Colt International Ltd

Fundamentals of Evaporative Cooling
CPD Technical Seminar 2020

CPD Accreditation

Colt International Limited

CIBSE CPD

Certification

of CPD course provision

This is to certify that

Colt International Ltd

has been registered as a CPD Course Provider by
The Chartered Institution of Building Services Engineers (CIBSE)

Accredited from 1 June 2019 to 31 May 2021

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CIBSE CPD

Colt have a number of CPD accredited topics including:

- Car park ventilation
- The general principles of smoke control
- Pressurisation
- Smoke shafts
- Overheating common corridors
- Smoke and fire curtains
- Louvre
- Evaporative cooling

A brief history of Colt

Colt International Limited

Founded in

1931

2017 UK turnover

£35 million

2017 Group turnover

£180 million

Manufacturing facilities in

UK, Holland & Germany

Accreditations and Memberships

Colt International Limited

Accreditations

- Altius Gateway
- CHAS
- Construction Line
- Safe Contractor
- Worksafe Contractor
- RoSPA

PPQ still required by clients

IFC certification

CERTIFICATED INSTALLER OF ACTIVE FIRE PROTECTION

smas worksafe contractor www.smasltd.com as recognised by SSIP SAFETY SCHEMES IN PROCUREMENT

health in CONSTRUCTION leadership group

QUALITY SYSTEM CERTIFICATION DNV·GL ISO 9001

ENVIRONMENTAL SYSTEM CERTIFICATION DNV·GL ISO 14001

SAFETY SYSTEM CERTIFICATION DNV·GL ISO 45001

Memberships

BSRIA

CIBSE PATRONS

ASFP www.asfp.org.uk

CIBSE CPD

FETA

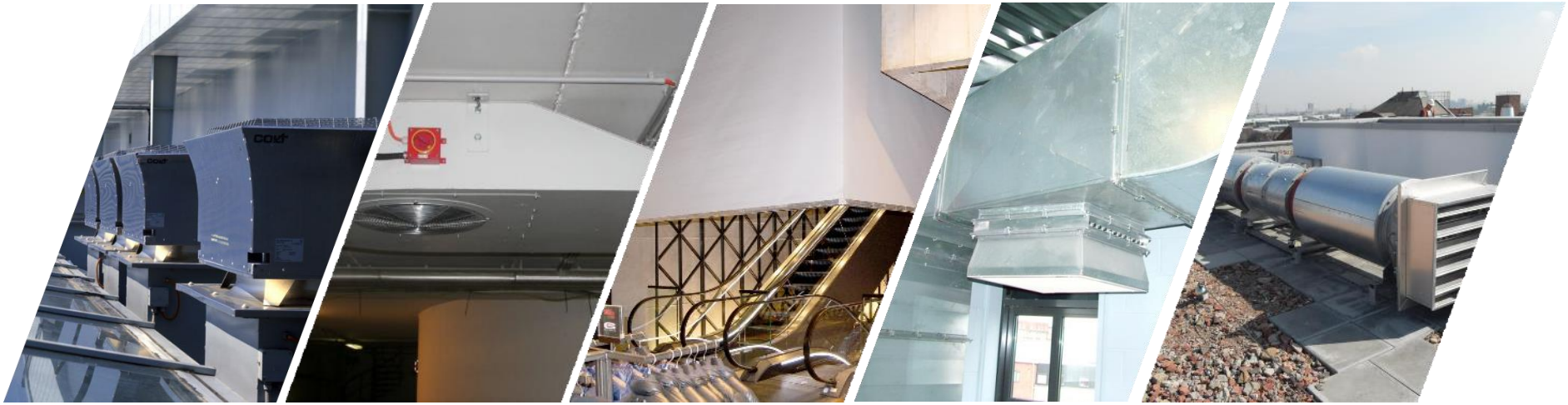
Smoke Control

Climate Control

Louvre & Shading

Service

Smoke Control



SHEVS
Smoke and Heat
Exhaust Systems

Car Park
Ventilation

Smoke
Containment

Pressurisation
Systems

Smoke Shaft
Systems

Climate control

Natural Ventilation

Hybrid Ventilation

Mechanical Ventilation

Evaporative Cooling

Louvre

Screening | Ventilation & Rain Defence | Shading | Acoustic

Service

24 hour call out

Nationwide Coverage

Spare Parts

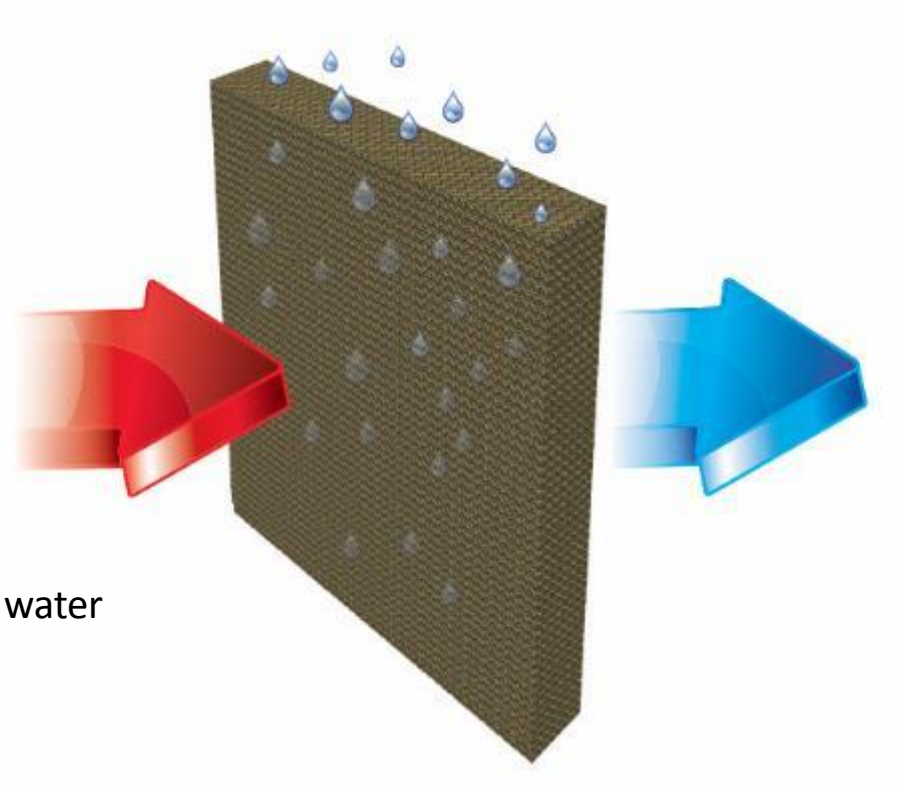
Surveys

Agenda

Fundamentals of Evaporative Cooling 2020

- **Principles & Terminology**
- Design Approach
- Product types, options & configurations
- Limitations and concerns
- Example projects & applications
- Questions

- Adiabatic cooling or Evaporative cooling?
  - Without addition / removal of energy



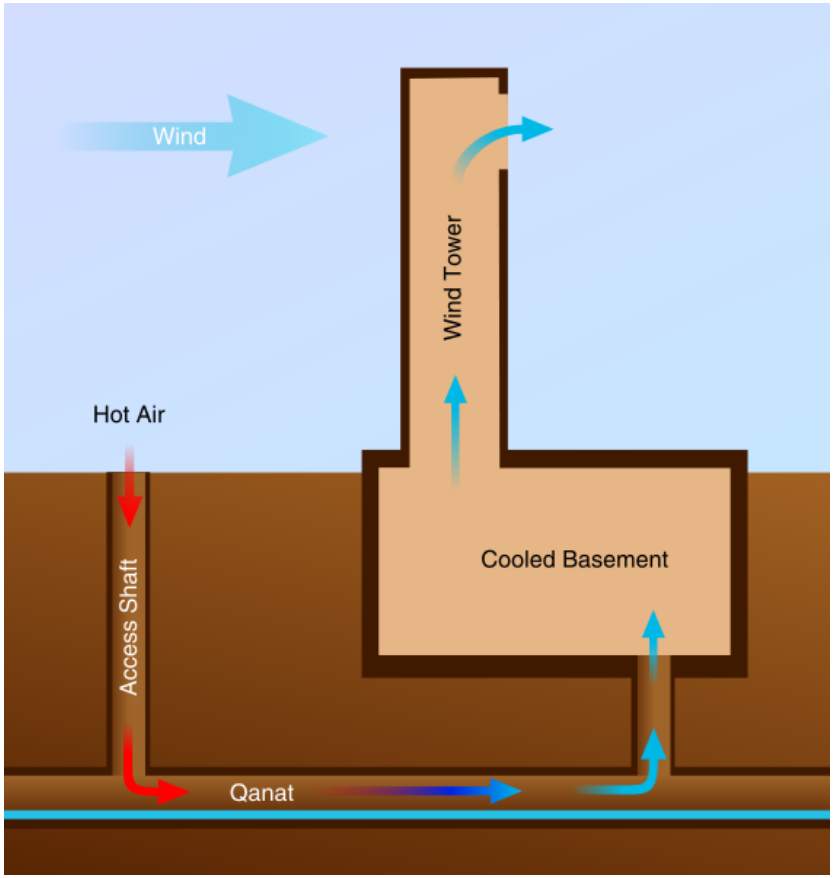
- Evaporation
  - Change of liquid to a gas
  - 2,436 kilojoules / gram
  - Heat energy taken from the air into the water vapour

- Other important terms;
  - **Dry Bulb Temperature** – air temperature measured by a regular thermometer.
  - **Wet Bulb Temperature** – lowest temperature which can be reached by evaporation of water
  - **Humidity** – measure of the amount of moisture held in the air relative to the amount it is capable of holding.
  - **Psychrometric Chart** – graphical representation of the psychrometric process.
  - **Adiabatic cooling = evaporative cooling**. They are exactly the same thing, and often you will find both phrases used.

