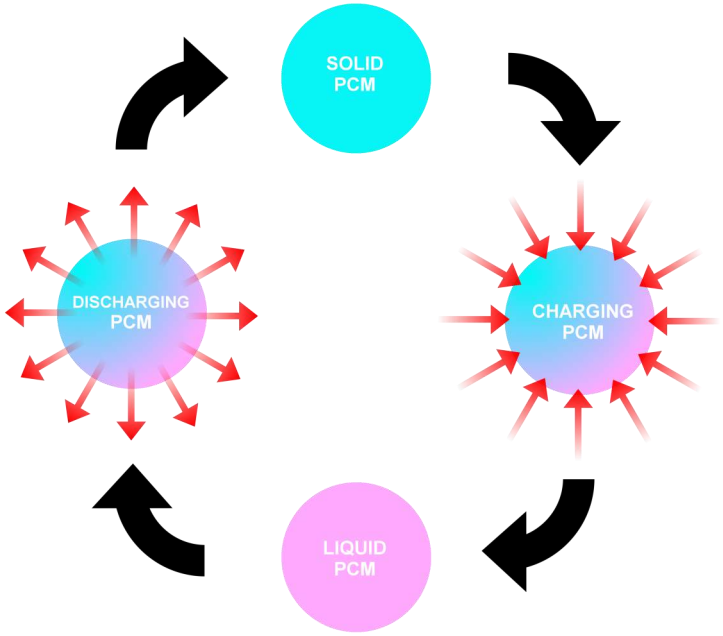
PCM

# Building Envelope
## Thermal Energy Storage

## What is TES?

**Thermal energy storage (TES) is the temporary storage of high or low temperature energy for later use, bridging the gap between availability and energy use. The storage cycle might be daily, weekly or seasonal depending on the system design.**

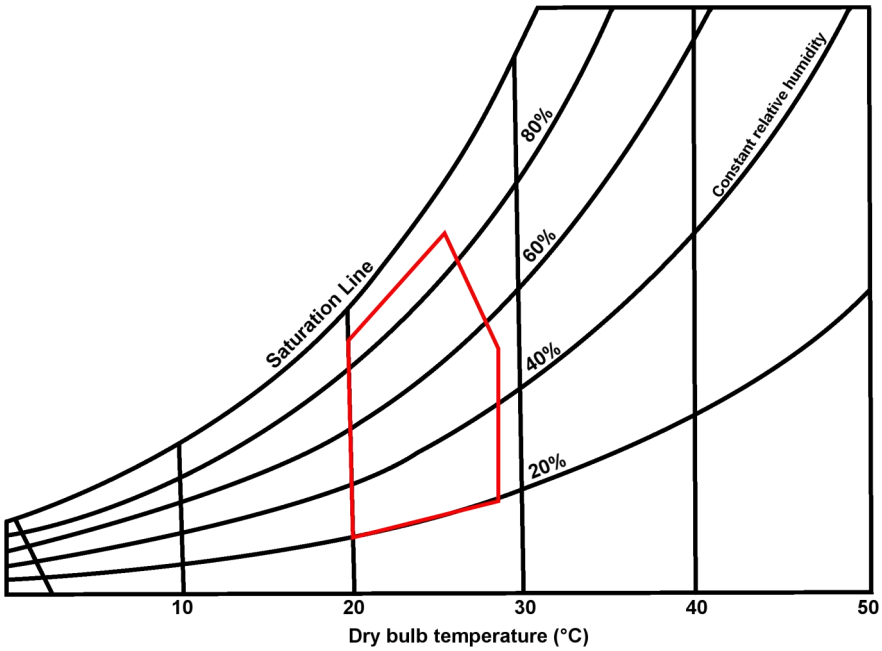
**This is achieved by applying Phase Change Materials (PCMs). These materials store and release thermal energy by melting and freezing at a given temperature. PCMs release large amounts of energy upon freezing in the form of latent heat, but absorb equal amounts of energy from the immediate environment upon melting.**




## Building Applications

- Air Conditioning
- Free Cooling
- Passive Cooling
- Fabric TES
- Solar Heating
- Tri-generation
- Solar Air Conditioning

