Disease Resilient nd Energy-Efficient Centralized Air-Conditioning Systems: An Overview

Webinar 2 - Disease Resilience and Energy Efficiency

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ADB TA 6563

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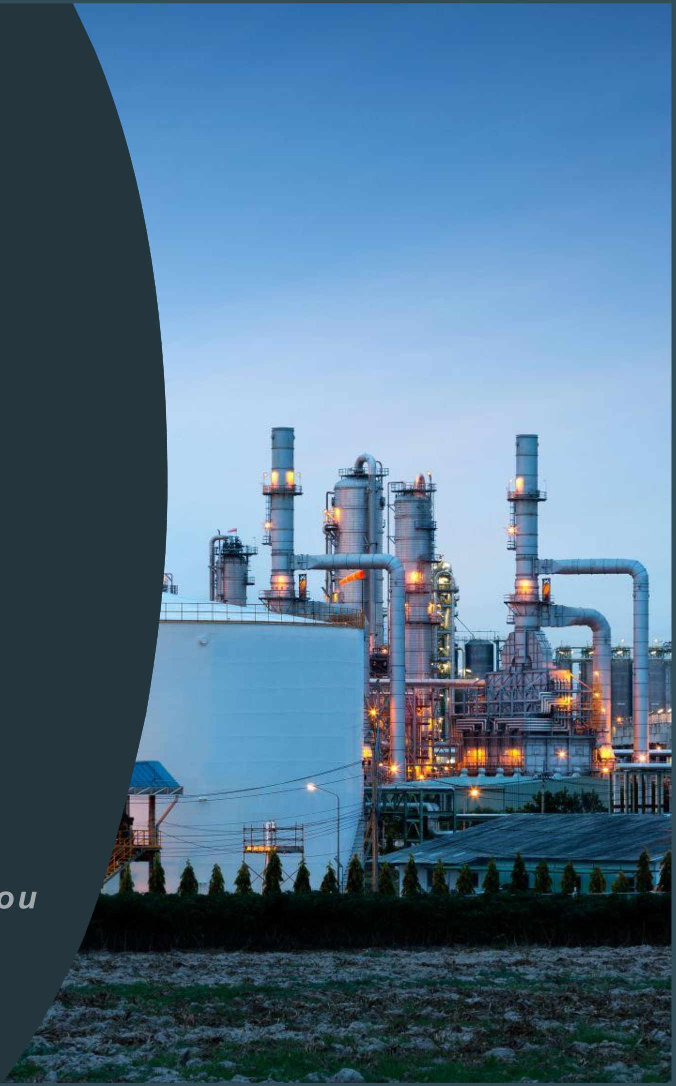

Disease Resilient and Energy-Efficient CAC Systems

- Introduction to Building Energy-efficiency
- Energy efficiency strategies
- Disease resilience of CAC system
- Summary

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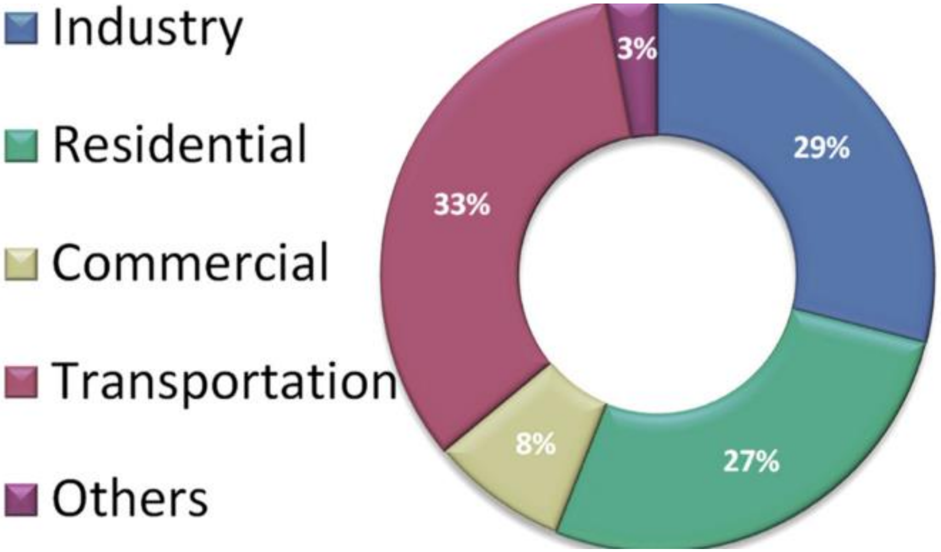
Introduction to Building Energy-efficiency

