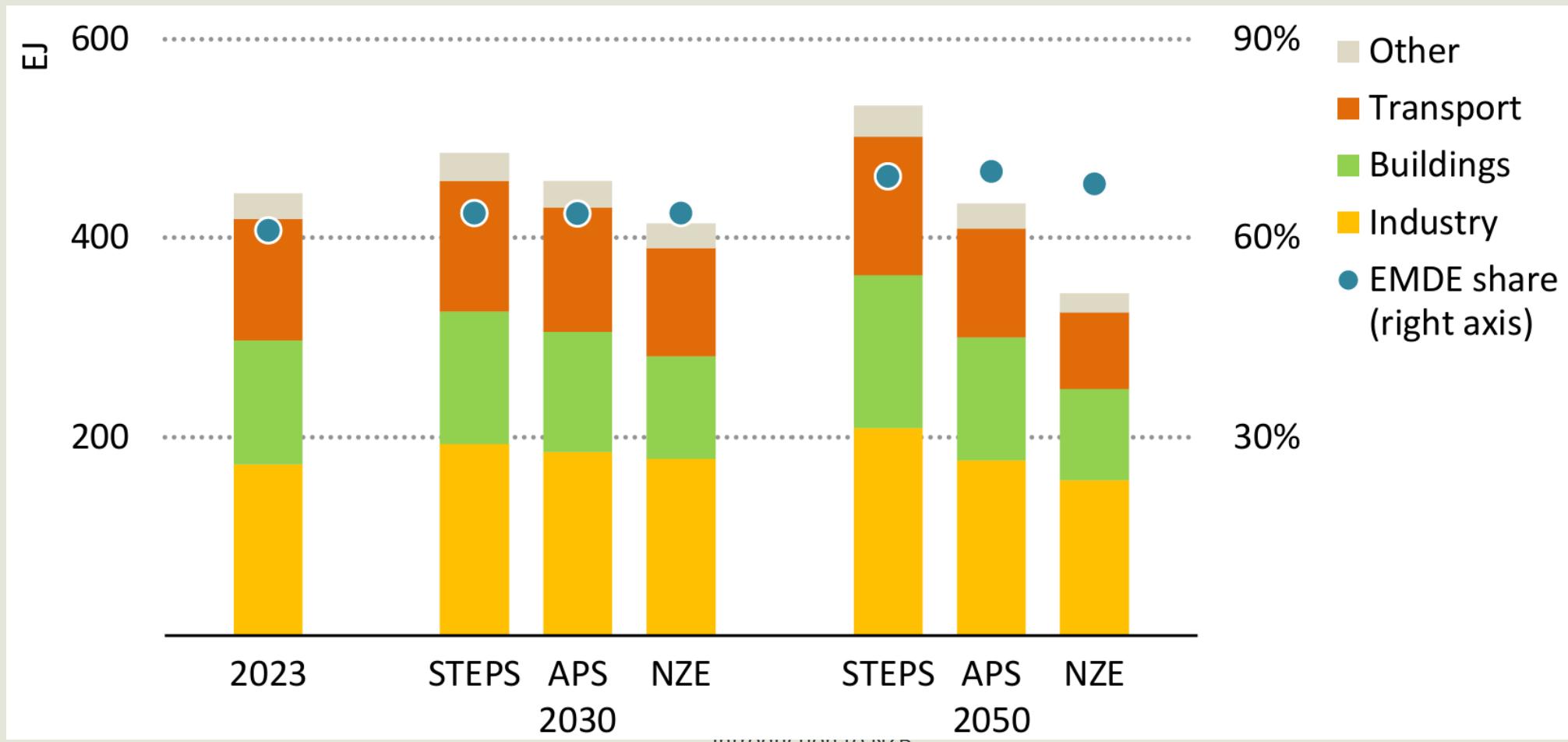


EN 410

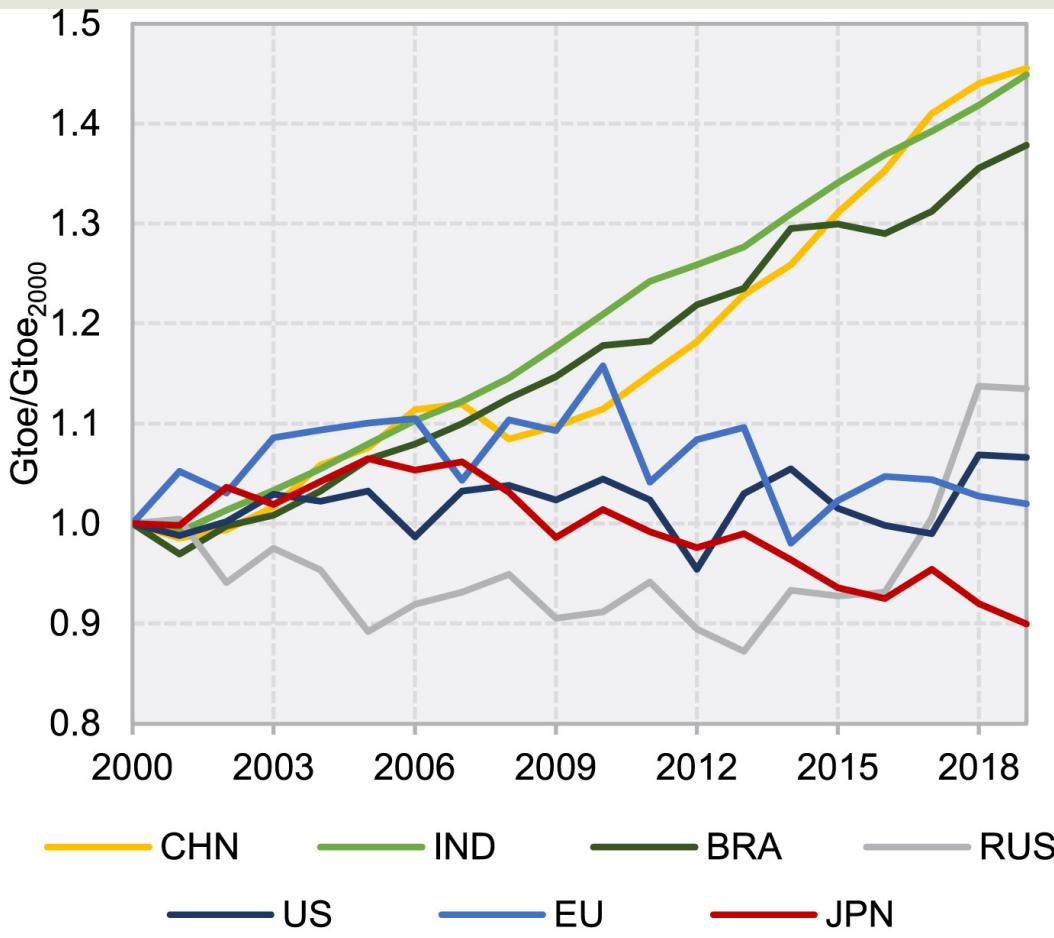
Energy Management

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Energy demand across sectors