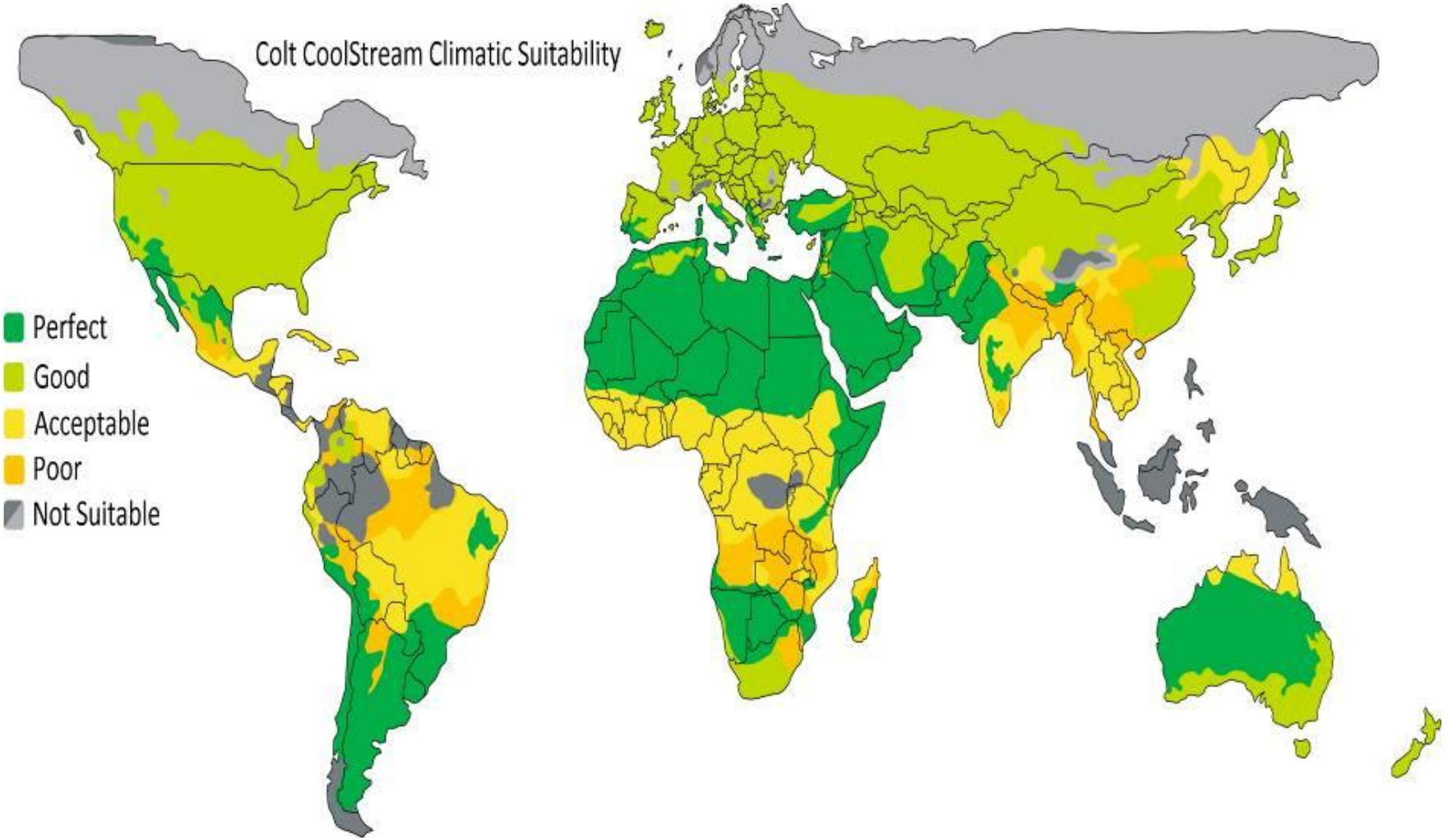
- Practical examples of Adiabatic Evaporative cooling?

  - Wet your finger and blow on it
  - Get out of the sea or a swimming pool when the day is breezy
  - Perfume or aftershave on your skin

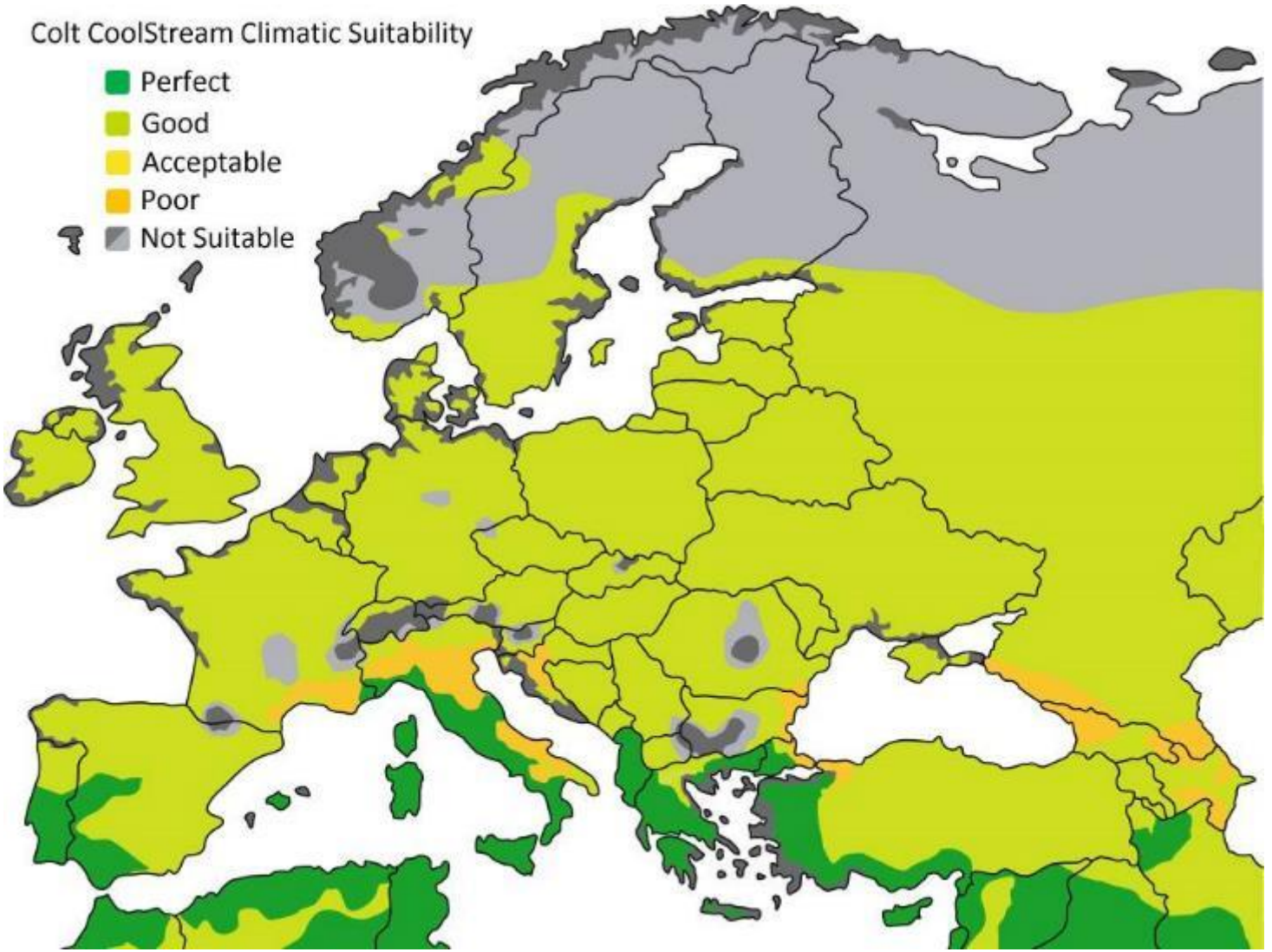
- Physical process
- Ancient Egypt & Greece had quite complex systems to exploit it
- Estimated to be millions of installations using the principle worldwide



- Where is the technology applicable



Applicability - Europe



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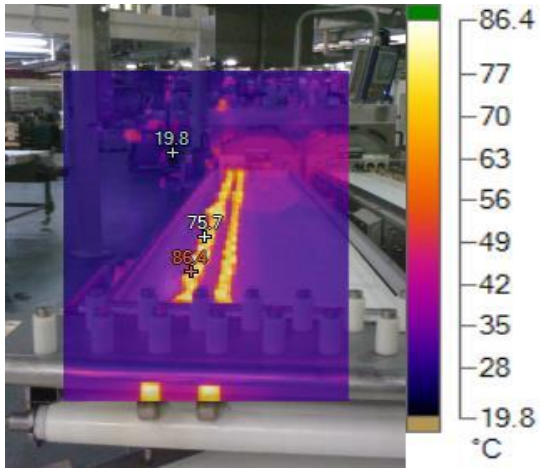
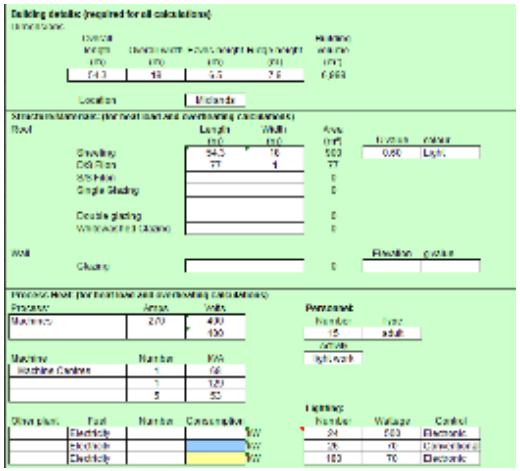
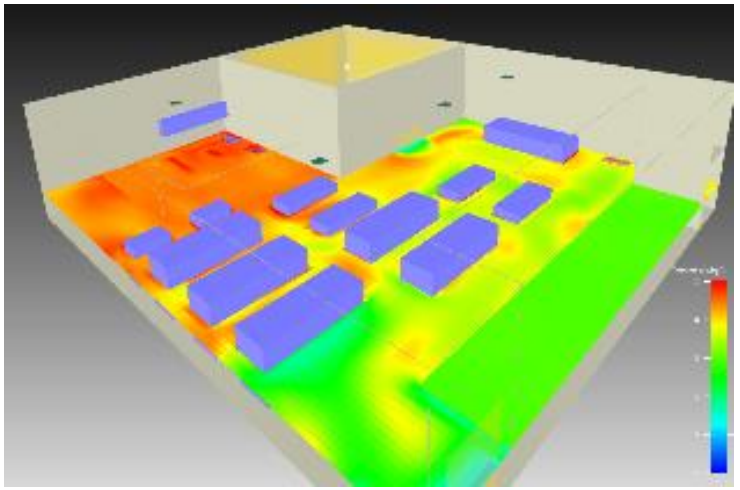
Defining the problem / understanding the objective

