Established in
1974

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Energy Management TSN and APUC UIG

JRF/Monodraught Low Energy Cooling Presentation Apr 3rd 2017

Agenda

- JRF/Monodraught – Company Profile
- Low Energy Cooling and Ventilation
- Any Questions?

- JRF – Company established in February 1983
- Partnered with Monodraught for over 25 Years
- Exclusivity for Scotland providing Design, Installation and Commissioning on all Monodraught Product Solutions
- Based in Glenrothes

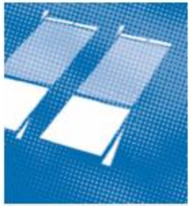
Monodraught®

part of the VKR Group

VKR

VKR Holding

- investing in daylight, fresh air and a better environment



Roof windows & skylights

VELUX

Altaterra

Vertical windows

DOVISTA

VELFAC

Rationel

O.H. Industri

SP Fönster

Traryd Fönster

Mockfjärds

Snidex

Natre

Lian

West Port

Solar thermal energy

Arcon-Sunmark

Pipeteq Systems

Ventilation & indoor climate

Monodraught

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Recognised as Industry Leaders

Monodraught are widely recognised as market leaders in sustainable low energy and low carbon solutions in natural ventilation, natural lighting and natural cooling. We are proud of our accreditations from prestigious independent organisations such as CIBSE and Ashden amongst others.

The Buckinghamshire Business Awards
Company of the Year 2016

best business AWARDS
Winner 2016
Best Small to Medium Sized Business

INVESTORS IN PEOPLE | Accredited Until 2019

bsi. making excellence a habit.

CIBSE BUILDING PERFORMANCE AWARDS 2012 WINNER
RECOGNISING EXCELLENCE IN MAKING BUILDINGS WORK

Ashden Award winner 2013

QMS ISO 14001 REGISTERED ASCB

QMS ISO 9001 REGISTERED ASCB

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Monodraught®

VISION : Harnessing nature to deliver exemplar sustainable indoor environments through innovation.

MISSION : Gaining customers for life by: Valuing our people, our products and our service.

Sales Consultation	Design	Manufacture	Installation	Commissioning	Service
CPD's	Building Simulation	Research & Development	Warranty	Sign Off	Monitoring
Customer Liaison	Quotation	Electronics	Site Excellence	Training	End user feedback
Co-ordination		Testing	Training		
		Certification			

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Product Categories

Natural and Hybrid Lighting

- Sunpipe®
- Sunpipe® LuxLoop
- Suncatcher®

Natural and Hybrid Ventilation

- Windcatcher®
- Windcatcher® X-Air
- Sola-boost®
- Sola-boost® X-Air
- HTM®
- Ventsair

Mechanical Ventilation

- MVHR

Natural and Hybrid Cooling

- Cool-phase®
- Cool-phase Hybrid®

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Coolphase®

Natural Cooling and Low Energy Ventilation System

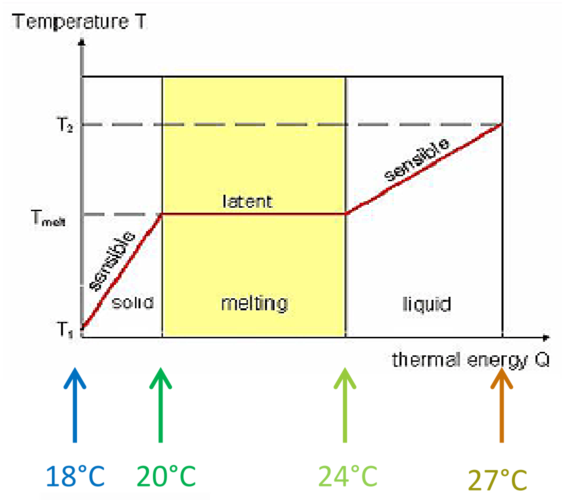
CIBSE BUILDING PERFORMANCE AWARDS 2012 WINNER
RECOGNISING EXCELLENCE IN MAKING BUILDINGS WORK

Ashden Award winner 2013

Phase Change Material

What is a PCM?

A phase-change material (PCM) is a substance which melts and solidifies at a certain temperature and in doing so is capable of storing or releasing large amounts of energy.



Using PCM's to store and release thermal energy

During the day as warm air is passed over the PCM it absorbs thermal energy from the air to turn from a solid to a liquid, thus cooling the air.

Over night as cooler air is passed across the PCM it releases the thermal energy it absorbed from the warm air during the day returning to its solid state.

This provides us with a **cooling cycle,** using only a low energy fan that is intelligently controlled.

ICE

MELTING / FREEZING

WATER

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Simple applications of PCM cooling systems

- When used as an application for natural cooling, the PCM works across a 24 hour period to keep the room cool.

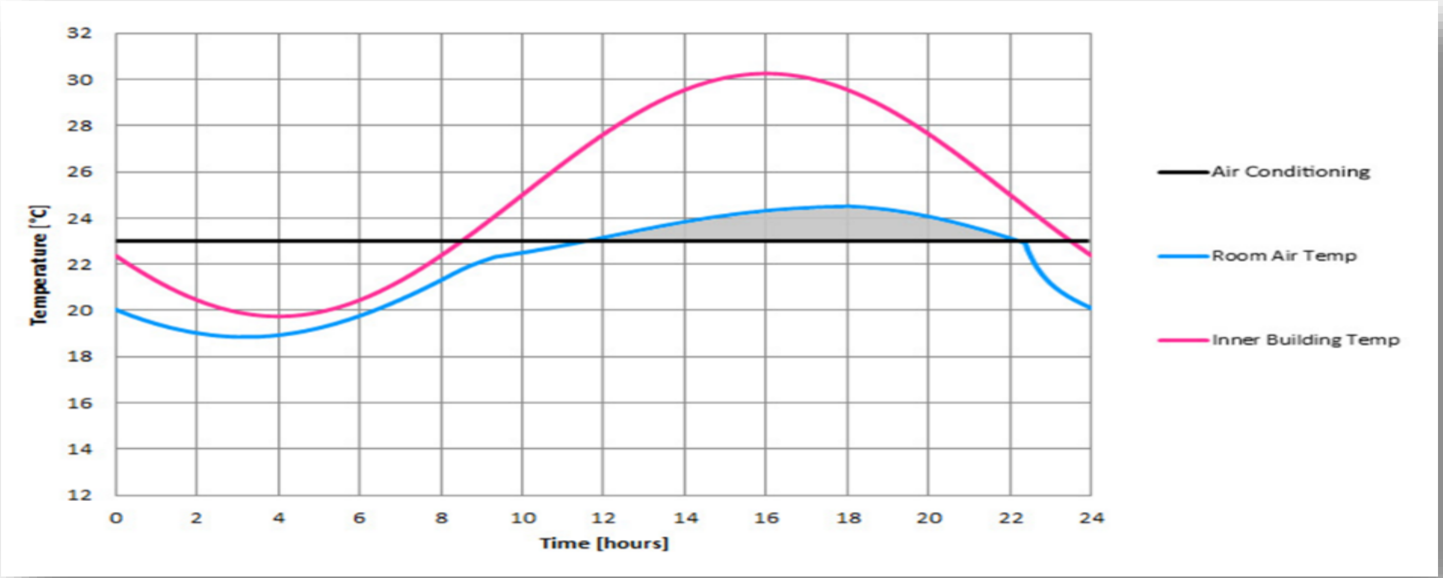
Example

- PCM in ceiling or wall tiles
- no temperature control and a separate ventilation strategy is required

Natural Cooling & Example

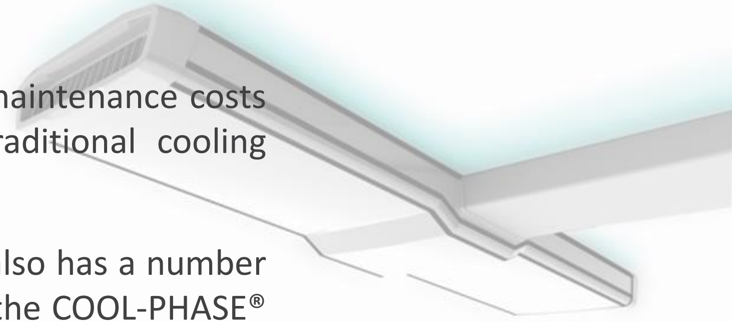
- Use PCMs with appropriate control strategy
- Example: Bournemouth University and Cool-phase®
- Removes need for traditional air conditioning units
  - Lower carbon footprint and energy costs
  - No requirement for harmful coolants found in refrigerants

What is “thermal comfort”?



What is COOL-PHASE®?

- COOL-PHASE® is a low energy cooling and ventilation system that reduces the running costs of buildings and creates a fresh and healthy indoor environment.
- The system uses a thermal energy store utilising a phase change material (PCM) in combination with intelligently controlled mechanical ventilation to actively cool and ventilate the building.
- The COOL-PHASE® system can maintain temperatures within the comfort zone, while radically reducing energy consumption by up to 90%, compared to a conventional cooling system.
- The reduction in energy usage combined with low servicing and maintenance costs and a long life span result in a strong financial case over traditional cooling approaches.
- Since no compressors or hazardous coolants are used the system also has a number of environmental benefits, while the lack of external units means the COOL-PHASE® system can be used where outside space or planning permission is an issue.



