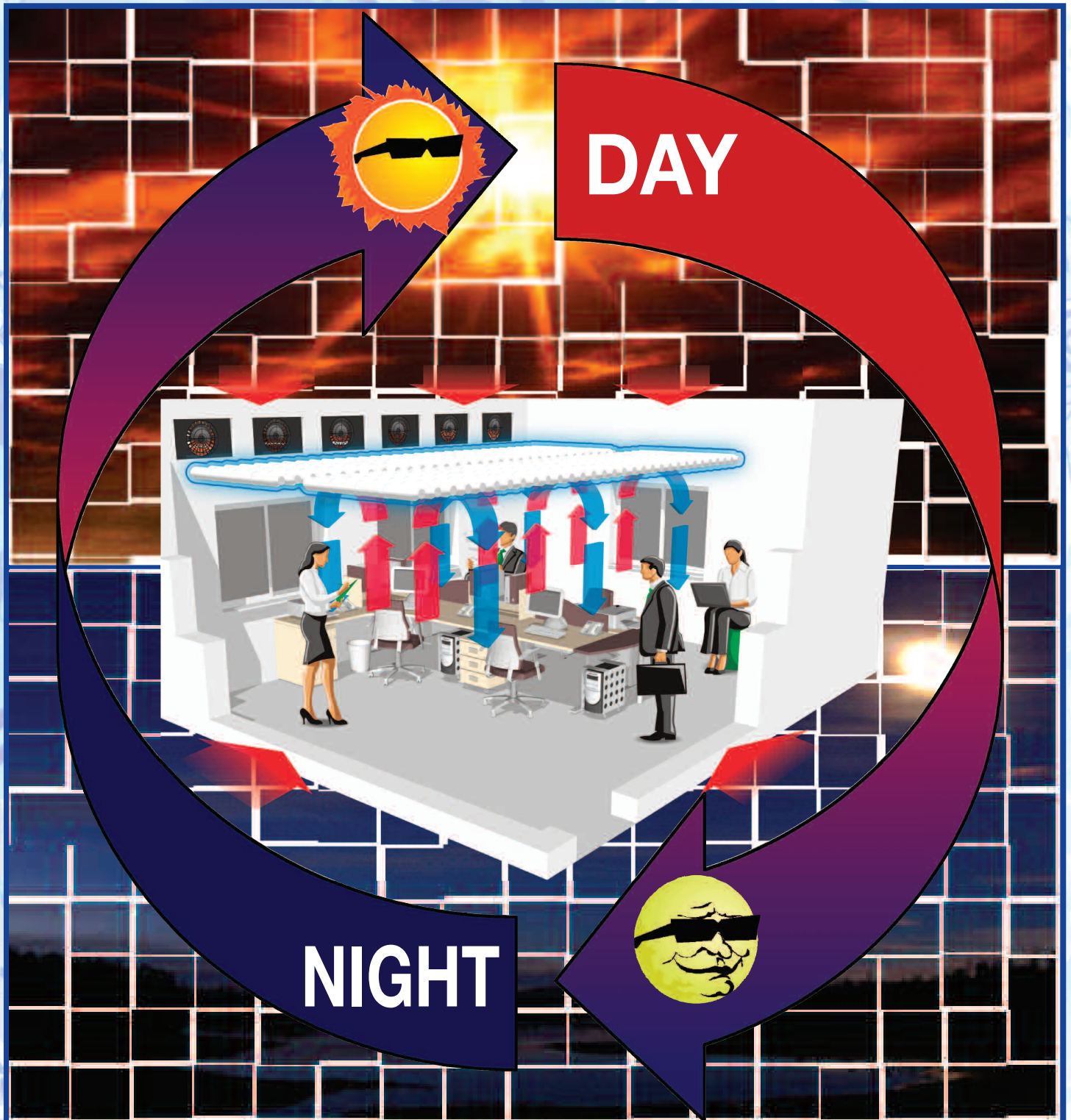


PlusICE™

Phase Change Materials

Passive Cooling



PCM

Phase Change Material Products Limited



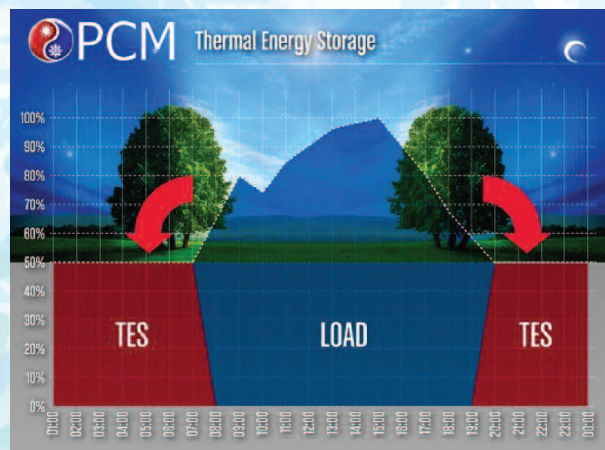
NATURAL ALTERNATIVE TO REDUCE ENERGY

THERMAL ENERGY STORAGE;

Thermal Energy Storage (TES) is the temporary storage of high or low temperature energy for later use. It bridges the gap between energy requirement and energy use. A thermal storage application may involve a 24 hour or alternatively a weekly or seasonal storage cycle depending on the system design requirements. Whilst the output is always thermal, the input energy may be either thermal or electrical.

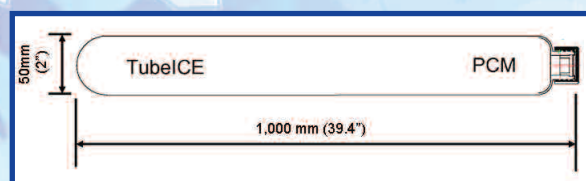
Phase Change Materials (PCMs) are products that store and release thermal energy during the process of melting & freezing (changing from one phase to another). When such a material freezes, it releases large amounts of energy in the form of latent heat of fusion, or energy of crystallisation. Conversely, when the material is melted, an equal amount of energy is absorbed from the immediate environment as it changes from solid to liquid.

For the majority of applications, PCM solutions have to be encapsulated in sealed containers. To this end, PCM Products Ltd. have developed many different standard type containers as well as custom-made containers for special applications. These containers can be applied to any water or air based TES systems and can be manufactured using our PlusICE Phase Change Materials (PCM) solutions which have operating temperatures between -40°C (-40°F) and $+117^{\circ}\text{C}$ ($+243^{\circ}\text{F}$).