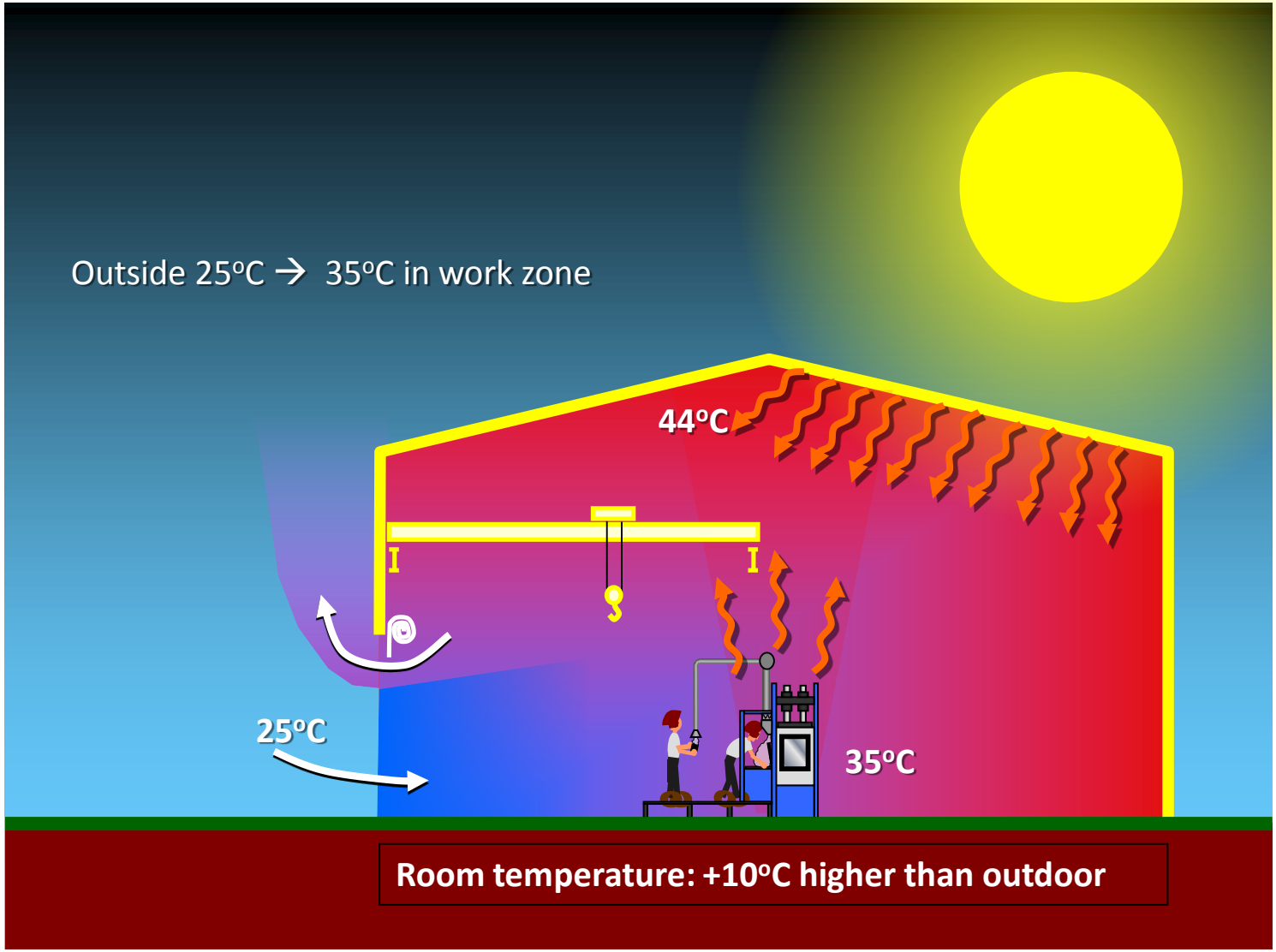
Fundamentals of Evaporative Cooling 2020

