



**Colt International Ltd**  
Fundamentals of Evaporative Cooling  
CPD Technical Seminar 2020



“People feel better in Colt conditions” | [www.coltinfo.co.uk](http://www.coltinfo.co.uk)



# 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

**Andrew Rowe**  
CPD Panel Chair  
CIBSE

**Olga Mendes**  
Membership Development Manager  
CIBSE

**The Chartered Institution of  
Building Services Engineers**  
222 Balham High Road  
London SW12 9BS  
T: 020 8675 5211  
E: [info@cibse.org](mailto:info@cibse.org)  
[www.cibse.org](http://www.cibse.org)



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**



Expertise built on proven experience | [www.coltinfo.co.uk](http://www.coltinfo.co.uk)

# Accreditations and Memberships

Colt International Limited



## Accreditations

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



Chas Accredited



PPQ still required by clients



**CERTIFICATED INSTALLER OF  
ACTIVE FIRE PROTECTION**



## Memberships





Smoke Control



Climate Control



Louvre & Shading

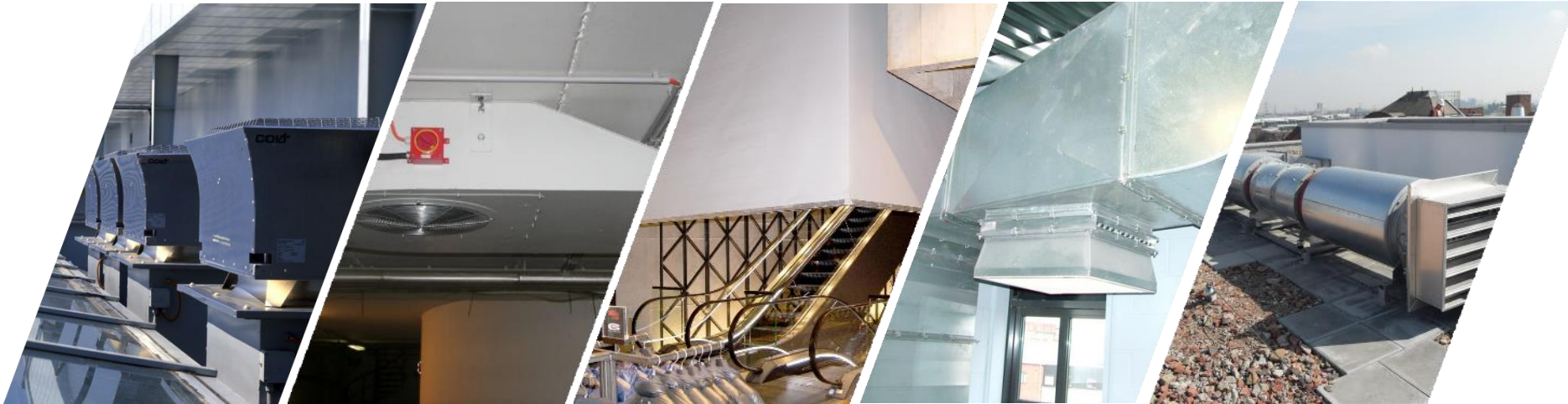


Service





## 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



# Performance & Screening Louvre

Colt International Limited



Louvre



Screening

Ventilation &  
Rain Defence

Shading

Acoustic



Expertise built on proven experience | [www.coltinfo.co.uk](http://www.coltinfo.co.uk)





## Service



24 hour call out

Nationwide Coverage

Spare Parts

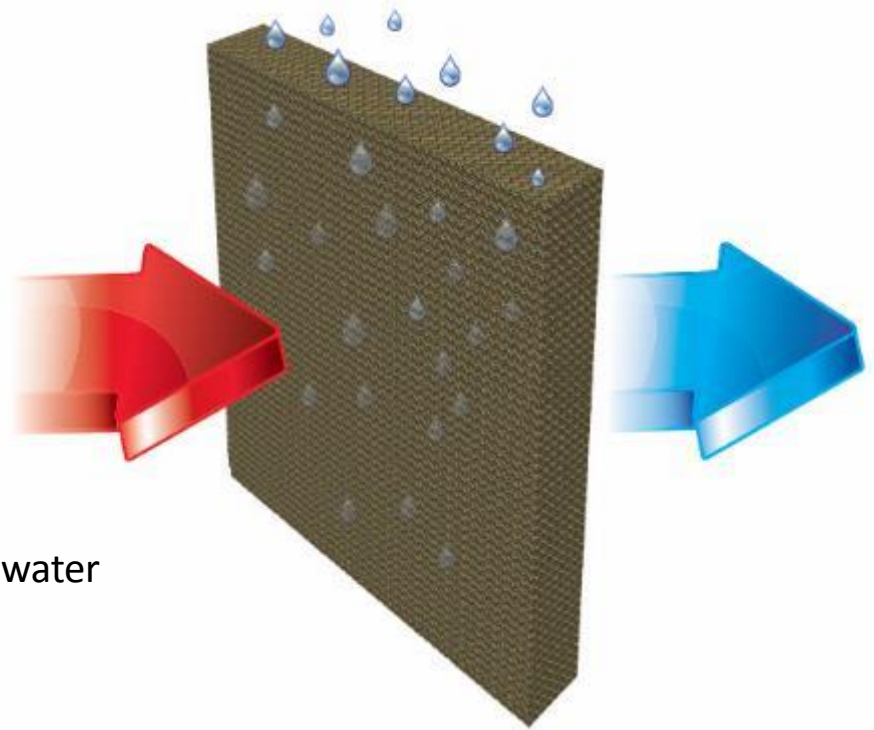
Surveys



- **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



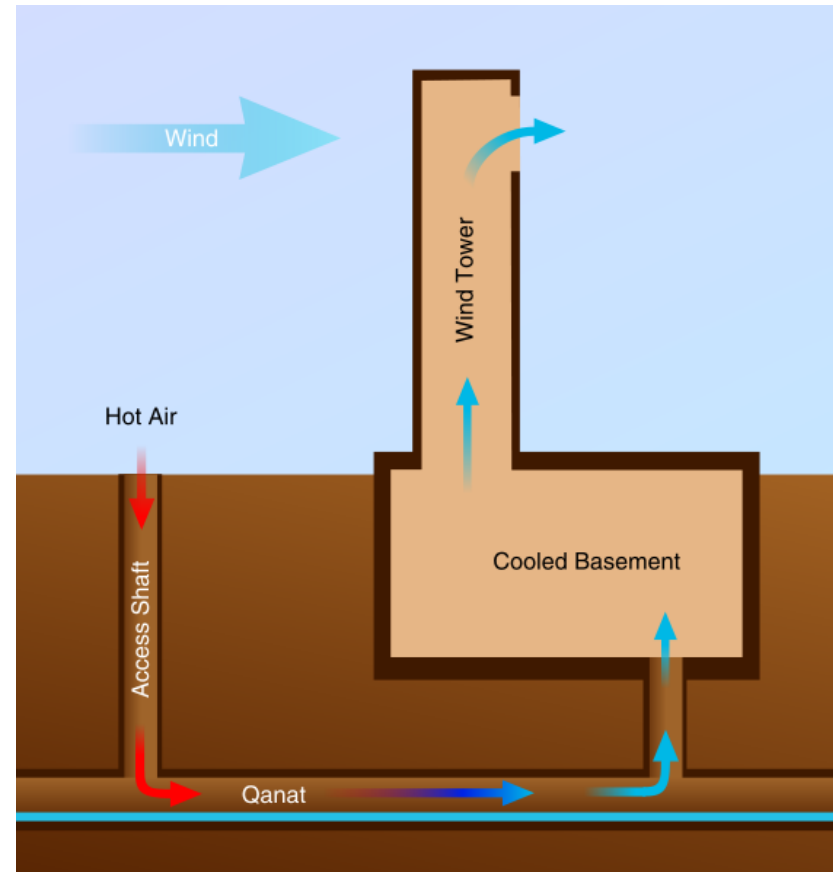
- Other important terms;
  - **Dry Bulb Temperature** – air temperature measured by a regular thermometer.
  - **Wet Bulb Temperature** – lowest temperature which can be reached by evaporation of water
  - **Humidity** – measure of the amount of moisture held in the air relative to the amount it is capable 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

