

Air Conditioning

Air Conditioning

- Advantages?
 - Closer environmental control
 - Greater comfort
 - Enhances value of property

Air Conditioning

- Disadvantages?
 - Additional capital costs
 - Can increase electricity consumption by up to 50%
 - Higher CO₂ emissions
 - Extra maintenance

When should we specify Air Conditioning?

Only when it is not possible to maintain a comfortable indoor environment using natural or mechanical ventilation because of:

- A need for humidity control
- High heat gains
- External noise
- Pollution

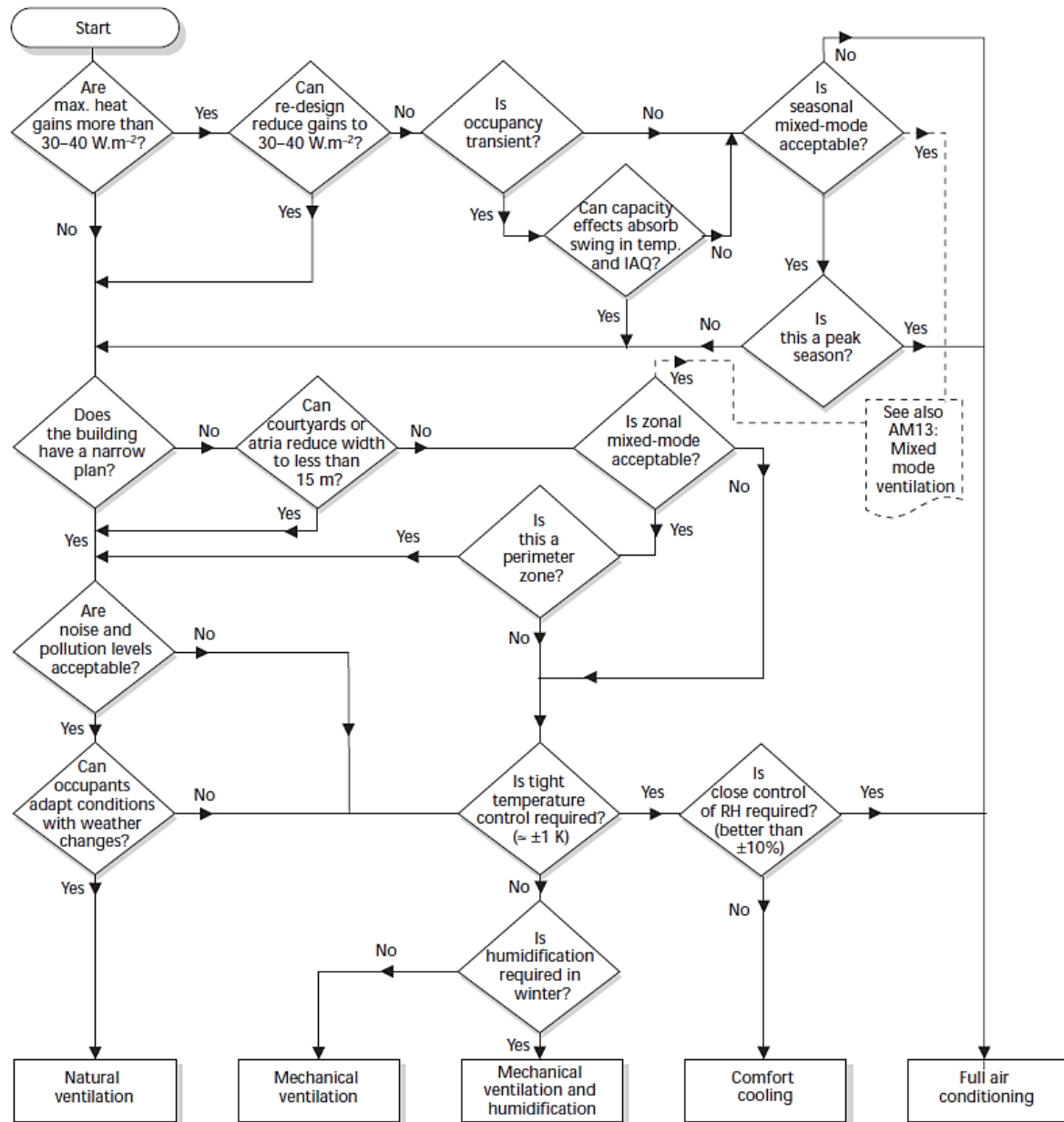
Humidity Control

- High latent gains
- Need to avoid static
- Climatic conditions
- Storage of sensitive goods or materials

High Heat Gains

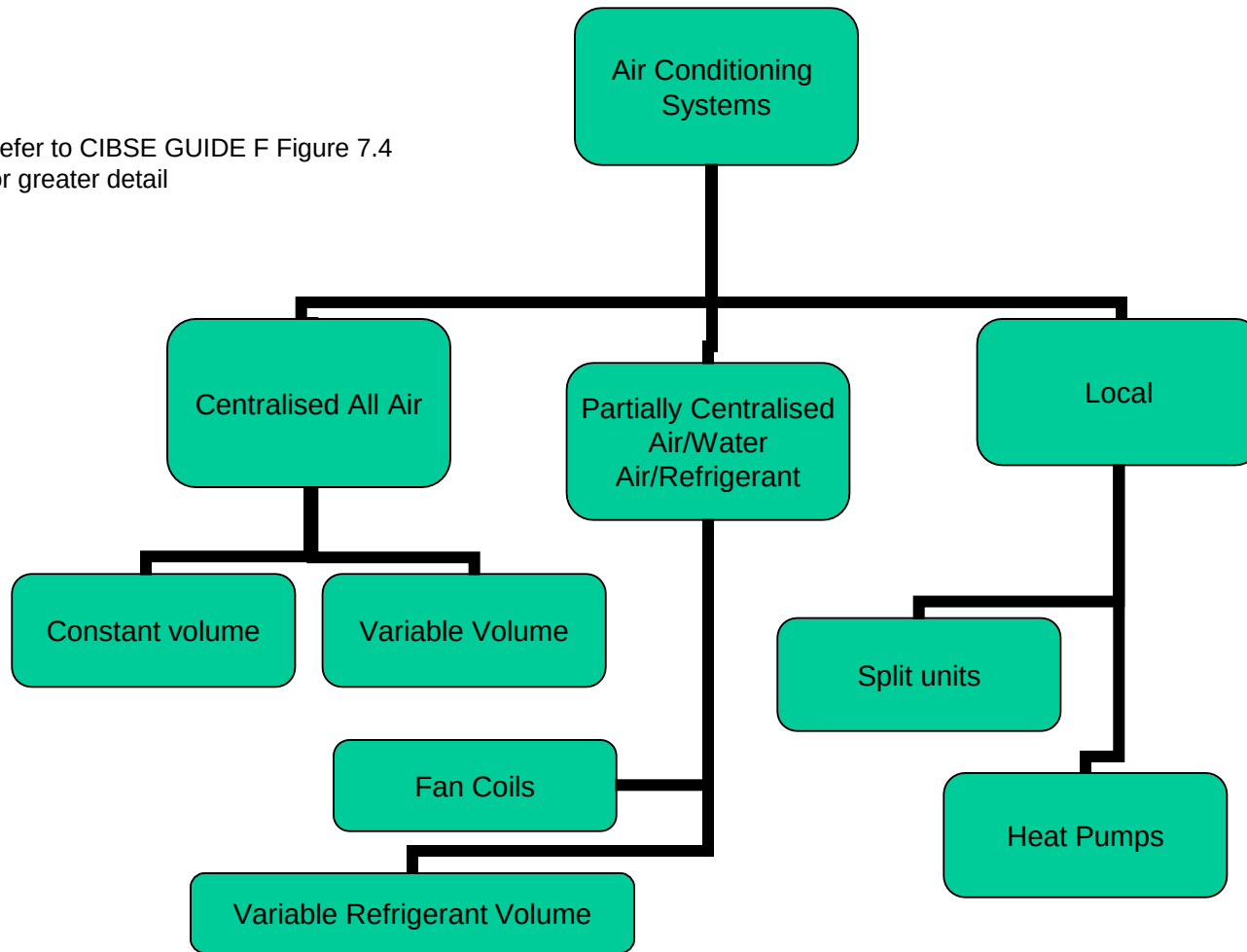
- Heat gain via fabric due to high external temperatures
- Solar gain
- People and other animals
- Computers and other equipment
- Lighting (even fluorescent lighting)
- Cooking