## Why Building Envelope TES?

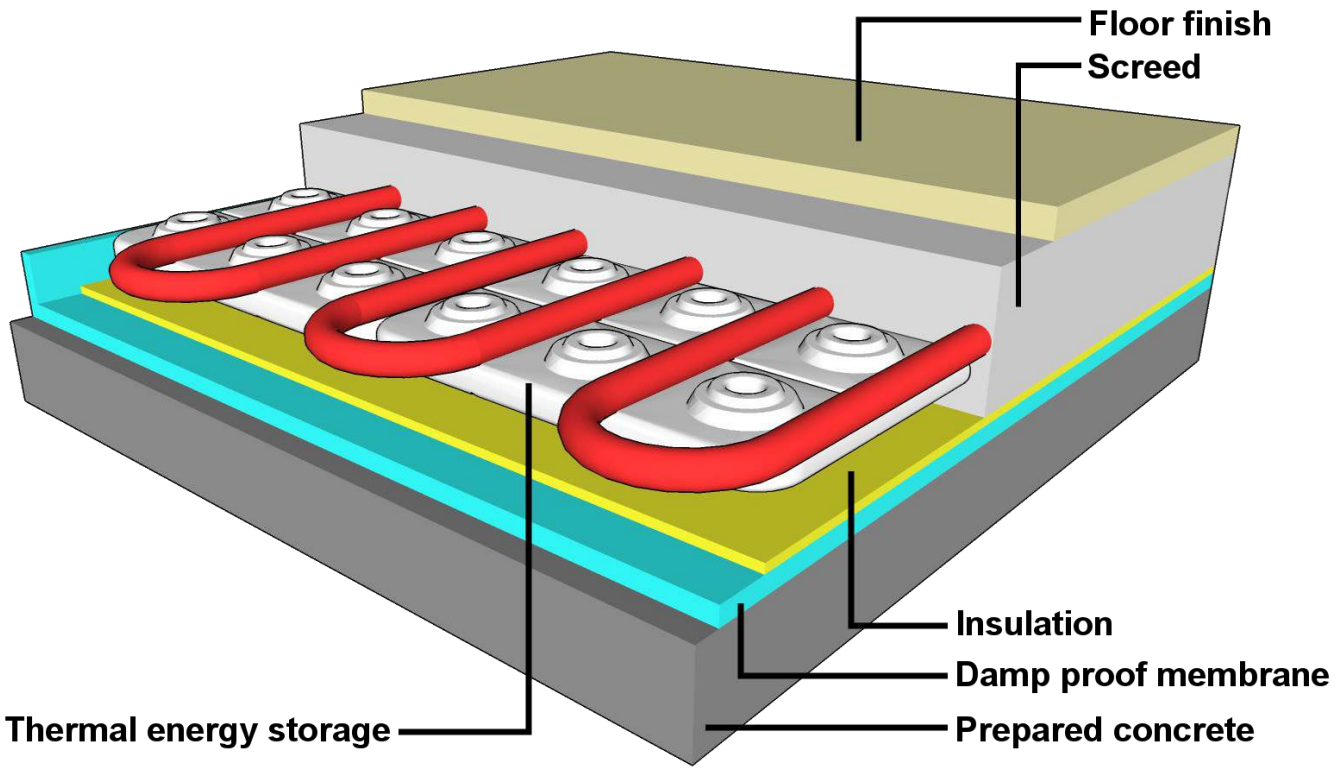



**PCMs can be selected so that they freeze and melt at the appropriate temperature to ensure that the building doesn't overheat or overcool. By introducing PCM into the building envelope it is possible to vastly increase the thermal mass of a building, helping ensure that rooms are maintained within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

# Underfloor Heating Applications

**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. 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. Because there isn't any moving parts, PCM TES is effectively maintenance free and once installed it simply becomes part of the building.**

