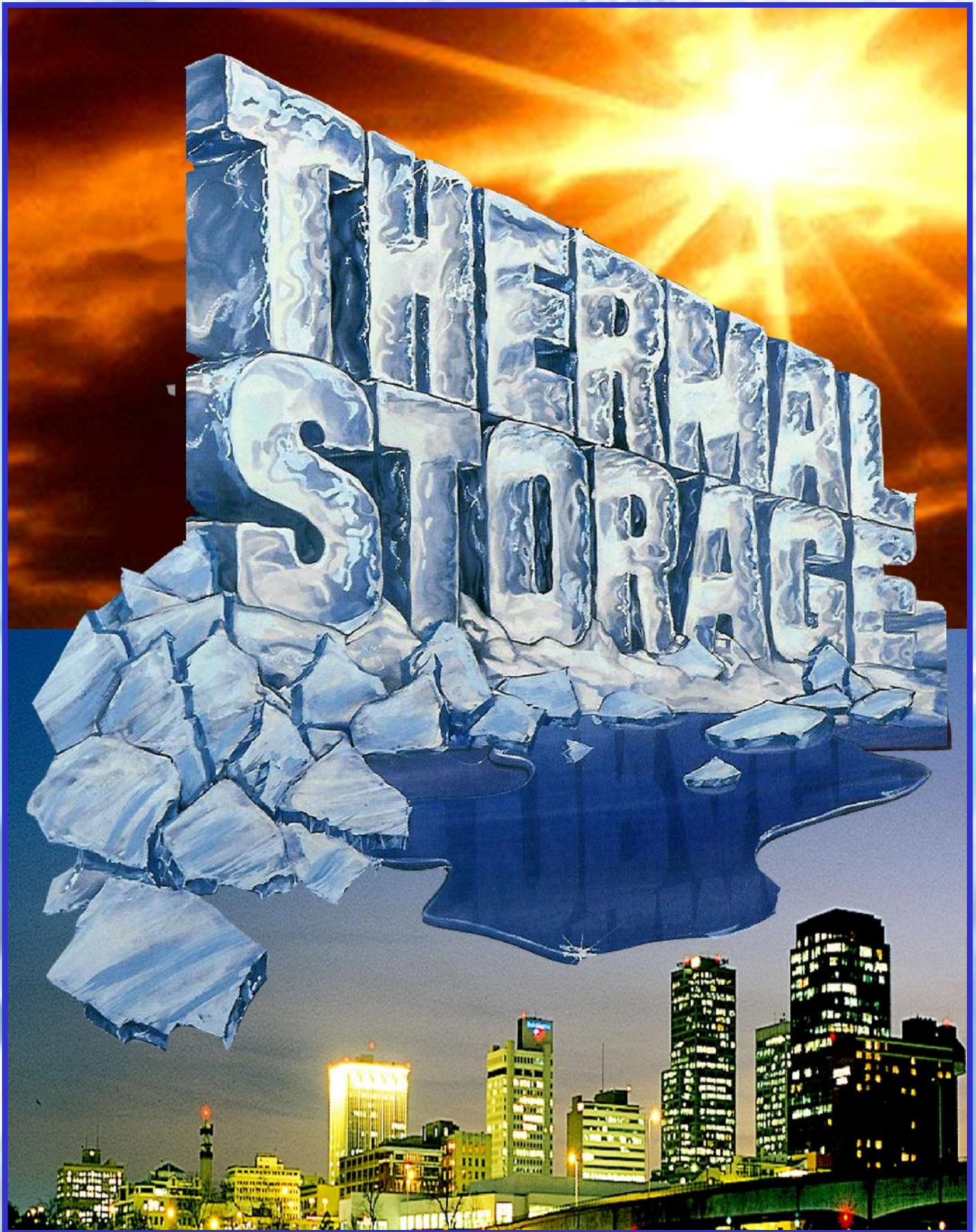


ThinICETM Phase Change Material



PCM

PHASE CHANGE MATERIAL PRODUCTS LIMITED



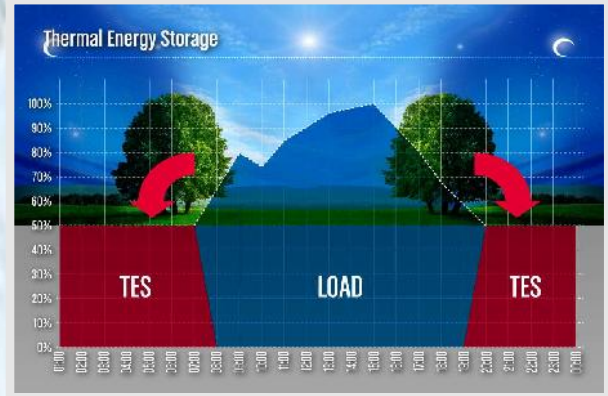
NATURAL ALTERNATIVE TO REDUCE ENERGY

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.