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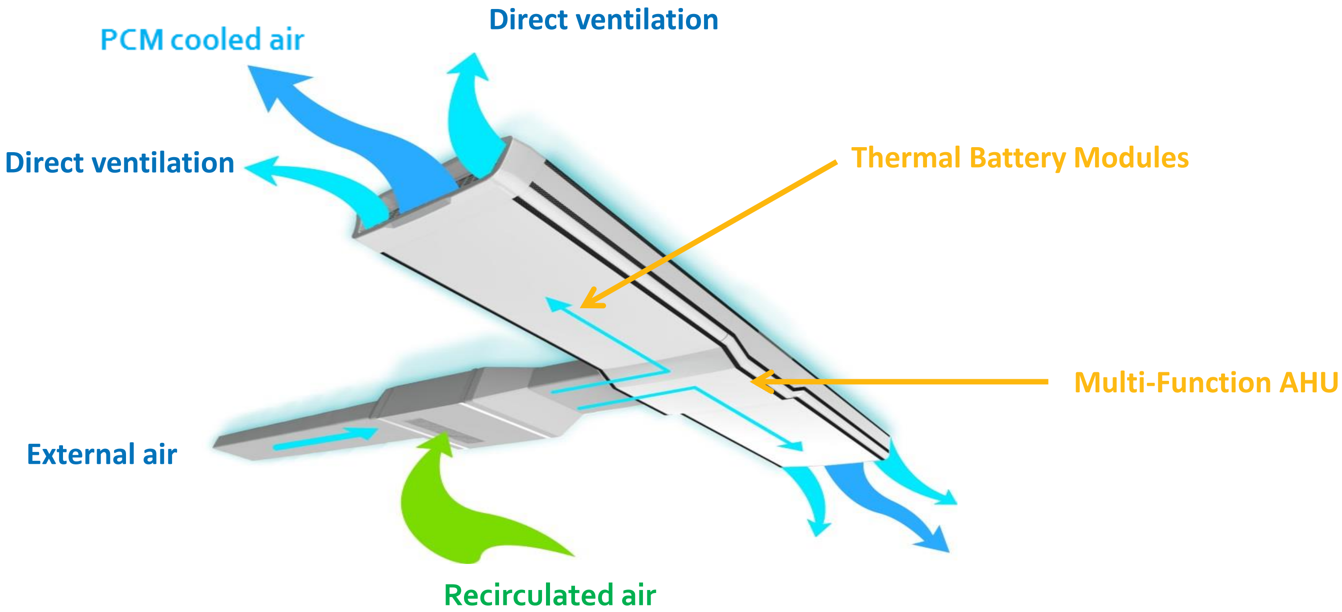
How does COOL-PHASE® work?



Thermal Battery Heat Exchanger Plates

- Drop tested from 3m height.
- Aluminium casing achieves excellent heat transfer from medium to PCM.
- Leak proof, 100% test of panels to ensure pressure tightness.
- Anti-corrosion coated.
- Non-flammable.
- PCM is tested to the German RAL standard – 10,000 cycles which equates to 27 years assuming 1 complete cycle a day.

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How does COOL-PHASE® differ?

COOL-PHASE®?

A unique low energy ventilation and natural cooling system that:

- Uses a phase change material (PCM) to provide a free cooling load.
- Provides demand control ventilation.
- Cools to control temperature within a comfortable range.
- Intelligent control of ventilation - night cooling, direct cooling and active cooling.
- Has low running and maintenance costs.
- Award winning patented technology.

What it isn't…

A high energy mechanical or AC system that:

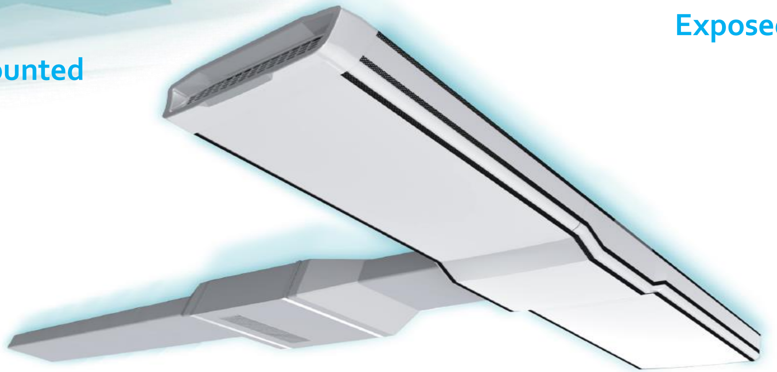
- An aggressive cooling system that achieves a constant set point.
- Has high running costs.
- May only ventilate or cool.

A passive PCM solution that is hard to integrate and control.

COOL-PHASE® – System Types

Ceiling Mounted

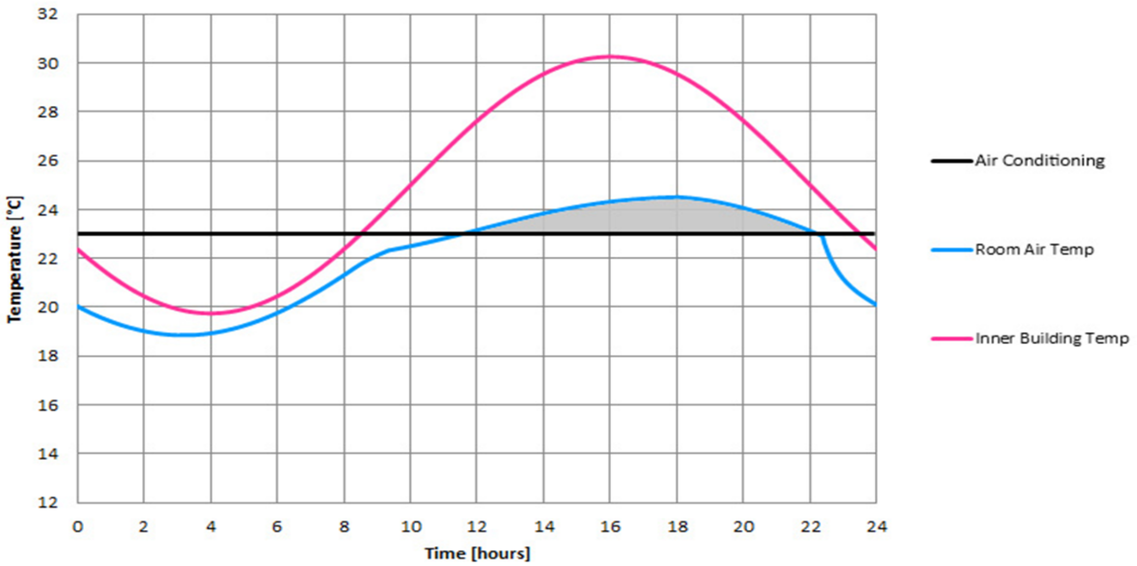
Exposed Void



Fascia

Thermal Comfort

- Without cooling the internal building temp will exceed the external temp
- COOL-PHASE® achieves thermal comfort via intelligent control of both ventilation and cooling
- You can use AC / Mechanical to cool to a flat line
- The extra cooling achieved uses much more energy