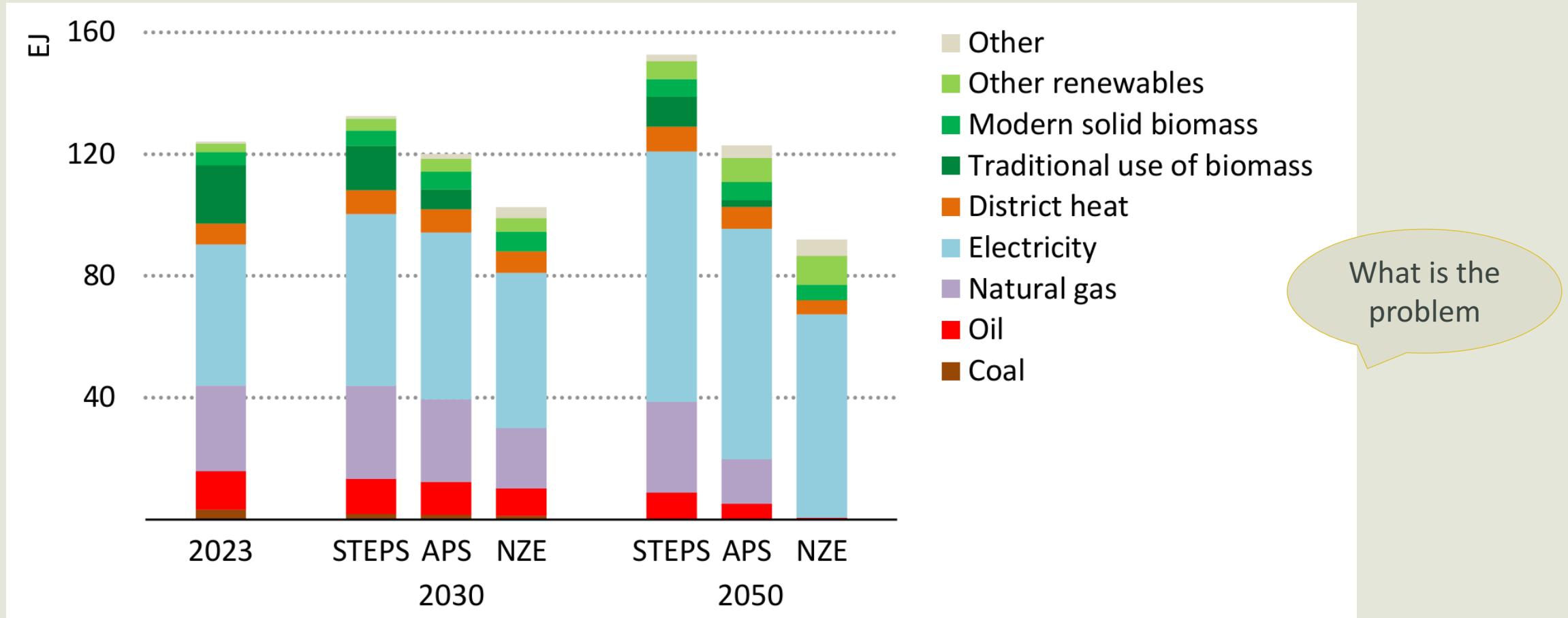


Why India?