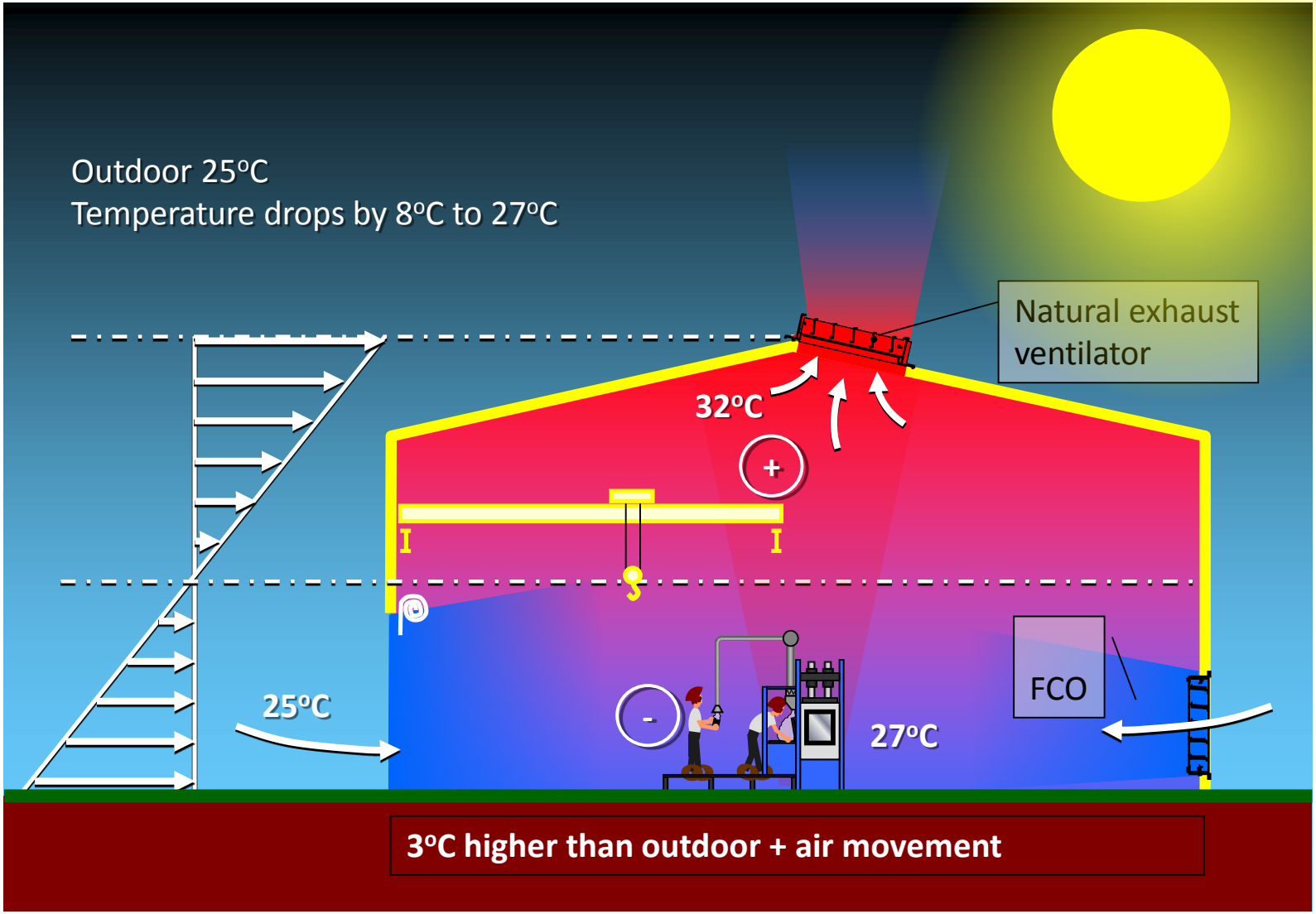


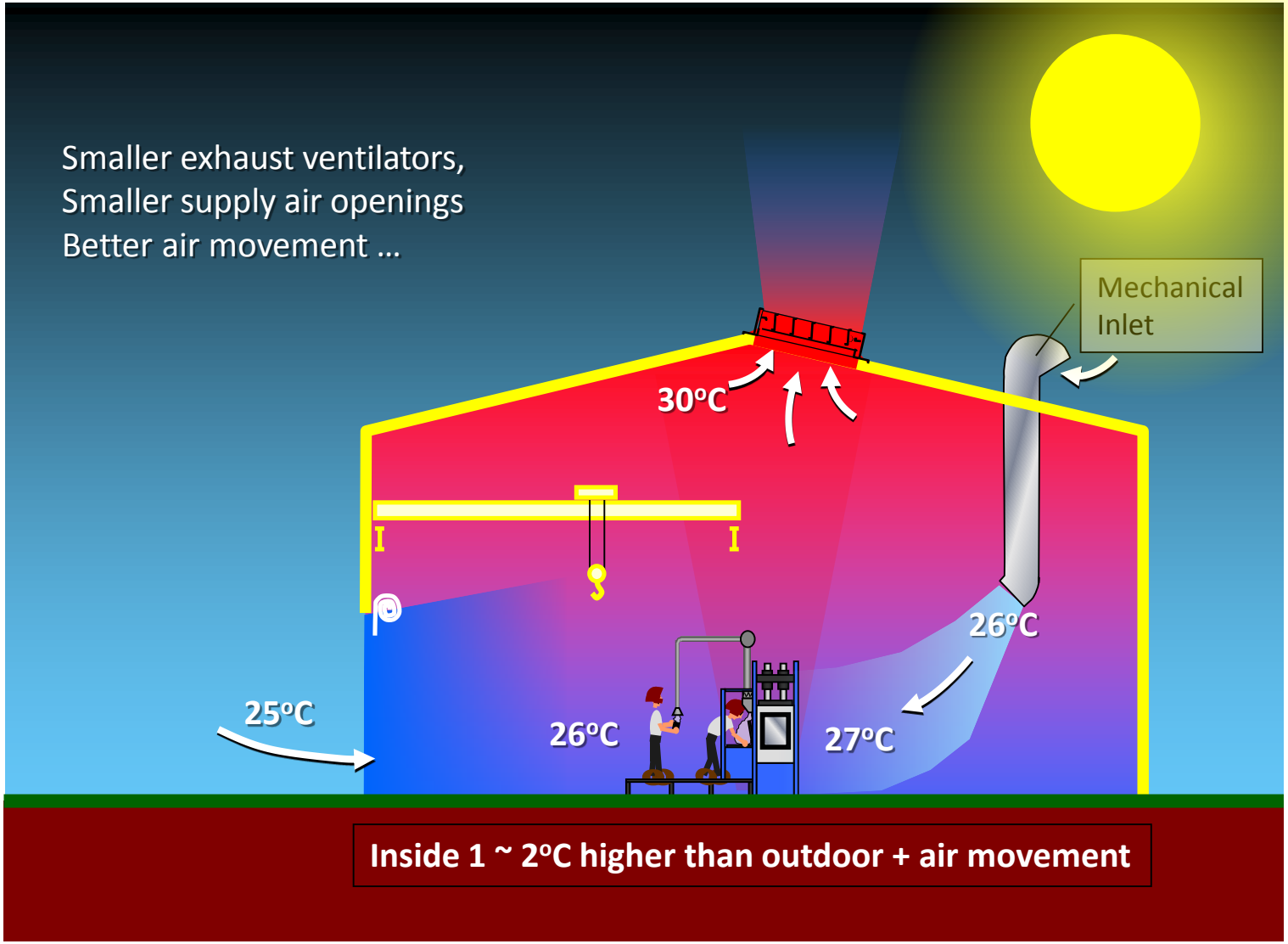




No ventilation

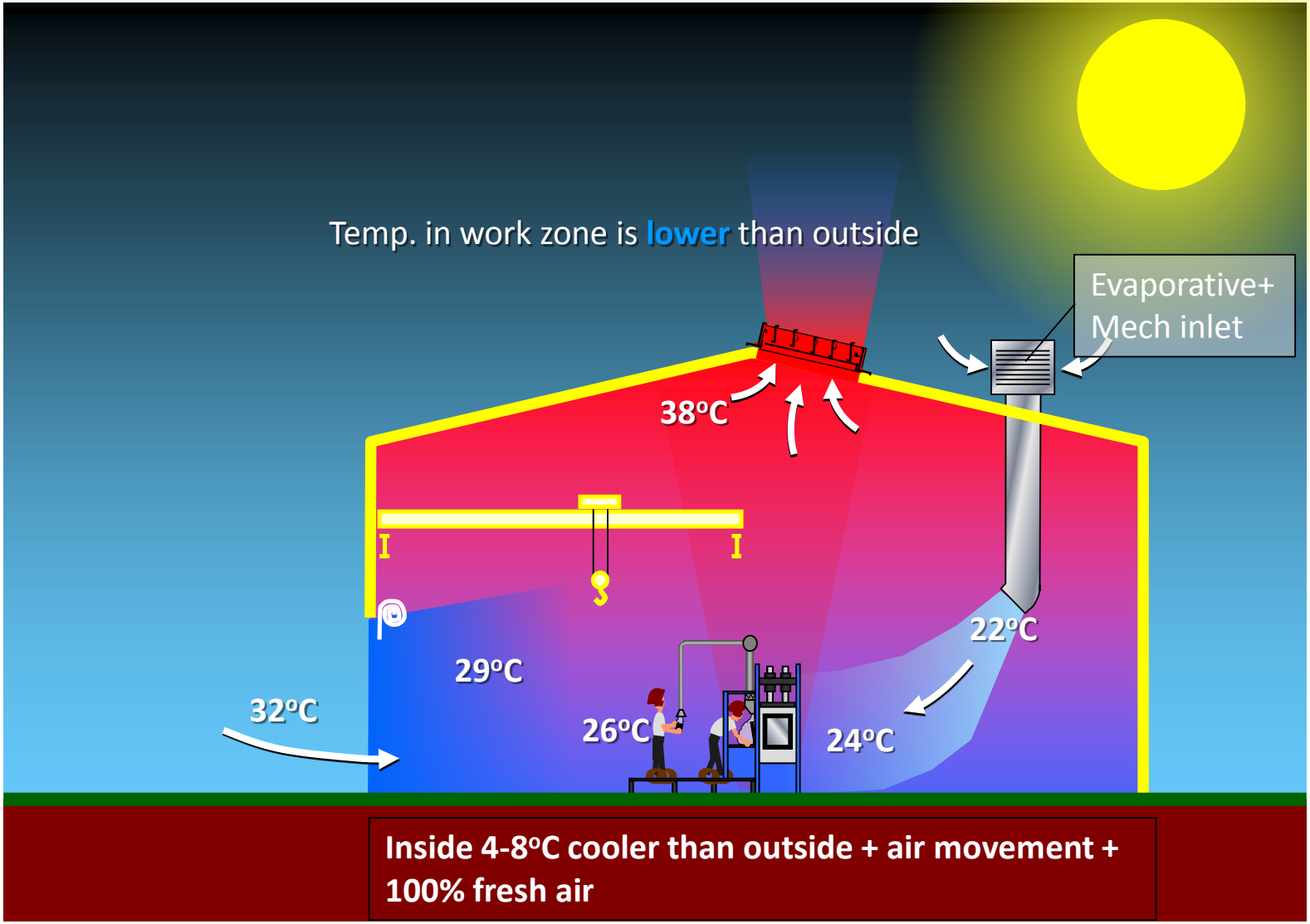


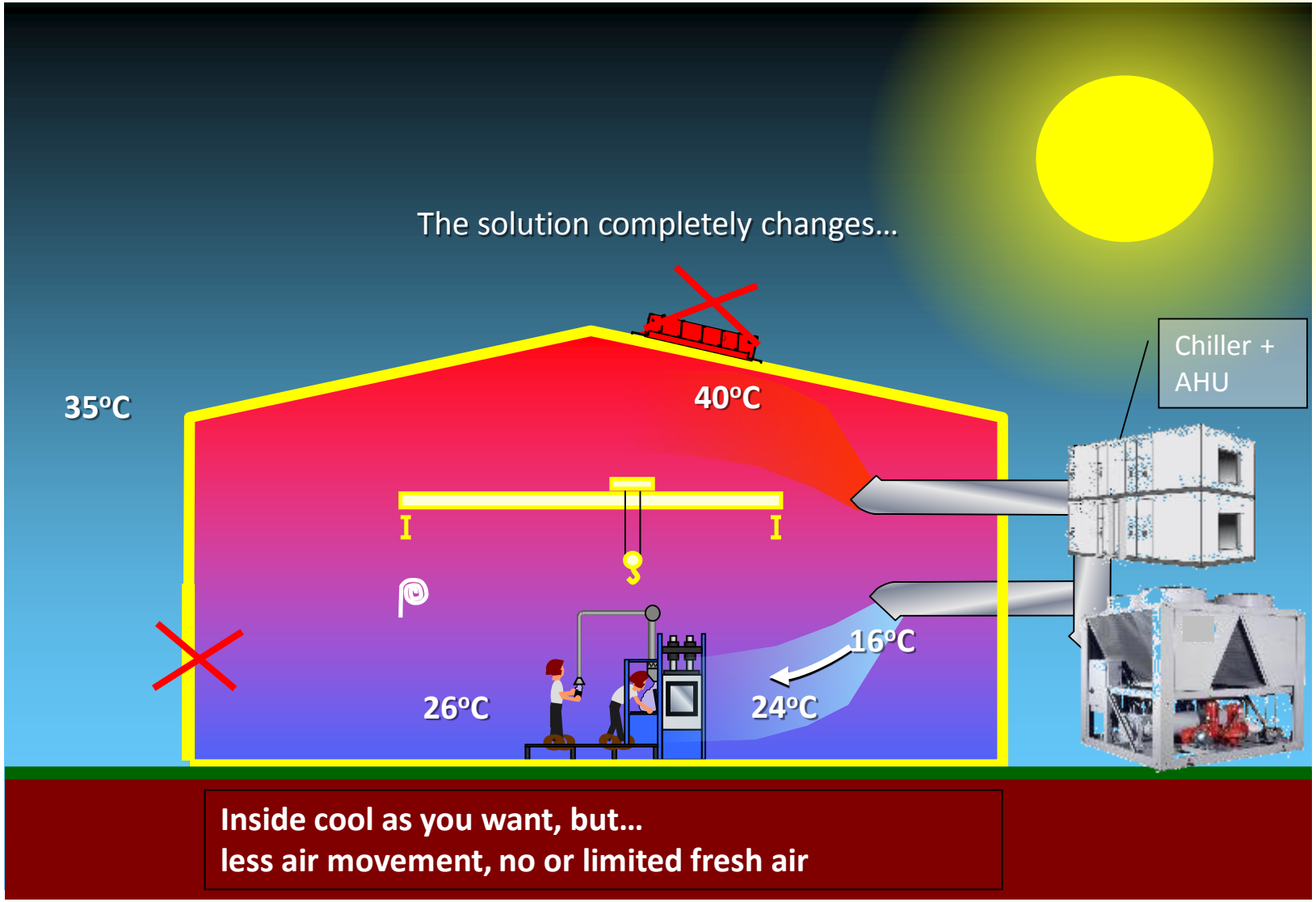

Outdoor 25°C
Temperature drops by 8°C to 27°C
Natural exhaust ventilator
32°C
+
25°C
-
27°C
FCO
3°C higher than outdoor + air movement


Smaller exhaust ventilators,
Smaller supply air openings
Better air movement …
Mechanical Inlet
30°C
26°C
25°C
26°C
27°C
Inside 1 ~ 2°C higher than outdoor + air movement