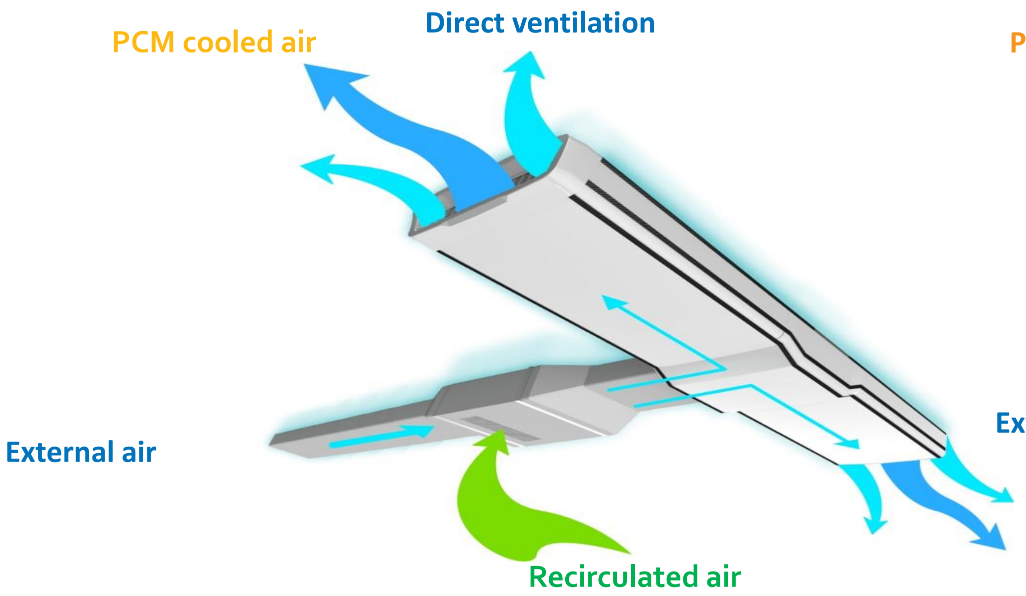
Performance

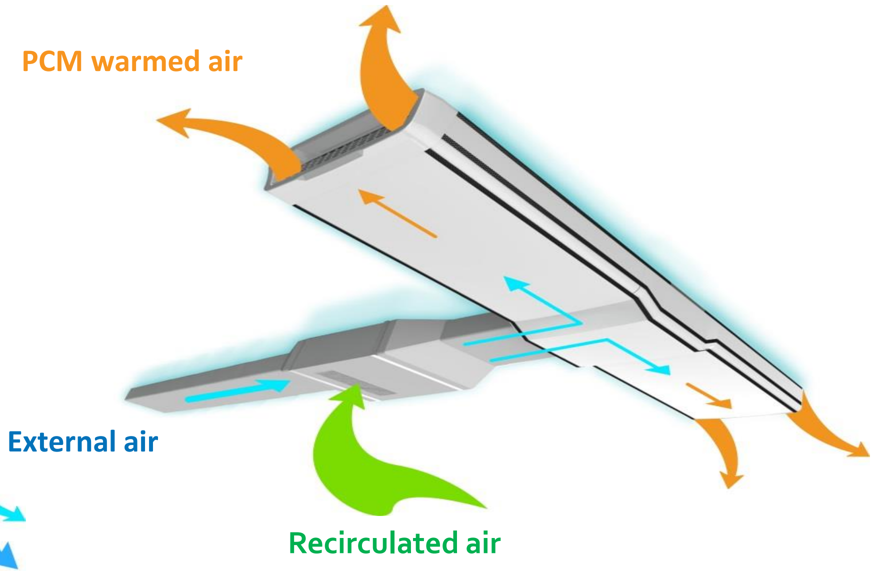
Total Cooling = **Free cooling** (ventilation) + **Night time cooling** (building + flush) + **Thermal batteries** (energy stored)

Per COOL-PHASE® Unit:

- Normal ventilation rate – **100 to 260** l/s
- Maximum ventilation rate - **300** l/s
- Total thermal energy storage – **6/8/10 KWhrs**
- Typical cooling in 24 hour period **>14/16/20 KWhrs**

Operational Modes





Cooling Modes

- Direct ventilation – external air
- Ventilation and cooling – external air
- Recirculation and cooling – internal air

Heating Modes

- Recirculating internal air – heat recovery
- Tempering supply air
- Mixing return/supply air

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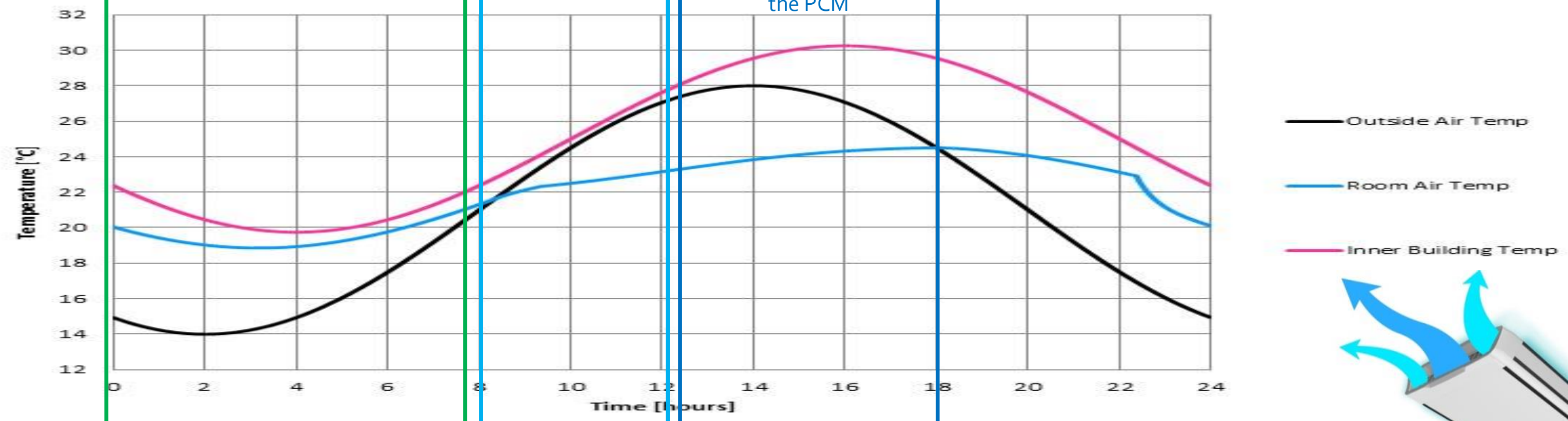
Performance

Night time cooling and PCM charging cycle

Direct ventilation

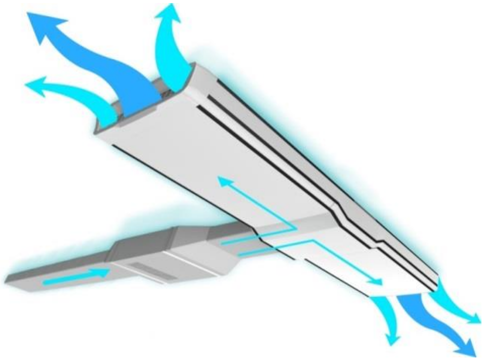
Active cooling via thermal batteries using the PCM



Two things achieved using one process

When external air is cool enough

Only uses external air when CO_2 level is high otherwise recirculates internal air through the battery to keep room cool



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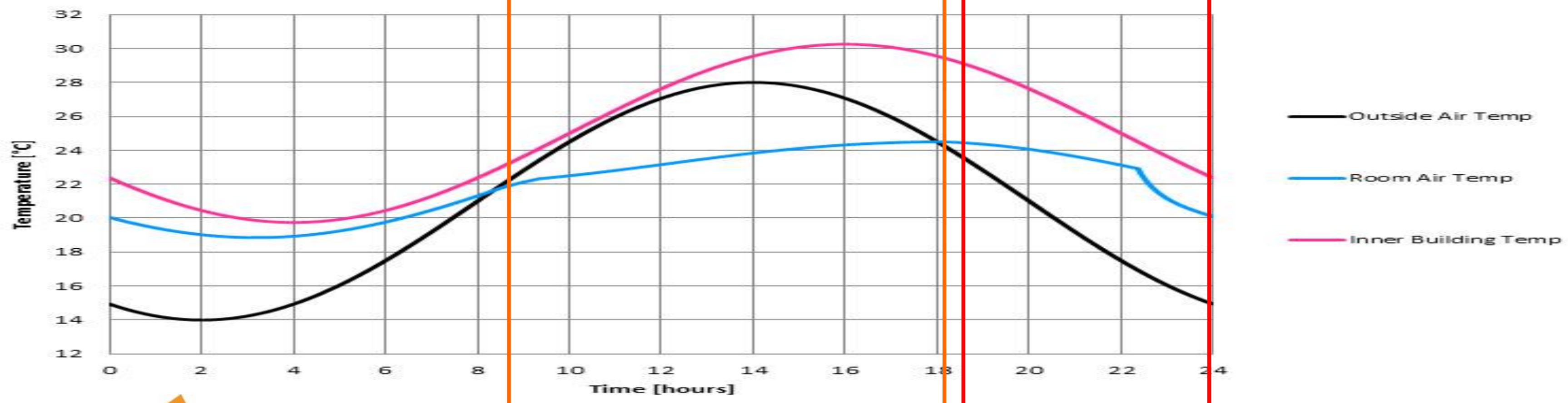
Performance

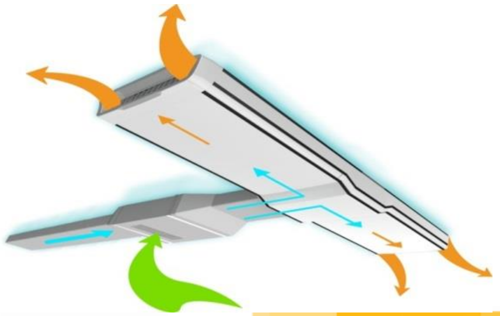
Ventilation warming of incoming / re-circulated air