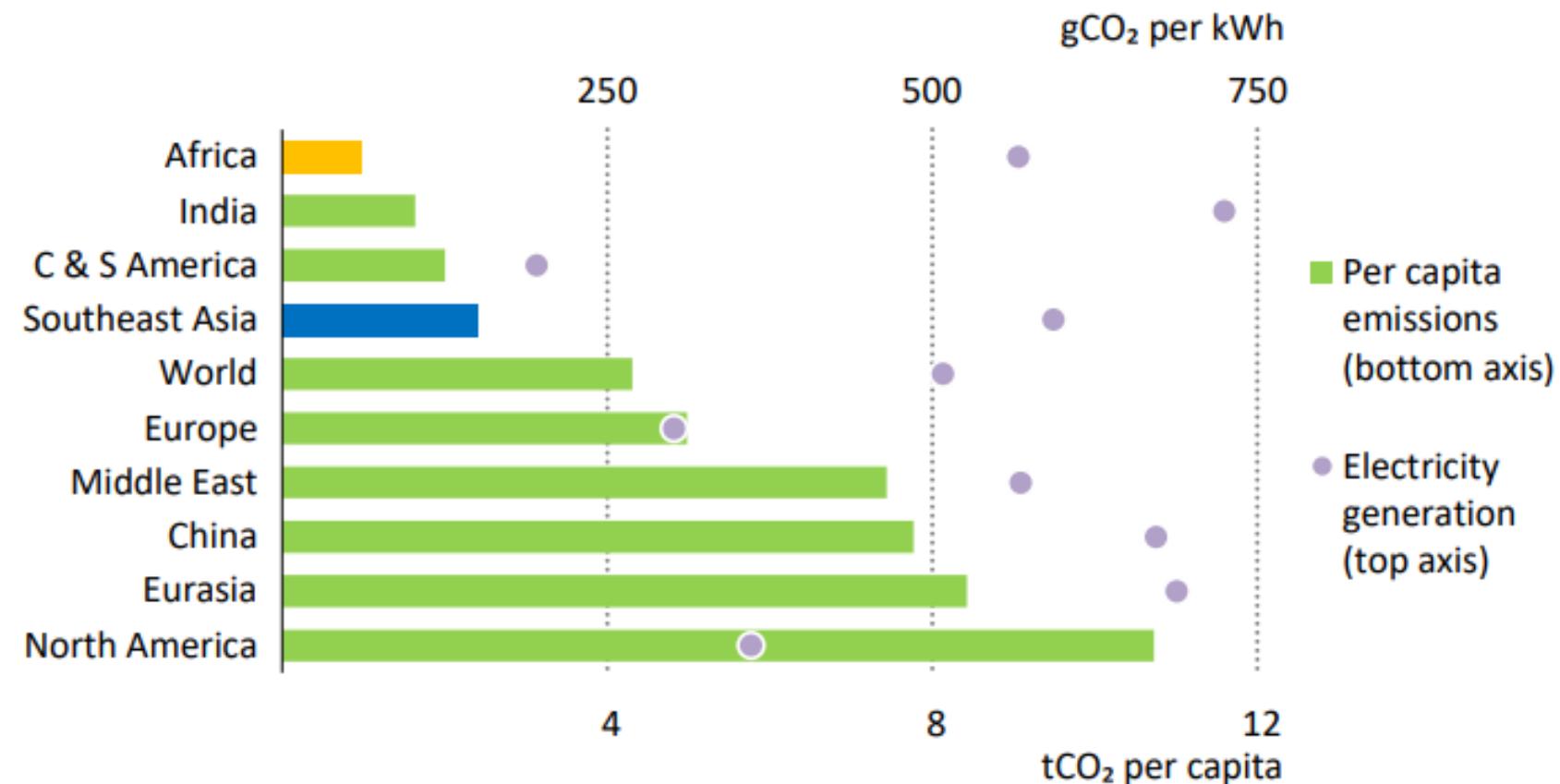


Region	2017 floor area (billion m ²)	% mandatory policy coverage, 2017	2050 floor area (billion m ²)	% growth without mandatory coverage
North America	37	83%	54	30%
European Union	29	97%	40	3%
Other advanced economies	13	96%	19	8%
China	58	100%	81	0%
India	21	9%	84	91%
Africa	21	8%	58	95%
Latin America	12	1%	26	98%
Other emerging economies	44	26%	99	84%
World	235	61%	461	71%

Building energy demand

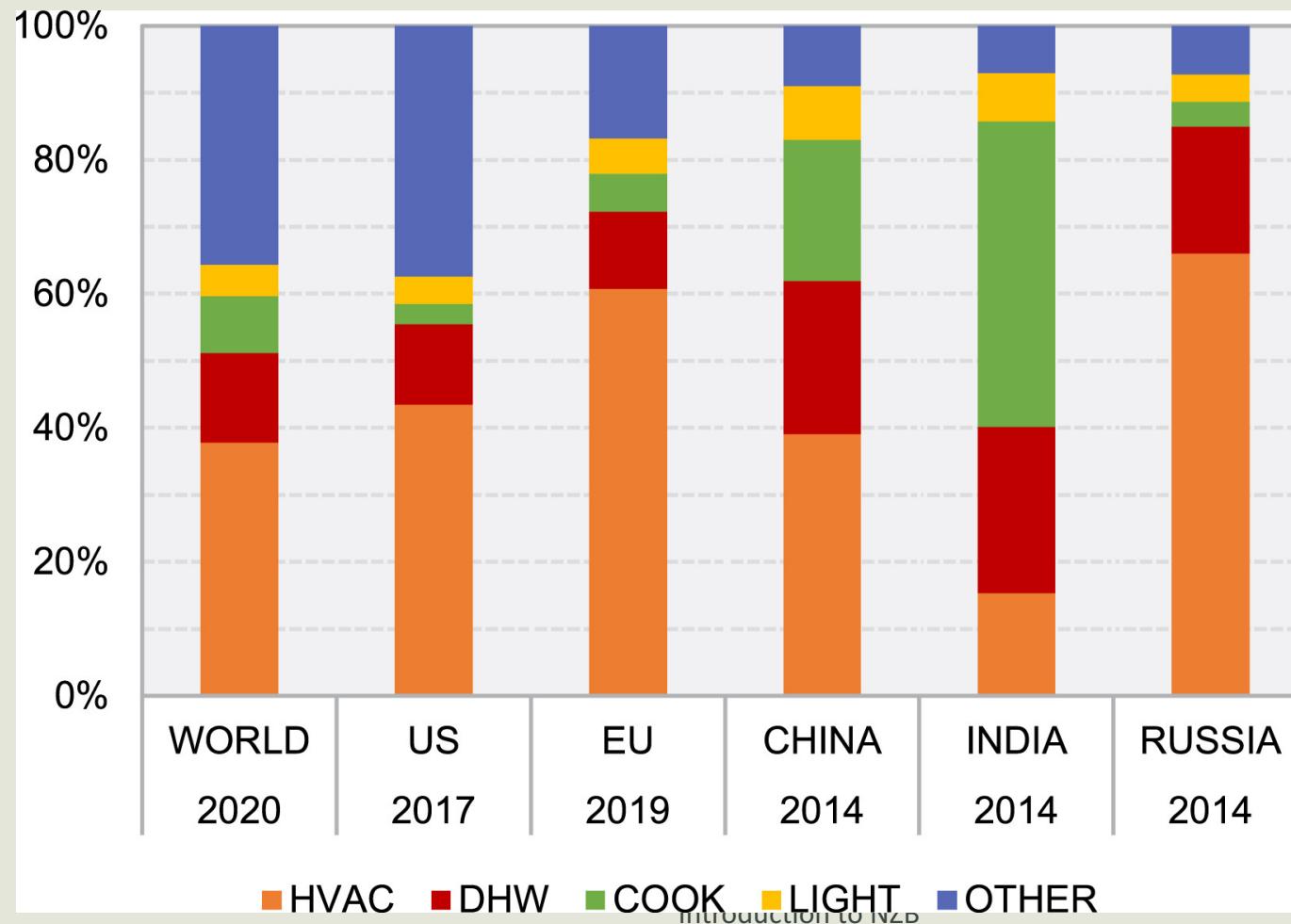


Why India?



India's per capita CO₂ emissions are 60% lower than the global average, but the emissions intensity of its electricity generation is among the highest of any country.