Natural ventilation and adiabatic cooled supply air

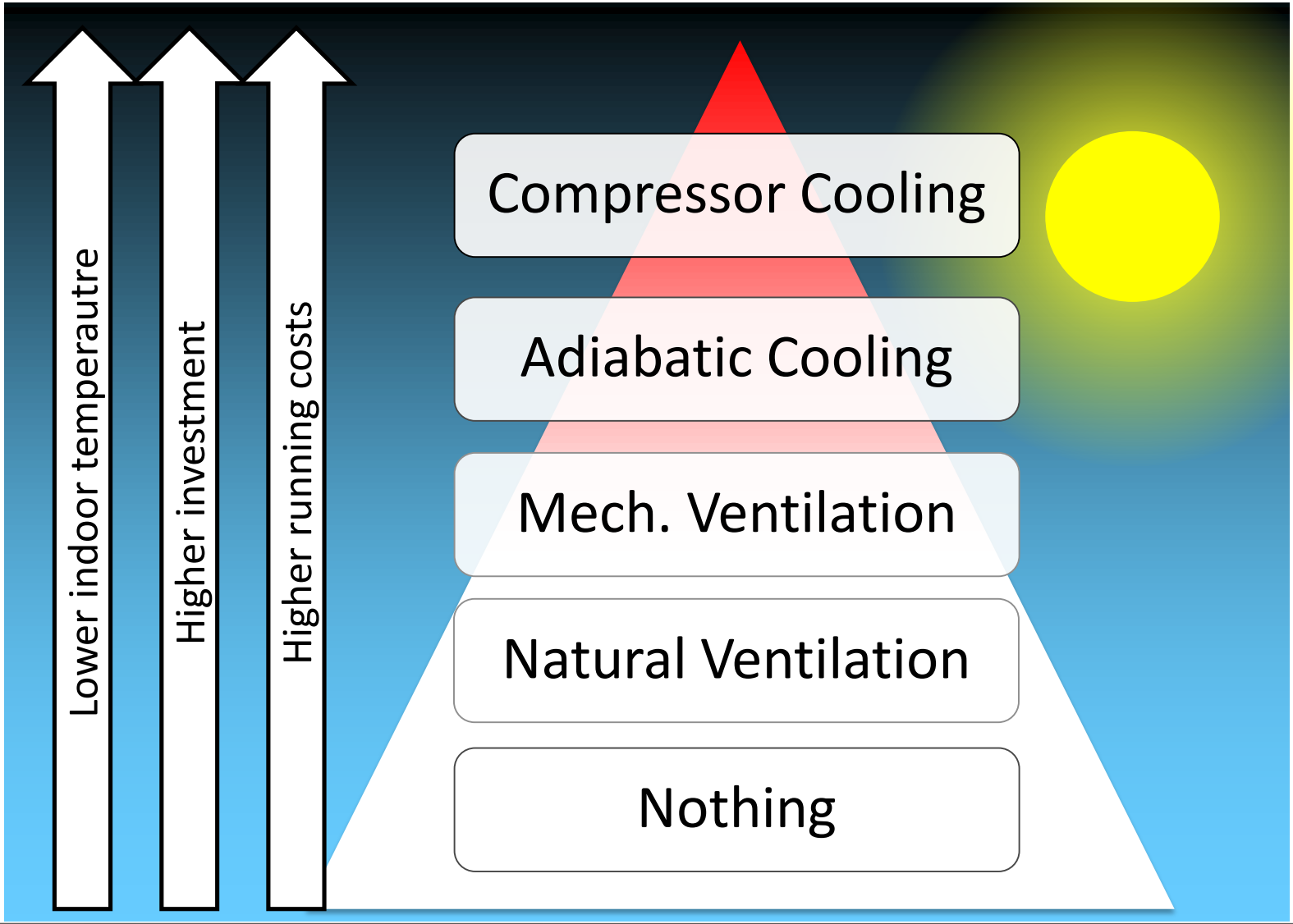
Fundamentals of Evaporative Cooling 2020




The solution completely changes…
35°C
40°C
Chiller + AHU
16°C
26°C
24°C
Inside cool as you want, but…
less air movement, no or limited fresh air