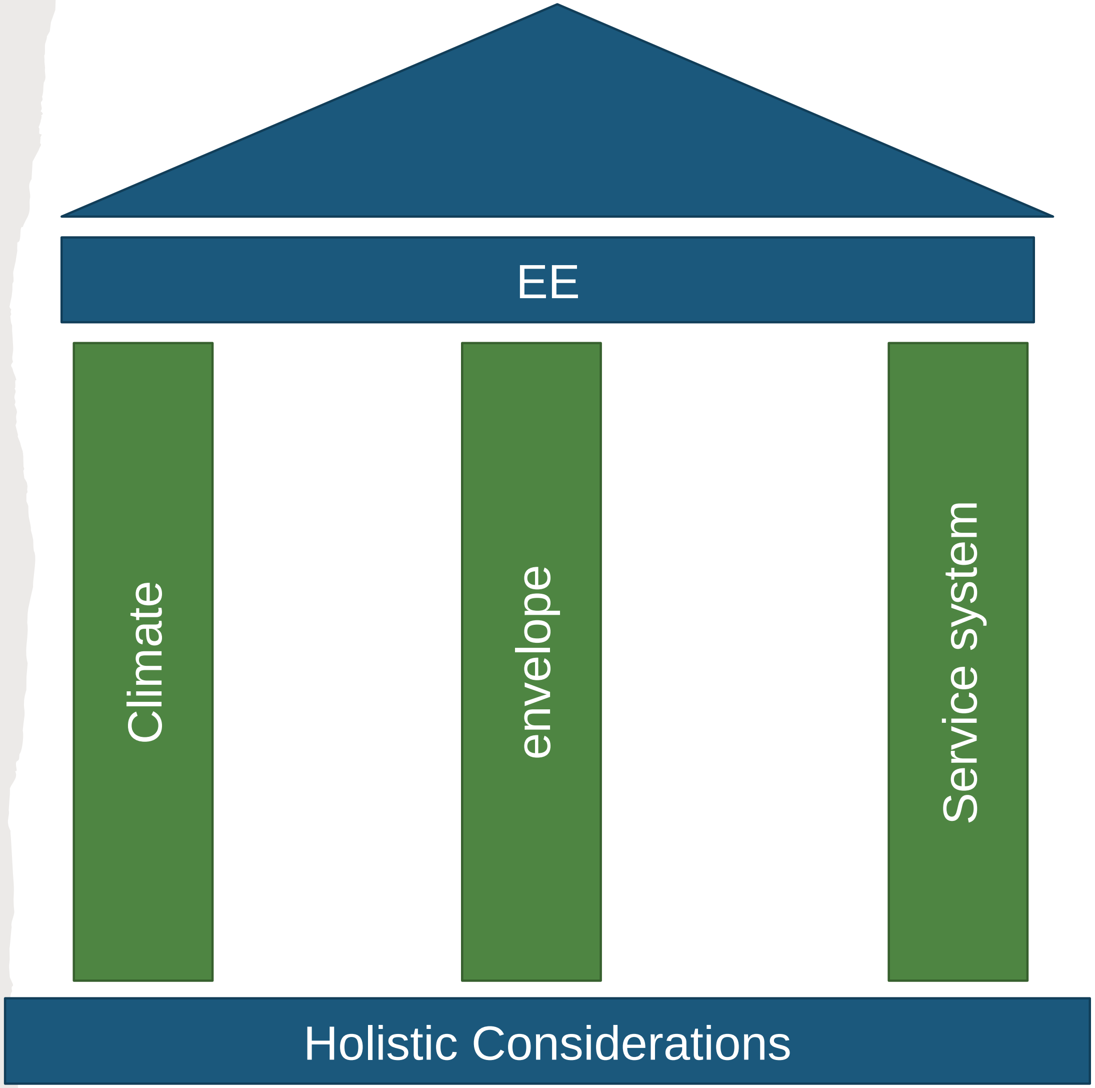
- The building section accounts for more than 30% of primary energy consumption around the world



Source: Laustsen, Jens. Energy Efficiency Requirements in Building Codes, Energy Efficiency

Introduction to Building Energy-efficiency

- Three Pillars of energy efficiency
- To improve building energy efficiency, all the three aspects should be integrally considered