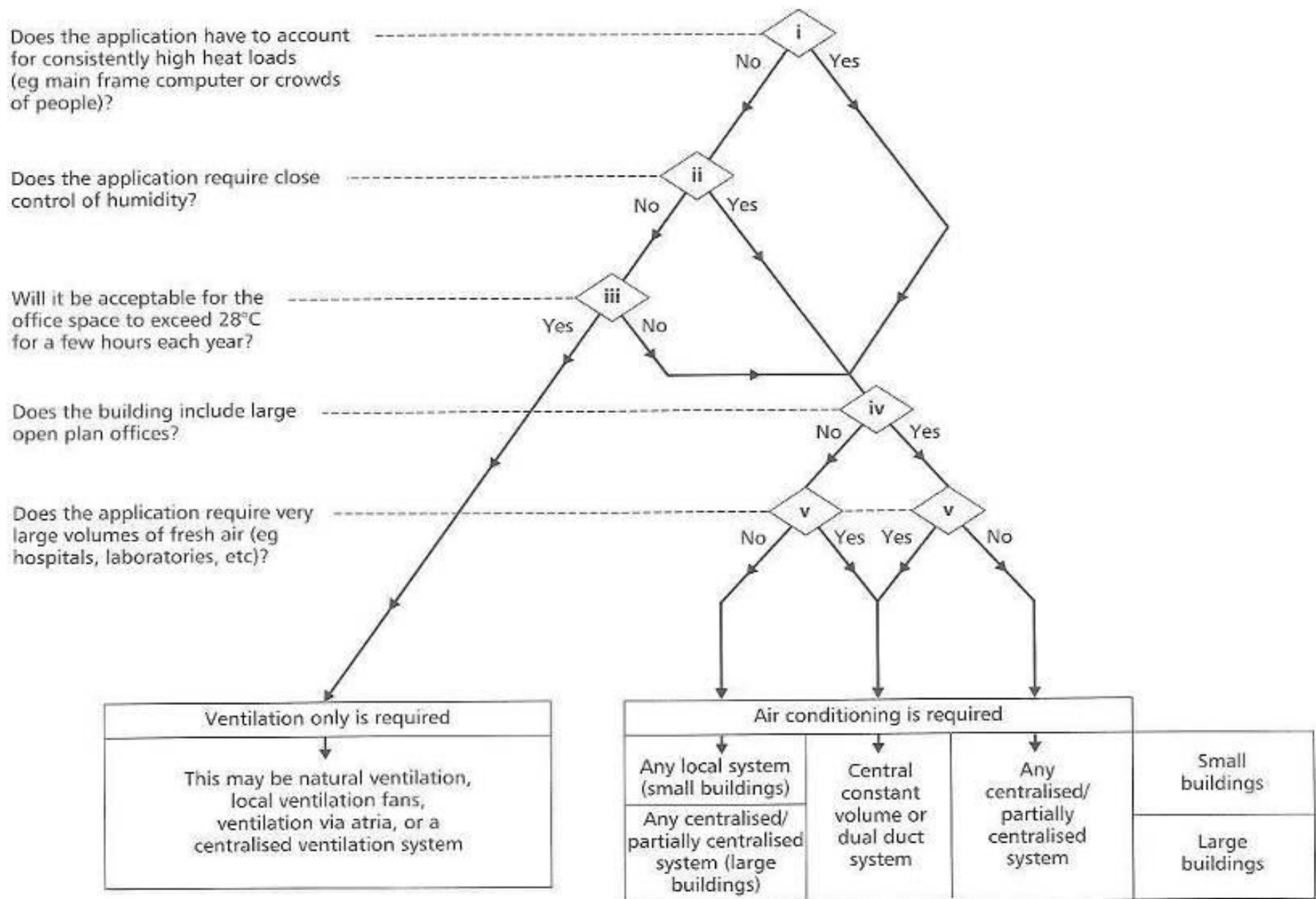
**Ventilation Only or Air
Conditioning ?**



Simplified A/C System Concepts

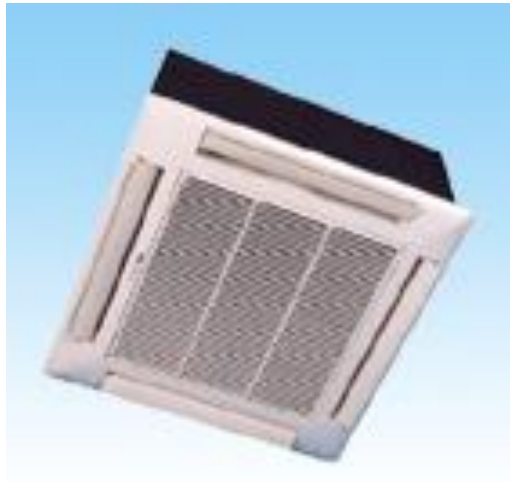
Refer to CIBSE GUIDE F Figure 7.4
for greater detail



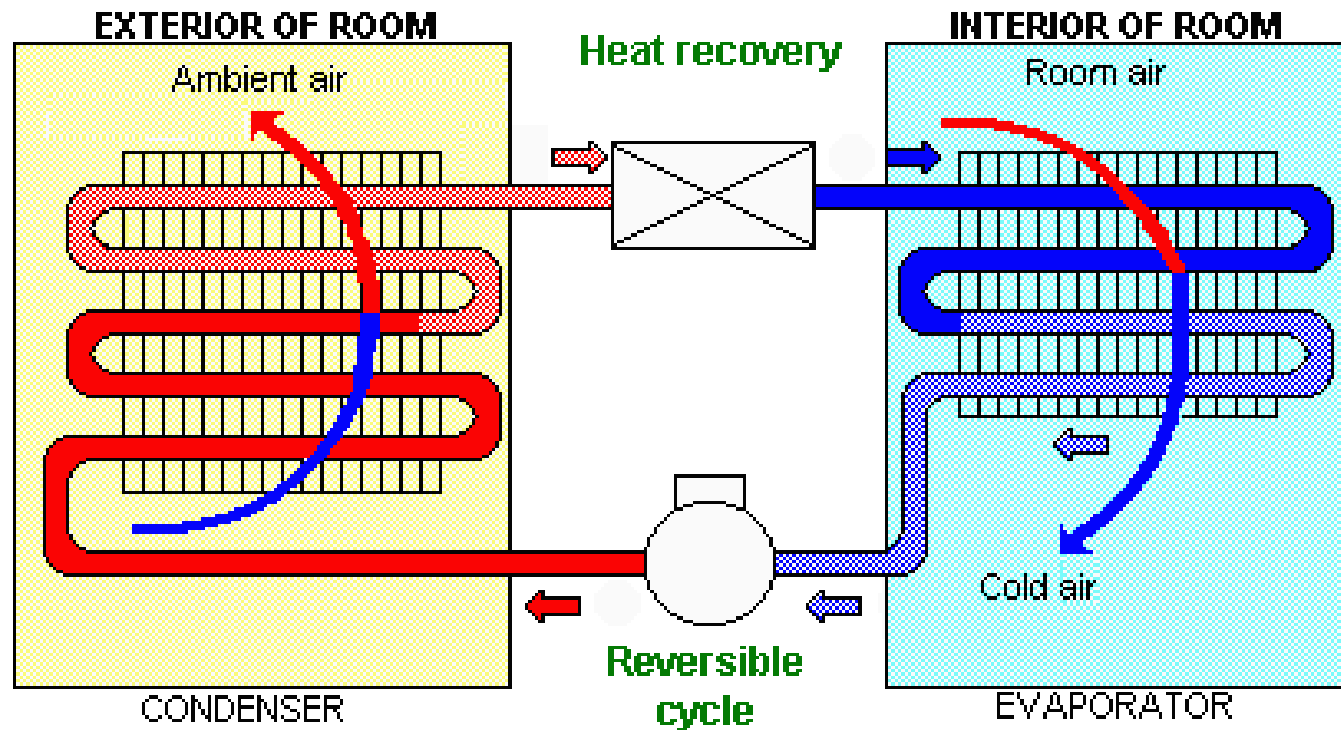


Local A/C Systems

- DX “through wall/window” units
- Individual reversible heat pumps
- Unitary split systems

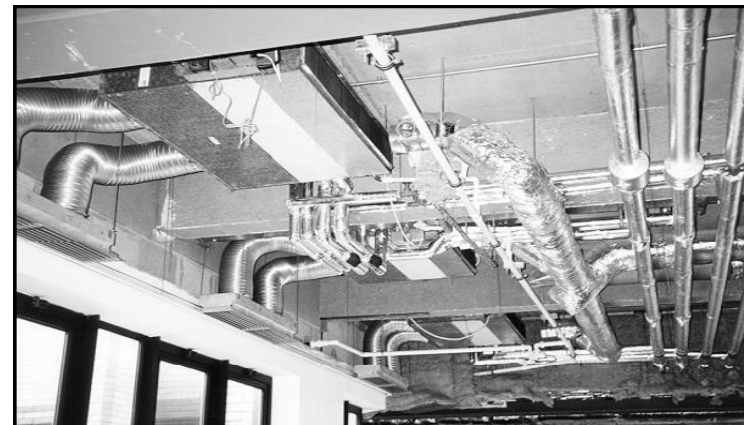
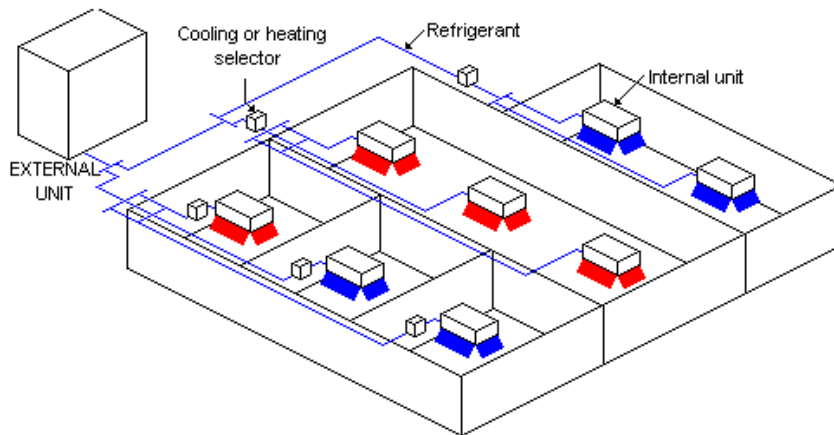