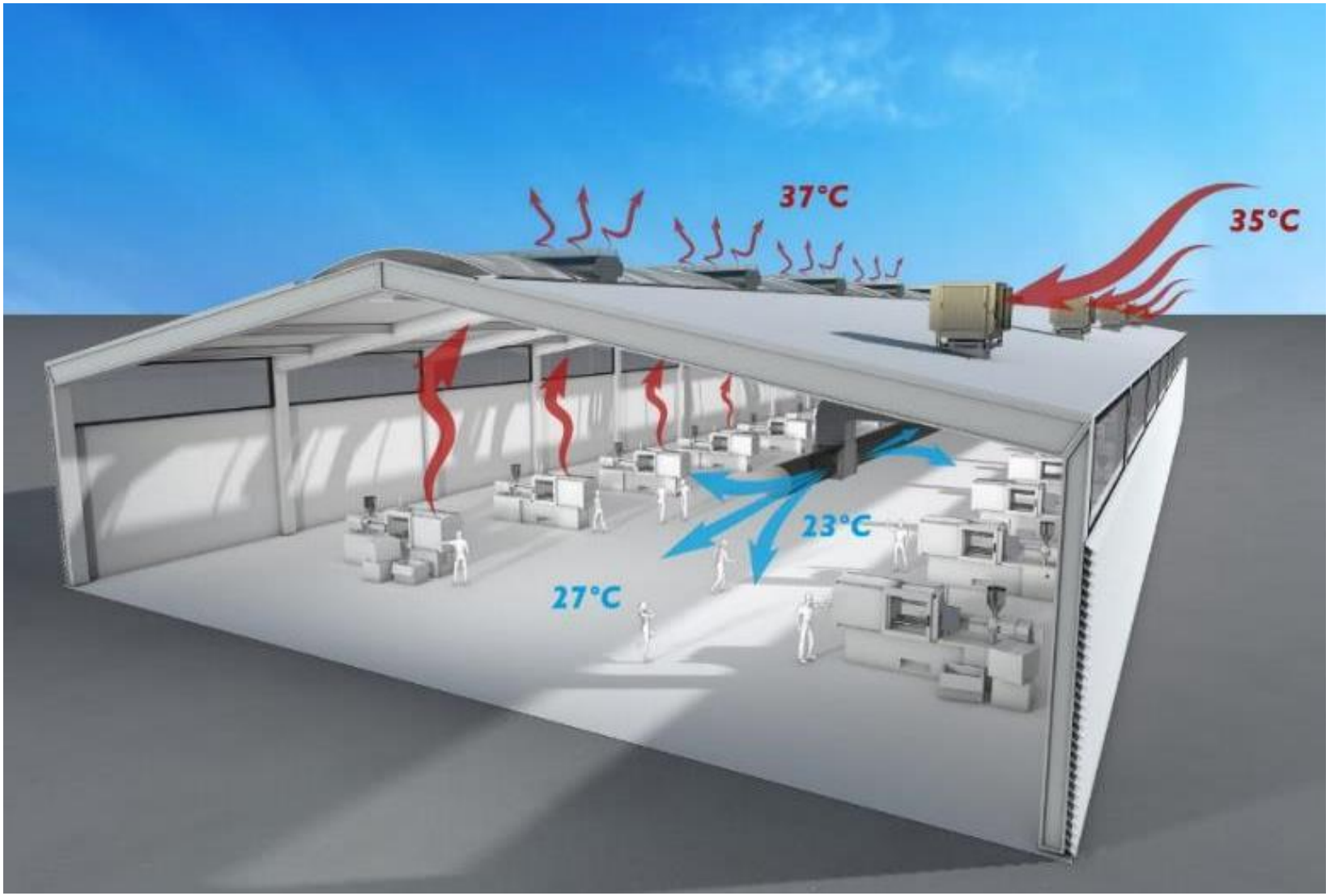
Cooling stage model

Fundamentals of Evaporative Cooling 2020



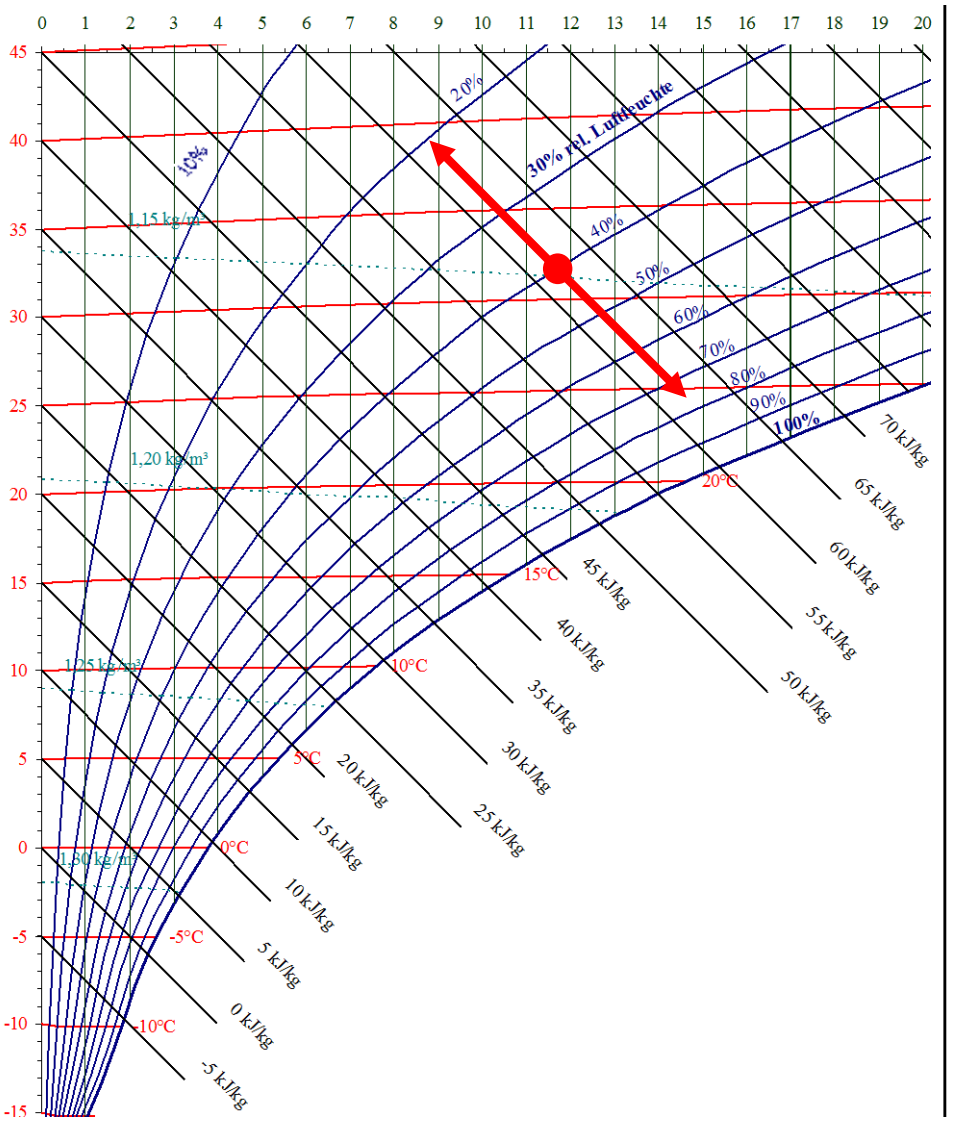
Evaporative cooling concept

Fundamentals of Evaporative Cooling 2020



Example calculation

- 32 deg C & 40% RH
- Resultant condition must lie on the enthalpy line

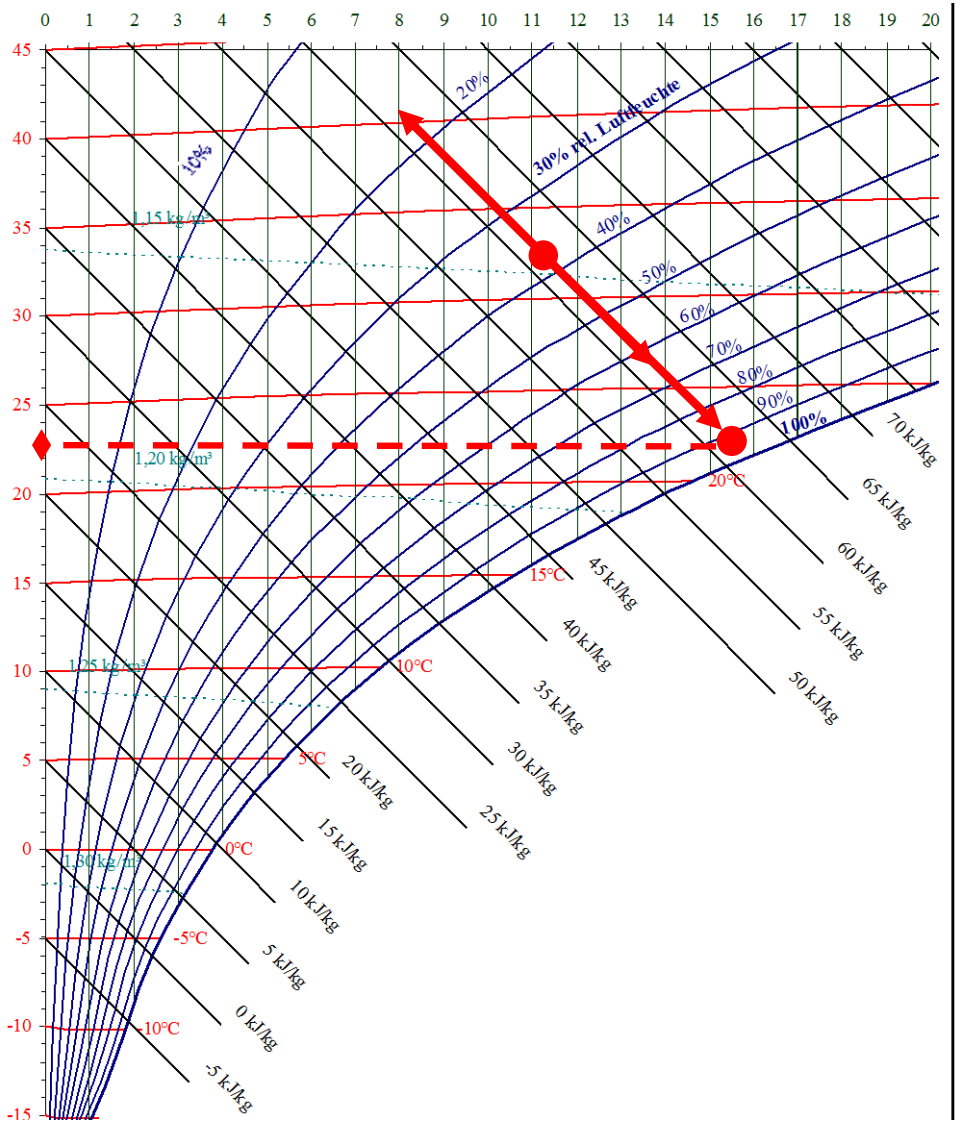


Example calculation 2

- Air temperature will reduce

&

- Relative Humidity will increase



So how much can I cool the air down by?

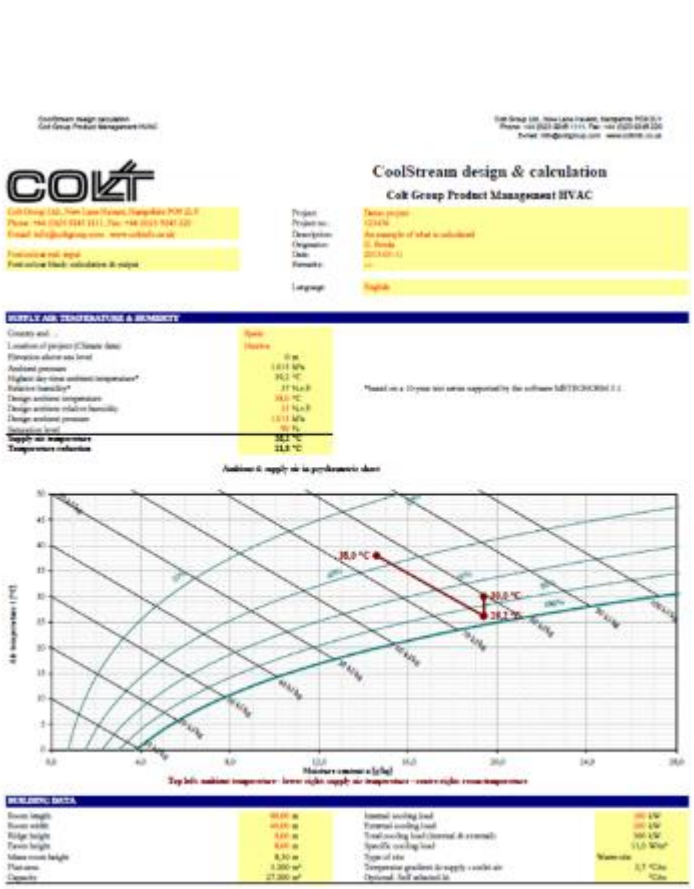
The temperature which is reached is dependent on the temperature and humidity. The table below shows what sort of supply air temperatures can be achieved at a variety of external conditions.

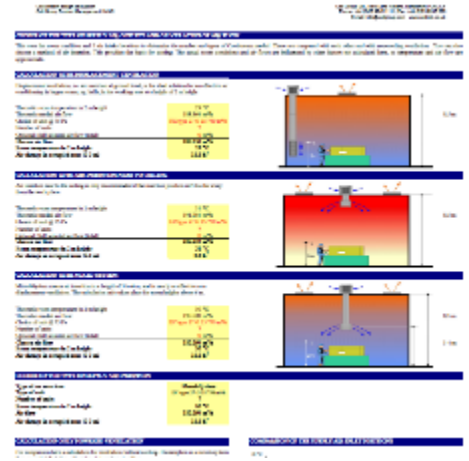
For example, an external outdoor temperature of 32°C and relative humidity (RH) of 40%, results in a supply air temperature of 23°C. That means the supply air temperatures is reduced by 9°C. It is possible to provide exacting values using the Colt Design Software.

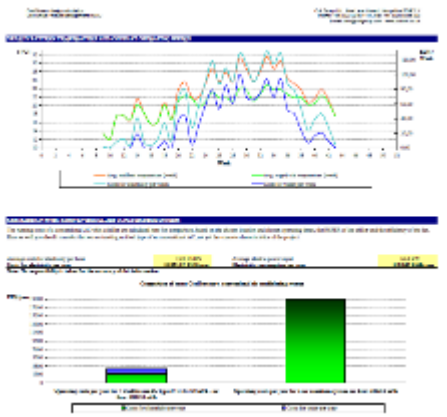
Outdoor air humidity	20 %		30 %		40 %		50 %		60 %	
Outdoor air temperature	Supply air temperature / *temperature reduction*									
20°C	10°C	*10°C*	12°C	*8°C*	14°C	*6°C*	15°C	*5°C*	16°C	*4°C*
24°C	13°C	*11°C*	15°C	*9°C*	17°C	*7°C*	18°C	*6°C*	20°C	*4°C*
28°C	16°C	*12°C*	18°C	*10°C*	20 °C	*8°C*	22°C	*6°C*	23°C	*5°C*
32°C	18°C	*14°C*	21°C	*11°C*	23°C	*9°C*	25°C	*7°C*	27°C	*5°C*
36°C	21°C	*15°C*	24°C	*12°C*	26°C	*10°C*	28°C	*8°C*	30°C	*6°C*
40°C	24°C	*16°C*	27°C	*13°C*	29°C	*12°C*	32°C	*8°C*	34°C	*6°C*

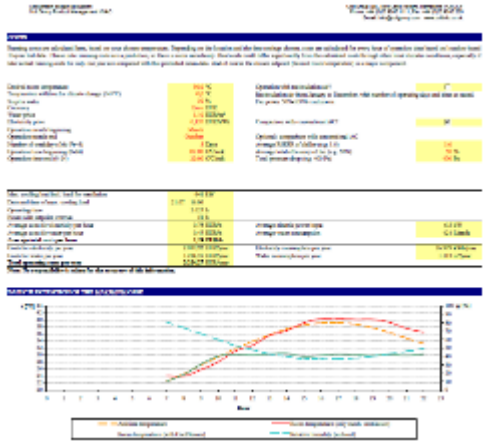
Example calculation 4

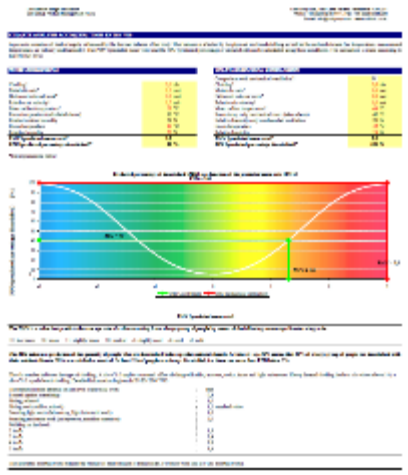
Fundamentals of Evaporative Cooling 2020