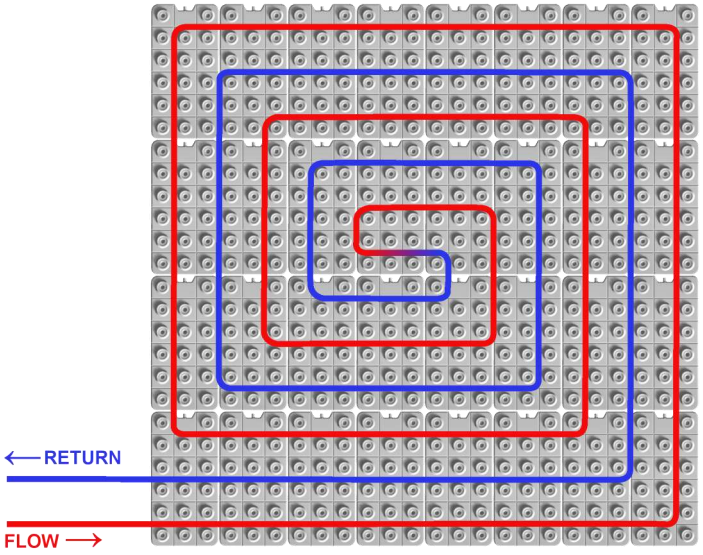
## Installation

**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. This creates a grid which allows the heating pipe to be laid easily. This grid helps hold the heat pipe in place throughout the screeding process ensuring that the finished underfloor heating system will distribute heat evenly.**

**Maintenance Free**

**No Moving Parts**

**Full Standby Capacity**




## ThinICE modules

An individual PCM module is known as a ThinICE. They are filled with approximately 1 litre of PCM solution which is then triple sealed for maximum security. It is possible to install these modules in the ceiling and other locations as a means of thermal energy storage.

# Increased Thermal Mass

It is possible to fill these modules with any of our S range PCMs, not only S27. Consult our sales team for any custom applications.

## System Sizing

Eight PCM modules can be installed per $m^2$. This allows for up to 0.6 kWh/$m^2$ TES.

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

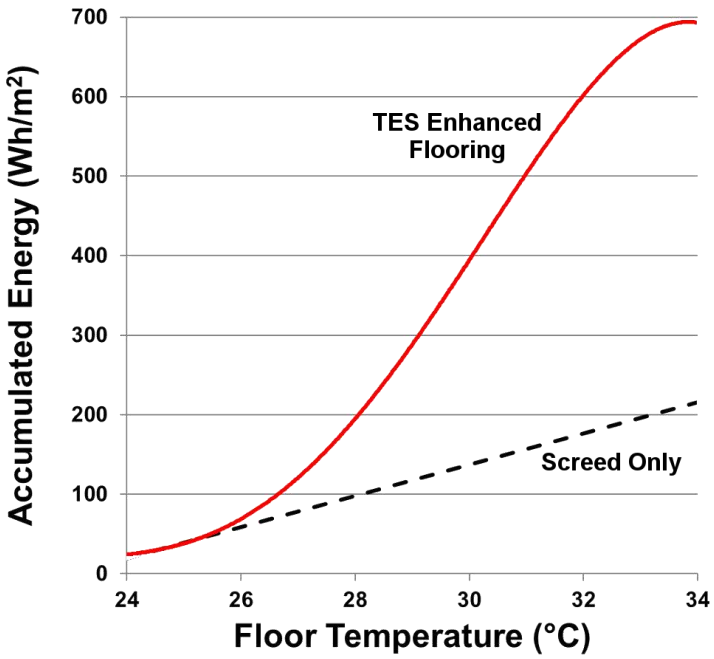
$$Q_{ins} = \frac{611.2\ Wh/m^2}{t} + \frac{Q_{peak} \times K}{A}$$

Where:
$Q_{ins}$ = heating system power (W/$m^2$)
$t$ = charging period available (hrs)
$Q_{peak}$ = peak heat load (W)
$K$ = diversity factor (usually 0.6)
$A$ = area of underfloor heating ($m^2$)

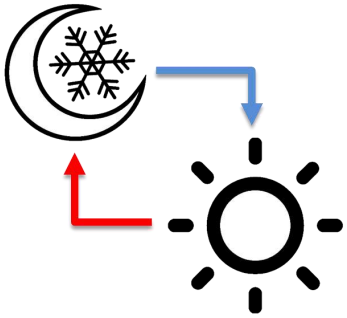
## Example

An underfloor heating system is planned for an 25$m^2$ room. There is an anticipated peak heat load of 1400W and there is a 7 hour charging period available. Using the above, we know that approximately 200 PCM modules could be installed. The heating system power can also be estimated:

$$Q_{ins} = \frac{611.2}{7} + \frac{1400 \times 0.6}{25} \approx 121 W/m^2$$



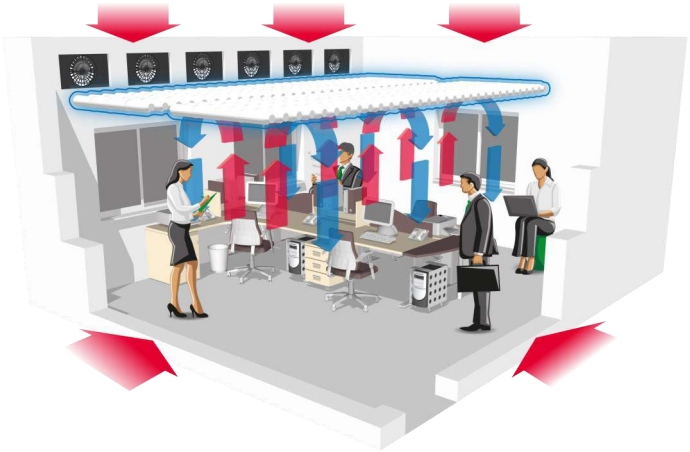
## Passive Cooling Applications



**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.**

**Take Advantage of Natural Cooling**

**Charge Period | Night Hours**



**Discharge Period | Day Hours**

**PCM modules are installed at a high level within the room, as the heat rises the PCM melts storing the excess energy. Cool air then returns back down into the room. At the end of the day, the PCM latent heat store will be fully expended. The room can now be ventilated, removing the excess heat and refreezing the PCM ready for the following day.**

## TubeICE™ Features

**TubeICE are custom-made 1000mm long containers which are filled with our PlusICE phase change material (PCM) solutions which have an operational range between – 40°C (– 40°F) and 117°C (243°F). A fully filled TubeICE weighs between 2~3kg (4.4~6.6lbs) depending on the type of PCM. They can be suspended from the ceilings easily using standing 50mm (2") pipe brackets where they absorb rising heat from the space below.**

**Using a conventional bracket system, it is possible to hang up to 12 TubeICE per $m^2$ ceiling area which would weigh approximately 40kg. In return, TubeICE can provide between 1.7~2.2 kWh/$m^2$ (0.046~0.057TR-h/$ft^2$) of thermal energy storage.**

# TubeICE™ Design Recommendations & Example

**It is possible to fit 12 TubeICE per $m^2$ (≈ 1 per $ft^2$) within the ceiling area, this same space is used for a number of other building services. The practical limit for these passive cooling modules is typically between 40~70% of the total ceiling area. TubeICE is best fitted using a concealed bracket with an open grill, with a gap of 150~250mm (6~10") between the module and the ceiling proper. Alternatively, for more practical environments a direct bracket can offer the most economical solution.**

**Assuming a $100m^2$ ($1,000ft^2$) office space, by using 1m (≈40") long TubeICE filled with 27°C (81°F) PCM there is 0.145kWh (0.041TR-h) thermal energy storage per TubeICE. By using standard brackets, up to 12 TubeICE per $m^2$ (or per $10ft^2$). Each bank of tubes therefore provides 1.74 kWh (0.49 TR-h) of energy storage for the occupied area.**

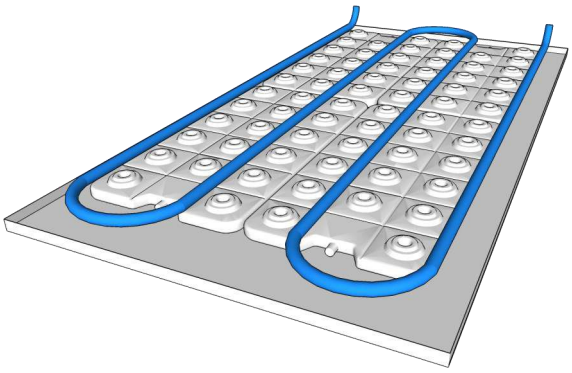
**Assuming that only 50% of the ceiling area is accessible and usable, with TubeICE approximately 87 kWh (24.7TR-h) of thermal energy storage can be gained for this $100m^2$ office.**

**As long as the occupied space has a nightly temperature of below 20~22°C (70~74°F) then the TubeICE filled with 27°C (81°F) PCM solution will freeze overnight storing free coolth ready to be used during the next day.**

**Should the high level ceiling temperature exceed 27°C (81°F) for around 4~6 hours, then the PCM could provide as much free cooling as a 15~22kW (4.3~6.2 TR) mechanical cooling system.**