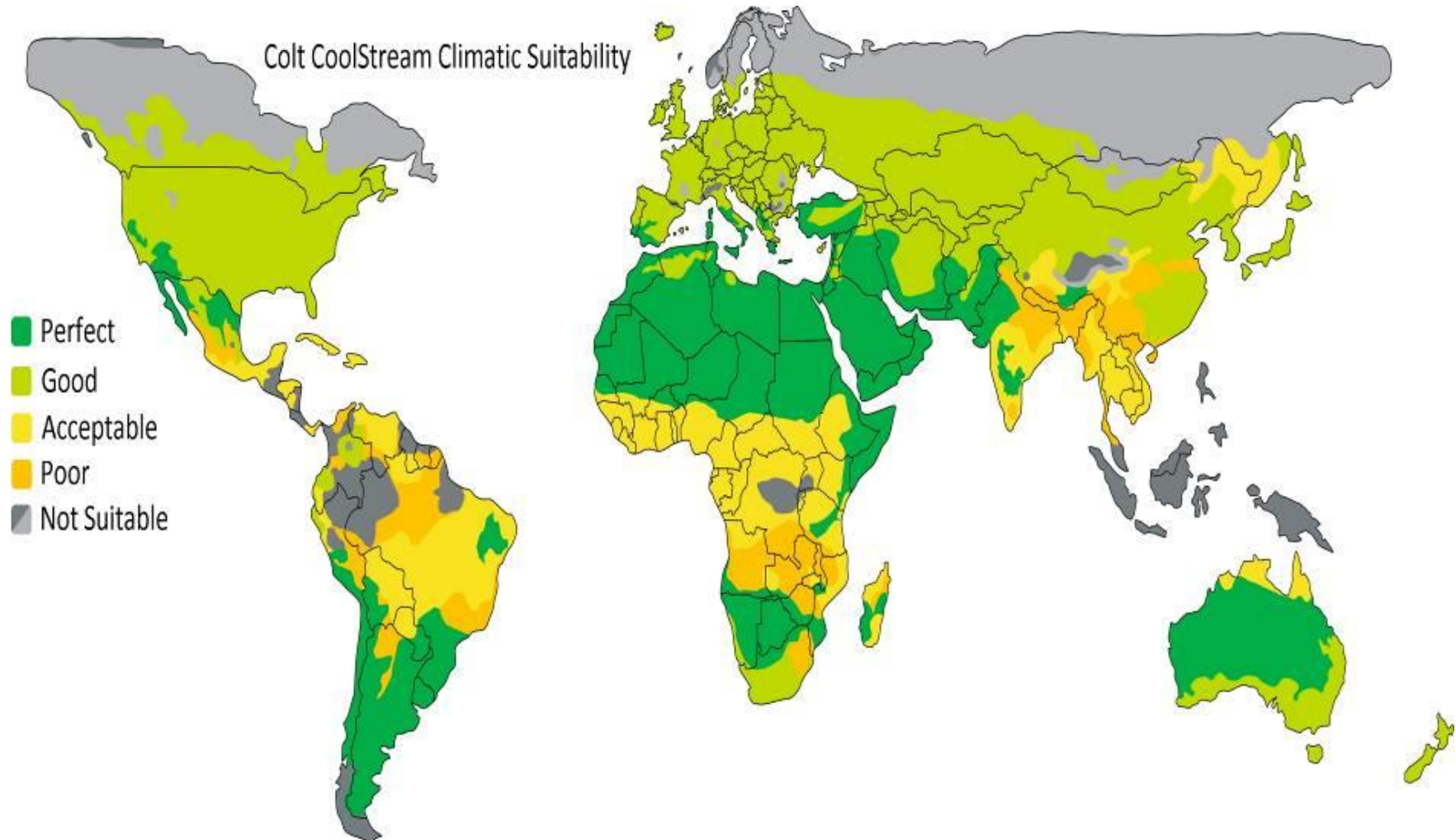


# Applicability - Global

Fundamentals of Evaporative Cooling 2020



- Where is the technology applicable



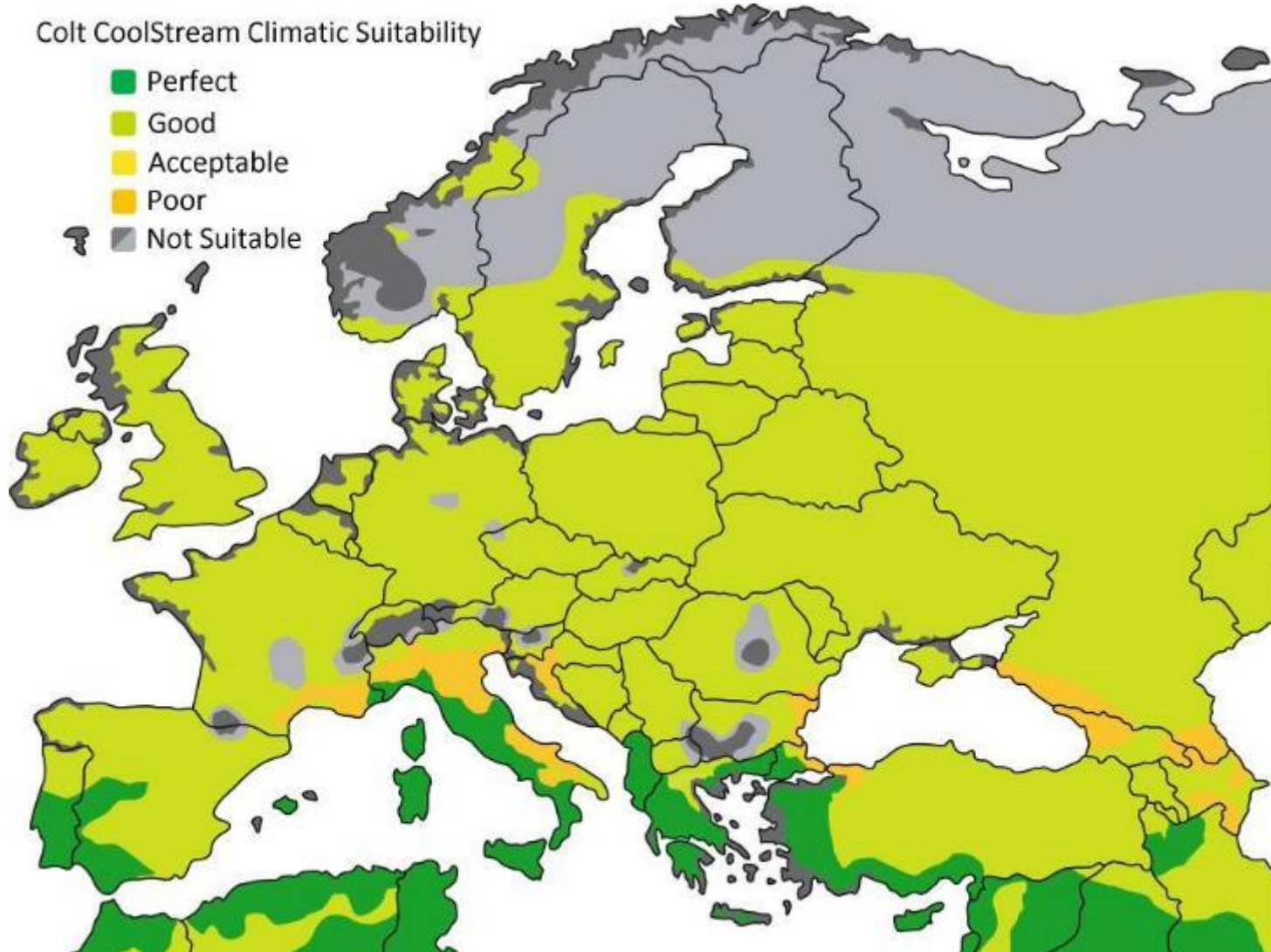
# Applicability - Europe

Fundamentals of Evaporative Cooling 2020



Colt CoolStream Climatic Suitability

- Perfect
- Good
- Acceptable
- Poor
- Not Suitable



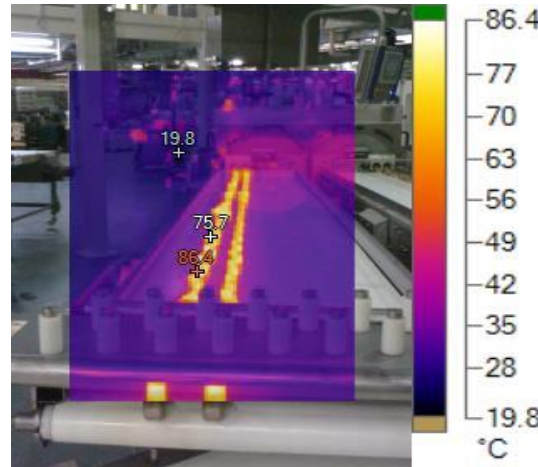


- Principles & Terminology
- **Design Approach**
- Product types, options & configurations
- Limitations and concerns
- Example projects & applications
- Questions



# Defining the problem / understanding the objective

Fundamentals of Evaporative Cooling 2020



**Building details (required for all calculations)**

Location:

**Structure details (for heat loss and cooling calculations)**

Roof	Length	WUB	Ava	UF	UF	UF
Double	54.0	16	503	0.06	Light	
Double	27	4	77			
Single Glazing			0			
Double glazing			0			
Window to floor ratio			0			

Wall:

**Internal Heat (for heat loss and cooling calculations)**

Process	Area	Power
Machining	200	400
		100

**Personnel**

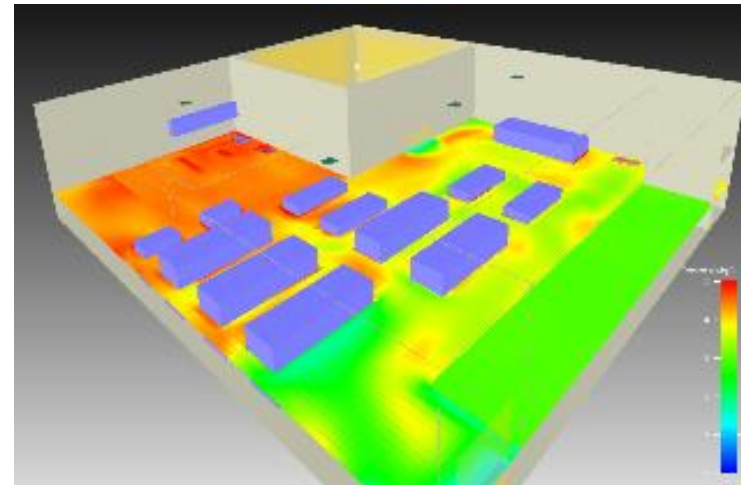
Personnel	Number	Power
Operator	15	100
Staff	1	100