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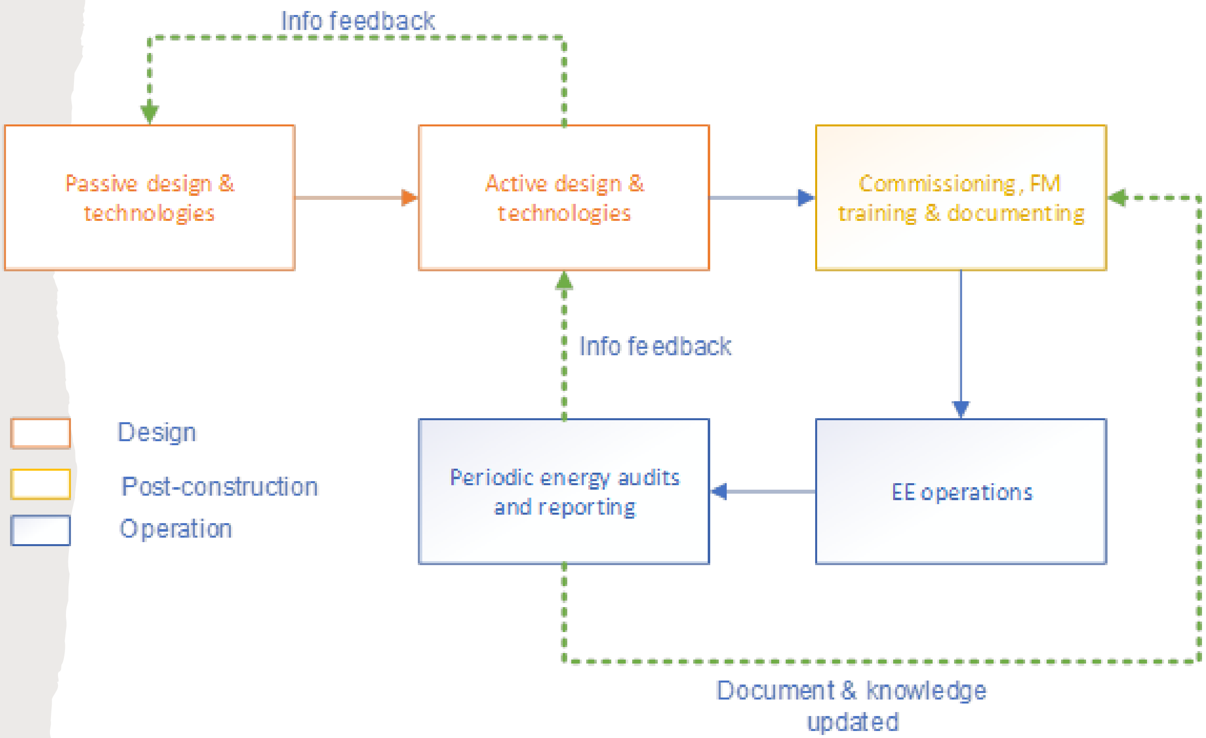
Energy efficiency strategies

- **Methodology :**

- Energy efficiency in buildings is a life-cycle process from design, construction, and operation, of which the design phase is very important, and retrofitting of building structure and mechanical systems usually requires significant cost and effort.
- It is a topic that needs to be addressed throughout all phases of a building's life cycle



Source: Yanping Zhou, Assessment report on energy-efficiency, 2021

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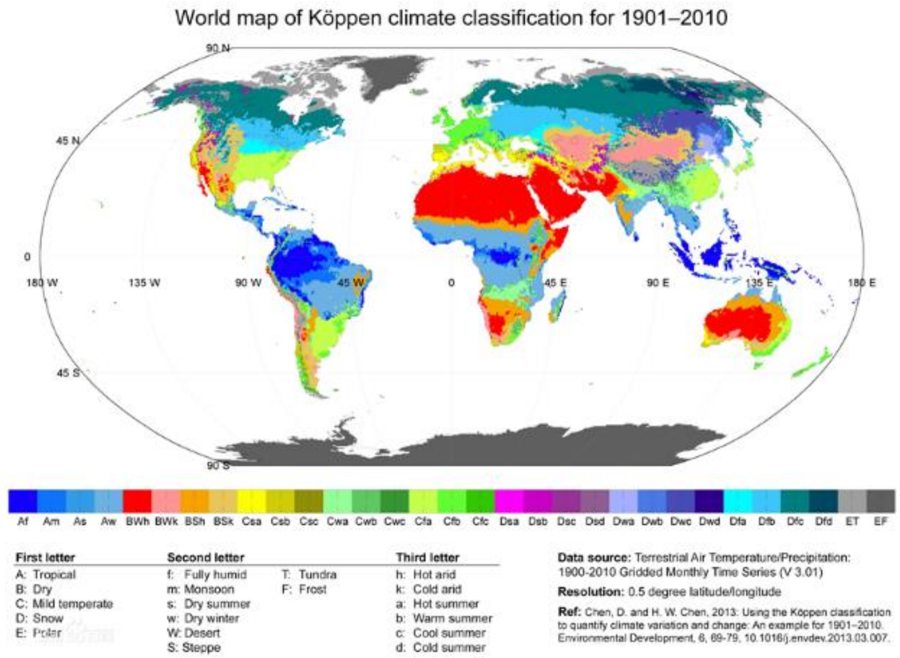
Energy efficiency strategies