End use intensity global and across countries



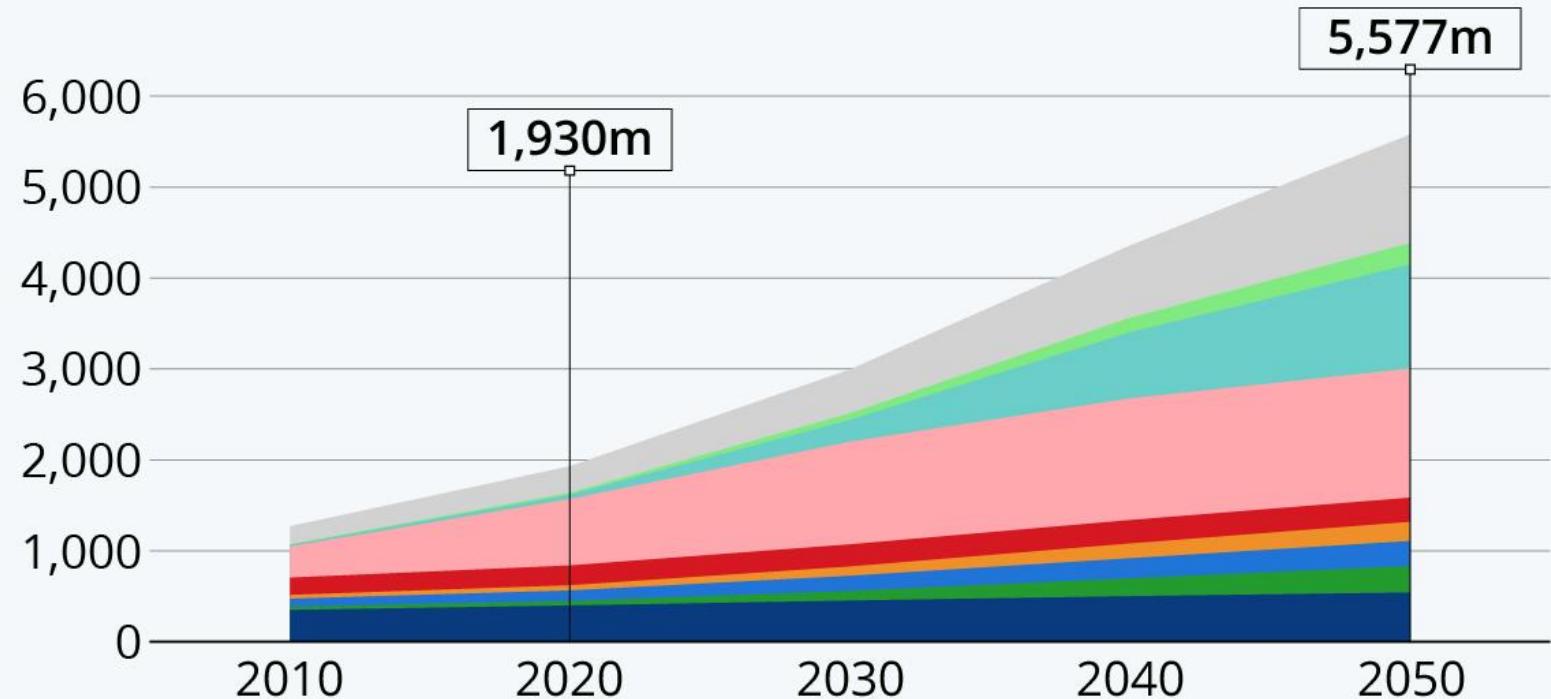
HVAC systems

- World's air conditioners and fans – 10% global electricity consumption.
- Energy demand for space cooling has risen at an average pace of 4% per year since 2000, twice as quickly as for lighting or water heating
- Higher energy consumption for space cooling particularly affects peak electricity demand, especially during hot days when equipment is used at full capacity.

China and India Drive Global Demand for Air Conditioning

Projected number of air conditioning units in use worldwide by country/region (in millions)

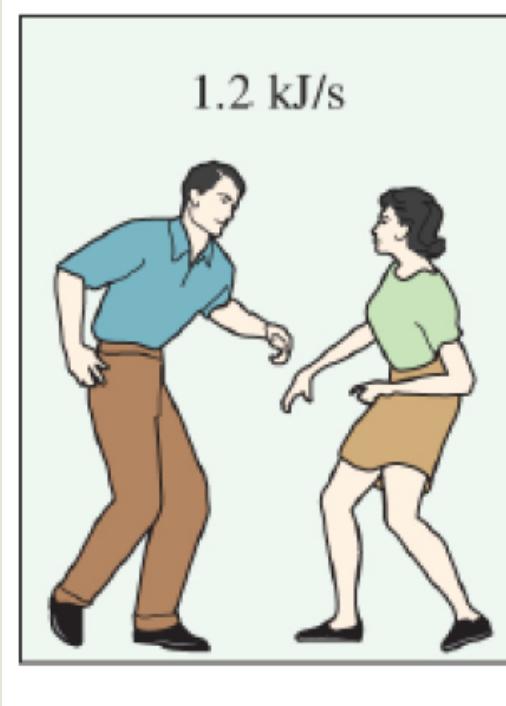
■ U.S. ■ Brazil & Mexico ■ European Union ■ Middle East
■ Japan & Korea ■ China ■ India ■ Indonesia ■ Rest of world



Why we need HVAC system?

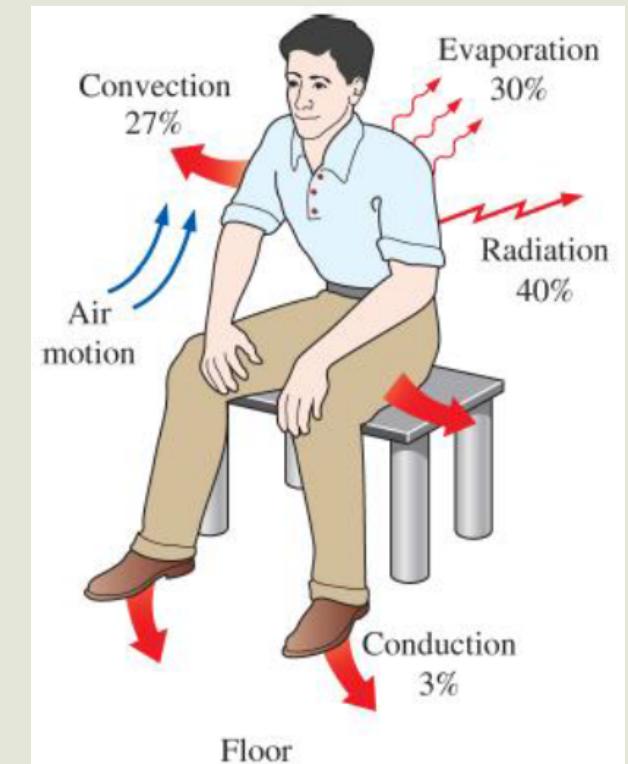
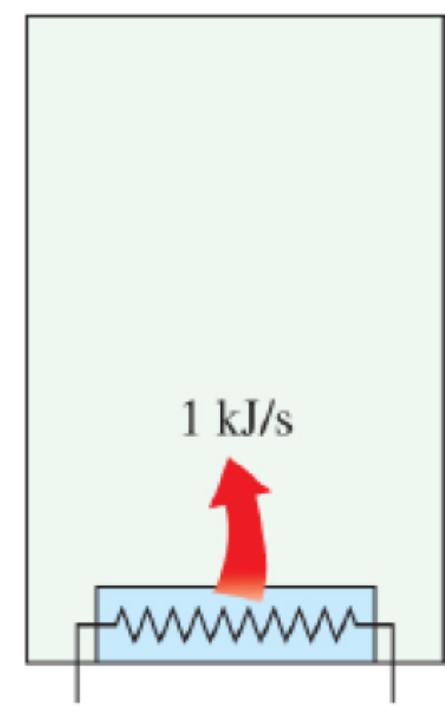