Unitary Split System Unit



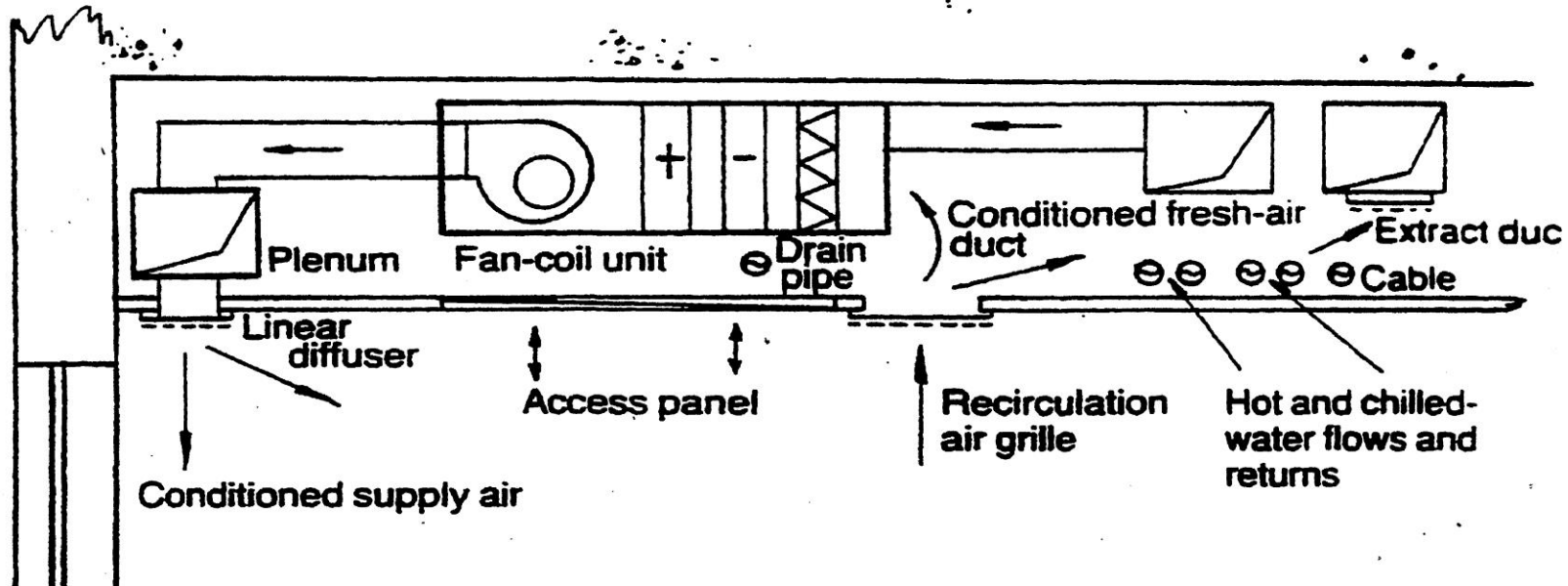
Partially centralised air/water and air/refrigerant A/C systems

- Fan coils (4/3/2 pipe)
- Chilled beams and ceilings
- Variable refrigerant volume
- Centralised air with reheat