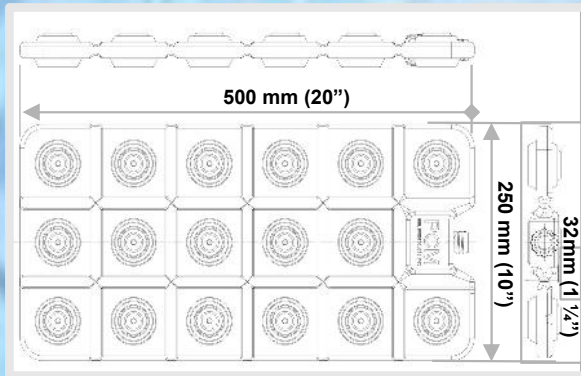
Phase Change Materials (PCMs) are products that store and release thermal energy during the process of melting & freezing (changing from one phase to another). When such a material freezes, it releases large amounts of energy in the form of latent heat of fusion, or energy of crystallisation. Conversely,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

In a majority of the applications, PCM solutions have to be encapsulated in sealed containers. To this end, PCM Products Ltd. Have developed many different standard 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 Material (PCM) solutions which have operating temperatures between **-40°C (-40°F)** and **+117°C (+233°F)**.



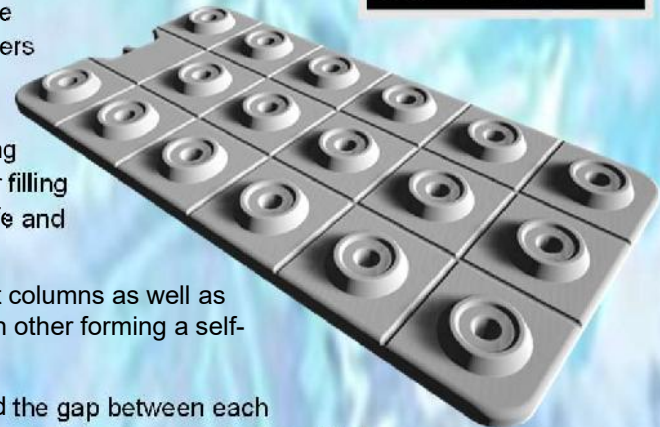
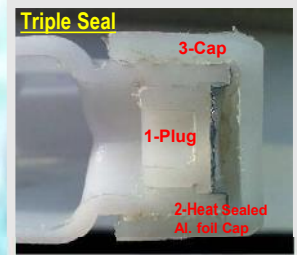
ThinICE Encapsulated Container;

These containers are blow moulded HDPE and can be filled with both negative or positive temperature PCMs up to ~50°C (122F) as above this temperature PCMs would not be suitable due to softening of the plastic and losing their strength.



When stacked there is a small gap between each container, allowing either air or water to flow easily over the containers while providing a large PCM surface area for heat transfer.

ThinICE custom-made HDPE plastic containers are filled with PlusICE PCM solutions and the filling port fully welded after filling in order to ensure safe and reliable operation.



The design of these plastic containers incorporate several internal support columns as well as external guide circles, allowing the containers to be stacked on top of each other forming a self-assembling large heat exchanger within the tank.

The self-stacking concept can be applied for both water and air circuits and the gap between each container provides an ideal flow passage with a large heat exchange surface. Surface grooves designed to be criss-cross pattern whereby the standard plastic or copper water pipes up to 15mm (1/2") can be placed on top or under these grooves providing direct contact with the HDPE container.

Weather underfloor heating or ceiling passive cooling applications having these direct contact with cooling or heating pipes facility provides an opportunity for active i.e. dynamic TES capability and extend the application of both passive and active cooling & heating applications.