Most animals come into this world with built-in insulation, but human beings come with a delicate skin.



Two fast-dancing people supply more heat to a room than a 1-kW resistance heater.

EN 410/607 Energy Management



Mechanisms of heat loss from the human body and relative magnitudes for a resting person.

Comfort Chart

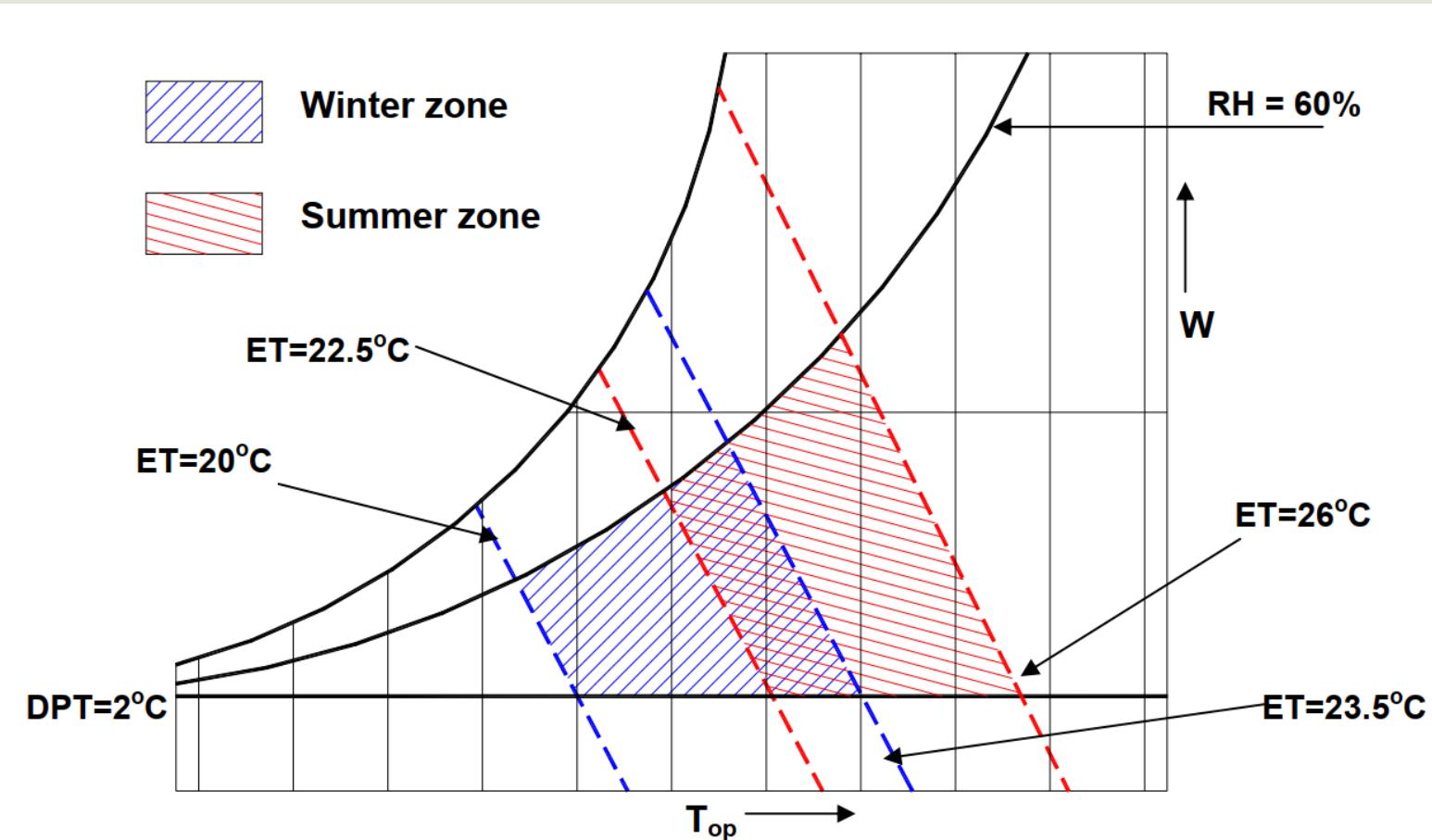
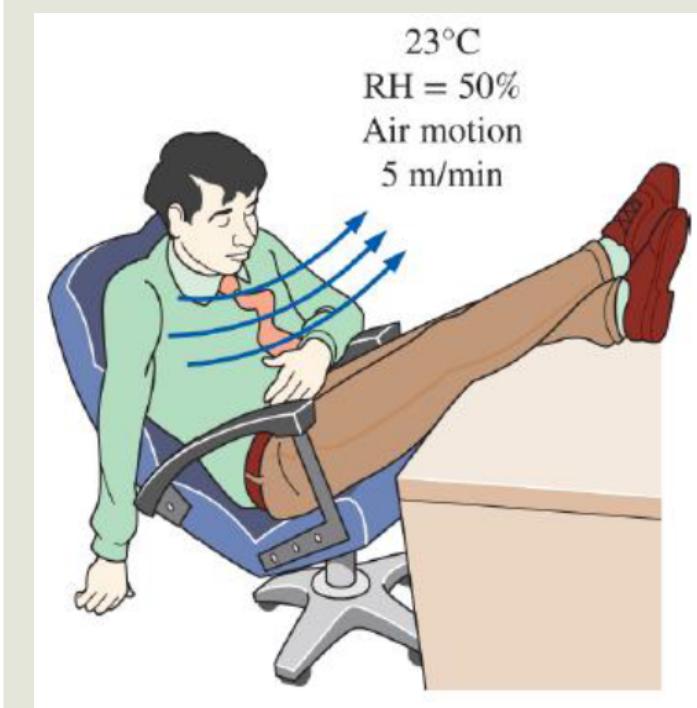
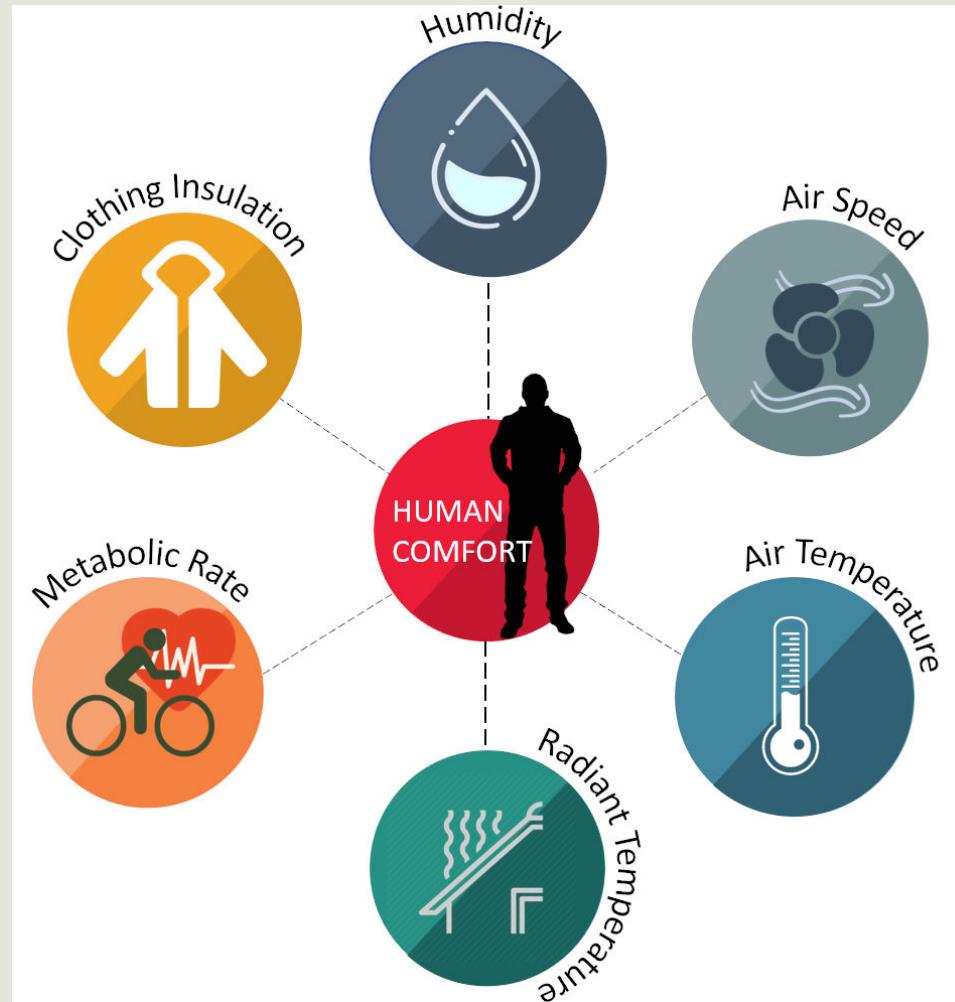