Heat harvesting



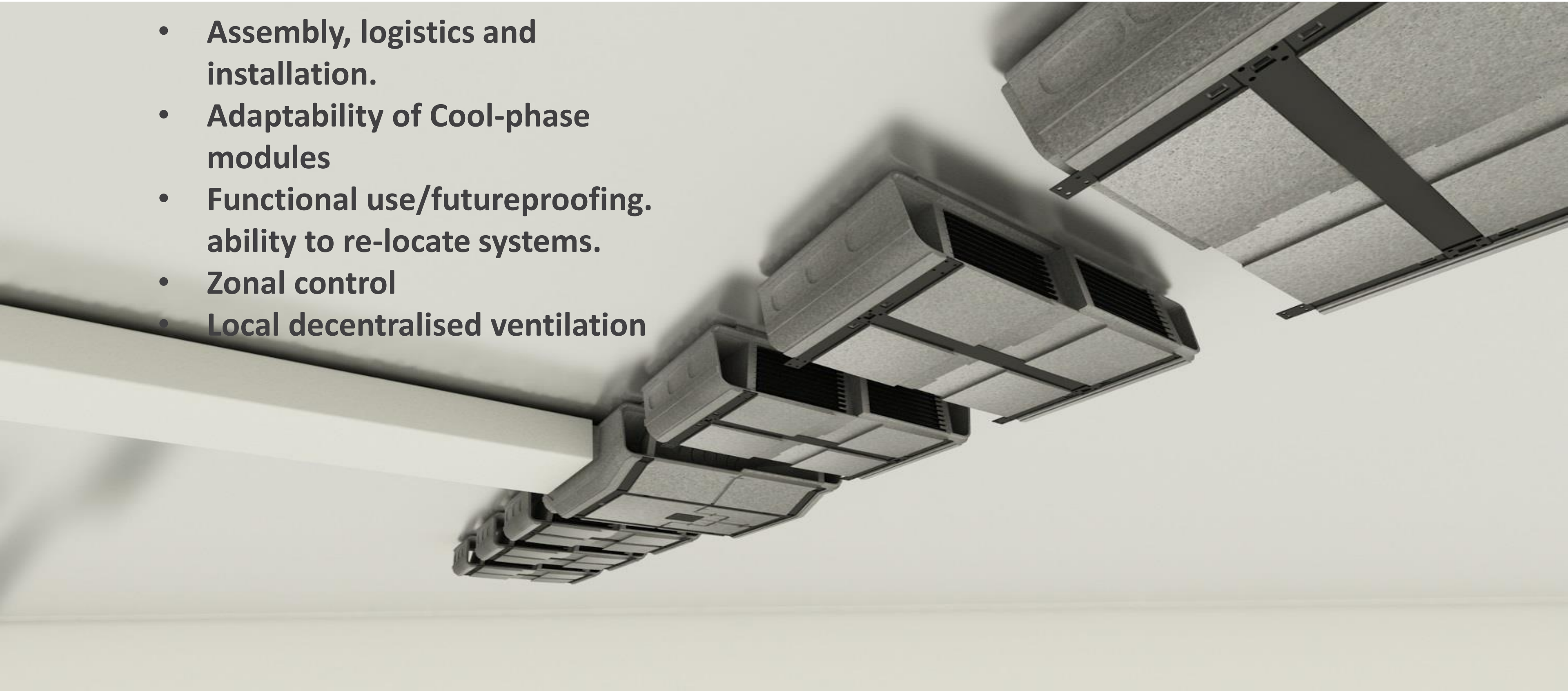
Ventilates the room whilst warming
the incoming air and mixing it
with re-circulated room air

Stores residual room heat across the afternoon and after the room has been vacated



Modular Design

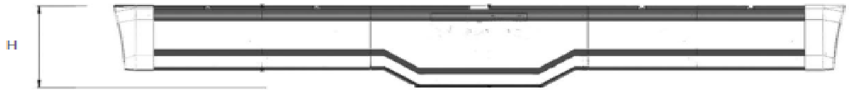
- Assembly, logistics and installation.
- Adaptability of Cool-phase modules
- Functional use/futureproofing. ability to re-locate systems.
- Zonal control
- Local decentralised ventilation

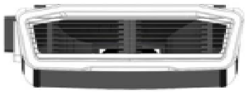


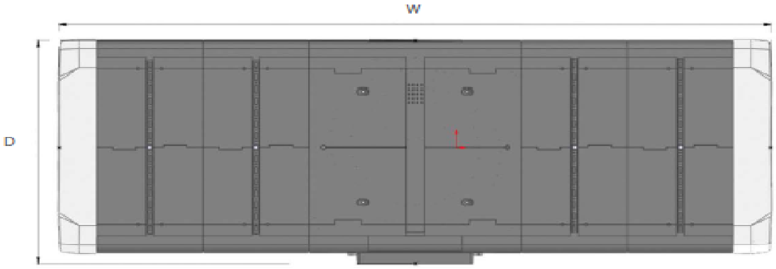
Modular Design

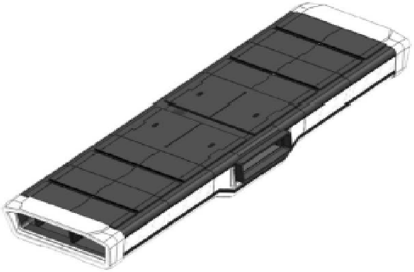
	CPN4F	CPN6F	CPN8F
Dimesions			
• Width (W)	3040 mm	3945 mm	4850 mm
• Depth (D)	966 mm	966 mm	966 mm
• Height (H)	350 mm	350 mm	350 mm
Thermal Energy Storage	6 kWh	8 kWh	10 kWh
Weight	210 Kg	300 Kg	390 Kg

*CPN4F









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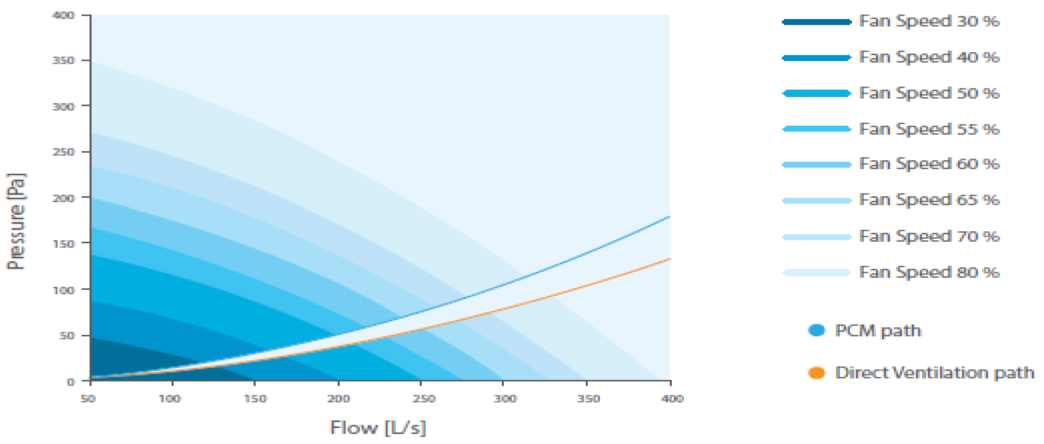
Specific Fan Power

Flowrate [L/s]	SFP	Power Consumption	Operation
100	0.075	7 W	**Normal Operation:** During normal operation the system operates at these flow rates to provide excellent internal air qualities.
125	0.086	11 W	
150	0.108	16 W	
175	0.130	23 W	**Boosted Operation:** The system can automatically increase the ventilation rates to provide additional fresh air when required and for compliance mode to meet 8 L/s per person for BB101 and 10 L/s per person for Guide A.
200	0.156	31 W	
225	0.190	43 W	
250	0.227	57 W	
260	0.238	62 W	
300	0.302	91 W	**Night Time Charge Operation:** The system automatically charges the PCM when required. During this mode we purge the space and cool the building fabric.

Note: Ventilation and specific fan power calculated for air passing through Thermal Battery heat exchanger, direct ventilation values will be slightly better.

Fan Curve



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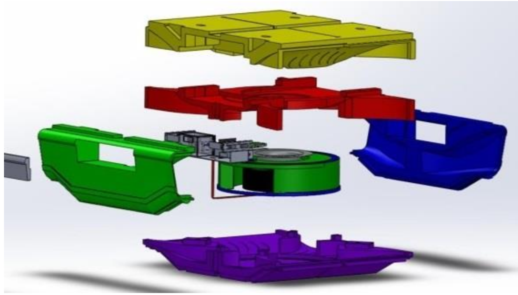
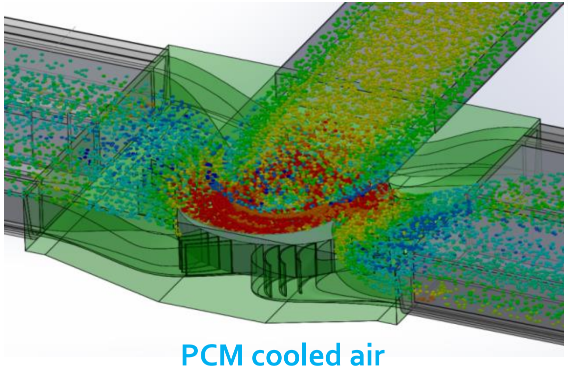
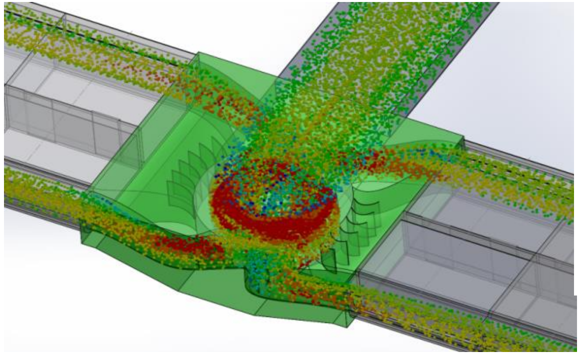
BIM