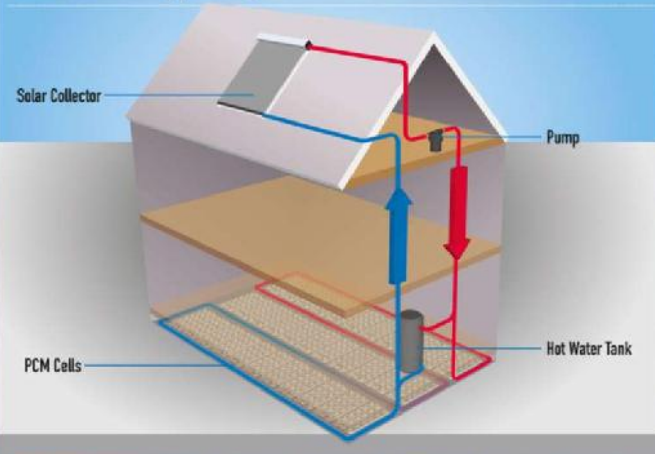
PCM Type	PCM (C)	PCM (F)	kWh per ThinICE	TES Tank Capacity (kWh/m3)	Weight per ThinICE (kg)	Ton-hrs per ThinICE (*)	TES Tank Capacity (Ton-hr/USG)	TES Tank Capacity (Ton-hr/ft3)	Weight per ThinICE (lbs)
S34	34	93	0.104	24	3.41	0.031	0.026	0.194	7.52
S32	32	90	0.125	29	2.37	0.037	0.031	0.234	5.23
S30	30	86	0.106	25	2.12	0.032	0.027	0.199	4.67
S27	27	81	0.120	28	2.49	0.036	0.030	0.224	5.48
S25	25	77	0.118	27	2.46	0.035	0.029	0.220	5.43
S23	23	73	0.115	27	2.47	0.034	0.029	0.215	5.45
S21	21	70	0.111	26	2.47	0.033	0.028	0.208	5.45
S19	19	66	0.104	24	2.47	0.031	0.026	0.195	5.44
S17	17	63	0.105	24	2.48	0.031	0.026	0.195	5.46
S15	15	59	0.104	24	2.45	0.031	0.026	0.194	5.41
S13	13	55	0.104	24	2.46	0.031	0.026	0.194	5.43
S10	10	50	0.098	23	2.39	0.029	0.024	0.183	5.27
S8	8	46	0.095	22	2.40	0.028	0.024	0.177	5.29

(*)- 1 Ton-hr = 12,000 Btu



NATURAL ALTERNATIVE TO REDUCE ENERGY

Underfloor Energy Storage



UNDER FLOOR HEATING

By introducing eutectic products into a radiant heating system, it is possible to capture excess heating during the day time and maintain that heat into the cold of night. 27°C (81°F) phase change material (PCM) is sealed inside HDPE modules. This material captures energy by melting and releases it when it freezes. All conventional floor finishes are rated to handle these temperatures.

Each module features a number of grooves which are optimally spaced out for runs of underfloor heat pipes; this close contact with the PCM ensures the best heat transfer

"Once installed, the thermal mass of a building may be increased by as much as 10-15 times."

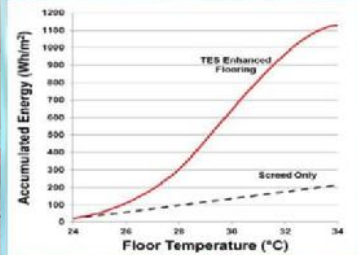
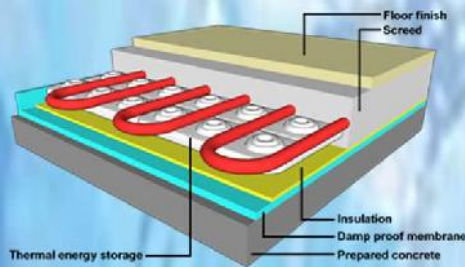
possible. They allow for pipe lengths to be easily held in place during the installation process requiring no specialist skills. Once installed, the thermal mass of a building may be increased by as much as 10-15 times. Thanks to there being no moving parts, PCM TES is effectively maintenance free and once installed it simply becomes part of the building

For the best results, this can be paired with a ground source heat pump (GSHP) or other renewable heating systems so that the entire PCM TES can be charged with free energy and then discharged nightly.

