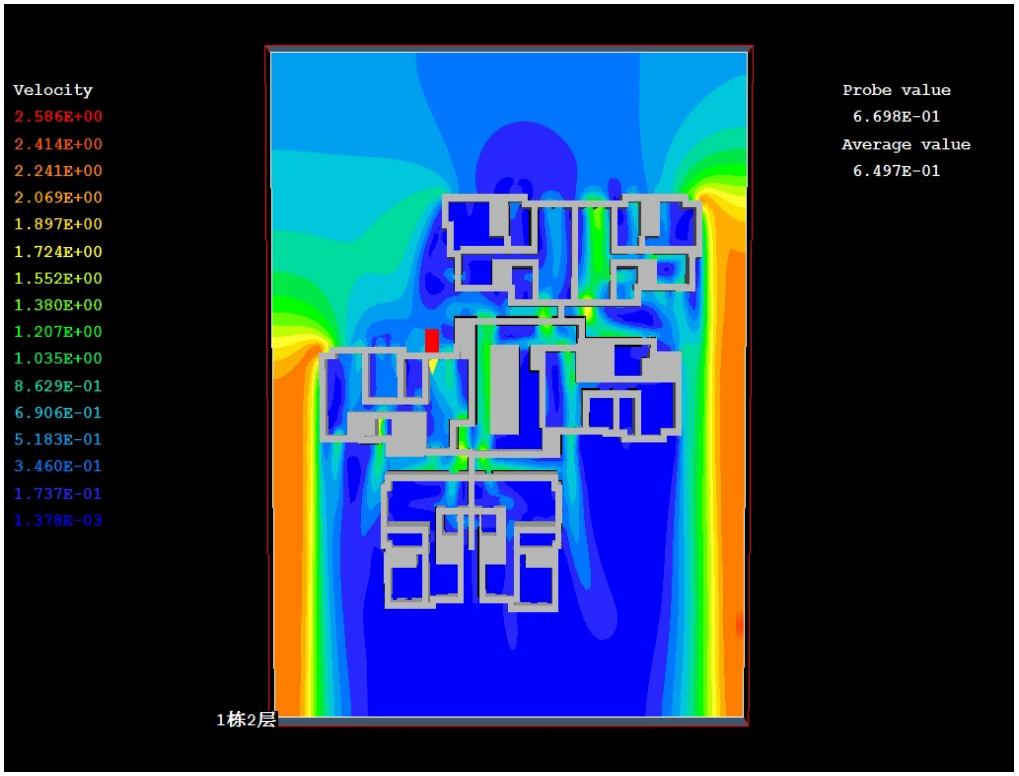
Integrated climate adaptive design of thermal comfort & EE

- Internal nature ventilation simulation-Summer





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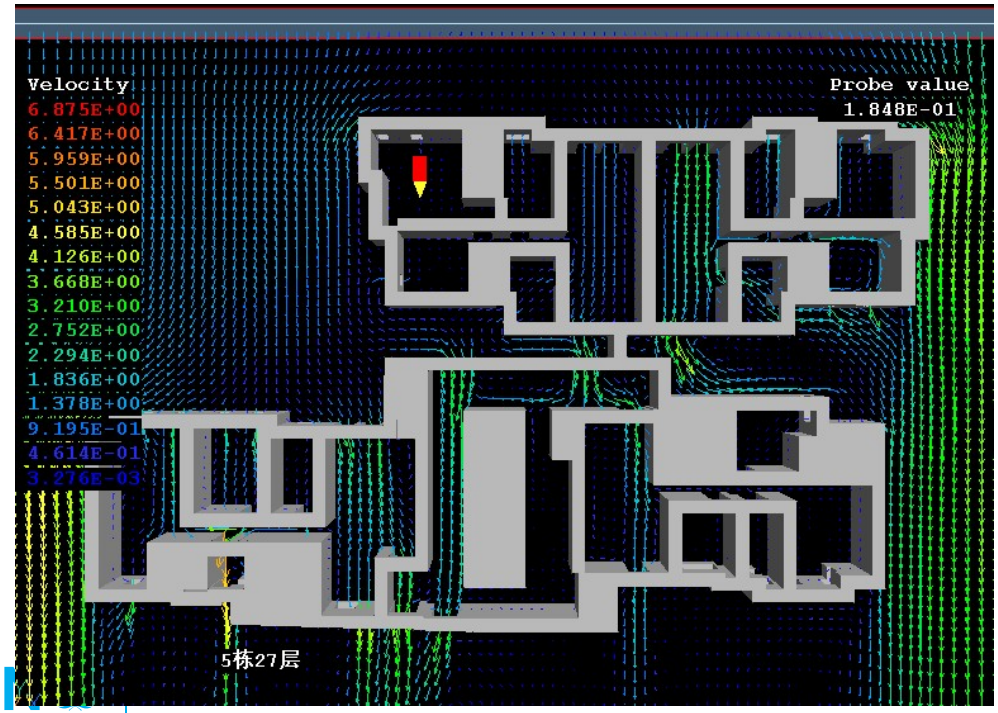
Integrated climate adaptive design of thermal comfort & EE

- Internal nature ventilation simulation-Summer



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Conclusions

- Green buildings requires to **have a systematic thinking** throughout the whole lifecycle of buildings on how to achieve good indoor air quality (health), high energy/water efficiency, and cost-effectiveness, e.g. from planning, landscaping, *architectural/MEP design*, construction, *commission, operation and maintenance*

- Health and energy efficiency are **two important features** in green building/community systems

- Energy efficiency improvements are **inherently** health improvements but need to combine with other components on top of energy systems to bring in multiple benefits. Thus, it requires **systematic and integrated building performance design**, which is different from the traditional design methodologies.

Thank you very much!

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