- **Climate :**

- World climates according to Köppen's Classification



Source: Deliang Chen, Hans Weiteng Chen, Using the Köppen classification to quantify climate variation and change

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Energy efficiency strategies

- **Climate :**

- A good technology roots in a local climate condition , that is however developed according to state of art norms acknowledged by the practitioners in building industry

- Map of Köppen's Classification

Major group	Criteria
A: Tropical	An average monthly temperature higher than 18℃ (64.4°F.) Annual precipitation exceeds 1,500 millimeters in this zone. High humidity levels and warm temperatures result in frequent, almost daily occurrences of cumulus or larger cumulonimbus cloud formations.
B: Dry	The complete absence or extremely low levels of annual precipitation. The very dry atmospheric conditions are the result of the combined evaporation and transpiration levels which in total exceed the total amount of precipitation. Vegetation is sparse or completely absent as a result of the dry climate with insufficient precipitation.
C: Temperate	Warm summers with high levels of humidity and mild winter seasons. The warmest month is at least 10℃ (60°F) or higher, while the coldest month is lower than 18℃ (64.4°F) but higher than -3℃ (26.6°F).
D: Continental	The average temperature of the warmest month is above 10℃ (50°F), while the coldest month is below -3℃ (26.6°F).
E: Polar	The warmest month of the year is below 10℃ (50°F). Extremely dry, with annual precipitation of less than 25 cm (10 inches).

Source: Yanping Zhou, Assessment report on energy-efficiency, 2021

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Energy efficiency strategies

- **Climate :**

- Most of the DMC countries are located in tropical and temperate climates

Major group	DMC countries
A: Tropical	Afghanistan; Armenia; Azerbaijan; Bangladesh; Cambodia; Cook Islands; Federated States of Micronesia; India; Indonesia; Kiribati; Lao People's Democratic Republic; Malaysia; Maldives; Marshall Islands; Myanmar; Nauru; Niue; Palau; Papua New Guinea; Philippines; Samoa; Singapore; Solomon Islands; Sri Lanka; Thailand; Timor-Leste; Tonga; Tuvalu; Vanuatu; Viet Nam.
B: Dry	India(middle); Kazakhstan; Mongolia; Pakistan; Turkmenistan; Uzbekistan.
C: Temperate	Bhutan; Brunei Darussalam; Georgia; Fiji; Hong Kong, China; Nepal; People's Republic of China(south); Republic of Korea; Taipei, China; Tajikistan.
D: Continental	Kyrgyz Republic; People's Republic of China(north).