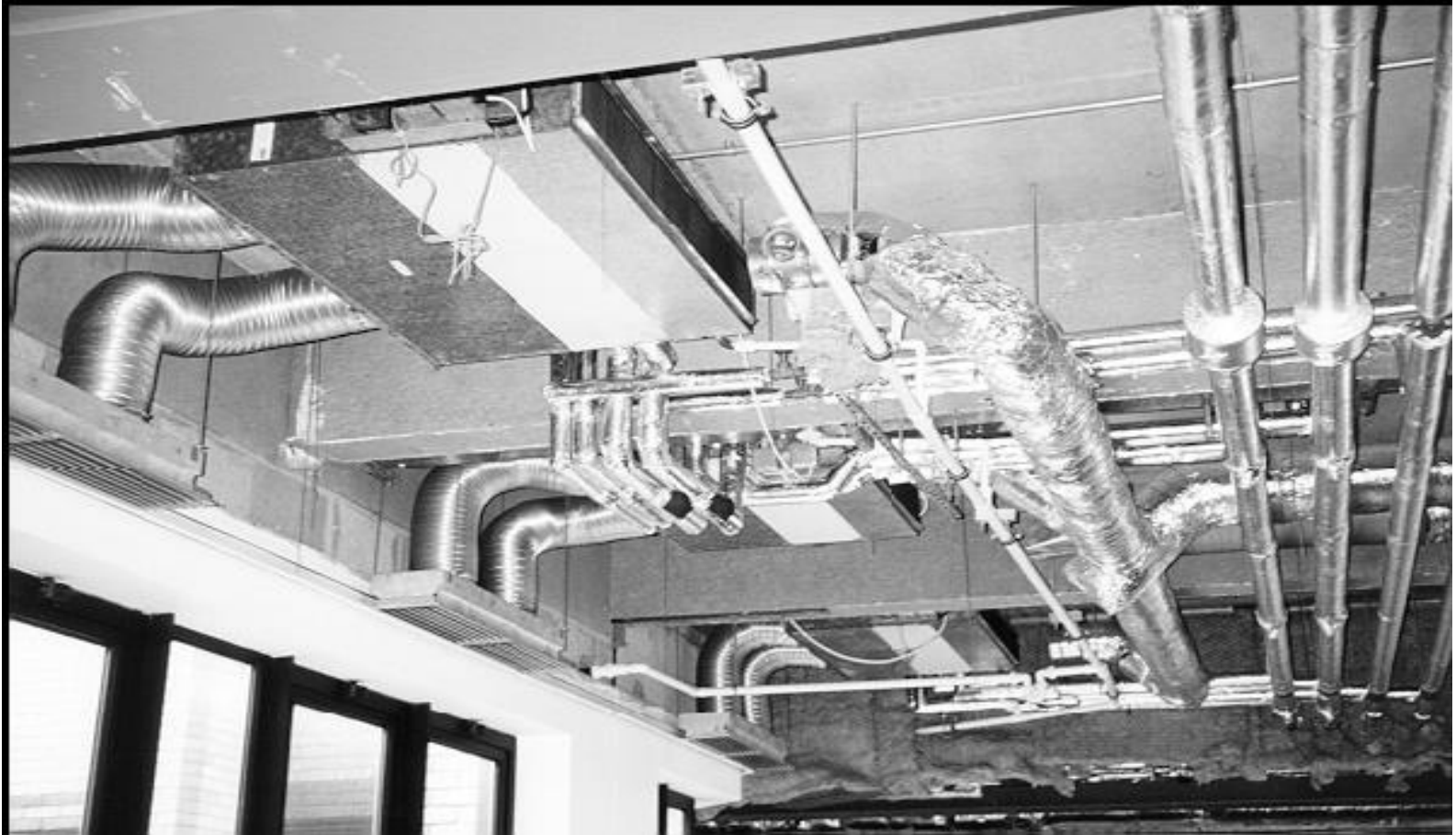


Four pipe fan coil unit

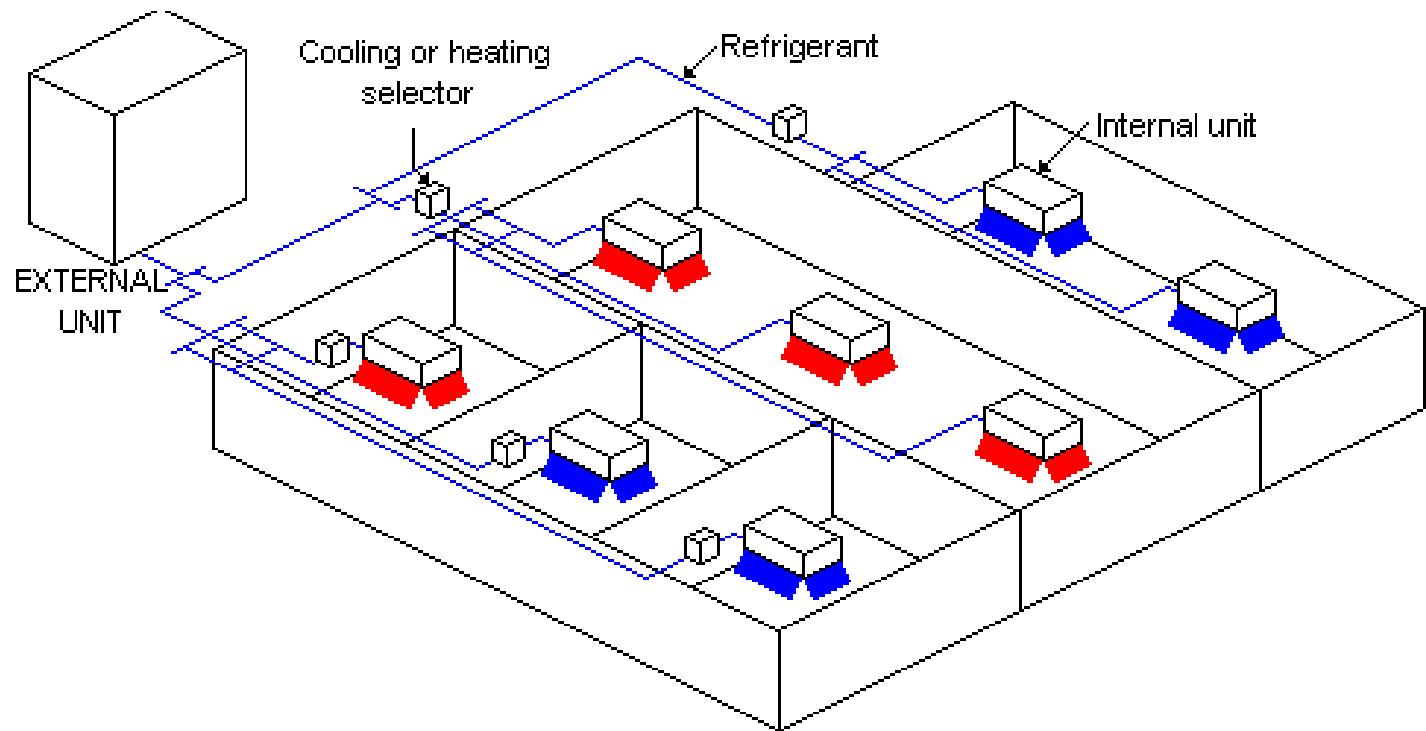
Four-pipe fan coil system



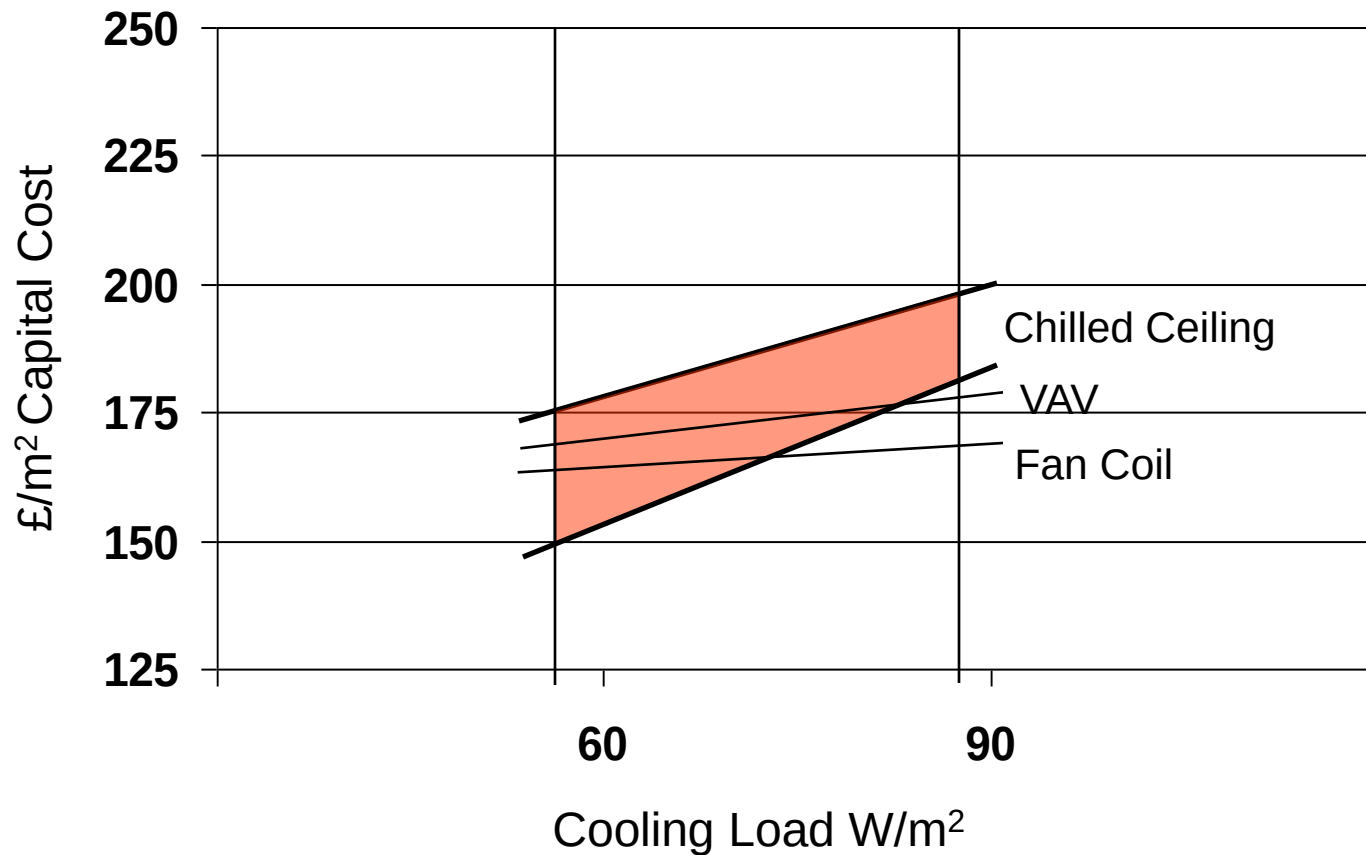
Fan Coil Unit



Variable Refrigerant Flow (VRF) Circulation of refrigerant in a cooling/heating system.