INSTALLATION

At normal conditions the PCM will be in solid form, making the modules very robust. Rows of modules can be laid directly on top of the insulation layer replacing conventional castelated panels. This creates a grid which allows the heating pipe to be laid easily, holding the heat pipe in place throughout the screeding process to ensure that the finished underfloor heating system will distribute heat evenly.

MAINTENANCE FREE
NO MOVING PARTS
FULL STANDBY CAPACITY



SYSTEM SIZING

Eight PCM modules can be installed per m². This allows for up to 0.995 kWh/m² TES.

For installers, it is important that the heating system has the appropriate power. This can be easily estimated using the below:

$$Q_{ins} = \frac{995.5 \text{ Wh/m}^2}{t} + \frac{Q_{peak} \times K}{A}$$

Where:

- Q_{ins} = heating system power (kW/m²)
- t = charging period available (hrs)
- Q_{peak} = peak heat load (kW)
- K = diversity factor (usually 0.6)

WHY BUILDING ENVELOPE TES?

PCMs can be selected so that they freeze and melt at the appropriate temperature to ensure that the building doesn't overheat or overcool. By introducing PCM into the building envelope it is possible to vastly increase the thermal mass of a building, helping ensure that rooms are maintained within the thermal comfort zone.

By installing PCM modules inside the building fabric itself, the end-users gain the thermal and performance benefits of PCMs without even being aware that they are in place.

As the PCM module is a static system with no moving parts the passive cooling concept is considered to be a maintenance and energy free option for improving the internal conditions of any built environment applications.

PASSIVE COOLING

"ThinICE modules can be installed at high levels so that heat goes up but doesn't come back down."



"Passive cooling takes advantage of the naturally occurring temperature swing caused by day & night."

Passive cooling takes advantage of the naturally occurring temperature swing caused by day & night. The excess coolth available in the night can be stored in the PCM, which is then released during the day, absorbing internal and solar heat gains.

ACTIVE COOLING WITH A PASSIVE SAFETY NET

It's easy to upgrade these passive cooling systems into an active chilled ceiling. This greatly improves the flexibility of a conventional HVAC system. Should, for any reason the HVAC machinery fails the frozen PCM modules offer an uninterrupted emergency relief cooling system giving the facility maintenance team an opportunity to react.

TAKE ADVANTAGE OF NATURAL COOLING

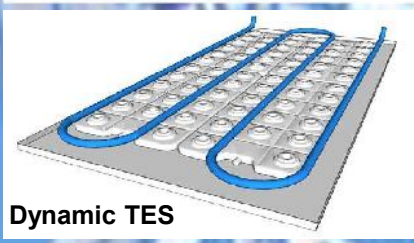
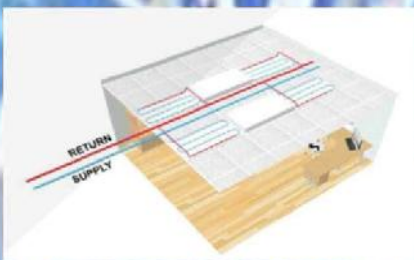
ThinICE modules can be installed at high levels so that heat goes up but doesn't come back down. This cooling effect can provide relief to building inhabitants or for electronic equipment.

If the site is located in a region where there are large day-night temperature swings, then it is possible to provide free cooling by ventilating the room at night to freeze the PCM modules by the morning. The size of the cooling machinery could then be greatly reduced leading to lower emissions, reduced maintenance costs and reduced operational costs.

For a standard 595x595mm ceiling tile, two ThinICE modules can be installed offering up to 0.96 kWh/m² of energy storage. At an installed weight of up to 24kg/m², most suspended ceilings are more than capable of handling this additional load. These are ideally fitted above a perforated metallic suspended ceiling. For more lightweight systems contact our sales team.



Static TES



Dynamic TES

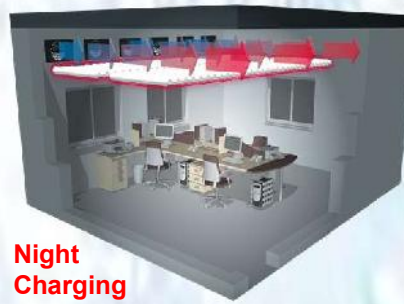


PlusICE World-wide Application Samples

Air Conditioning Applications;

A wide range of PlusICE solutions offer a wide range of air conditioning and comfort cooling applications. PlusICE solutions have been applied for passive cooling tiles, plaster boards and heat pipe passive cooling units as a direct air cooling application.