**Machine**

Machine	Number	Power
Machining Centre	1	66
	1	100
	2	55

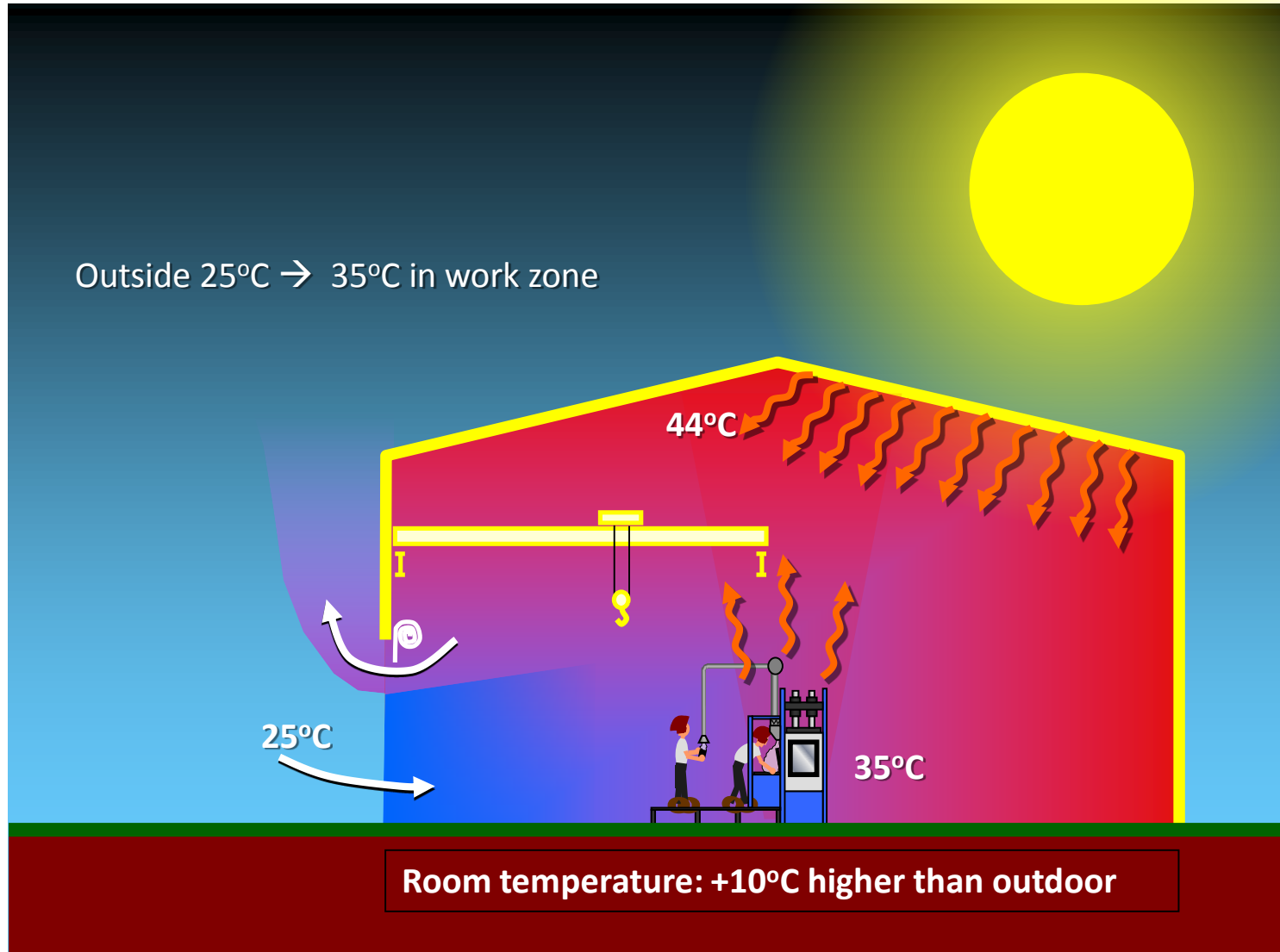
**Lighting**

Direction	Type	Number	Power	Control
Indoor	Electronic	24	503	Electronic
Outdoor	Electronic	16	16	Electronic
Outdoor	Electronic	100	70	Electronic