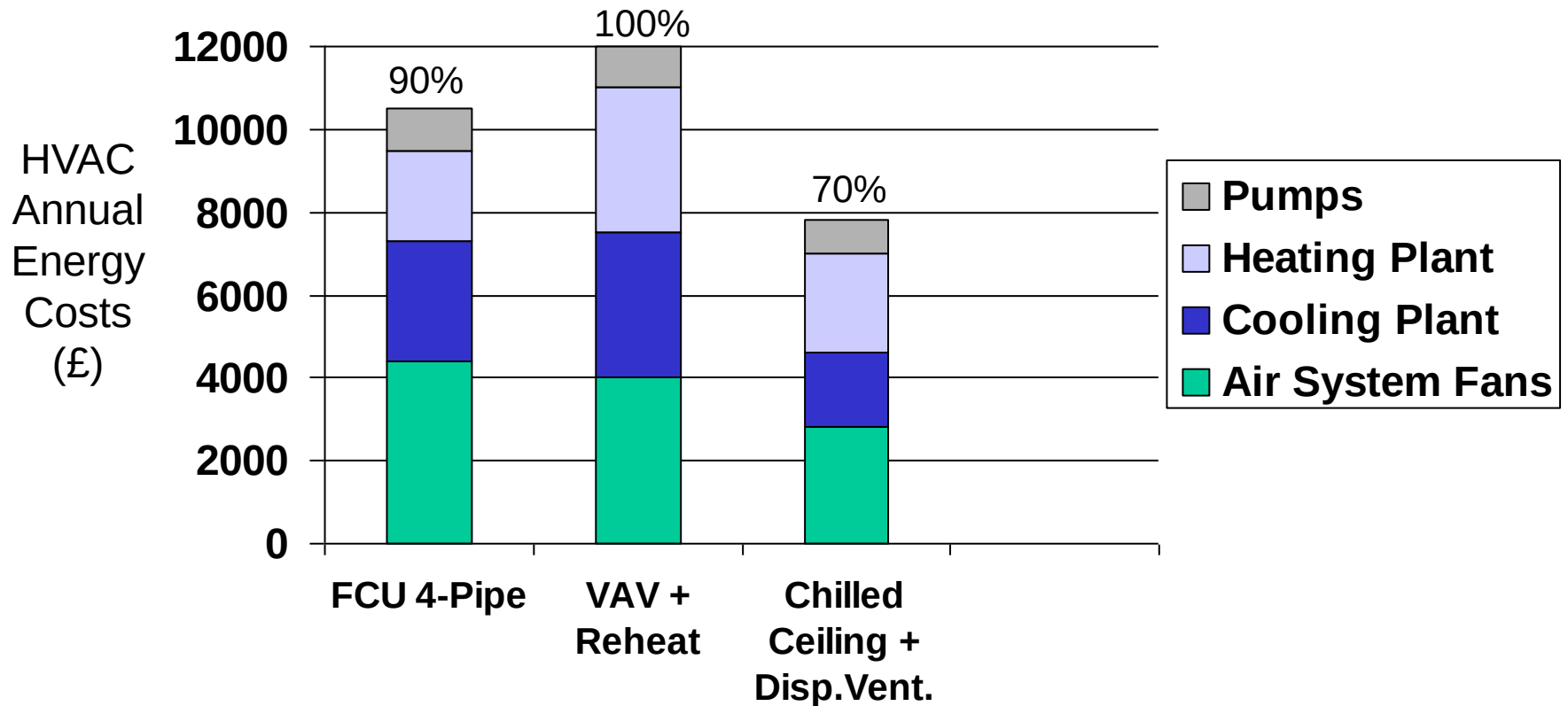


System Capital Cost Comparison

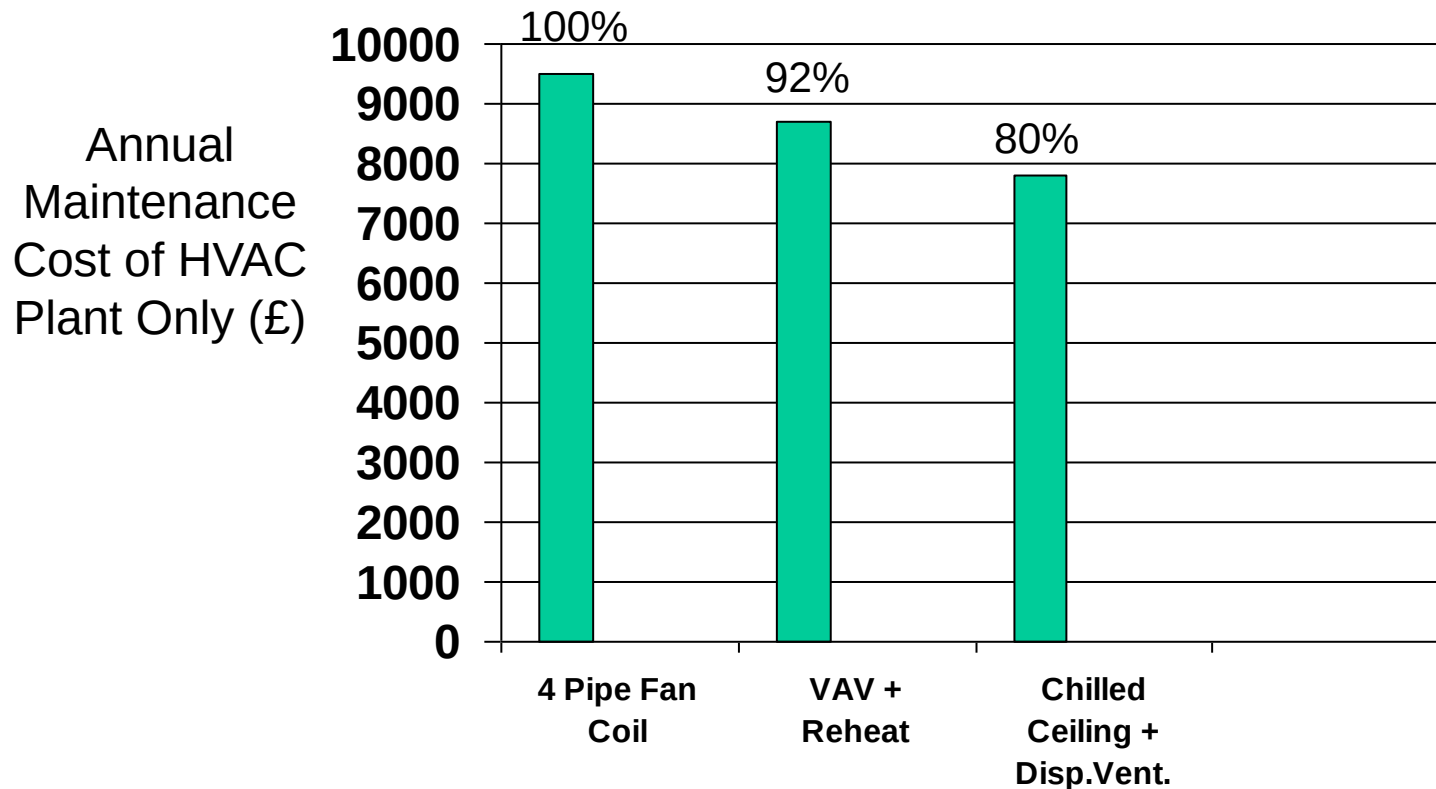


Air Conditioning System	Capital Cost £/m²		
	35 W/m²	60 W/m²	90 W/m²
4 Pipe Fan Coil	157	168	179
VAV & Reheat	153	173	194
Displacement Ventilation	134	-	-
Chilled Ceiling + Disp. Vent. LPHW perimeter heating	-	179	219
Chilled Ceiling + Disp. Vent. Electric panel heating	-	165	205
Chilled Ceiling + Mixing ventilation	-	152	197