# Chilled Ceiling Applications

**It is also possible to take a passive system and upgrade it into a chilled ceiling. ThinICE PCM modules have been carefully sized to fit above a standard suspended ceiling grid. These can be fitted above perforated metallic suspended ceilings for the best performance. At an installed weight of 11.5kg/m2, most suspended ceilings are more than capable of handling this additional load.**



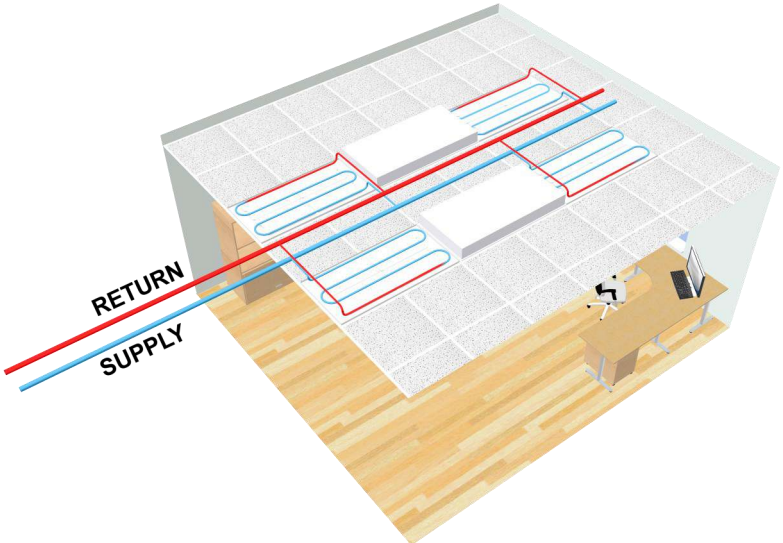
**For a standard 595x595mm ceiling tile, two ThinICE modules can be installed offering up to 0.15 kWh of energy storage.**

## Active Cooling with a Passive Safety Net

**ThinICE features a number of channels which allow cold water pipes to be installed in close contact with the PCM module. This upgrades the system into an active chilled ceiling system where the PCM acts as a buffer during peak heat loads.**

**Should, for any reason the active cooling system machinery fails the frozen PCM modules offer an uninterruptable emergency relief cooling system giving the facility maintenance team an opportunity to react.**

**If the site is located in a region where there are large day-night temperature swings, then it is possible to attain 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.**



# Passive Shelter Applications

**Electrical components generate heat and if this heat is not removed, then it accumulates within confined spaces. Once the enclosure temperature exceeds the operating limit of the electronics (typically 45°C (112°F)) the system shuts itself down. This is exacerbated if the enclosure is exposed to solar gains, such as gas pipeline stations, telecom shelters or exposed panels.**

**Some enclosures are in remote locations where the only electricity available is through solar panels. This is sufficient for running electronics but would be impossible to run a mechanical cooling system. A passive cooling system relies only on 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. This free-cooling is easy to install and most importantly, cheap and easy to maintain.**

**A number of common applications for these passive cooling systems include: telecom shelters, remote pumping stations, data centre backup systems, public buildings, and train signal boxes.**

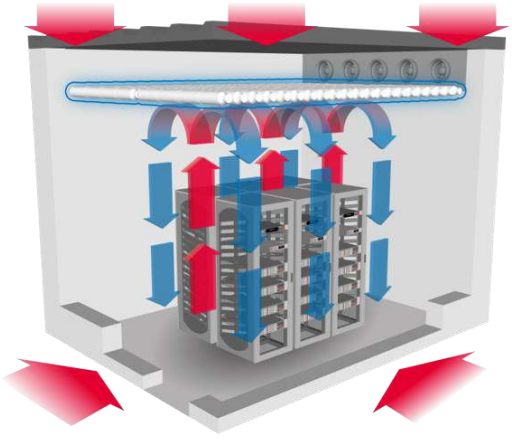
## Remote Pumping Stations

**Main oil or gas pipeline pumps and monitoring systems are typically in very remote areas where mains power isn't available. PCM Products has worked with many large petrochemical companies developing custom-made passive cooling solutions, such as passive shelters, control panel enclosures and backup facilities for mechanical cooling plants.**

## Data Centre Backup

**It is common practice to install 100% stand-by air conditioning units for any data centre, but the lack of regular operating hours for stand-by units results in a very high maintenance cost and the risk of non-starter units. Passive cooling offers a means to provide backup cooling, with minimal maintenance costs.**

**Charge Period | Night**



**Discharge Period | Day**