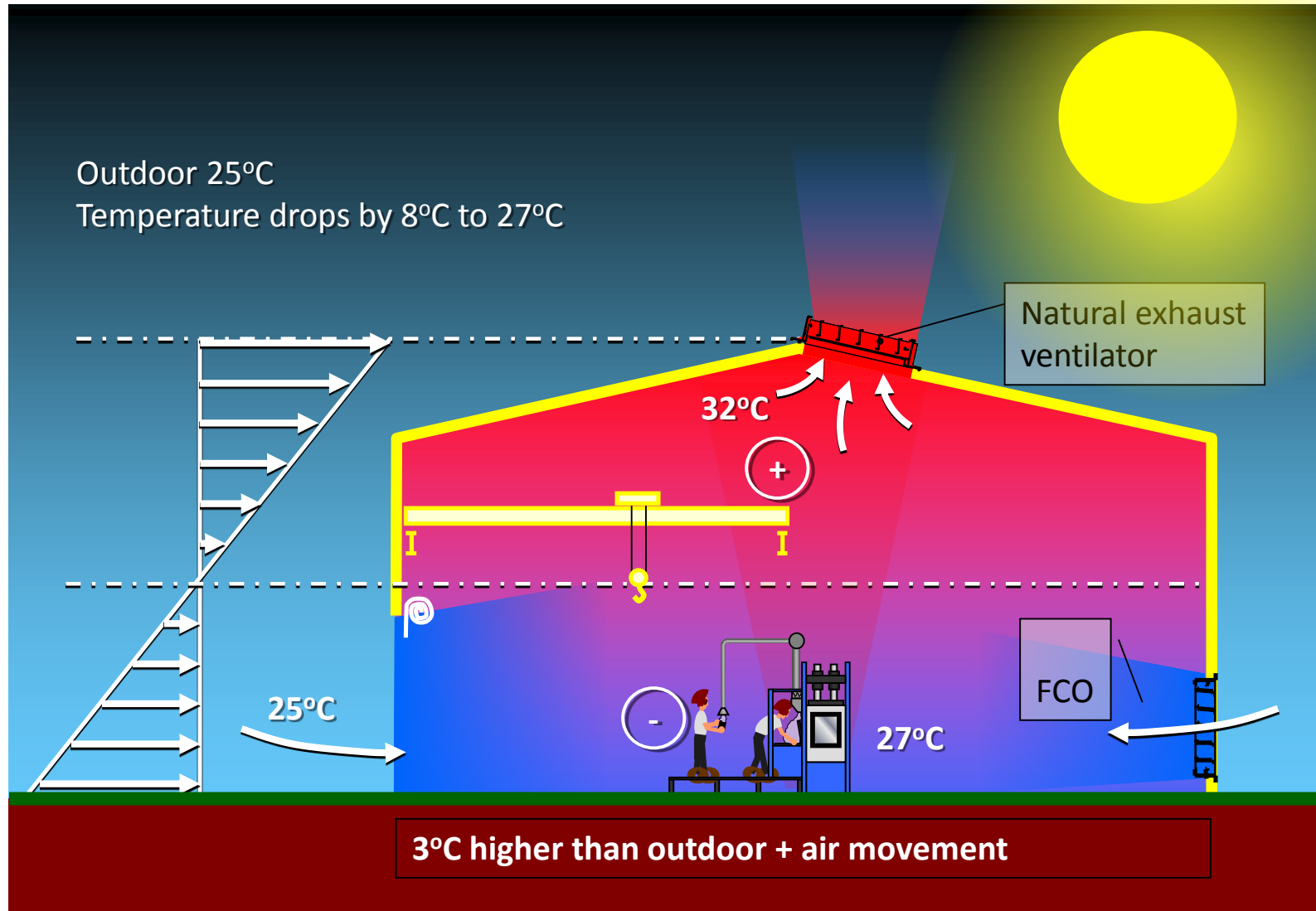
# No ventilation

Fundamentals of Evaporative Cooling 2020



# Natural ventilation

Fundamentals of Evaporative Cooling 2020

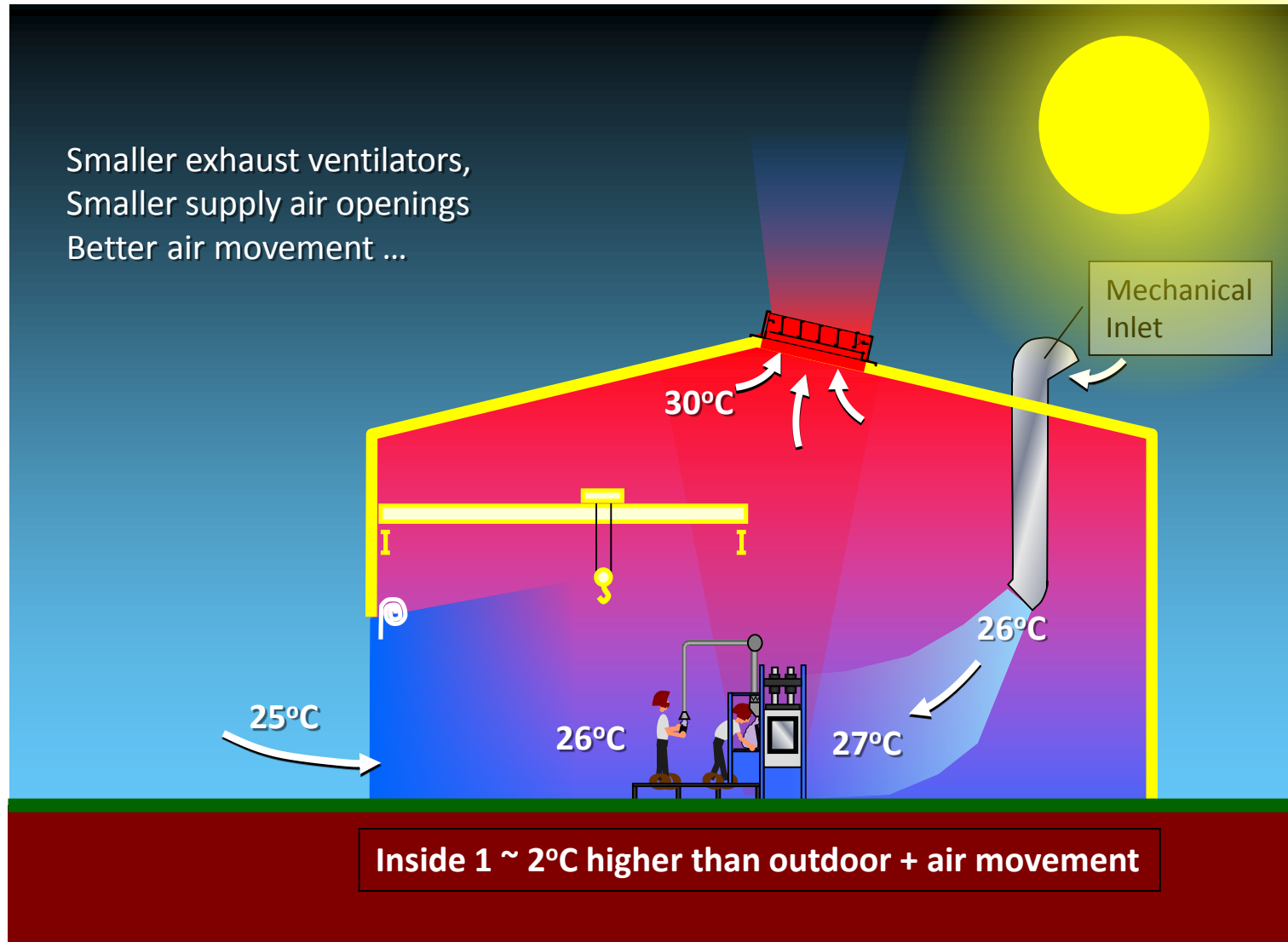


# Natural and mechanical ventilation

Fundamentals of Evaporative Cooling 2020

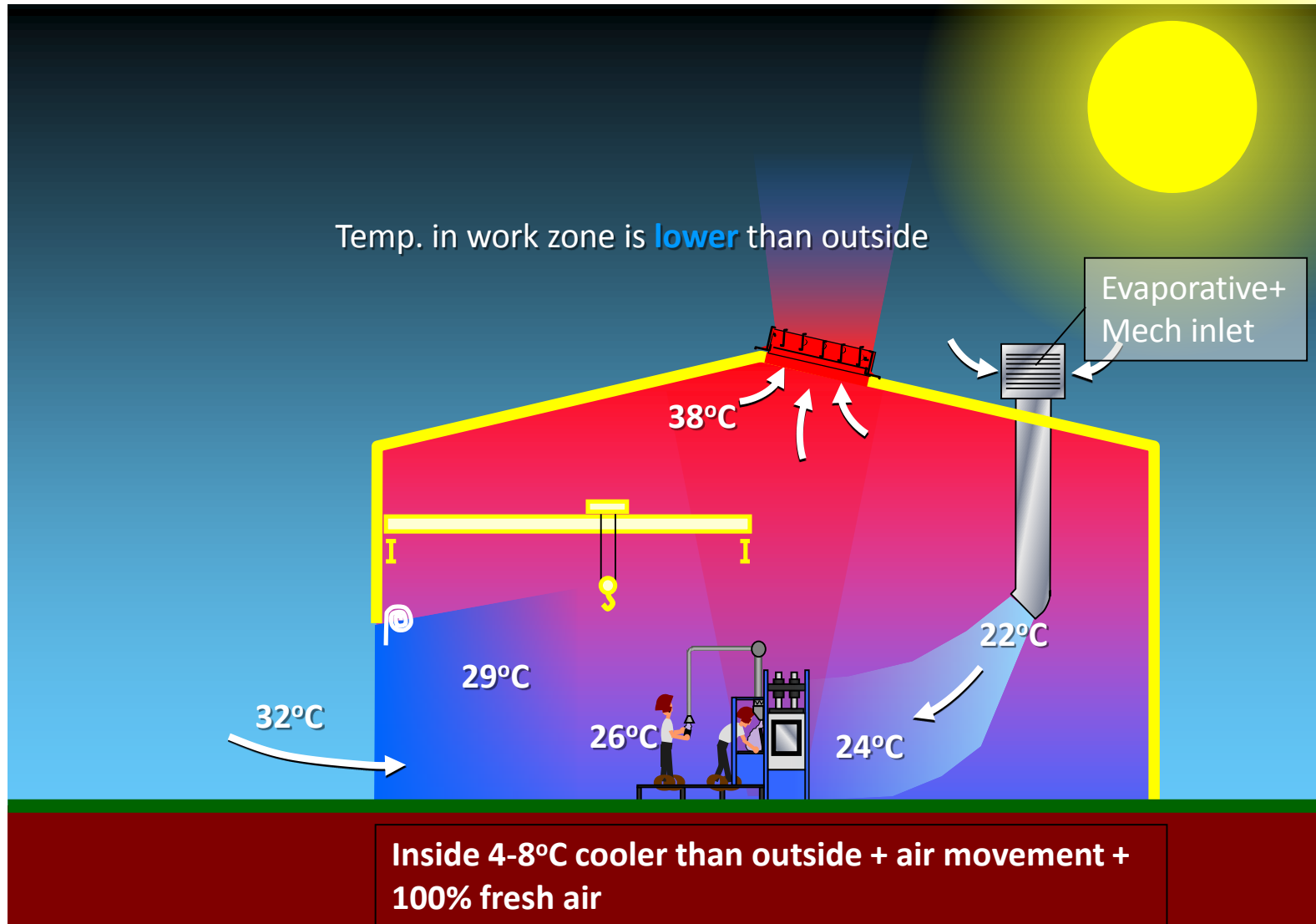


Smaller exhaust ventilators,  
Smaller supply air openings  
Better air movement ...



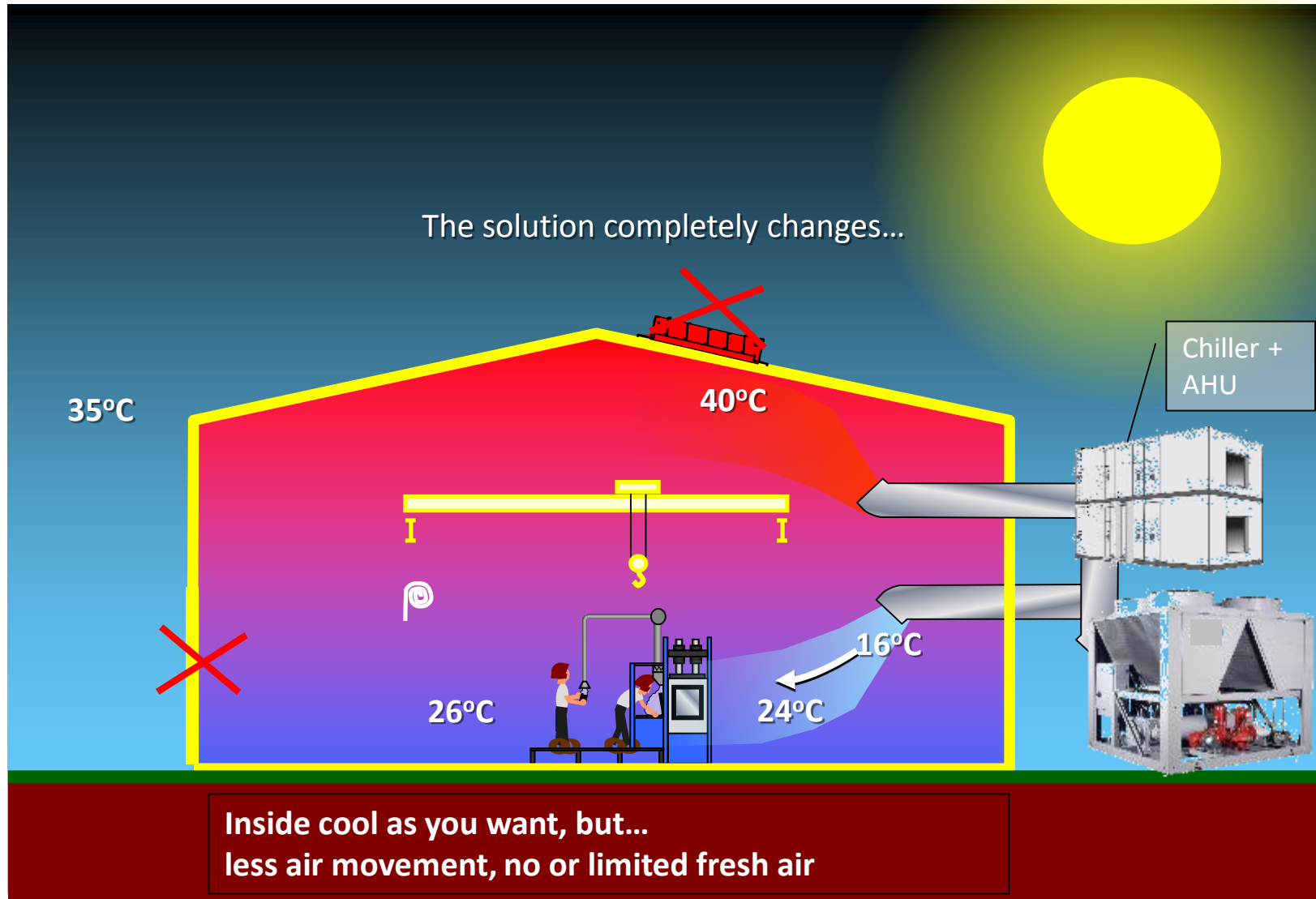
# Natural ventilation and adiabatic cooled supply air