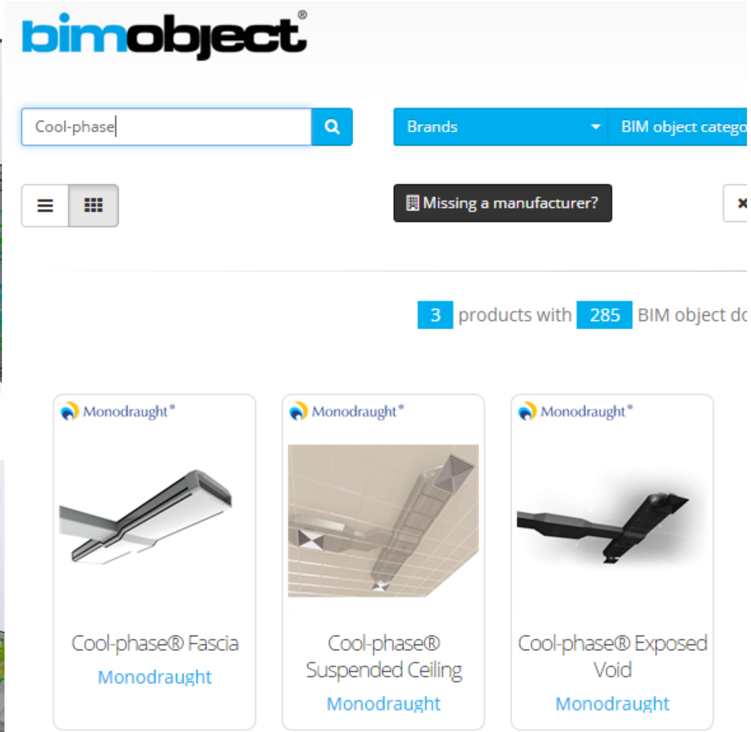




PCM cooled air



Free cooling



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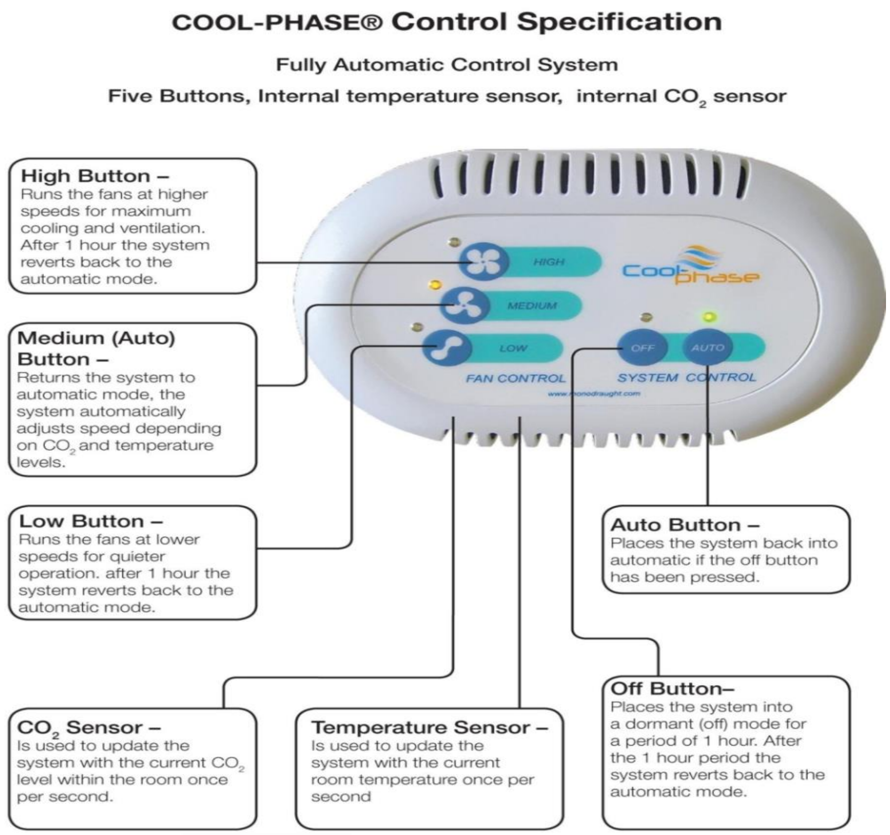
Controls



Controls and user interface:

• Wall mounted controls with room temperature, humidity and CO2 sensors.

• Master / slave mode to control multiple units in a single zone.

BMS Interface:

• Single digital on/off input to enable/disable system from BMS or Fire Alarm circuit.

• Single digital on/off output to be used in one of the following modes:

»» Heating – The system will signal to the BMS to turn on heating when temperatures fall below a preset level.

»» Cooling – The system will signal to the BMS to turn on a secondary cooling system when temperatures rise above a preset level.

»» Fault – The COOL-PHASE system will signal to the BMS when there is a fault in the system.

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Controls - Touchscreen LCD wall controller (Optional)

Touchscreen LCD wall controller:

- 7” Touch LCD display
- Designed to be recess mounted for flush finish.
- Finished with a brushed aluminium fascia.
- Plastic ABS casing houses fixing tensioners to fix behind wallboard.

- Provides graphical insight into operation of system.
- User interface. Can explore how system works, adjust settings, monitor performance.

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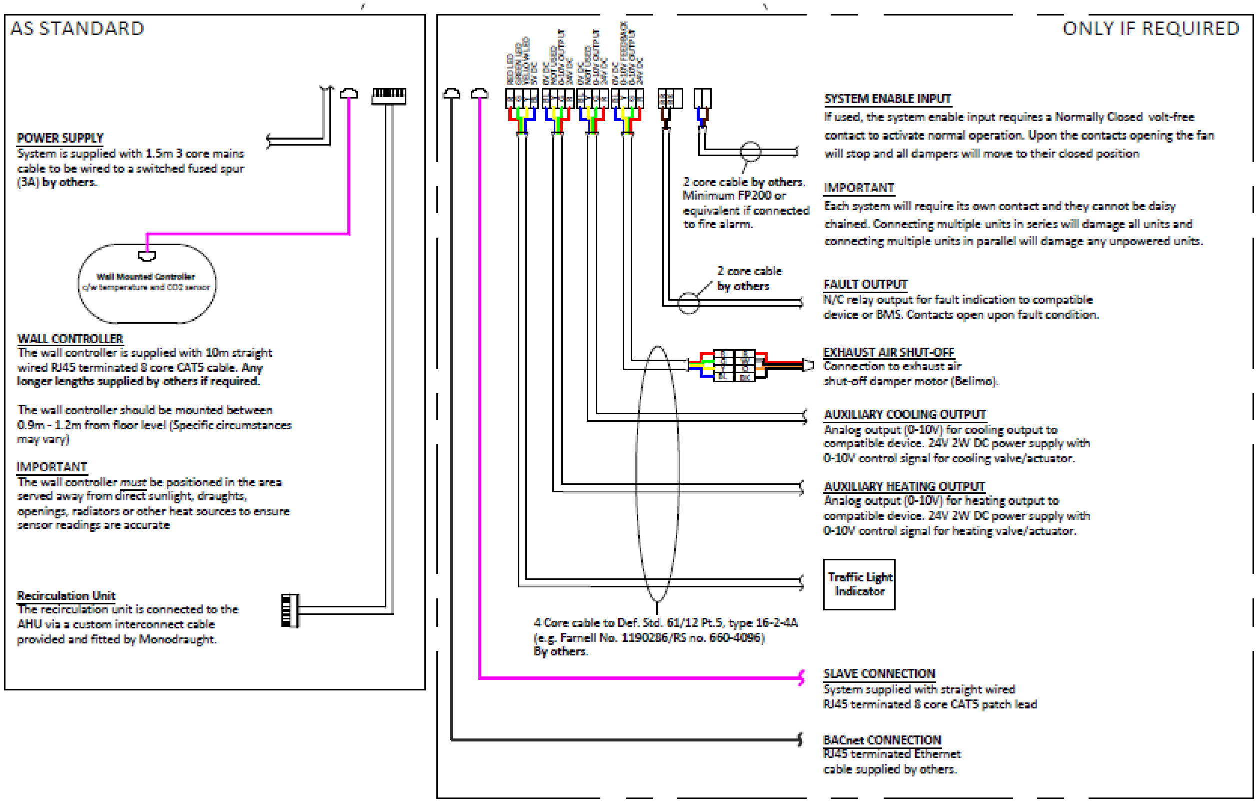
Controls – Schematic



Controls - BACnet

Optional plugin BACnet module

Each COOL-PHASE® system has its own unique BACnet address

Multiple installations of COOL-PHASE® units located in one room are linked together to form one system.

The BACnet module requires an RJ45 ethernet connection (by others) from the central BACnet gateway to the AHU of the COOL-PHASE® unit.