Source: Yanping Zhou, Assessment report on energy-efficiency, 2021

Source: https://thumbs.dreamstime.com/

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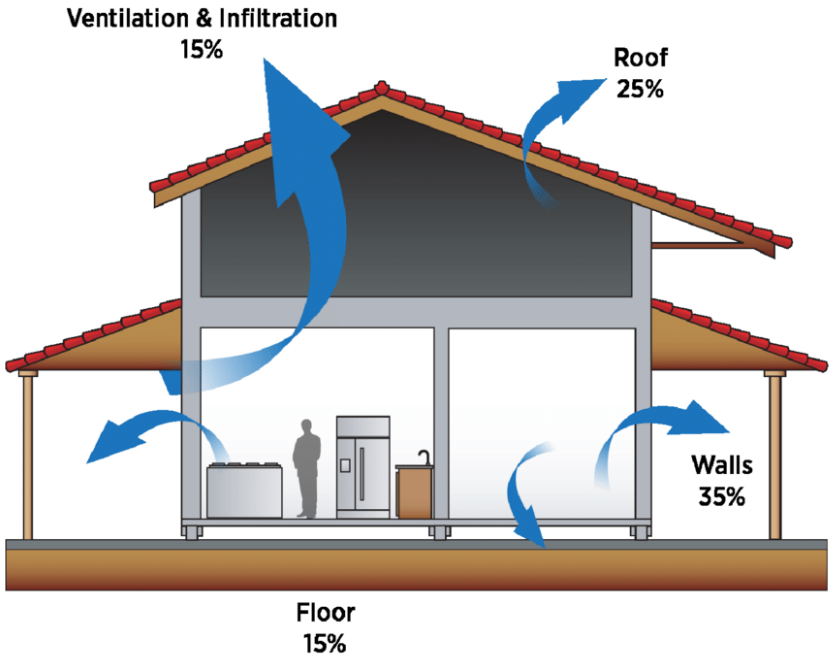
Energy efficiency strategies

- Building envelope contributes to 60-75% of the heat gain/loss

- Thermal performance depends on shape factor, heat transfer, ventilation, air tightness



Source: Laustsen, Jens. Energy Efficiency Requirements in Building Codes

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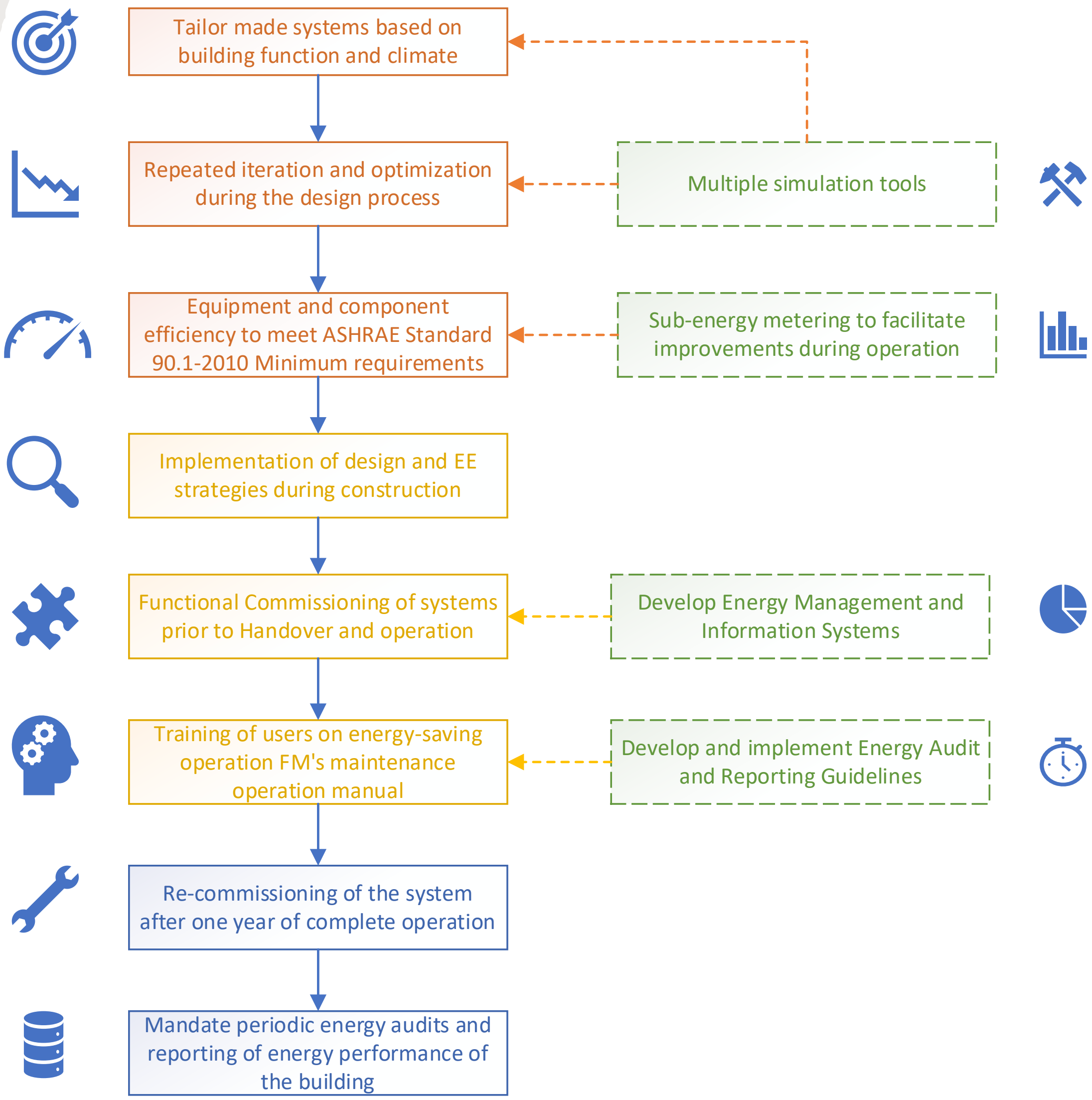
Energy efficiency strategies