Fundamentals of Evaporative Cooling 2020



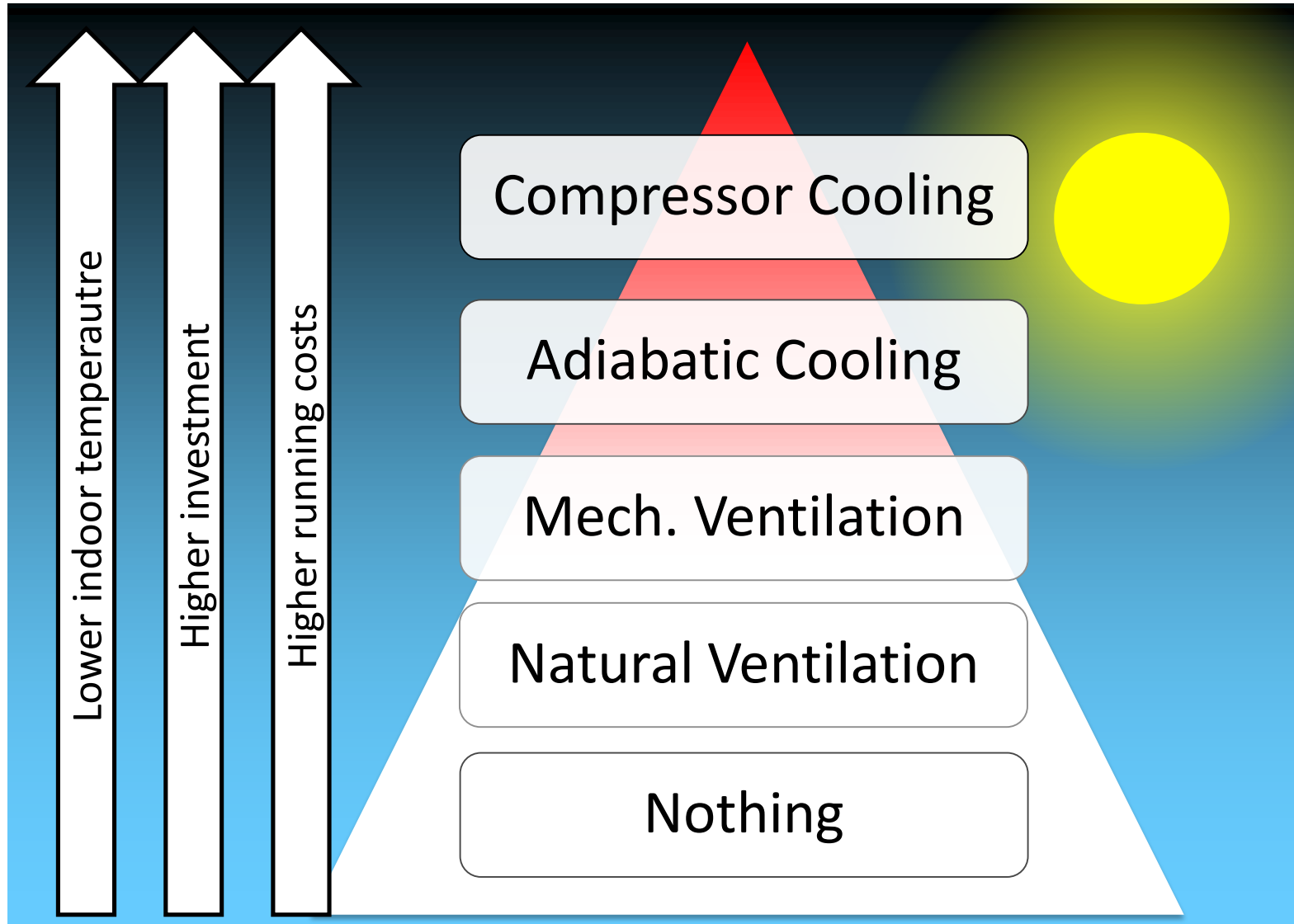
# Mechanical cooling

Fundamentals of Evaporative Cooling 2020

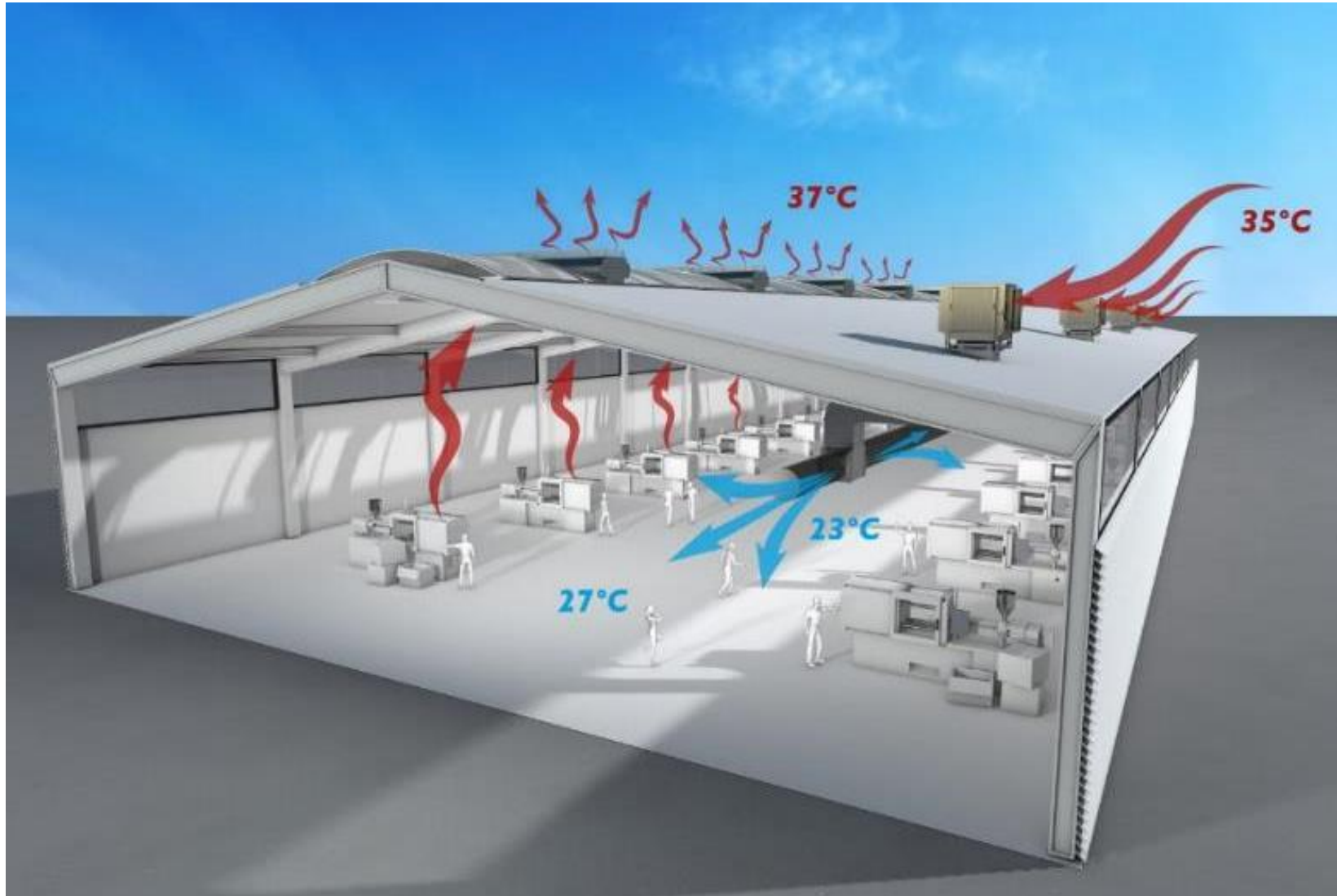


# Cooling stage model

Fundamentals of Evaporative Cooling 2020





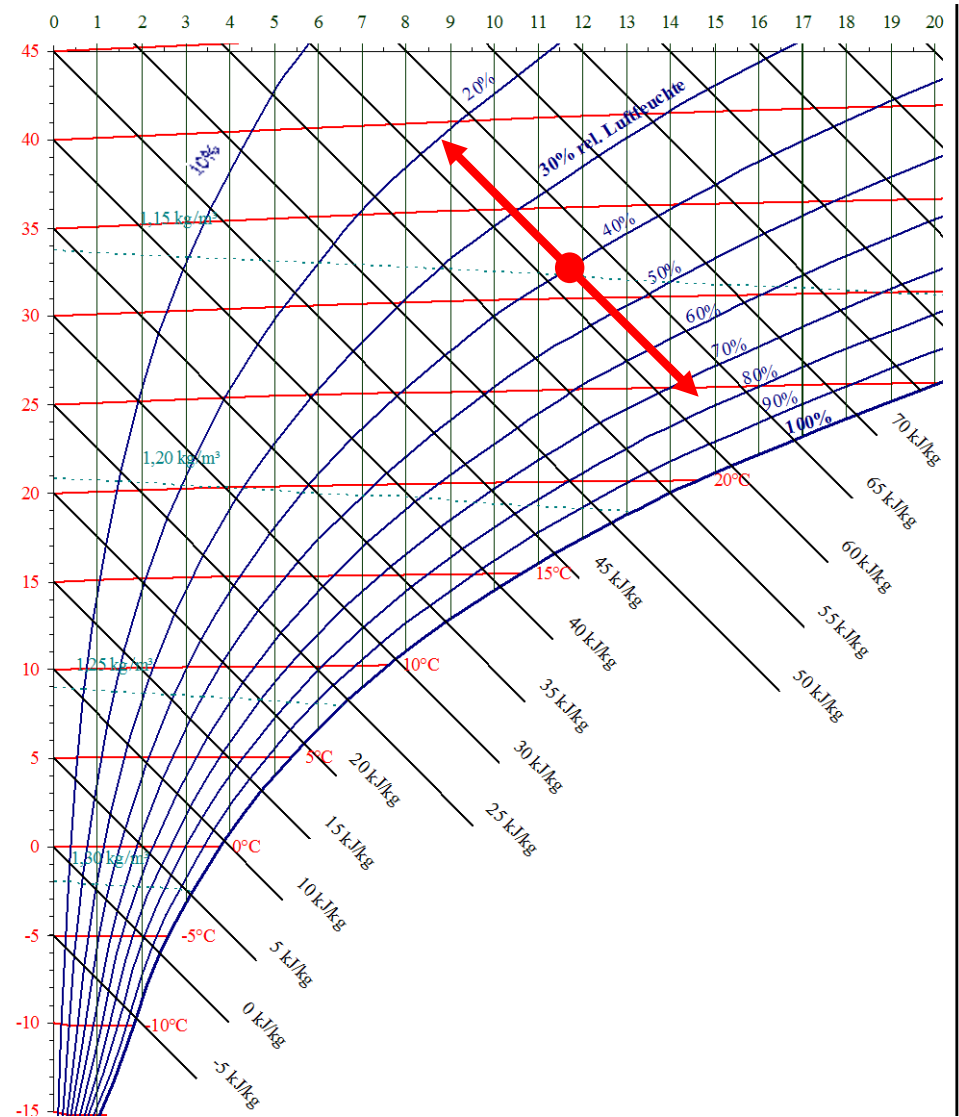


# Example calculation

Fundamentals of Evaporative Cooling 2020



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

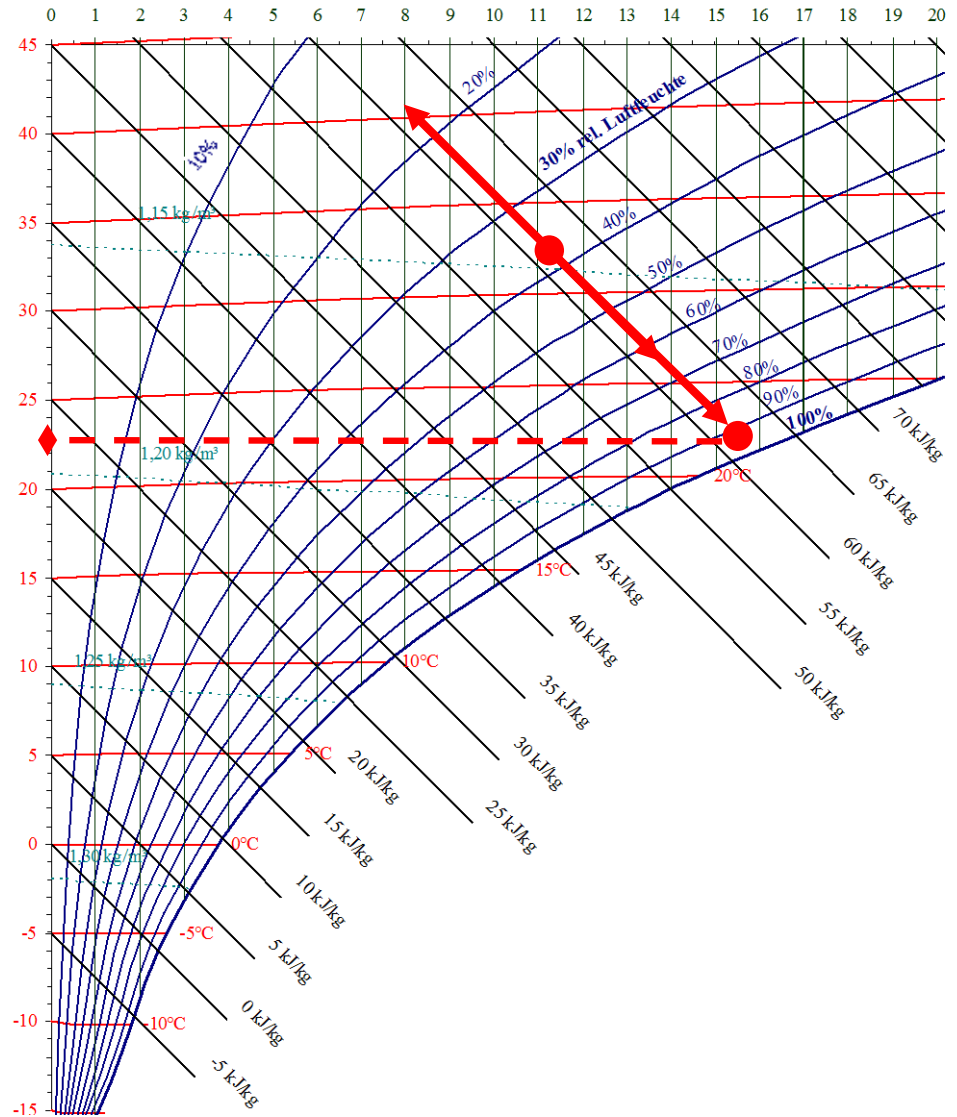


# Example calculation 2

Fundamentals of Evaporative Cooling 2020



- Air temperature will reduce
- &
- Relative Humidity will increase



# Example calculation 3

Fundamentals of Evaporative Cooling 2020



## 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



**COLT**  
Cool Group Product Management HVAC

**CoolStream design & calculation**  
Cool Group Product Management HVAC

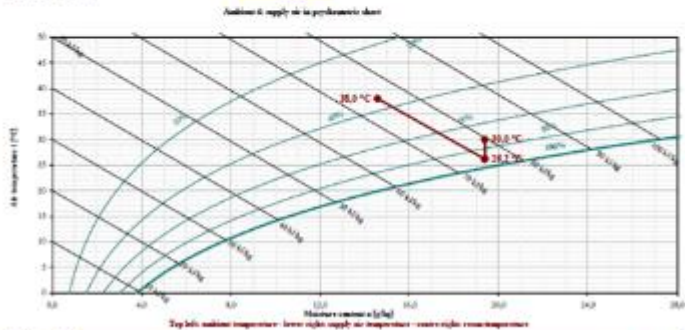
Project: **Test project**  
Project no.: **021476**  
Description: **An example of what is calculated**  
Organization: **01.0000**  
Date: **2021-03-11**  
Remarks:

Language: **English**

**SUPPLY AIR TEMPERATURE & HUMIDITY**

Location of project / Climate data: **Spain**  
Elevation above sea level: **0 m**  
Atmospheric pressure: **1.011 MPa**  
Highest dry-bulb ambient temperature\*: **35.2 °C**  
Relative humidity\*: **31.5% RH**  
Design ambient temperature: **33.0 °C**  
Design ambient relative humidity: **31.5% RH**  
Design ambient pressure: **1.011 MPa**  
Relative humidity: **30.0%**  
Supply air temperature: **22.0 °C**  
Temperature reduction: **13.0 °C**

\*Based on a Drybulb wet sensor supported by the software METEORICAL 2.0



**REQUIREMENTS**

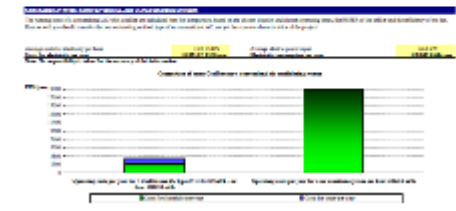
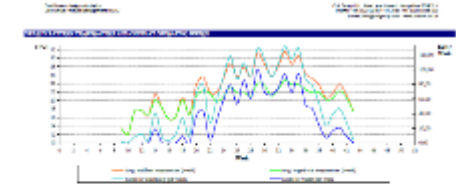
Room length	10.00 m	Internal cooling load	100.0 kW
Room width	10.00 m	Total cooling load (internal & external)	100.0 kW
Room height	3.00 m	Specific cooling load	1.00 W/m²
Room volume	300.0 m³	Type of site	Medium
Mass	1,500 kg	Temperature gradient for supply + outside air	13.0 °C
Capacity	27,000 m³	Optimal: full selected by	13.0 °C

**COOLING AND DEHUMIDIFICATION**

Room air temperature at supply air: **22.0 °C**  
Room air humidity ratio at supply air: **7.5 g/kg**  
Room air dry-bulb temperature at supply air: **22.0 °C**  
Room air wet-bulb temperature at supply air: **14.4 °C**  
Room air enthalpy at supply air: **38.2 kJ/kg**  
Room air density at supply air: **1.20 kg/m³**  
Room air volume flow rate at supply air: **100.0 m³/s**  
Room air mass flow rate at supply air: **120.0 kg/s**  
Room air specific volume at supply air: **0.83 m³/kg**  
Room air specific humidity at supply air: **7.5 g/kg**  
Room air specific enthalpy at supply air: **38.2 kJ/kg**  
Room air specific entropy at supply air: **0.63 kJ/kg·K**  
Room air specific heat capacity at supply air: **1.00 kJ/kg·K**  
Room air specific heat capacity at constant pressure at supply air: **1.00 kJ/kg·K**  
Room air specific heat capacity at constant volume at supply air: **0.71 kJ/kg·K**  