Fig.29.3: ASHRAE comfort chart for a sedentary person (activity ≈ 1.2 met)



A thermally
comfortable
environment.

Thermal comfort



Purpose of HVAC system

The purpose of comfort air conditioning is to provide an artificial environment in a given volume irrespective of ambient conditions as required for comfort and welfare of occupants by controlling dry-bulb temperature (DBT), humidity, air movement, cleanliness, noise level, etc.

Psychometrics

Moisture air – Dry air (Nitrogen, oxygen, argon, CO₂, etc.) +
Water vapor (varies with T and P)

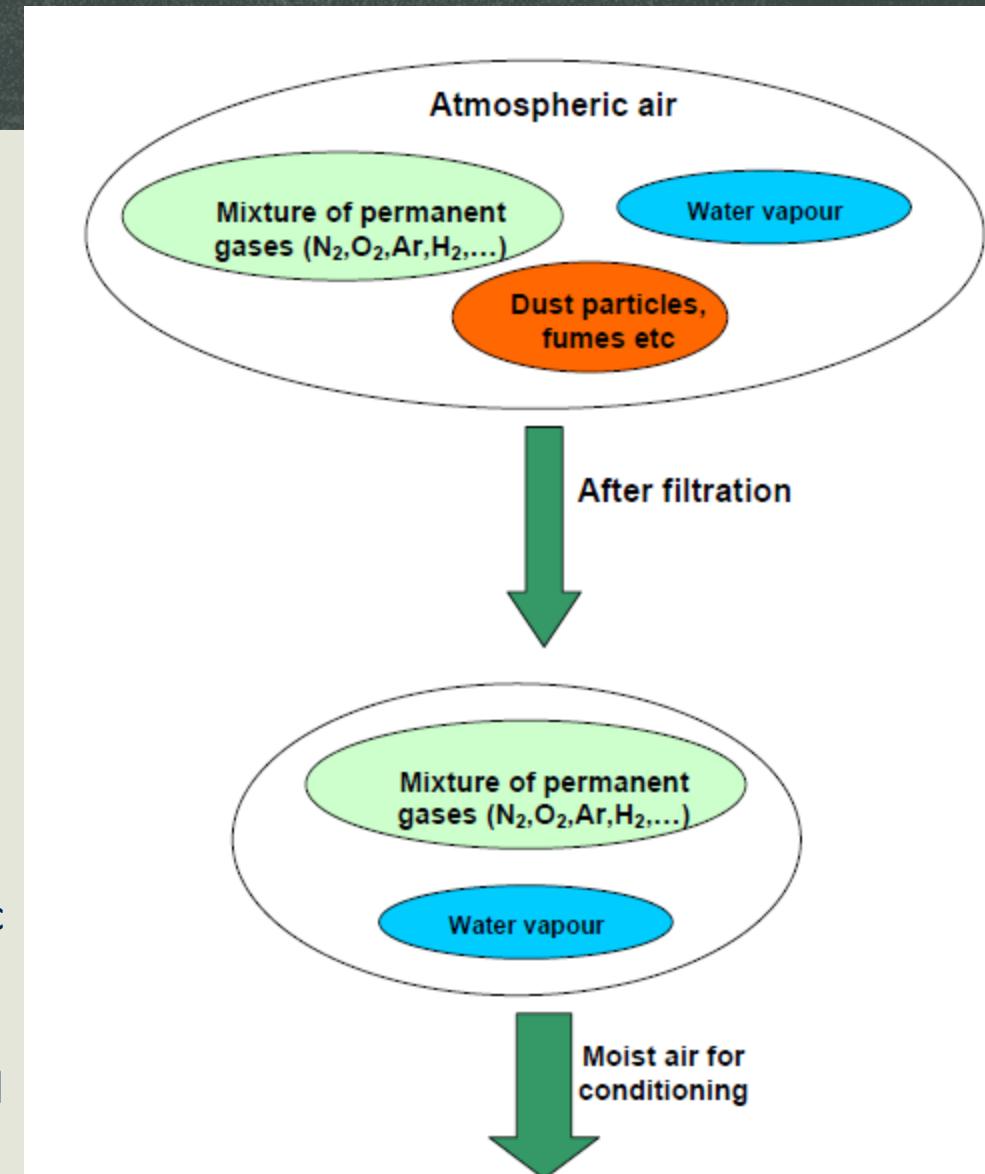
- Dry bulb temperature
- Saturated vapor pressure
- Relative humidity
- Specific humidity
- Specific volume
- Enthalpy