Comparative system energy costs at 45 W/m²

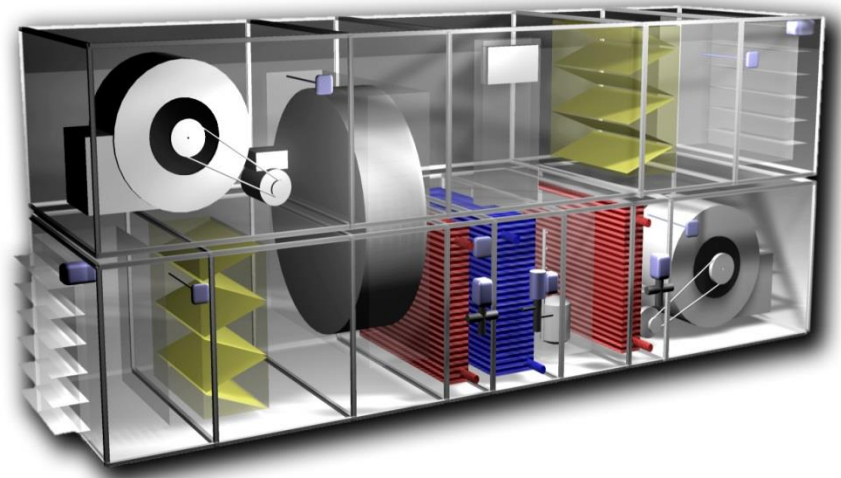


Maintenance Cost Comparison



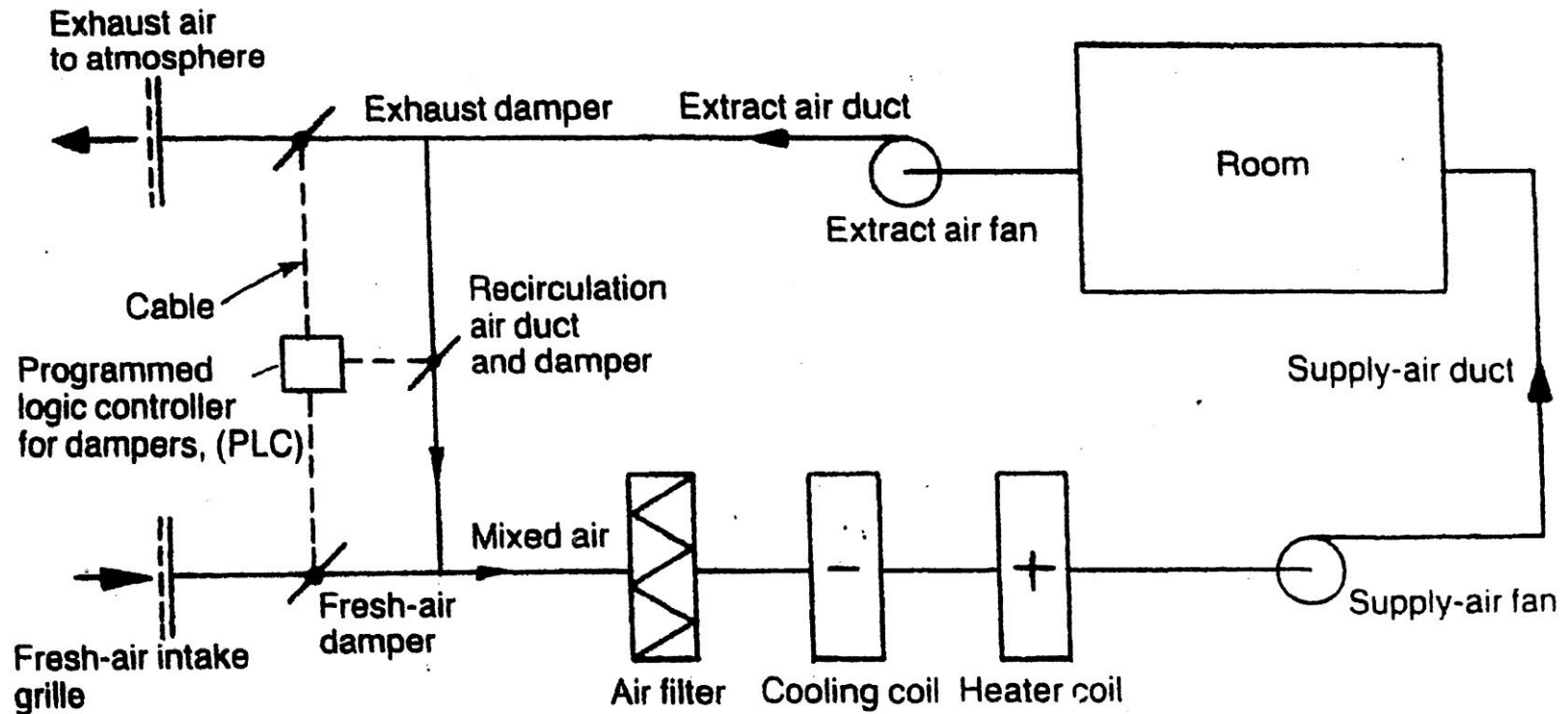
Centralised All Air

- Constant volume (single zone)
- Variable air volume
- Dual duct

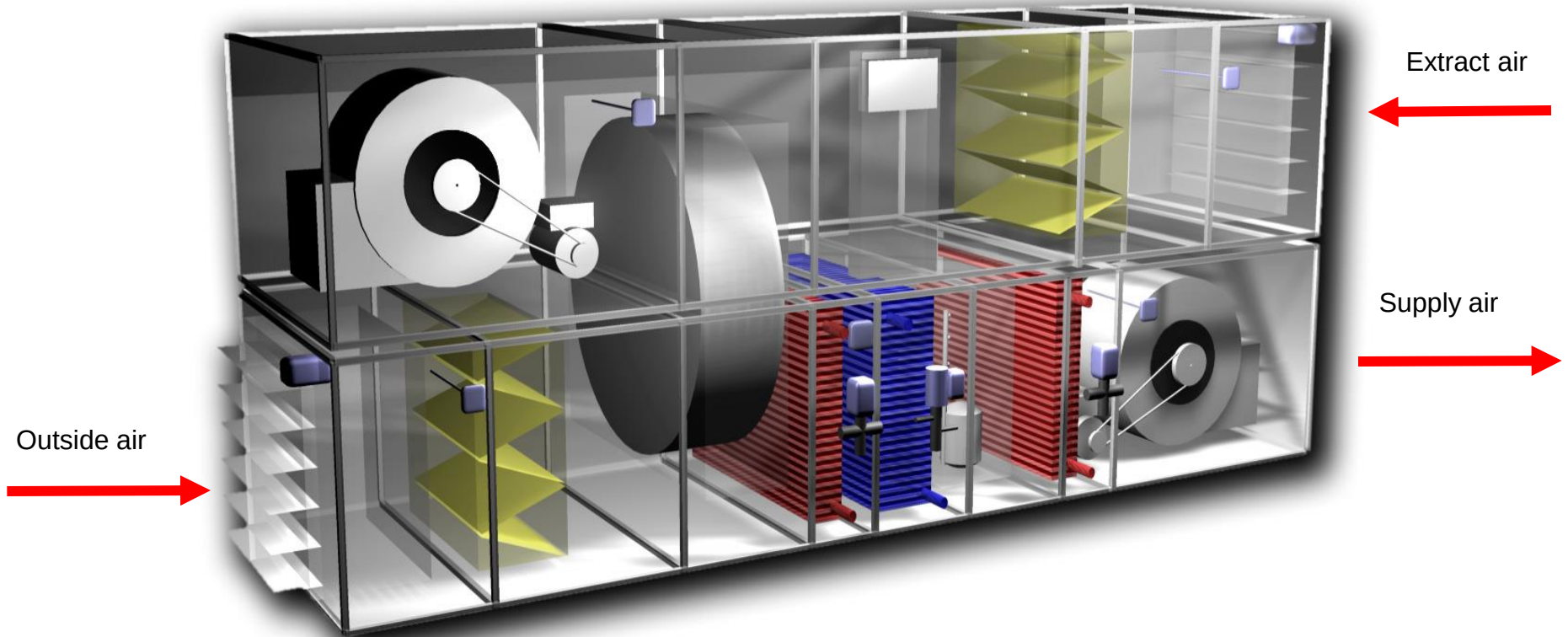


All Air Constant Volume Principle

Single Duct Constant Volume Air Conditioning System

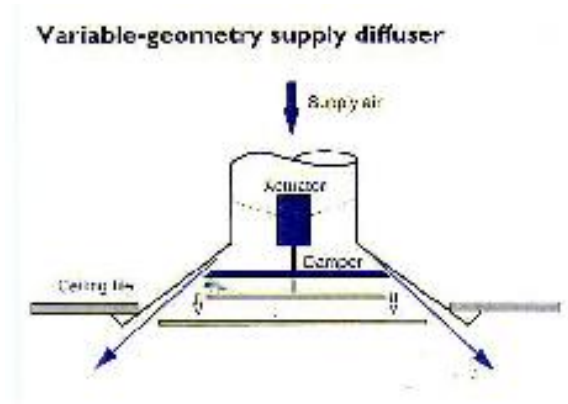


Constant Air Volume – AHU



Variable Air Volume (VAV)

- Air is supplied from central plant at a constant temperature to VAV terminal units within zones
- Terminal units contain thermostatically controlled damper regulating volume of air into zone in relation to cooling load
- Main supply/extract fans can operate for much of the time at reduced speed when overall demand from zones is low
- Air velocities from diffusers are usually maintained when air volumes are reduced by using fan-assisted terminal units or variable geometry supply diffusers

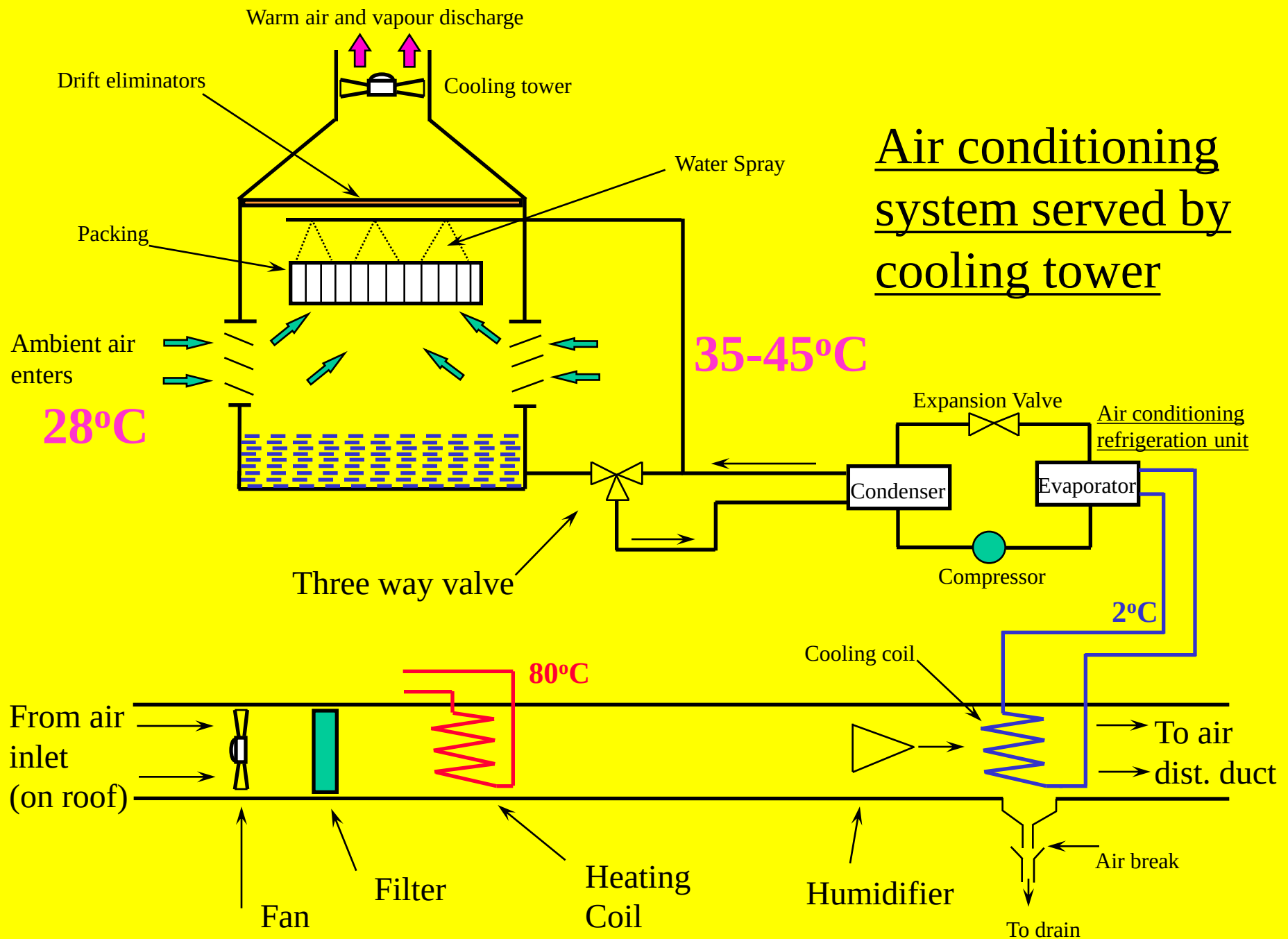


Dual Duct

- Hot and cold air transported separately around building and mixed to the desired condition at or near to the zone
- Have inherently high transport energy, heating and cooling loads
- Should not be used without reclaimed energy applied
- Dual duct VAV systems offer improvements in energy efficiency

Chillers

- Refrigeration plant producing chilled water
- Usually based on the vapour compression cycle but absorption cycle machines also available
- Available in smaller sizes as packaged units with integral heat rejection
- DX packaged units can also supply the cooling coils of an integral AHU directly with refrigerant avoiding the need for a chilled water circuit
- Larger chillers usually employ external heat rejection devices