Room air specific heat capacity at constant pressure at room air: **1.00 kJ/kg·K**  
Room air specific heat capacity at constant volume at room air: **0.71 kJ/kg·K**  
Room air specific heat capacity at constant pressure at ambient air: **1.00 kJ/kg·K**  
Room air specific heat capacity at constant volume at ambient air: **0.71 kJ/kg·K**  
Room air specific heat capacity at constant pressure at outdoor air: **1.00 kJ/kg·K**  
Room air specific heat capacity at constant volume at outdoor air: **0.71 kJ/kg·K**  
Room air specific heat capacity at constant pressure at indoor air: **1.00 kJ/kg·K**  
Room air specific heat capacity at constant volume at indoor air: **0.71 kJ/kg·K**  
Room air specific heat capacity at constant pressure at outdoor air: **1.00 kJ/kg·K**  
Room air specific heat capacity at constant volume at outdoor air: **0.71 kJ/kg·K**  
Room air specific heat capacity at constant pressure at indoor air: **1.00 kJ/kg·K**  
Room air specific heat capacity at constant volume at indoor air: **0.71 kJ/kg·K**

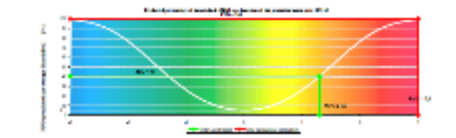
**COOLING AND DEHUMIDIFICATION**

Room air temperature at supply air: **22.0 °C**  
Room air humidity ratio at supply air: **7.5 g/kg**  
Room air dry-bulb temperature at supply air: **22.0 °C**  
Room air wet-bulb temperature at supply air: **14.4 °C**  
Room air enthalpy at supply air: **38.2 kJ/kg**  
Room air density at supply air: **1.20 kg/m³**  
Room air volume flow rate at supply air: **100.0 m³/s**  
Room air mass flow rate at supply air: **120.0 kg/s**  
Room air specific volume at supply air: **0.83 m³/kg**  
Room air specific humidity at supply air: **7.5 g/kg**  
Room air specific enthalpy at supply air: **38.2 kJ/kg**  
Room air specific entropy at supply air: **0.63 kJ/kg·K**  
Room air specific heat capacity at supply air: **1.00 kJ/kg·K**  
Room air specific heat capacity at constant pressure at supply air: **1.00 kJ/kg·K**  
Room air specific heat capacity at constant volume at supply air: **0.71 kJ/kg·K**  
Room air specific heat capacity at constant pressure at room air: **1.00 kJ/kg·K**  
Room air specific heat capacity at constant volume at room air: **0.71 kJ/kg·K**  
Room air specific heat capacity at constant pressure at ambient air: **1.00 kJ/kg·K**  
Room air specific heat capacity at constant volume at ambient air: **0.71 kJ/kg·K**  
Room air specific heat capacity at constant pressure at outdoor air: **1.00 kJ/kg·K**  
Room air specific heat capacity at constant volume at outdoor air: **0.71 kJ/kg·K**  
Room air specific heat capacity at constant pressure at indoor air: **1.00 kJ/kg·K**  
Room air specific heat capacity at constant volume at indoor air: **0.71 kJ/kg·K**  
Room air specific heat capacity at constant pressure at outdoor air: **1.00 kJ/kg·K**  
Room air specific heat capacity at constant volume at outdoor air: **0.71 kJ/kg·K**  
Room air specific heat capacity at constant pressure at indoor air: **1.00 kJ/kg·K**  
Room air specific heat capacity at constant volume at indoor air: **0.71 kJ/kg·K**