- **Actions in different phases to achieve an energy efficiency target**

- ASHRAE 90.1-2010 gives the definition of building envelope parameters and equipment efficiency in several climatic environments



Source: Yanping Zhou, Assessment report on energy-efficiency, 2021

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Energy efficiency strategies

- Cooling and Heating Systems
- Renewables: natural source, implementation and maintenance costs, incentives, local regulations, and characteristics of the energy profile.
  - Solar
  - Wind
  - Wave
  - Geothermal, etc
- Hybrid systems
  - Renewables integrated with envelope
  - Energy planning on a larger scale

Source: https://www.lowcarbonbuildings.org.uk/

Energy efficiency strategies

- Energy efficiency strategies
- Some can be used nearly always, but more require careful assessment

A	B	C	D	Energy demand control via passive design	Comments
●	●	●	●	Orientation and shape factor	first steps to optimize the buildings
●		●	●	Microclimate environment	use tress, terrain, surrounding structures to improve EE
●	●		●	Roofs, facades, glazing/Window-wall-ratio	case-by-case study required
●	●	●		Shading	exterior shading design is the priority
●			●	Airtightness	critical for fresh air conditioning load
	●		●	Thermal storage envelope	dry and large diurnal range area
●	●	●	●	Natural day-lighting	recommended whenever possible
	●	●	●	Natural ventilation	not recommended for hot and humid areas
				Use energy-efficient mechanical system	
				Internal gains	
●	●	●	●	Energy saving appliances	recommended whenever possible
●	●	●	●	LED lighting	recommended whenever possible
				Energy, heating & cooling source system	
●	●	●	●	BCHP	natural gas, combined heat+cool+power demand
●	●	●	●	Fuel Cell	small facility possible
●	●	●	●	Ice storage	when electricity rate favorable overnight
●	●	●	●	Waste-Heat Absorption Heat Pumps	helpful when there is waste heat available nearby
●	●	●	●	Ground (water) source heat pump	heat should be balanced for the earth
●	●	●	●	Water loop heat pump	simultaneous heat and cool, large span, like malls
●	●	●	●	Condensing heat recovery of chiller/HP	recovered heat for domestic hot water
	●			Evaporative cooling system	dry and large diurnal range area
				Distribution sub-system	
●	●	●	●	Fresh air heat recovery	particularly effective in humid areas
●	●	●	●	Desiccant dehumidification system	effective when low-grade heat available
●	●	●	●	VFD of fans and pumps	recommended whenever possible
				HVAC system terminals	
●	●	●	●	CO2 controlled ventilation	offices /other spaces where occupancy varies widely
	●		●	Radiant systems, e.g. capillary ceiling, radiant floor	condensation control is vital
●		●	●	DOAS stand-alone fresh air systems	particularly effective in humid areas
●	●	●	●	Displacement ventilation	large and tall spaces

A: Tropical
B: Dry
C: Temperate
D: Continental

Source: Yanping Zhou, Assessment report on energy-efficiency, 2021

Disease resilience of CAC system

- Design of air conditioning systems should adapt to pneumonia and other respiratory infections
- Large open offices should be renovated quickly to flexible partitions during a pandemic

Source: https://www.appliedworkplace.co.uk/blog/office-partitions-flexible-office-solutions/

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Summary

- Reducing carbon emissions has important implications for the current rapidly deteriorating global climate
- In DMC countries, a 20% improvement in energy efficiency over local standards is often easy to achieve
- The design should also integrate a special chapter to cover its disease resilient capabilities, which only makes sense when the flexibility can be included in the very beginning of new buildings.

Source: https://img.thedailybeast.com/

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Thank you

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