PlusICE solutions are also applied for indirect TES applications like chilled ceiling / cooling tower free cooling circuits as well as heat rejection TES applications in a number of formats.

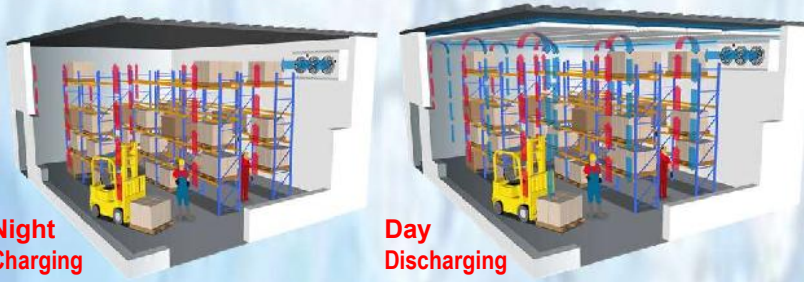


Night Charging



Day Discharging

Refrigeration Applications;



Night Charging

Day Discharging

TES can be applied at both the cold and hot side of the refrigeration cycle. PlusICE beams are used to provide free sub-cooling for the refrigerating circuit.

Eutectic plates provide ideal low cost and simple refrigeration around the world. PCM Products also offers standard cold boxes to match these plates for medicine, food and other wide temperature ranges are offered

by the PlusICE solution enabling designers around the world to apply this PCM technology in many ways in order to stabilising heat loads and matching the heat load and time balance for an economical and reliable operation. Loads in dairies, breweries, industrial processes and food factories can be simply balanced by PCM TES systems to suit the operating temperatures of the system.

Passive Cooling Applications;

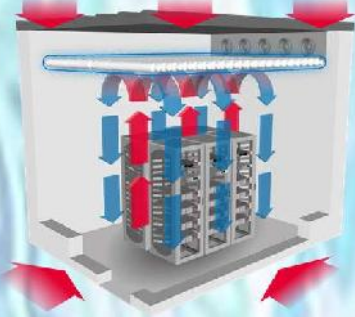
PCM solutions between 21°C(70°F) and 34C () range offers ideal free passive cooling for air conditioning / electronic chamber / enclosure /and passive cooling shelter applications without any mechanical refrigeration.

Variations such as granules, powder and rubber formats enable designers around the world to apply TES technology in many interesting and challenging ways from drink can cooling sleeve up to space applications.

Special Applications;



Night Charging



Day Discharging

PCM Products recently extended their PlusICE range down to -117°C (-134°F) which offer the possibility of very low temperature TES and this new range has opened the door for cryogenic / low temperature TES application.

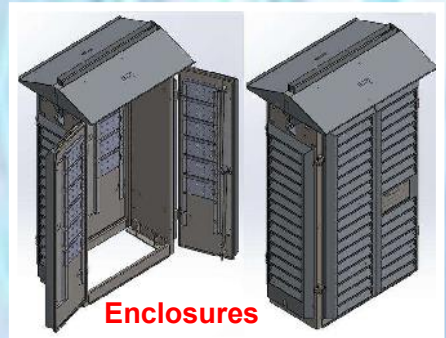
Although having a wide range and various standard ice packs PCM products also offers a product development services for any custom-made ice packs solutions to match the required size and capacity.



ICE PACKS



Battery



Enclosures

TECHNICAL SUPPORT

PCM Products offer full system design support to assist in proper selection and integration into existing or new installations as part of our customer commitment.

We offer full consultancy on product development on a strict confidentiality basis and the possibility of Licensee options for local manufacturing. Please consult our technical sales team at sales@pcmproducts.net for your specific application or visit our web site www.pcmproducts.net

For additional information contact;

Distributor / Installer Stamp



PHASE CHANGE MATERIAL PRODUCTS LIMITED

Unit 32, Mere View Industrial Estate, Yaxley, Cambridgeshire, PE7 3HS, United Kingdom

Tel: +44-(0)-1733 245511 Fax:+44-(0)-1733 243344 e-mail:info@pcmproducts.net www.pcmproducts.net