TubeICE™ FEATURES;

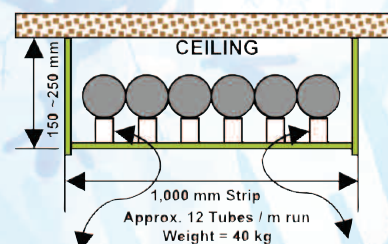
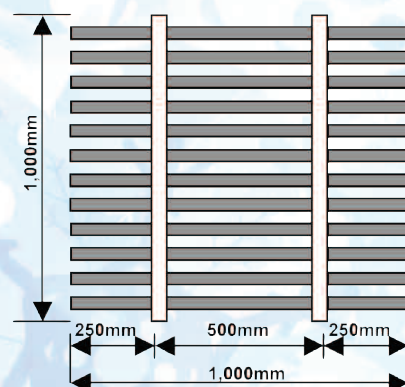
TubeICE concept is based on custom-made plastic containers filled with our PlusICE Phase Change Materials (PCM) solutions which have operating temperatures between -40°C (-40°F) and $+117^{\circ}\text{C}$ ($+243^{\circ}\text{F}$). They can be stacked in either cylindrical or rectangular tanks for atmospheric / pressurized systems for a variety of thermal energy storage applications.



TubeICE Bracket

Once the TubeICE containers are filled with PCM they weigh between 2~3 kg (4.4~6.6 lbs) each depending on PCM type and by simply using standard 50mm (2") pipe brackets they can be suspended from the ceiling area to act like a heat absorbing sponge to soak up the rising heat within the enclosure.

Using conventional bracket systems it is possible to hang 12 TubeICE containers per m^2 ceiling area and the overall total weight could be in the region of 40kg and in return these tubes can provide anywhere between 1.7 ~2.2 kWh/ m^2 (0.046~0.057 TRh/ ft^2) energy depending on the PCM type.



Direct Bracket



Concealed Bracket

Although TubeICE containers are manufactured in 50mm (2") diameter by 1,000 mm (~40") lengths, any other size or shape containers can be manufactured to suit the site requirements. Please consult our technical team for any special and custom-made applications.