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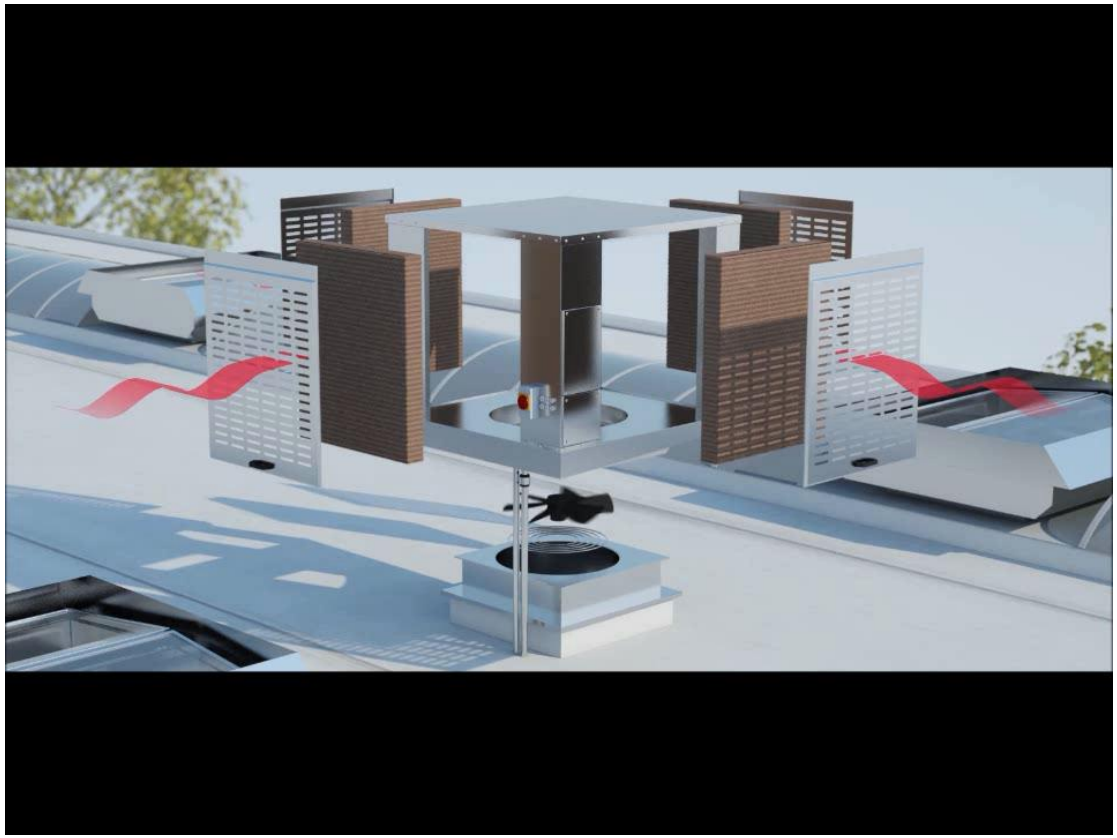
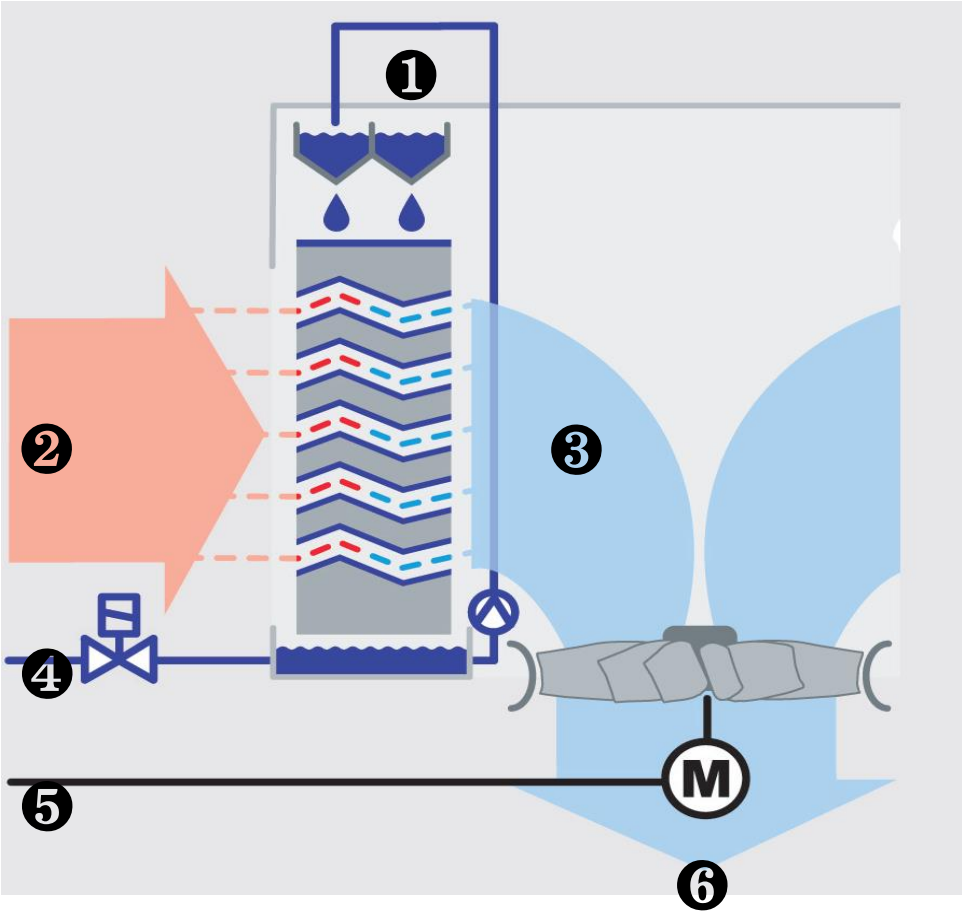


Form and function of a standard evaporative cooler



❶ water distribution system, separated from the air flow

❷ Warm air

❸ Air stream, free from micro-droplets

❹ Drinking water

❺ Electrical energy

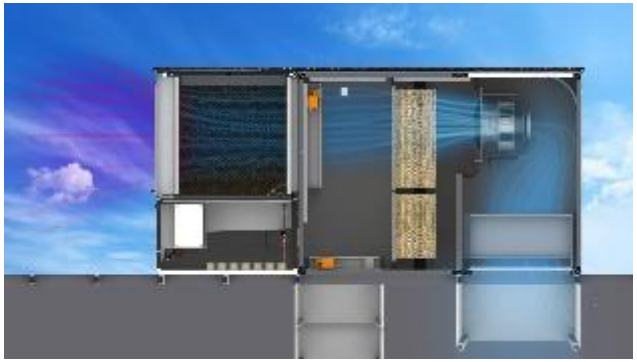
❻ Cooled air to building

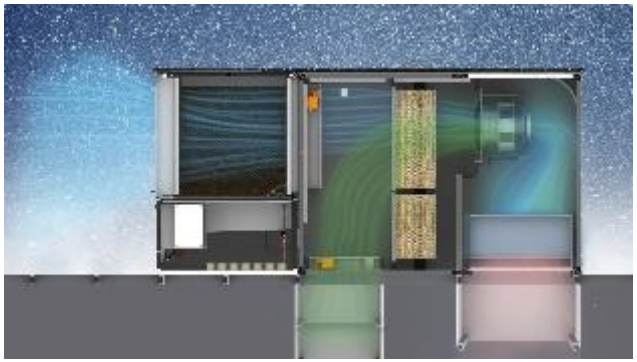
Taking on the air handling unit (AHU) role.

Modern evaporative coolers do more than just supply cool air. Like a traditional AHU, they can be configured to provide additional air treatment like **filtration**, **heating** and **warm air recycling.** Meaning they really can provide an alternative to the AHU with year-round ability.




Cooling | Heating | Filtration | Warm Air Recycling.





Summer

Cool filtered supply air

Spring & Autumn

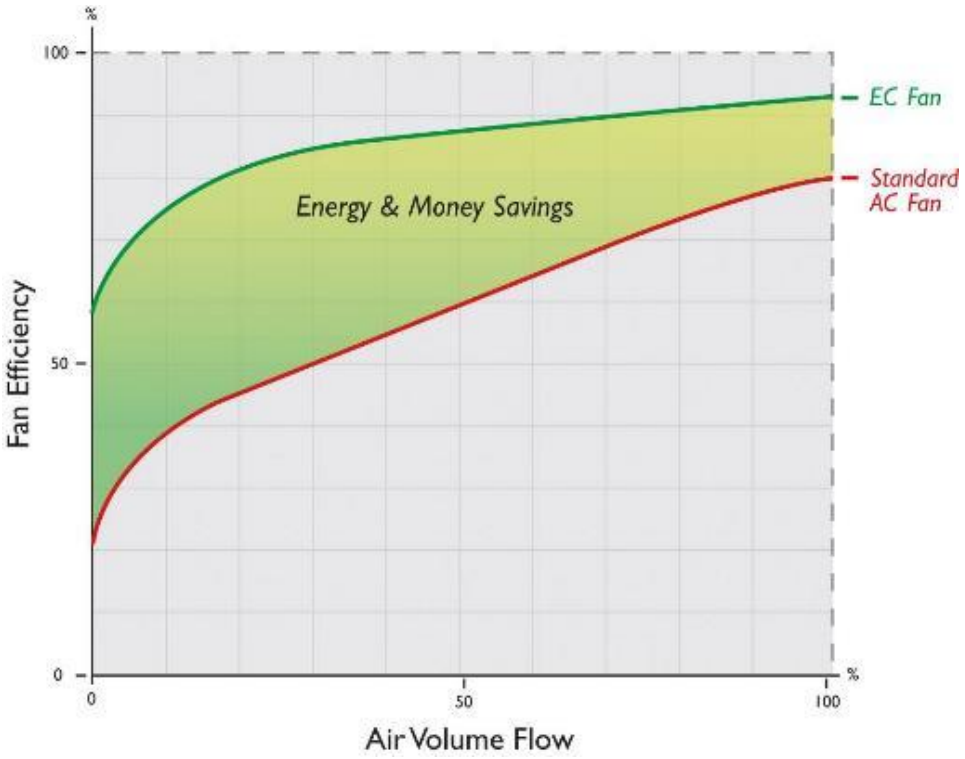
Cool filtered supply air mixed with warmer filtered internal air to pre-heat the supply air