The following information is available for display over BACnet:
- Room temperature
- Room CO2 level
- Cool-phase operation mode
- External/Duct air temperature
- Fault indication
- Cool-phase charge status
- Filter status

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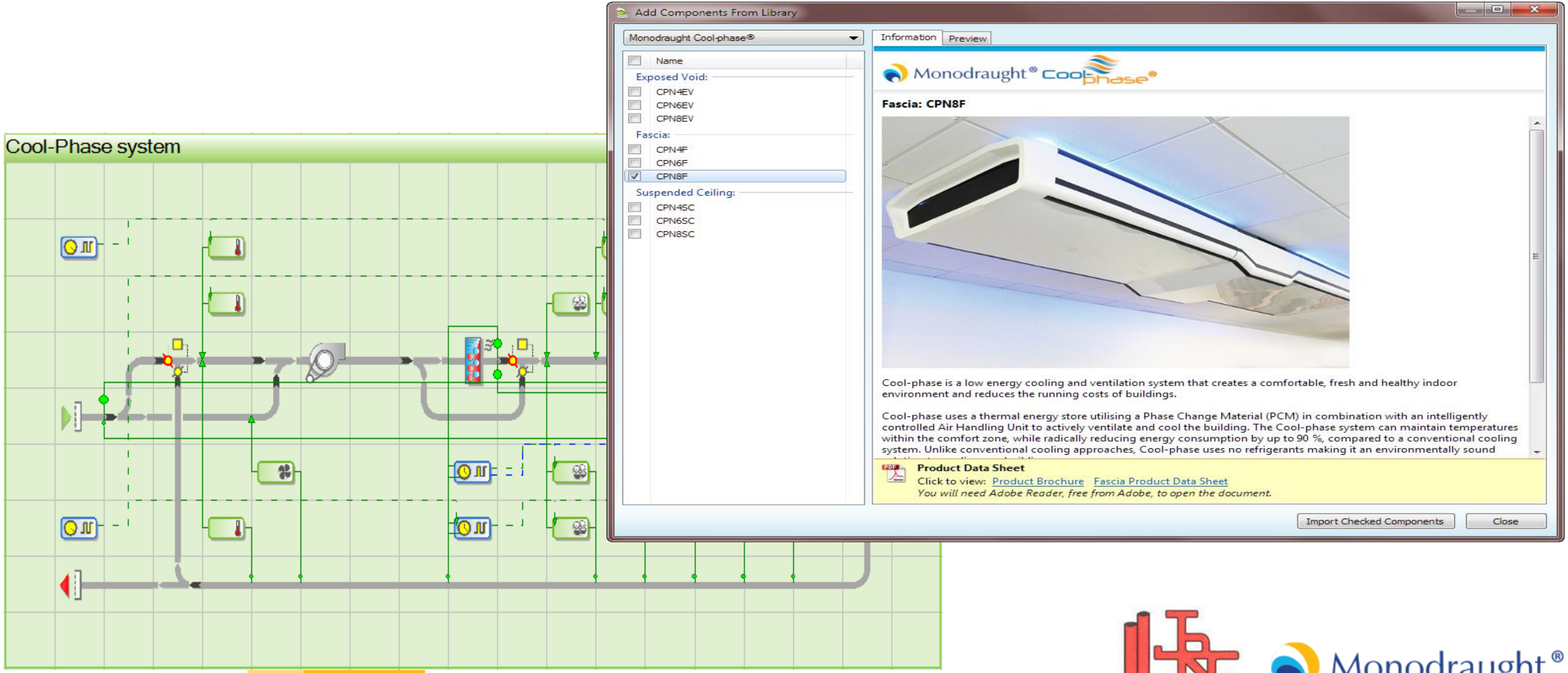
COOL-PHASE® IES integration into Apache HVAC



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Design Concept – Dynamic Simulation

Low Energy Cooling & Ventilation Proposals for Harrogate Civic Offices, Yorkshire

3. MODELLING DATA

3.1. Project weather file

Item	Project Specific Data
Weather File	GBR_Leeds_CIBSE-DSY.epw

Table 3.1 – Weather data.

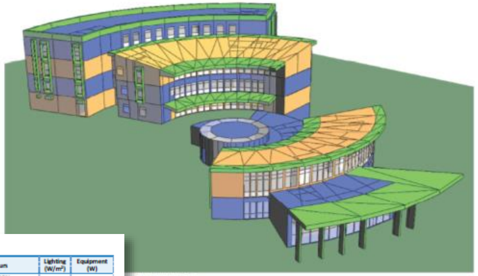
3.2. Building Construction inputs

Item	Construction data
Construction U-Values	External walls - 0.1 W/m².K Floor - 0.1 W/m².K Roof - 0.1 W/m².K Glazing – 1.3 W/m².K
Glazing g-Value	0.4 & 0.28
Infiltration rate	0.25 Air Changes per Hour

Tables 3.2a - Building construction data (as per previous IES model).

Room	Area (m²)	Internal height (m)	Volume (m³)	External Glazing Orientation & Area (m²)	Percentage of openable Glazing* (%)
G28 Customer Contact	90.0	3.3	297.0	3.7m² North West facing 8.64m² South West facing	0%
G02 Cafe / Waiting Room	96.0	4.3	412.8	21.6m² South facing	0%
H09 Meeting Room 03	91.0	4.3	391.3	17.16m² North East facing 3.36m² North West facing 21.6m² South West facing	12m², summer occupied periods, when temp. >22°C or when CO2 >1300ppm
H23 Office Accommodation (S)	188.0	3.1	582.8	15.84m² South West facing	15.84m² Windows, summer occupied periods, when temp. >22°C or when CO2 >1300ppm
H44 Office Accommodation (N)	227.0	3.1	703.7	17.9m² North facing	17.9m² Windows, summer occupied periods, when temp. >22°C or when CO2 >1300ppm
J11 Office Accommodation (S)	190.0	3.1	589.0	26.4m² South West facing	26.4m² Windows, summer occupied periods, when temp. >22°C or when CO2 >1300ppm
J22 Office Accommodation (N)	342.0	3.1	1060.2	27.2m2 North facing 3.2m2 West facing	30.4m² Windows, summer occupied periods, when temp. >22°C or when CO2 >1300ppm
K11 Office Accommodation (S)	190.0	3.1	589.0	26.4m² South facing 6.8m² North facing	26.4m² Win & 7.56m² Louvres, summer occupied periods, when temp. >22°C or when CO2 >1300ppm
K23 Office Accommodation (N)	407.0	3.1	1261.7	32.64m² North facing 3.2m² West facing	35.84m² Windows, summer occupied periods, when temp. >22°C or when CO2 >1300ppm
L07 Office Accommodation (N)	404.0	3.1	1252.4	32.64m² North facing 3.2m² West facing 22.4m² South facing	58.24m² Windows, summer occupied periods, when temp. >22°C or when CO2 >1300ppm

Tables 3.2b – Room construction data (as per previous IES model).



modelled building

3.3. Building thermal inputs

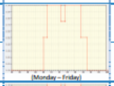
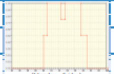
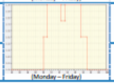
Room	Occupants	Sensible gain (w/person)	Latent gain (w/person)	Occupancy hours	Lighting (W/m²)	Equipment (W)
G28 Customer Contact	15 No.	73.0	50.0	11:00-12:00 @25% 12:00-14:00 @100% 14:00-15:00 @75% (Monday – Friday)	8.0	15.0 W/m²
G02 Cafe / Waiting Room	40 No.	73.0	50.0	 (Monday – Friday)	8.0	10.0 W/m²
H09 Meeting Room 03	30 No.	73.0	50.0	09:00-12:00 @100% 13:00-16:00 @100%	8.0	15.0 W/m²
H23 Office Accommodation (S)	35 No.	73.0	50.0	 (Monday – Friday)	8.0	20.0 W/m²
H44 Office Accommodation (N)	47 No.	73.0	50.0		8.0	20.0 W/m²
J11 Office Accommodation (S)	34 No.	73.0	50.0	 (Monday – Friday)	8.0	20.0 W/m²
J22 Office Accommodation (N)	67 No.	73.0	50.0		8.0	20.0 W/m²
K11 Office Accommodation (S)	36 No.	73.0	50.0		8.0	20.0 W/m²
K23 Office Accommodation (N)	77 No.	73.0	50.0	 (Monday – Friday)	8.0	20.0 W/m²
L07 Office Accommodation (N)	75 No.	73.0	50.0		8.0	20.0 W/m²

Table 3.3: The thermal modelling inputs for the areas to be assessed (as per previous IES model & Data sheets).

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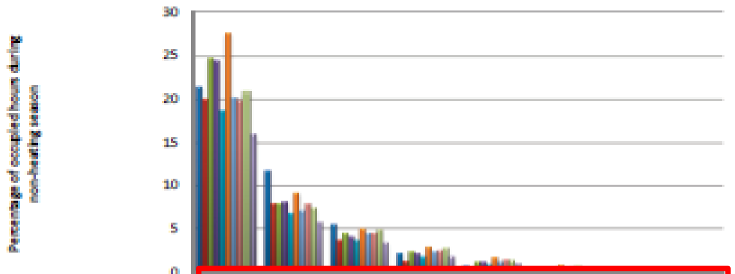
Design Concept – Dynamic Simulation - Results

5.1. CIBSE Guide A Cumulative frequency of Internal Temperature predictions

The analysis within this section presents the cumulative frequency of occurrence of internal air temperatures to evaluate if the proposed scheme complies with CIBSE Guide A thermal comfort Criteria.



	> 23.00	> 24.00	> 25.00	> 26.00	> 27.00	> 28.00	> 29.00	> 30.00
00 - CUSTOMER CONTACT G28	21.6	11.8	5.5	2.2	0.7	0	0	0
00 - WAITING ROOM/CAFÉ G02	20.1	8	3.7	1.3	0.2	0	0	0
01 - LARGE MEETING 03 H09	24.9	8	4.5	2.4	1.2	0.4	0.1	0
01 - OFFICE ACC H23	24.6	8.2	4.1	2.2	1.2	0.2	0	0
01 - OFFICE ACC H44	18.8	6.9	3.7	1.8	0.9	0.1	0	0
02 - OFFICE ACC J11	27.7	9.2	5	2.9	1.7	0.8	0.1	0
02 - OFFICE ACC J22	20.3	7.2	4.5	2.4	1.2	0.4	0.1	0
03 - OFFICE ACC K11	19.9	8	4.5	2.5	1.5	0.6	0.1	0
03 - OFFICE ACC K23	20.9	7.5	4.9	2.8	1.4	0.7	0.2	0
04 - OFFICE ACC L07	16.1	5.8	3.4	1.8	1	0.3	0	0

Figure 5.1a – Annual cumulative frequency of internal dry resultant temperature within each area modelled during occupied hours exceeding temperature bracket with proposed Monodraught systems.