**COOLING AND DEHUMIDIFICATION**

Room air temperature at supply air	22.0 °C	Room air humidity ratio at supply air	7.5 g/kg
Room air dry-bulb temperature at supply air	22.0 °C	Room air wet-bulb temperature at supply air	14.4 °C
Room air enthalpy at supply air	38.2 kJ/kg	Room air density at supply air	1.20 kg/m³
Room air volume flow rate at supply air	100.0 m³/s	Room air mass flow rate at supply air	120.0 kg/s
Room air specific volume at supply air	0.83 m³/kg	Room air specific humidity at supply air	7.5 g/kg
Room air specific enthalpy at supply air	38.2 kJ/kg	Room air specific entropy at supply air	0.63 kJ/kg·K
Room air specific heat capacity at supply air	1.00 kJ/kg·K	Room air specific heat capacity at constant pressure at supply air	1.00 kJ/kg·K
Room air specific heat capacity at constant pressure at supply air	1.00 kJ/kg·K	Room air specific heat capacity at constant volume at supply air	0.71 kJ/kg·K
Room air specific heat capacity at constant pressure at room air	1.00 kJ/kg·K	Room air specific heat capacity at constant volume at room air	0.71 kJ/kg·K
Room air specific heat capacity at constant pressure at ambient air	1.00 kJ/kg·K	Room air specific heat capacity at constant volume at ambient air	0.71 kJ/kg·K
Room air specific heat capacity at constant pressure at outdoor air	1.00 kJ/kg·K	Room air specific heat capacity at constant volume at outdoor air	0.71 kJ/kg·K
Room air specific heat capacity at constant pressure at indoor air	1.00 kJ/kg·K	Room air specific heat capacity at constant volume at indoor air	0.71 kJ/kg·K
Room air specific heat capacity at constant pressure at outdoor air	1.00 kJ/kg·K	Room air specific heat capacity at constant volume at outdoor air	0.71 kJ/kg·K
Room air specific heat capacity at constant pressure at indoor air	1.00 kJ/kg·K	Room air specific heat capacity at constant volume at indoor air	0.71 kJ/kg·K



**COOLING AND DEHUMIDIFICATION**

Room air temperature at supply air	22.0 °C	Room air humidity ratio at supply air	7.5 g/kg
Room air dry-bulb temperature at supply air	22.0 °C	Room air wet-bulb temperature at supply air	14.4 °C
Room air enthalpy at supply air	38.2 kJ/kg	Room air density at supply air	1.20 kg/m³
Room air volume flow rate at supply air	100.0 m³/s	Room air mass flow rate at supply air	120.0 kg/s
Room air specific volume at supply air	0.83 m³/kg	Room air specific humidity at supply air	7.5 g/kg
Room air specific enthalpy at supply air	38.2 kJ/kg	Room air specific entropy at supply air	0.63 kJ/kg·K
Room air specific heat capacity at supply air	1.00 kJ/kg·K	Room air specific heat capacity at constant pressure at supply air	1.00 kJ/kg·K
Room air specific heat capacity at constant pressure at supply air	1.00 kJ/kg·K	Room air specific heat capacity at constant volume at supply air	0.71 kJ/kg·K
Room air specific heat capacity at constant pressure at room air	1.00 kJ/kg·K	Room air specific heat capacity at constant volume at room air	0.71 kJ/kg·K
Room air specific heat capacity at constant pressure at ambient air	1.00 kJ/kg·K	Room air specific heat capacity at constant volume at ambient air	0.71 kJ/kg·K
Room air specific heat capacity at constant pressure at outdoor air	1.00 kJ/kg·K	Room air specific heat capacity at constant volume at outdoor air	0.71 kJ/kg·K
Room air specific heat capacity at constant pressure at indoor air	1.00 kJ/kg·K	Room air specific heat capacity at constant volume at indoor air	0.71 kJ/kg·K
Room air specific heat capacity at constant pressure at outdoor air	1.00 kJ/kg·K	Room air specific heat capacity at constant volume at outdoor air	0.71 kJ/kg·K
Room air specific heat capacity at constant pressure at indoor air	1.00 kJ/kg·K	Room air specific heat capacity at constant volume at indoor air	0.71 kJ/kg·K



# Agenda

Fundamentals of Evaporative Cooling 2020

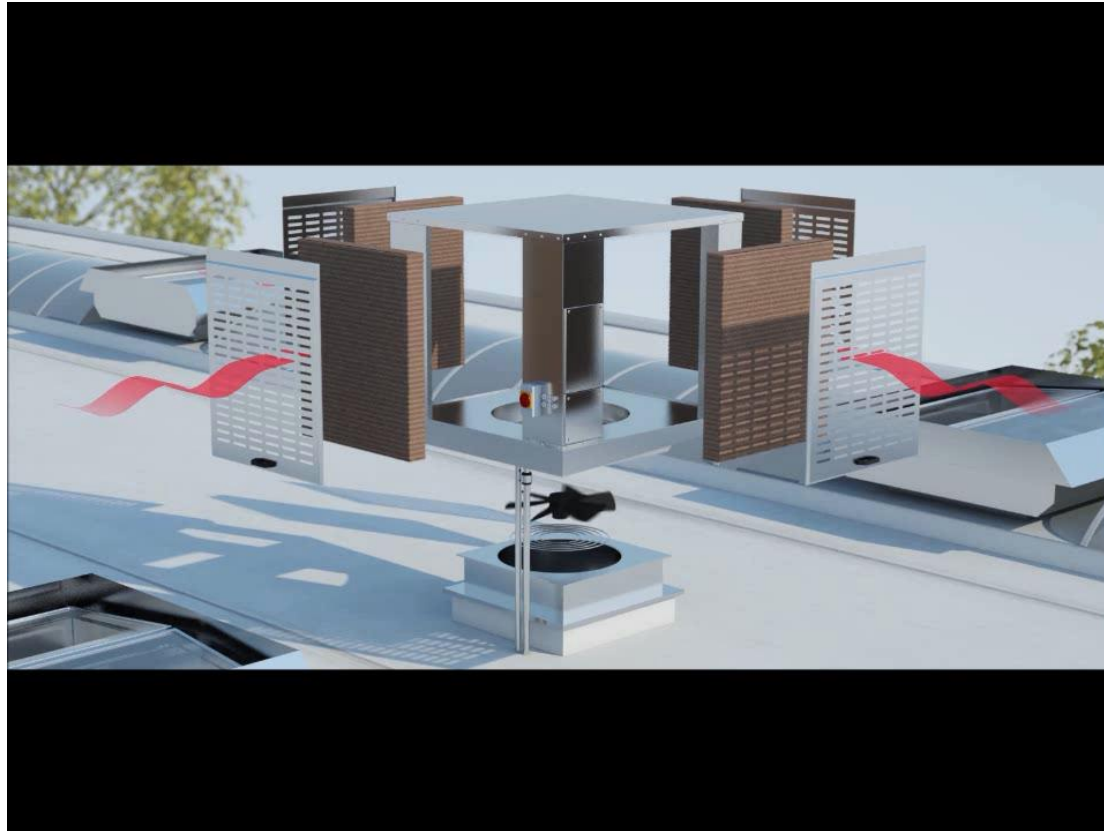


- Principles & Terminology
- Design Approach
- **Product types, options & configurations**
- Limitations and concerns
- Example projects & applications
- Questions



# A typical configuration

Fundamentals of Evaporative Cooling 2020

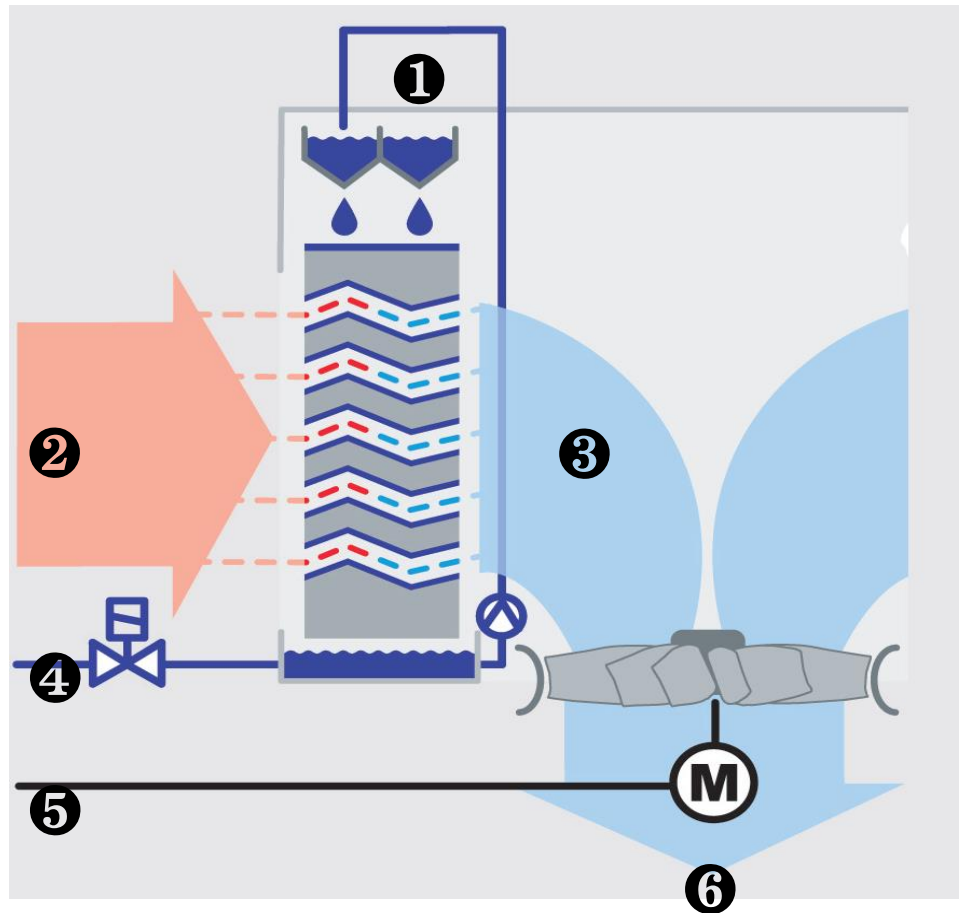


Form and function of a standard evaporative cooler



# A typical configuration

Fundamentals of Evaporative Cooling 2020



- ① water distribution system, separated from the air flow
- ② Warm air
- ③ Air stream, free from micro-droplets
- ④ Drinking water
- ⑤ Electrical energy
- ⑥ 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.

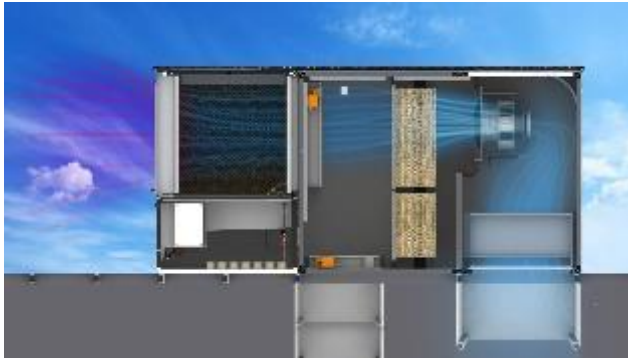


Cooling | Heating | Filtration | Warm Air Recycling.