Examples of Heat Rejection Devices



Flatbed Dry Cooler



V-Coil Dry Cooler



Flatbed Condenser

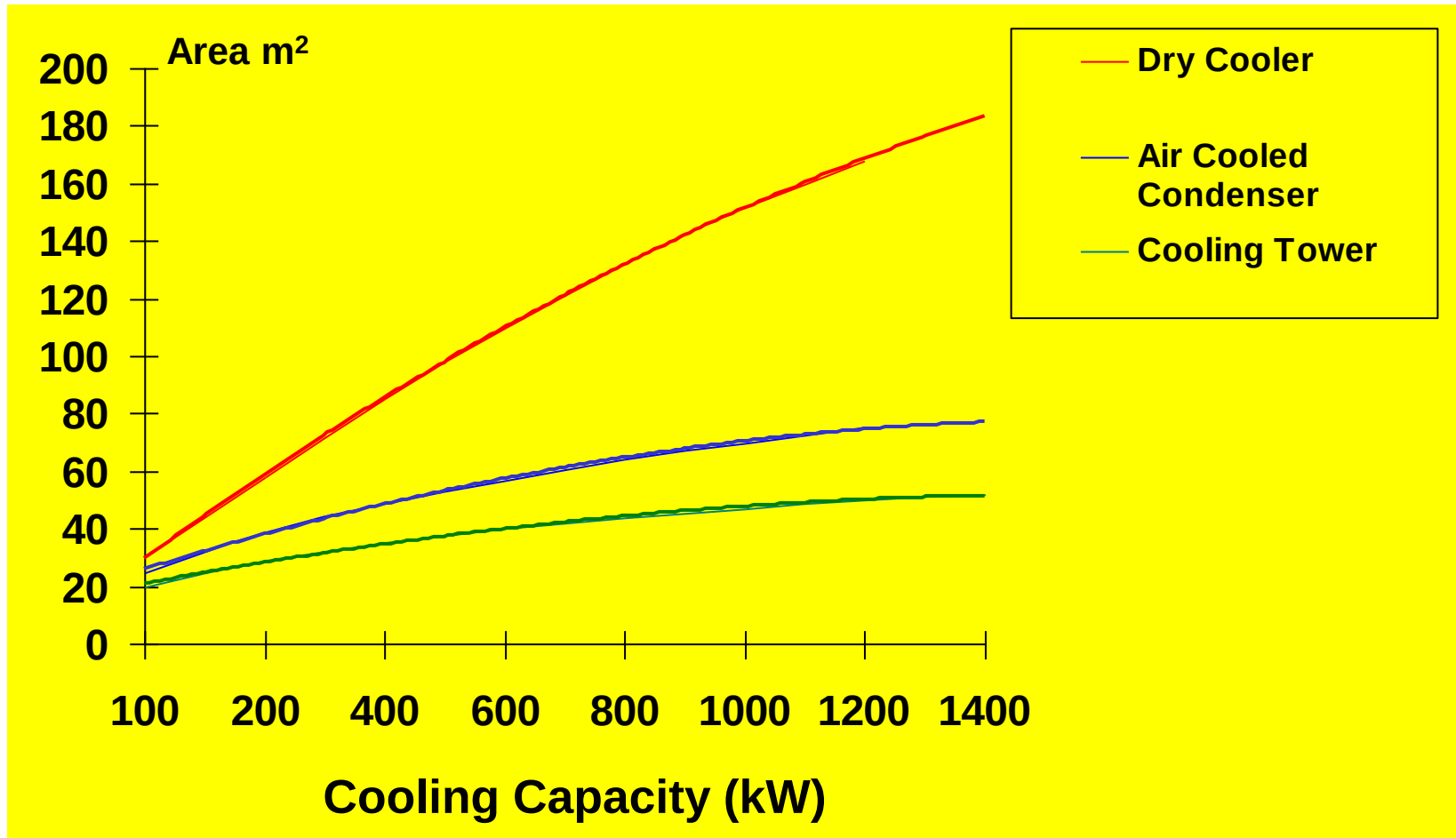
Cost of Air Conditioning

System type	Costs			CO ₂ emission (kg/m ²) p.a.
	Capital (£/m ²)	Energy (£/m ²) p.a.	Maintenance	
Centralised 'all-air' systems				
Ventilation and heating - no air conditioning	100	1.9	Medium	30
Constant volume (single zone)	160	3.0	Medium	50
Variable air volume (VAV)	180	2.4†	Medium to high	40†
Dual duct	210	3.4	Medium	55
Partially centralised air/water systems				
Centralised air with reheat	200	3.1	Medium to high	50
Induction units	160	3.2	High	50
Fan coil units	170	3.2	Medium to high	50
Unitary heat pump	130	3.2	Medium to high	55
Local systems				
Heat and local ventilation-no air conditioning	90	1.1	Low	17
Through wall packages	70‡	3.5	Low	75
Split unit packages	85‡	3.5	Medium to high	75
Individual reversible heat pumps	110	3.0	Medium to high	55
Variable refrigeration flow rate	130	2.8	Medium to high	50

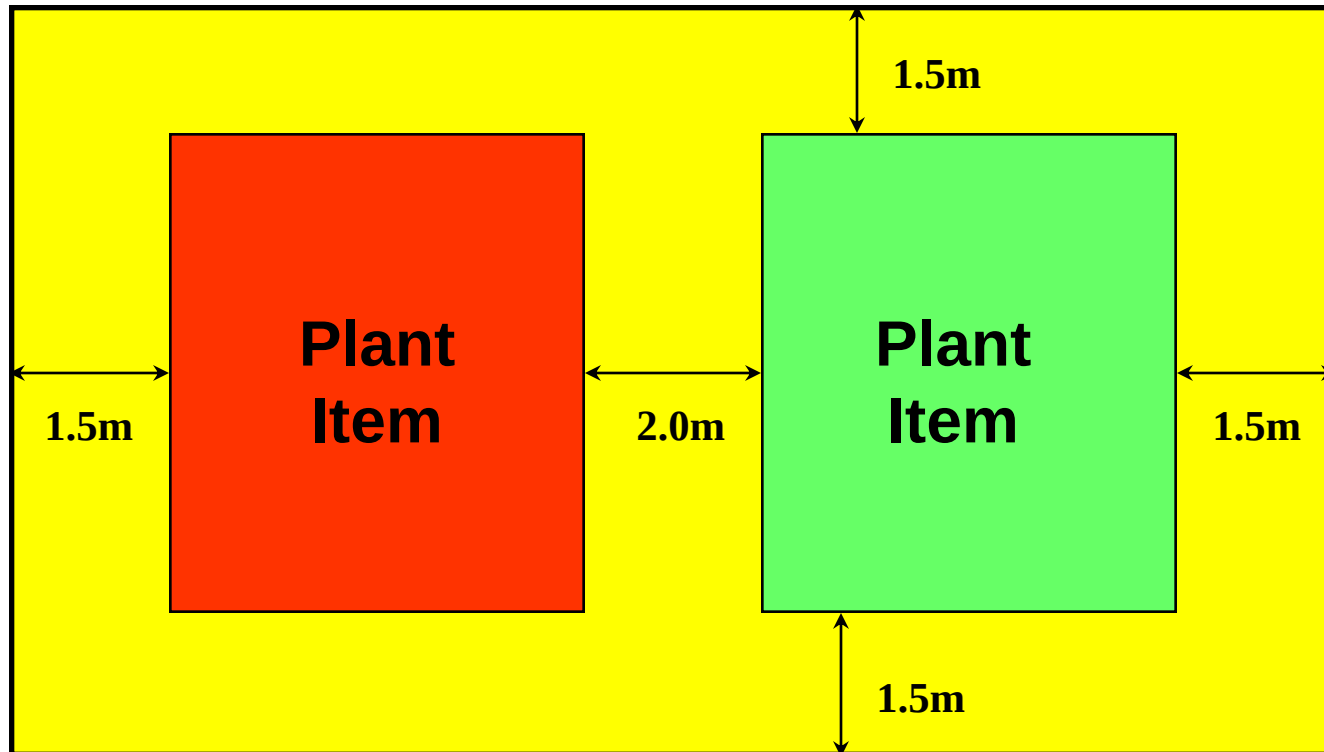
† System fitted with variable speed fan; ‡ Excludes separate provision of heating

Note: Figures are indicative only and based on gross floor area and 1992 costs; capital costs exclude related building work and cost of BMS

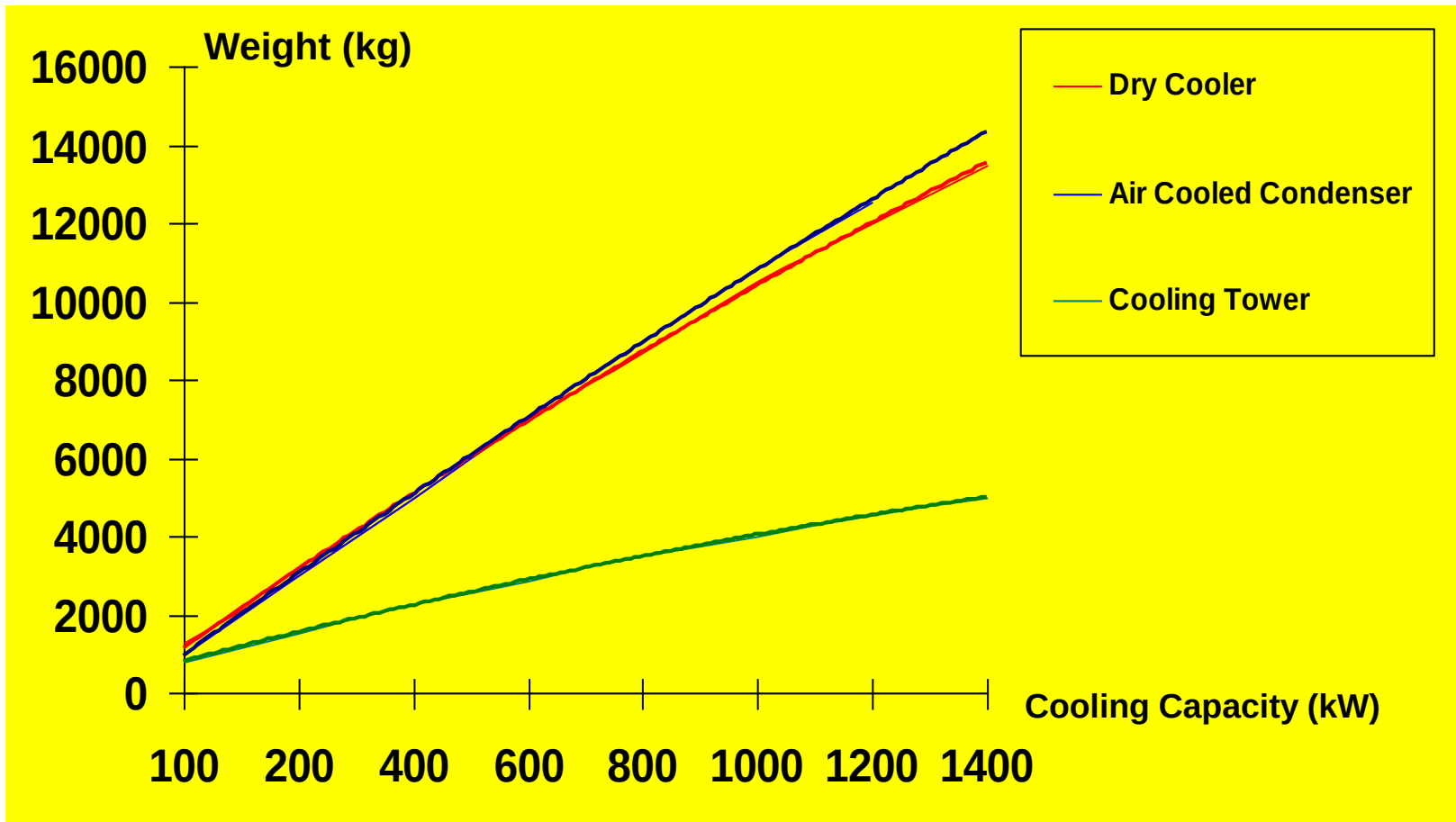
Roof Mounted Plant Floor Area (Gross)