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Natural cooling case study

- A recent publication in the REHVA journal undertook a year long monitoring programme

- PCM system in university computer room

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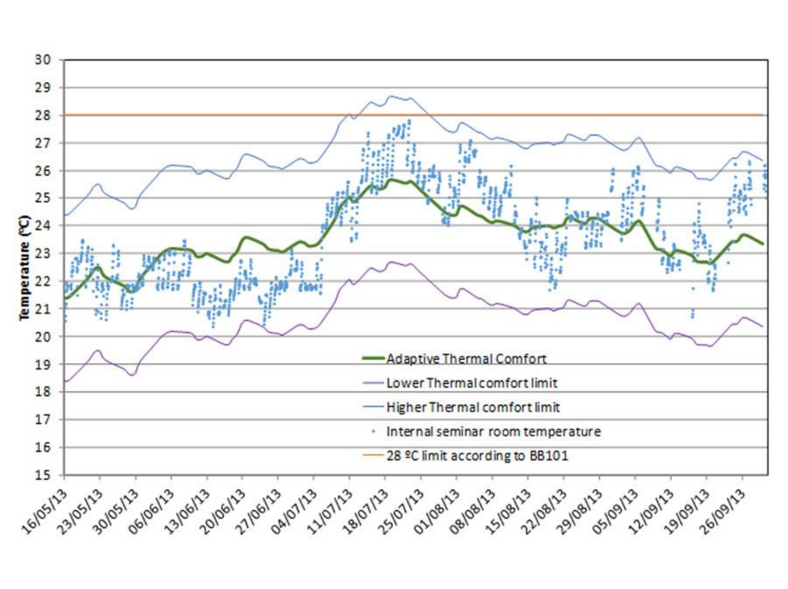
Natural cooling case study (2)

- Results showed:
  - System maintained room temperature within EFA criteria between 20°C and 28°C
  - CO_2 concentration average less than 1,000ppm
  - Fan energy used 0.77kWh/m² compared to traditional mechanical ventilation of 6kWh/m²



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Organisations utilising natural or hybrid cooling

COOL-PHASE® - As installed – Above Ceiling

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COOL-PHASE® - As installed – Fascia

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Case Study - Bournemouth University

Location: Bournemouth
Contact: Steve Cox, Bournemouth University
Systems: Cool-phase®
Sector: Education

Results

The Cool-phase system monitors and records temperatures, CO2 levels and energy use. The results below are based on data collected by the units installed in each Classroom between 20th April 2012 and 24th June 2013.

Temperature Comparison

This table shows the overall average daily temperatures for each Classroom. It is clear from the table that the Cool-phase systems have kept the temperature within a very comfortable band.

This table shows the percentage of time that the internal temperature has spent at over 25°C , 28°C and 32°C during the logged period.

Air Quality

Background or atmospheric CO^2 level is approximately 400 parts per million (ppm) and 1500ppm or above would be considered a high level.

Energy Use

As shown in this table the two Cool-phase units installed in the Science Lecture Room used a combined 138.5KWHs of energy across the logged period. Assuming 0.11£/KWh that amounts to £15.24 or an average of **£0.25p a week.**

Daily Temperatures (°c) Science Lecture Room		
Average	Min Average	Max Average
20.6°c	19.0°c	21.9°c

Max Temperatures (%) Science Lecture Room		
>25°c	>28°c	>32°c
0.01%	0%	0%

CO^2 Levels Science Lecture Room		
> 1000ppm	>1200ppm	>1500ppm
0%	0%	0%

Energy Used Science Lecture Room – 61 weeks			
Cost in £'s (Assumed 0.11£/KWh)	138.5 KWhs	£15.24 total	£0.25p Wk

Case Study - ARU

Case Study – Low Energy Ventilation and Cooling

Anglia Ruskin University
Cambridge Chelmsford Peterborough

Location: Cambridge

Contact: Andy Lefley, Assistant Director Building Services

Systems: COOL-PHASE® system

Sector: Education

Bryant Building Computer Room

In January 2013 a computer room used by the Faculty of Science and Technology at Anglia Ruskin University in Cambridge had its aging air conditioning system replaced with two Cool-phase low energy cooling and ventilation systems. The units were fitted discreetly within the existing ceiling void.

‘I am very excited by this technology and the opportunity to improve student comfort without increasing the energy burden to Anglia Ruskin’, said Andy Lefley, Assistant Director of Building Services, Estates & Facilities.

The Bryant Building, Anglia Ruskin University

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Case Study - ARU

Internal Temperature

Table 1 shows the average daily temperatures for the Science & Technology computer room.

Table 2 shows the percentage of time that the internal temperature has exceeded 25°C, 28°C and 32°C during the data logging period.

Table 1: Daily Temperatures (°c) 25/01/13 - 01/09/13		
Average	Min Average	Max Average
22.7°c	20.9°c	23.8°c

Table 2: Max Temperatures (%) 25/01/13 - 01/09/13		
>25°c	>28°c	>32°c
3%	0%	0%

Air Quality

3 shows that the CO_2 concentration in Room 016 where the two Cool-phase units are installed is consistently maintained below the threshold level.

Table 3: CO2 Levels 25th Jan 13 to 2nd Sep 13		
> 1000ppm	>1200ppm	>1500ppm
11%	3%	0%

Energy Consumption

Table 4 shows the energy consumption of the two Cool-phase units installed in the Bryant building. The combined usage was 197.6 KWh of electricity across the thirty one week data logging period. Assuming a standard electricity tariff of 0.11£/KWh, that amounts to total energy costs of £21.74, or just **70p a week for the two Cool-phase units.**

Table 4: Energy Used 25th Jan 13 to 2nd Sep 13	
Master Unit	100.2 KWhs
Slave Unit	97.4 KWhs
Combined Units	197.6 KWhs
Cost in £'s (Assumed 0.11£/KWh)	£21.74

Sustainability – BREEAM

Potential to contribute towards 28 BREEAM credits.

Note: Based upon BREEAM New Construction-Non-Domestic Buildings 2011

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Soft Landings

Service

Monitoring

End user feedback

Audit of Performance

- **Location:** Leeds
- **Contact:** Jackie Hunt, University of Leeds
- **Systems:** 2N° Cool-phase® Systems
- **Sector:** Education

University of Leeds – Psychology Common Room

Psychology Common Room

Two new Cool-phase® units have been discreetly positioned within the ceiling void to provide natural cooling to the Psychology Common Room at Leeds University.

This table shows the overall average daily temperatures for each room.

Daily Temperatures (°C)			
Room	Average	Min Average	Max Average
Psy 1	21.9°C	20.3°C	22.8°C
Psy 2	21.4°C	19.6°C	22.5°C

Internal Temperature Results

This data was collected from 2 Master units between 11th November 2013 and 6th November 2014. The temperature and CO_2 levels were analysed between the occupied hours of 9.00 – 17.00, Monday to Friday.

Max Temperatures (%)			
Room	>25°C	>28°C	>32°C
Psy 1	0.1%	0%	0%
Psy 2	0.1%	0%	0%

This table shows the percentage of time that the internal temperature has spent at over 25°C, 28°C and 32°C during the logged period.

CO_2 Levels

Background or atmospheric CO_2 level is approximately 400 parts per million (ppm) and 1500ppm or above would be considered a high level.

CO_2 Levels			
Room	> 1000ppm	>1200ppm	>1500ppm
Psy 1	0.7%	0.1%	0%
Psy 2	1.8%	0.1%	0%

Energy Consumption

The Energy use is shown over a 24hr logged period

Each system - Energy Use over approx. 50 weeks				
Psy 1	131.5 KWh	£14.47 total	29p per week	Approx. £15 Per annum
Psy 2	97.7 KWh	£10.75 total	21p per week	Approx. £11 Per annum

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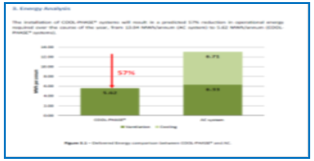
Why use COOL-PHASE®?