# 4 season performance

Fundamentals of Evaporative Cooling 2020



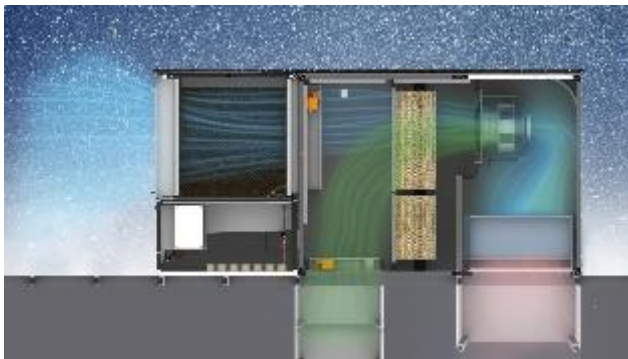
## Summer

Cool filtered supply air



## Spring & Autumn

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



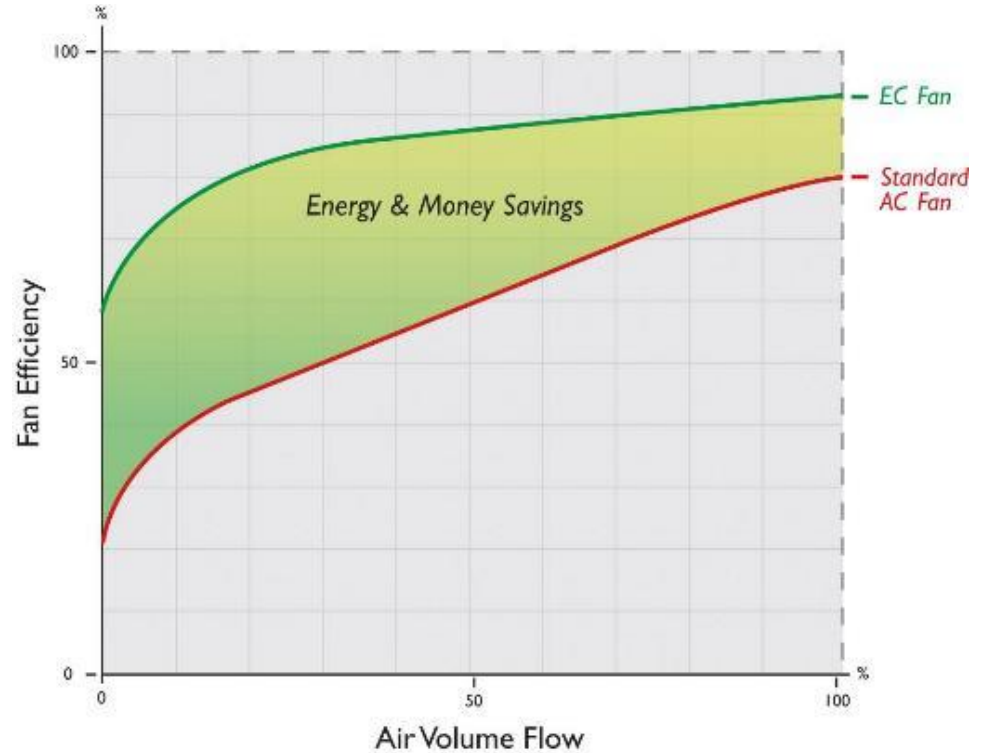
## Winter

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

Fundamentals of Evaporative Cooling 2020



## 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



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



### 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:
  - $v = 2 \sim 2,5 \text{ m/s} = \text{critical speed for droplets}$
  - $\rightarrow v = 1 \sim 1,7 \text{ m/s @ Colt}$
  - $\rightarrow \text{no droplets}$
- Drain and dry cycle every 24hrs
- VDI 6022



# Agenda

Fundamentals of Evaporative Cooling 2020



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





# Example projects – food industry

Fundamentals of Evaporative Cooling 2020



## Dairy Plant:

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



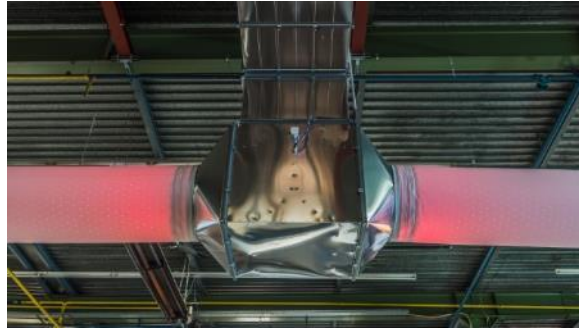
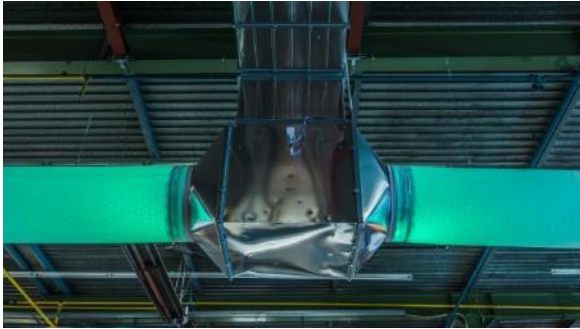


## Plastics Packaging Factory:

- 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

Fundamentals of Evaporative Cooling 2020



## 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



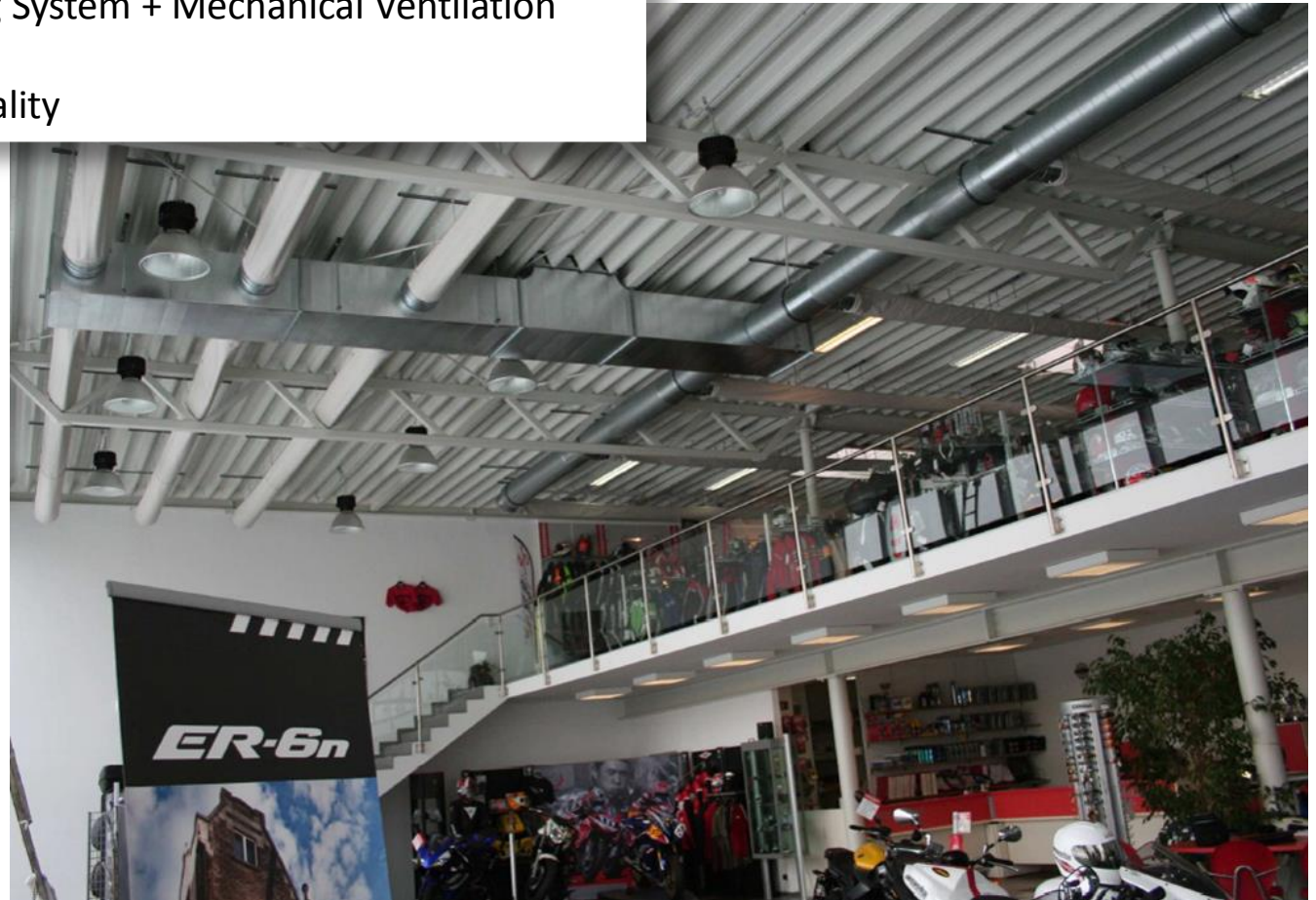
# Example projects - retail

Fundamentals of Evaporative Cooling 2020



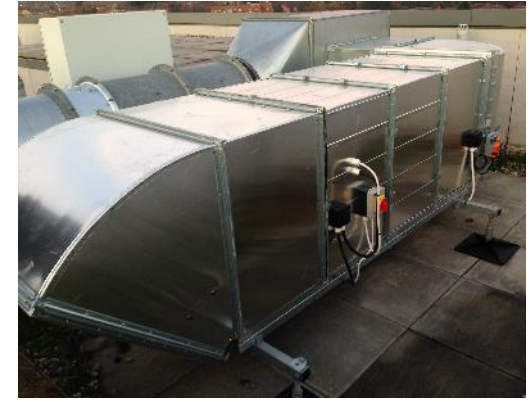
## Retail showroom

- 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...

**COLT**

"People feel better in Colt conditions" | [www.coltinfo.co.uk](http://www.coltinfo.co.uk)