How many properties needed to define the state?

From Gibb's phase rule, number of independent thermodynamic properties (N) required to define the state of mixture is given by,

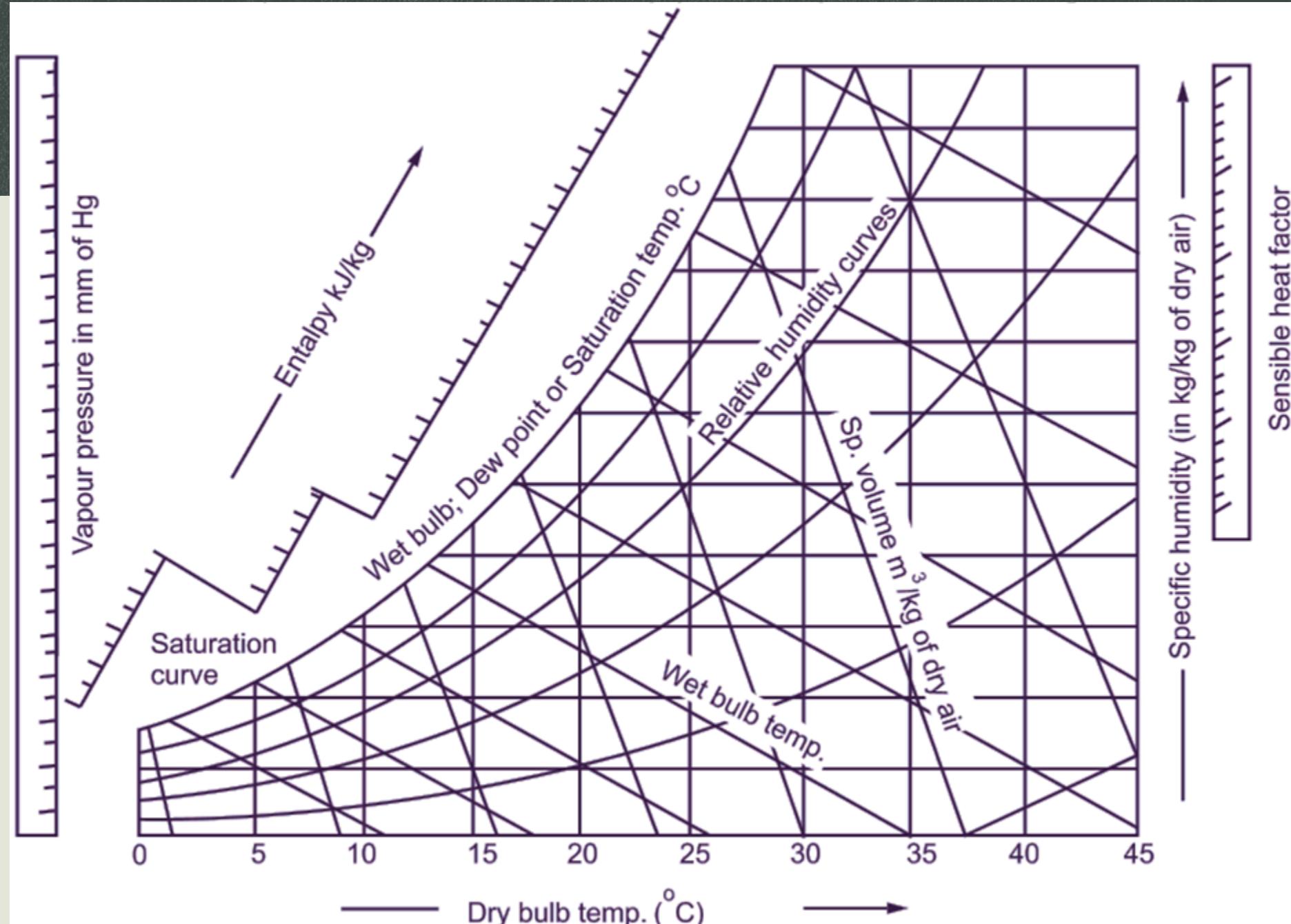
$$N = C + 2 - P$$

Where, C is number of components (2; dry air and water vapour) and P is number of phases (1; gaseous).