Cost

- Lower energy usage and costs
- Servicing and maintenance regimes
- Impact on sales price and rental potential
- Modelled energy use is more probabilistic than competitors

Environment

- Building Regulations (ventilation and thermal comfort)
- Environmentally damaging coolants, e.g. R22
- Carbon Reduction Commitments (CRC)

Practical

- Planning issues and outside space
- Peak load shifting
- External noise

Health & Well-being

- Staff productivity and attendance
- Sick Building syndrome
- Air quality
- Cold air dumping /thermal gradient

Building Value

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The need for a COOL-PHASE® Hybrid System

Reliant on External Conditions

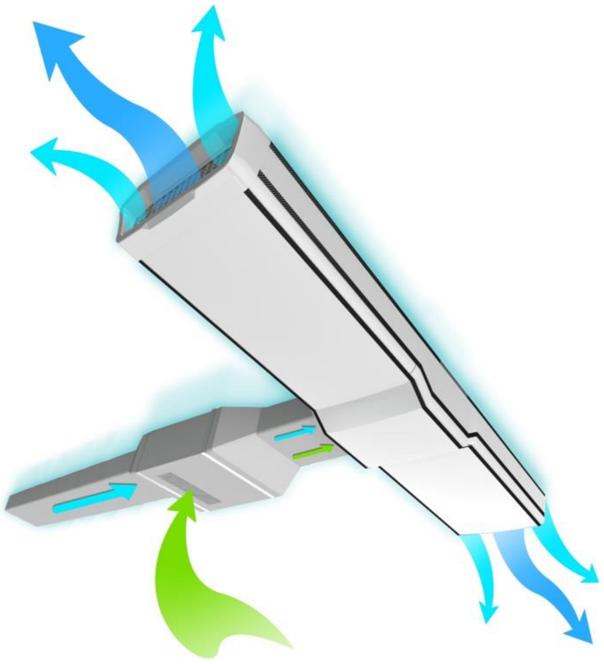
- During night in summer periods, if temperature does not fall below a certain point, PCM cannot be charged. **Warmer climates with lower temperature boundaries.**
- If the PCM is not properly charged, air from the room cannot be re-circulated through the PCM to provide cooling

Capacity of the Thermal Batteries

- The PCM has a certain capacity which eventually will run out, resulting in inconsistent room temperatures and the need for additional units. **Areas of long occupied periods, 24hr.**

No precise temperature control

- Standalone COOL-PHASE is not designed to maintain a set point like air conditioning.



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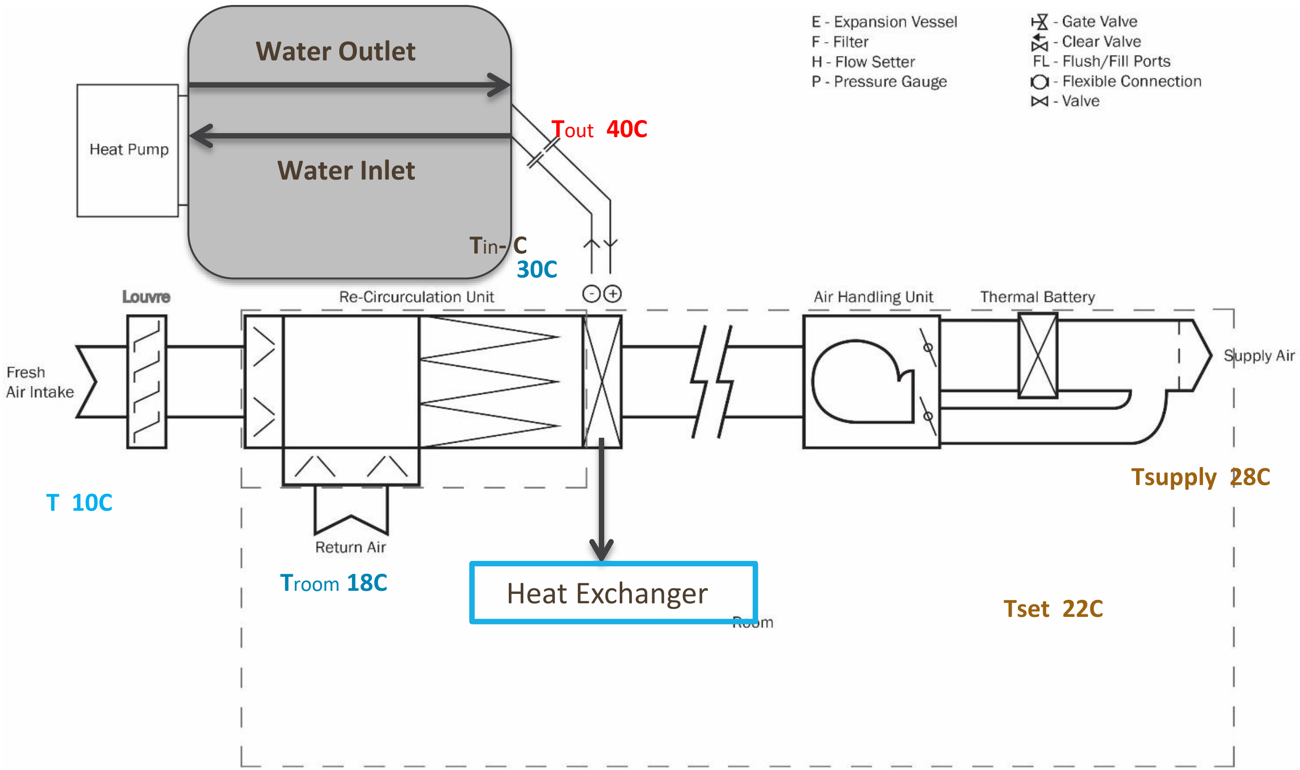
How does the COOL-PHASE® Hybrid Heat Pump work?



The Heat Pump will be connected to the COOL-PHASE via a heat exchanger

Heat Exchanger is specifically designed to be integrated within the existing COOL-PHASE System

The chilled/hot water leaving the heat pump will pass through the Heat Exchanger located inside the COOL-PHASE Unit

The Heat Exchanger will allow for cool/warm air to be supplied to the room or to charge the Thermal Batteries

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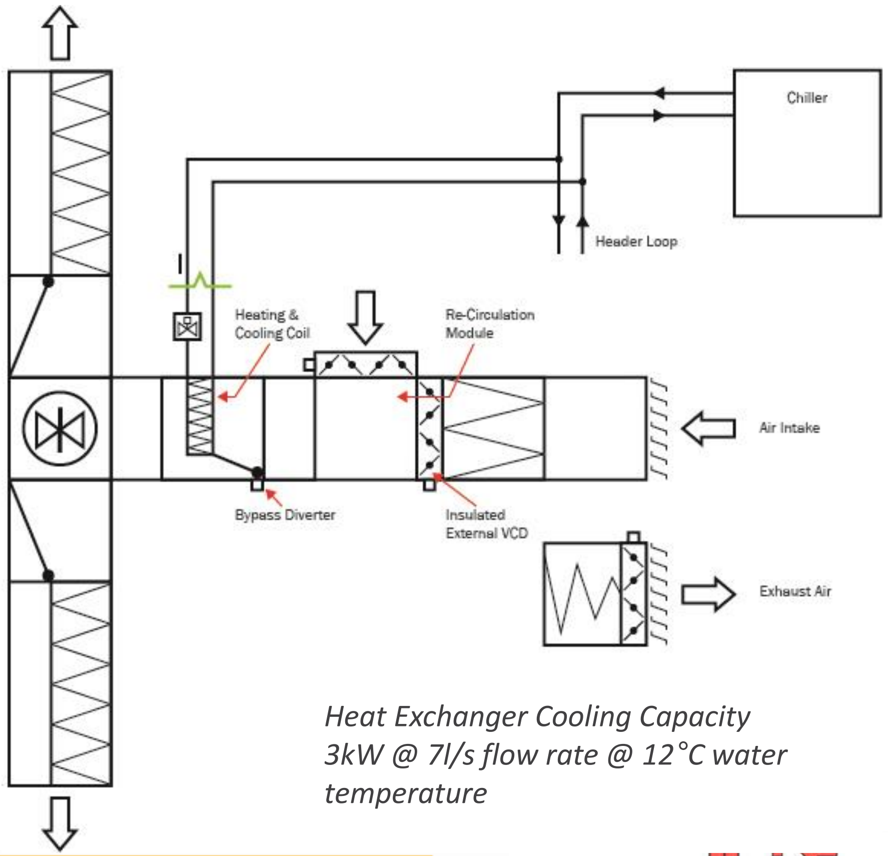
COOL-PHASE Hybrid – HVAC Diagram Chiller

CHW is connected to the COOL-PHASE via a Header Loop and 2 pipe connection to a Heat Exchanger

Heat Exchanger is specifically designed to be integrated within the COOL-PHASE System

The Heat Exchanger cools recirculated room air and mixed fresh air which is supplied via the direct air path to the room or can charge the Thermal Batteries



Heat Exchanger Cooling Capacity 3kW @ 7l/s flow rate @ 12°C water temperature

Control Strategy - Hybrid

Summer Season

If the external air temperature does not fall to 18°C then the chiller (CHW) will be activated to charge the PCM from 1am to 6am.

Day Time: If the temperature exceeds 24°C, the system will switch to direct air path and CHW coil activated

Winter Design Criteria

- **Daytime: 19-21°C**
- **Night-time: 15°C**

Summer Design Criteria

- **Daytime: 24±2°C**

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COOL-PHASE Hybrid Heat Pump – Benefits

The integration of our Cool-Phase Hybrid System will allow for the following improvements:

- More precise room temperature control - Capacity to achieve a certain Set Temp & Consistency
- Charging the Thermal Batteries when external conditions will not allow
- Provide direct Heating or Cooling when the thermal batteries run out of capacity
- Depending on Heat Pump Model (capacity) - Capability of support of Multiple COOL-PHASE Systems
- Keep Running Costs & CO_2 Emissions to a minimum

Conclusion

- Traditional air conditioning can offer accurate temperature and humidity control
- PCM based natural cooling and ventilation is beneficial for
  - Drastically reducing energy
  - Maintain temperature and CO_2 levels
  - Significantly improve sustainability
  - Positive impact on the health & wellbeing

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Any Questions?

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