INNOVATION FOR ENERGY SAVING TECHNOLOGIES

BUILDING SERVICES PASSIVE COOLING APPLICATIONS

PCM Charge Period • Night Hours



PCM Discharge Period • Daylight Hours



Our wide range of PlusICE solutions offer numerous air conditioning and comfort cooling applications. PlusICE solutions are also successfully applied for passive cooling applications such as chilled ceiling / cooling tower free cooling circuits as well as heat rejection systems. Passive cooling relies on naturally occurring night and day time temperature swings. The cool energy available over-night is stored within the PCM and later the stored energy is used to absorb the internal and solar heat gains during day-time for an energy free passive cooling system.



University of Westminster, London
Passive Office Cooling

Although it is possible to apply 12 TubelCE per m² (~1 TubelCE / ft²) within the ceiling area but as the same area is also used for other services, the practical limit for the passive cooling modules free area could be anywhere between 40~70% of the ceiling area.

Design Example;

Lets say we have a 100 m² (1,000 ft²) office space and using 27°C (81°F) PCM in 1m (~40") long TubelCE which provides us with 0.145 kWh (0.041 TRh) thermal energy storage. Using standard brackets one can accommodate 12 Tube ice per m² (12 TubelCE per 10ft²). Using standard brackets one can accommodate 12 Tube ice per m²

(12 TubelCE per 10 ft²). In other words, every 1m² (10ft²) area covered with TubelCE filled with 27°C (81°F) PCM provides 1.74 kWh (0.49 TRh) energy storage for the occupied space area.



TubelCE
behind Tiles



TubelCE Beams
within the false ceiling area



Nottingham University
Passive Cooling Units



Solar House,
Passive Cooling
USA



Pendle Vale School,
Lancs., UK

Assuming one can only cover 50% of the ceiling area with TubelCE, the design provides approximately 87 kWh (24.7 TR-h) energy storage capacity for 100 m² (1,000 ft²) space.

As long as the occupied space temperature goes below 20~22 °C (70~74°F) over-night, that would be more than enough to freeze the 27°C (81°F) PCM solution and in return this stored free energy is used to absorb heat from the occupied area during day-time.

If the high level ceiling temperature during peak day-time remains 4~6 hours above 27°C (81°F) PCM which acts like a heat sponge to soak up the heat and that means the stored passive energy could provide as much as equivalent to a 15~22 kW (4.3~6.2 TR) mechanical cooling system.

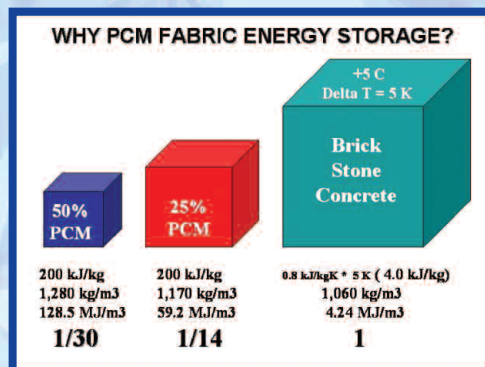


NATURAL ALTERNATIVE TO REDUCE ENERGY

FABRIC ENERGY STORAGE;

Many organic solutions can be converted to dust, granule, powder or even rubber forms thereby offering new horizons to accommodate and embed the PCM solution as part of the building fabric and façade. The addition of as little as 25% PCM into the building fabric increases the building thermal performance 14 times in comparison with the same amount of conventional building materials.

As almost all organic solutions do not cause any concern for corrosion they can be simply mixed with the building materials as part of the fabric both externally and internally. Alternatively, PCM mixture can be incorporated as part of the furnishing.



Granule



Rubber



Beads



Seats

Any passive cooling entirely relies on the temperature swing between day and night and as such the selection of the PCM temperature is critical to stay within the middle of high day-time and low night-time temperatures. By simply utilising free cold energy absorbed during night-time used to cool the space during high ambient periods, i.e. during day-time, or alternatively storing the hot energy during day-time and utilising this stored free energy during night cold periods, one can simply stabilise the space temperature swing and minimise or may even completely eliminate the energy usage.