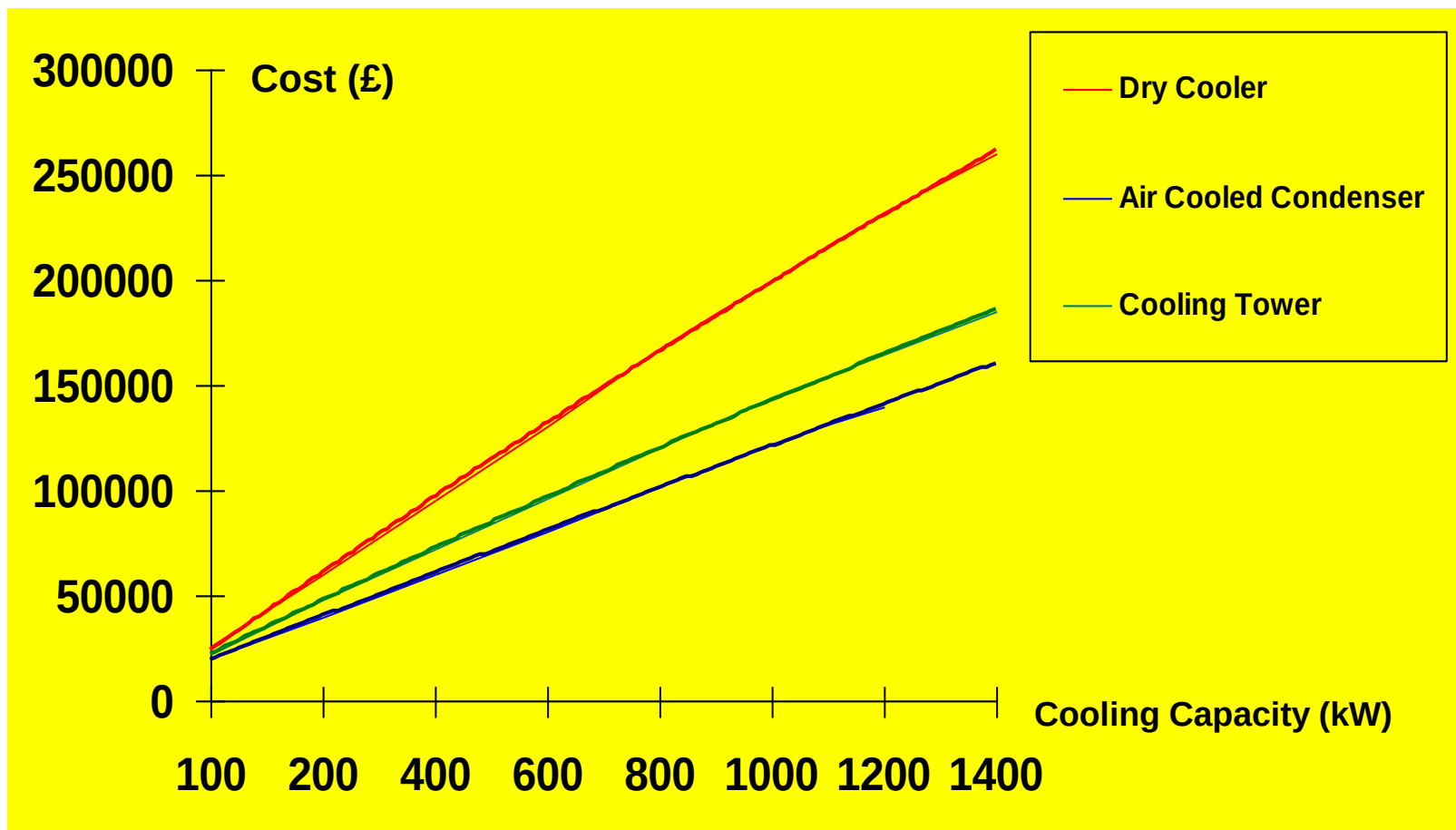
Allowances made for access in estimating gross plant areas



Working weights of roof top plant

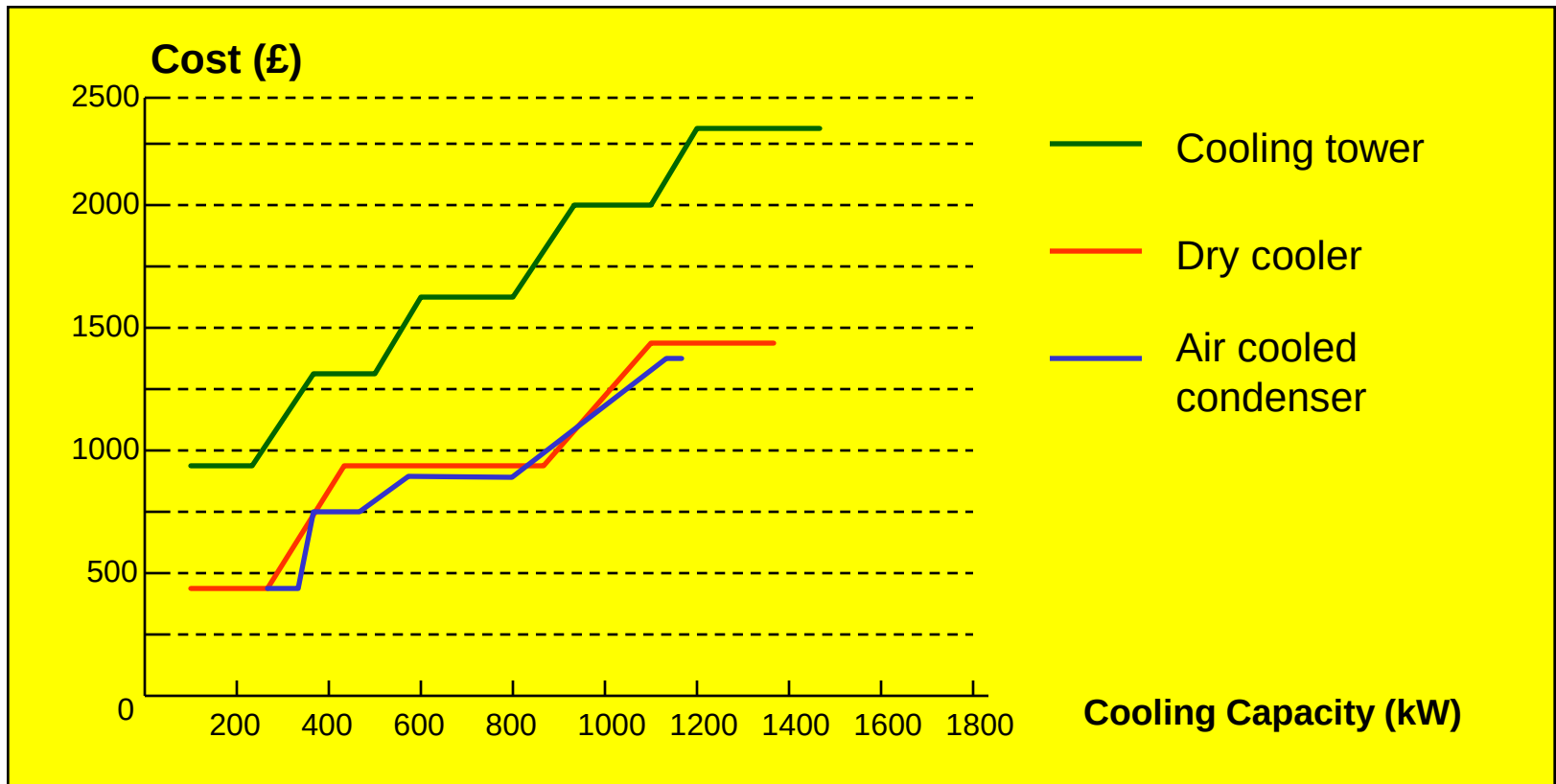


Capital costs of cooling system & chiller



Annual maintenance costs

(Excluding chiller and pumps)



Total Annual Operating Costs

(a) Cooling Capacity 200kW

Annual cost item	Cooling Tower & Chiller	Dry Cooler & Chiller	Packaged air cooled chiller
Investment	7010	8720	6310
Electrical consumption	2080	2460	2290
Water Treatment	1750	-	-
Maintenance	920	420	420
Total	11760	11600	9020

Total Annual Operating Costs

(b) Cooling Capacity 600kW

Annual cost item	Cooling Tower & Chiller	Dry Cooler & Chiller	Packaged air cooled chiller
Investment	16120	20350	14710
Electrical consumption	6100	6950	6780
Water Treatment	4540	-	-
Maintenance	1640	840	910
Total	28400	28140	22400

Total Annual Operating Costs

(c) Cooling Capacity 1200kW

Annual cost item	Cooling Tower & Chiller	Dry Cooler & Chiller	Packaged air cooled Chiller
Investment	27190	35630	25640
Electrical consumption	11950	13470	13470
Water Treatment	8050	-	-
Maintenance	2320	1320	1350
Total	49510	50420	40460