Psychometric Chart

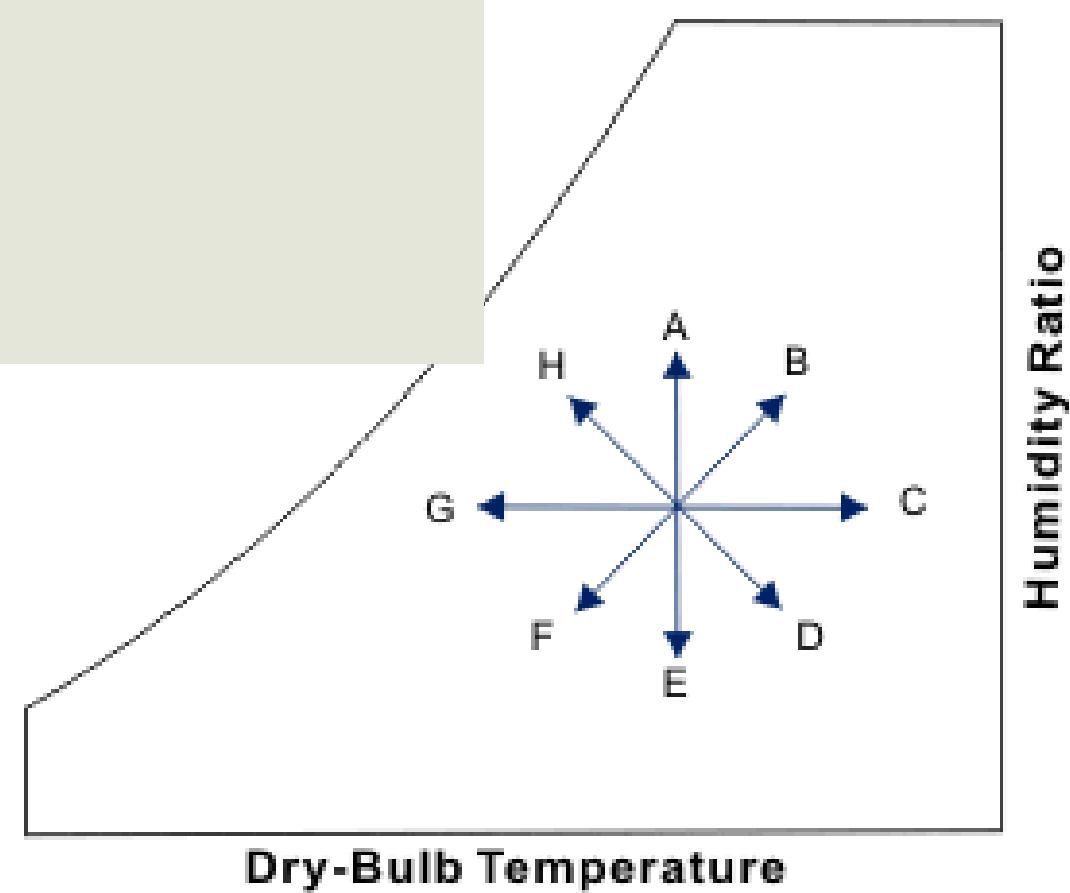
Wet bulb temperature



Psychometric process

	T	W
A		
B		
C		
D		
E		
F		
G		
H		

Air Conditioning Process



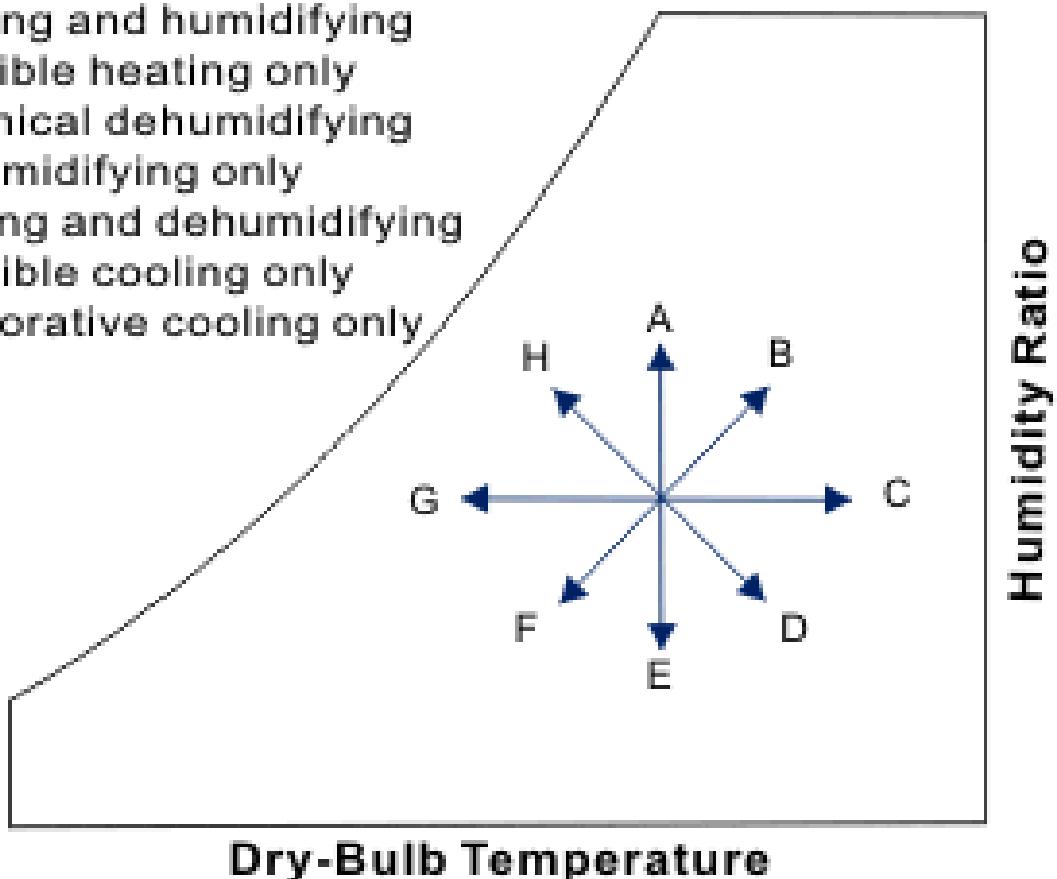
Psychometric process

How do estimate the energy transfer in each process

B and F are the major air conditioning process

Air Conditioning Process

A = Humidifying only
B = Heating and humidifying
C = Sensible heating only
D = Chemical dehumidifying
E = Dehumidifying only
F = Cooling and dehumidifying
G = Sensible cooling only
H = Evaporative cooling only



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