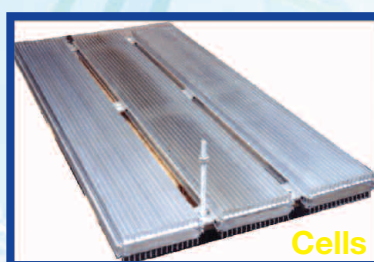
ENCLOSURE PASSIVE COOLING APPLICATIONS



Furniture



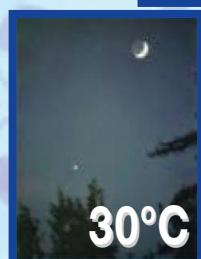
45°C
Shelter



Cells



Tubes



30°C



55°C

Electrical components generate heat whilst running, if these components are housed in a confined space, the internal temperature of the enclosure can rise well above the upper operational limit of the components, resulting in either shut down or burn out for the system. This is exacerbated if the enclosure is exposed to solar gains, for example in telecom shelters, gas pipeline stations or exposed control panels etc..

Hence, if these

electrical enclosures / shelters / mobile phone transmitting boxes are located near to a power source, they are provided with 100% run / stand-by mechanical cooling systems for a safe and reliable operation all year round. However, if the same enclosures are located in remote areas whereby no electricity source is available, one can run the electronics using solar energy / battery set up BUT solar energy can not run a mechanical cooling system.



Telecom Shelter Back-up

A passive cooling system relies simply on the swing between day and night ambient temperatures and by simply storing night free cold energy to use during day-time to keep the shelter inside temperature below the design limits.



TubeICE
Shelter Passive Cooling



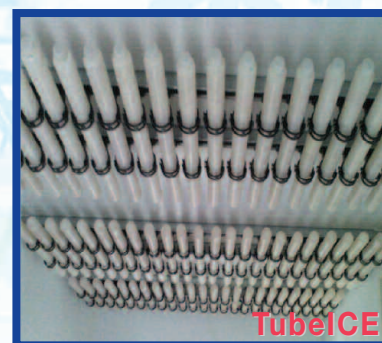
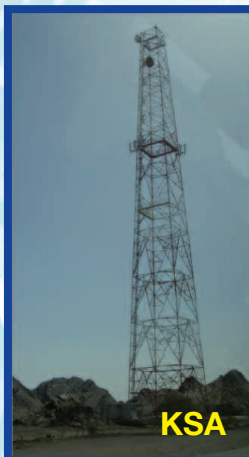
INNOVATION FOR ENERGY SAVING TECHNOLOGIES

TELECOM SHELTERS PASSIVE COOLING

If the telecom shelters are located in remote areas, one can run the electronic systems using solar PV cells and battery packs without the mains power but as the mechanical cooling requires far greater power requirements than the electronic solar power driven mechanical cooling it is almost impossible to operate. Heat generated by the electronics plus the solar gains during day time results in the enclosure temperatures exceeding the upper safety limit of the electronic circuits and as result the system shuts down for safety.

By simply storing the cold night-time energy in the form of passive cooling PCM beams one can over-come this over heating risk. As the energy is naturally stored free of any primary energy use such as gas, oil or electricity it has no running cost. As there are no moving parts, it is also maintenance free and at the end of its useful life it can be fully recycled or disposed of without any environmental issues.

PCM can be encapsulated either in TubeICE or Beams or any other suitable formats and positioned at high level within the shelter to act as passive cooling modules.



TubeICE



PCM Beams



Typical Telecom Shelter Passive Cooling



TubeICE

ELECTRICAL PANEL PASSIVE COOLING

All electrical components and batteries generate heat during normal operation and when these components are placed in air tight or even ventilated spaces the heat generated by the components accumulates within the enclosure and can cause over-heating problems.

In order to overcome this over-heating risk a PCM passive cooling concept can be applied to regulate the internal temperatures and ensure that the enclosure stays within the design limits.



REMOTE PUMP STATIONS PASSIVE COOLING



LIBYAN
DESERT

PASSIVE COOLING SHELTER

Main oil or gas pipeline pumps and monitoring stations are generally located in very remote areas whereby the mains power is generally not available. PCM Products have worked with many large, petrochemical companies developing custom-made passive cooling applications for their pipeline remote location shelter and electrical / control panels providing either back-up cooling for the mechanical cooling plant or alternatively a stand alone passive cooling system simply utilising the cool night-time energy to keep the enclosure below its upper operating limit during day-time operation.

COMPUTER ROOMS BACK UP PASSIVE COOLING

It is common practice to install 100% stand-by air conditioning units for any shelter and computer / data installation but the lack of regular operating hours for stand-by units results in very high maintenance and the risk of non-starter units.