Winter

Warmer filtered internal air and heating, with minimum filtered fresh air ventilation

EC vs **AC fans**

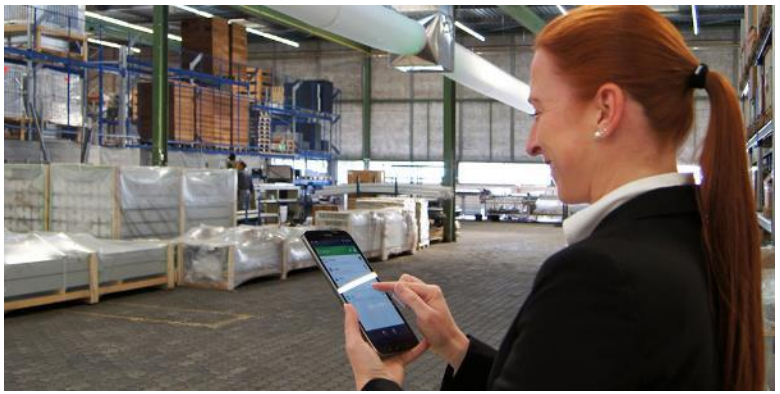
- Automatic fully variable control 0…100% fan speed
- “as much as necessary, as little as possible”



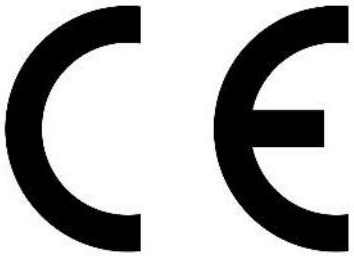
Advanced controls = optimum performance

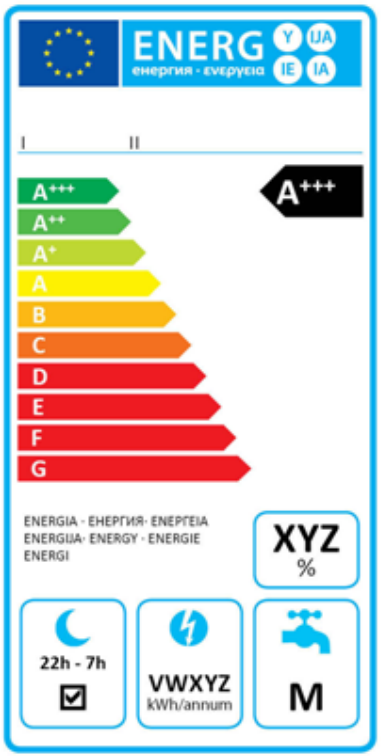
Key features of modern evaporative cooling control systems;

- Intelligent variable fan speed
- Automatic water management
- Condensation protection
- Dynamic drying management
- Remote maintenance diagnostics
- Energy counter
- Weekly timers
- Night cooling
- PC, Tablet, Smartphone control
- Fire alarm interfaces
- Air quality – CO / VOC, sensors
- BMS Integration



- Machinery Directive
- Low Voltage Directive
- Eco-design Directive (ErP)
- Gas Appliances Directive
- VDI 6022





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Legionella

Conditions for Legionella contamination:

- Stagnant water, 20°C – 55°C (optimum 37°C)
- Water droplets 1-5µm in the air stream

Prevention Measures

- Temperature control: T water always <25°C
- Refresh water
- Water evaporates directly on desorption medium:

  v = 2 ~ 2,5 m/s = critical speed for droplets

  → v = 1 ~ 1,7 m/s @ Colt

  → no droplets
- Drain and dry cycle every 24hrs
- VDI 6022

VDI 6022

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Dairy Plant:

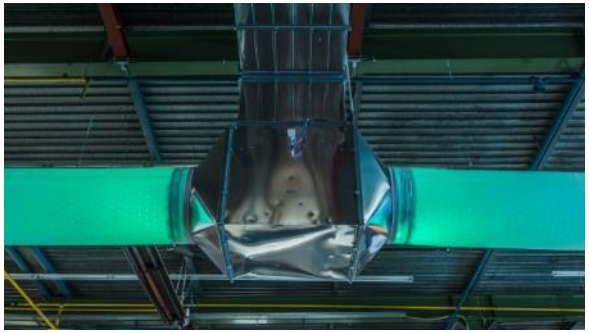
- Evaporative Cooling System
- 38kW vs 750kW for “traditional” chilled water HVAC system

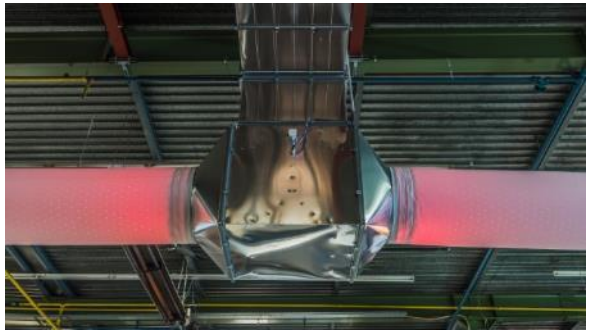
Example projects – plastics industry

Plastics Packaging Factory:

- Evaporative Cooling System with AHUs to address specialist project requirements
- Displacement ventilation (picture left showing supply ducts)
- Natural extract for top floor
- Mechanical extract for lower floor

Example projects – manufacturing industry



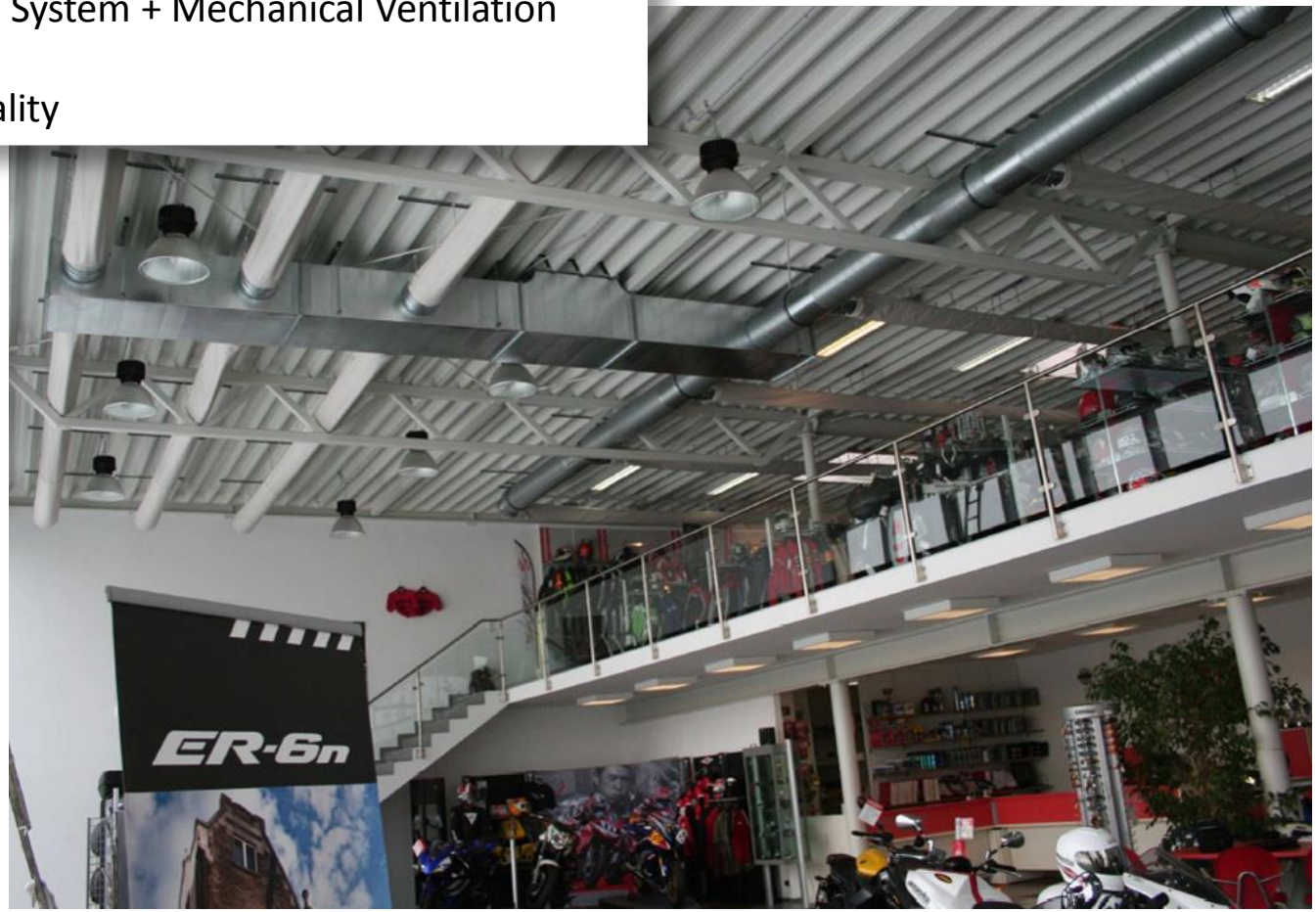


Manufacturing facility:

- Evaporative Cooling System + Mechanical Ventilation
- Cooling, Fresh Air & RH <60%
- Good indoor air quality for employees
- Traffic light fabric supply duct system for visual feedback on HVAC status

Retail showroom

- Evaporative Cooling System + Mechanical Ventilation
- Cooling, Fresh Air
- Good indoor air quality



Residential Apartment Building

- Evaporative Cooling System + Mechanical Ventilation
- Cooling, Fresh Air
- Good indoor air quality
- CIBSE TM52 and TM49 compliance

- Fresh air supply for high indoor air quality
- Cooling capacity increases as external temperature rises
- Future proof (against predicted warming through climate change)
- Low running costs (typically 90% reduction vs. AC)
- Low weight – smaller equipment size than mechanical ventilation solutions
- Modern units include filtration, waste heat recycling & winter heating (gas, electric, hot water)
- No adverse impact on comfort – ISO7730
- Building doors, roller shutters etc can stay open with minimal impact
- Combine with natural or mechanical exhaust or smoke exhaust (dual purpose)
- Simple, safe and reliable operation, natural process
- Simple and low cost maintenance
- Hygienic and safe
- Modern, intelligent controls

Q&A Session…