PCM based passive cooling back up units operate whereby the standard mechanical cooling charges the PCM-based secondary unit and in the event of power failure or long weekend periods with no central A/C supply, the PCM-based unit requires only a small DC/AC power provided from the back up system to circulate the air and the energy stored within the PCM can keep the enclosure below its upper limits up to 4~6 hours without any mains power requirement.



14 kWh
(4 Ton-hr)

BACK-UP MODULE



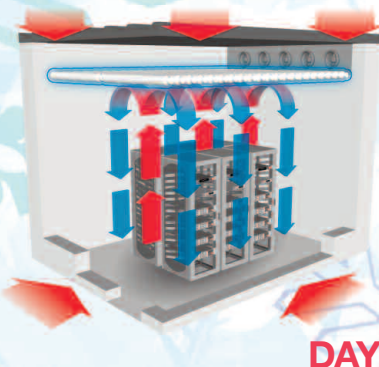
INNOVATION FOR ENERGY SAVING TECHNOLOGIES

ELECTRONIC PASSIVE COOLING APPLICATIONS

When main circuit boards and processors are in operation, they generate considerable heat and if this heat is not removed it accumulates within the confined space and the surrounding temperature rises and if it goes above the maximum operating limit of the electronics (generally +45 °C (112 °F)) the system shuts itself down from the safety protection units.

By selecting a PCM that changes phase at a temperature between ambient and the upper operational limit, cool energy can be stored during unused periods. Later this stored energy acts like a heat sponge to soak up the heat from the circuit. Heat generated by the electrical equipment is absorbed by the PCM and in return the enclosure temperature is maintained below the upper limit of the system for a safe and reliable operation.

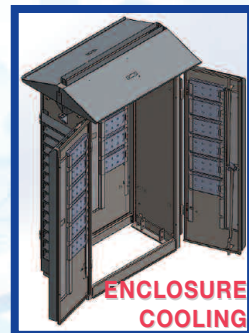
In particular, organic solutions are non-conductive as well as non-corrosive and therefore they are safe to contact directly any electrical component. The recently developed thermoformed version of our organic PCM solutions or solid-solid PCM products can be moulded into any shape and as it does not turn liquid even during phase change it offers a leak and effectively risk free operation. Alternatively, PCM solutions can be encapsulated in either metal or plastic containers / pouches to act as heat sinks to suit a variety of temperature range and applications.



DATA PROTECTION



When a data logger is placed in excessively hot locations like engine tests, ovens, furnaces etc., it may be exposed to temperatures greater than the recommended maximum operating temperatures. Some loggers can cope as high as 110 °C (240 °F) but beyond that they are damaged beyond repair. Insulation delays this heat conduction and offers limited time, but by simply adding PCM as part of the insulation kit the standard time delay of this heat migration can be increased by as much as 10~20 times and effectively the logger can be kept within the high temperature environment far longer than by using conventional insulation alone. A number of manufacturers offer safes for data back up. Although they offer protection against direct combustion of the content, the internal temperature of the safe may rise to excessive levels if exposed to fire for any length of time. This can render sensitive storage media such as data disks, tapes, CDs and DVDs useless. By simply incorporating a PCM thermal shield into the safe, the contents can be protected from the outside temperatures for much longer.



BATTERY COOLING

During their charging and discharging periods all batteries generate heat and if the batteries are located within a sealed enclosure this heat can become excessive. The higher the temperature the greater the life of the battery is reduced. Additionally, the holding power as well as the output during discharge are reduced significantly. By simply incorporating PCM heat sinks which are charged under standard ambient conditions and later this stored PCM energy absorbs the heat generated by the batteries during charging or discharging periods. PCM heat sinks overcome the fluctuation of the battery temperatures which can be stabilised for a reliable, safe operation and extended life.

TECHNICAL SUPPORT

PCM Products offers full system design support to assist in proper selection and integration into existing or new installations as well as product development services from conception to completion as part of our customer commitment.

We offer full consultancy on product development on a strict confidentiality basis and the possibility of Licensee, know-how and technology transfer options for local manufacturing. Please consult our technical sales team at info@pcmproducts.net for your specific application or visit our website www.pcmproducts.net

For additional information contact;

Distributor/Installer Stamp



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