



TES SYSTEMS AND CHP SYSTEMS

CEM REFRESHER TRAINING

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FOR ENERGY MANAGEMENT AND EFFICIENCY PROFESSIONALS





THERMAL ENERGY STORAGE TECHNOLOGY-2

FOR ENERGY PROFESSIONALS

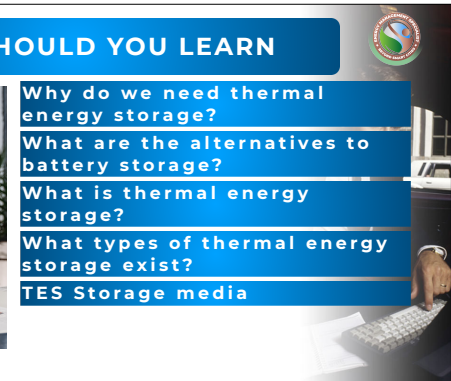
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ENERGY SPECIALIST CURRICULUM



WHAT SHOULD YOU LEARN





Why do we need thermal energy storage?

What are the alternatives to battery storage?

What is thermal energy storage?

What types of thermal energy storage exist?

TES Storage media

WHY DO WE NEED THERMAL ENERGY STORAGE?



Renewable energy and increased electrification are central to many countries' decarbonisation strategies and for good reason: We urgently need to cut emissions and 90% of those reductions can be attained through energy efficiency and electrification based on renewable energy. The falling prices of renewable energy also add to the incentive.

However, renewable energy fluctuates and so with the increased uptake of renewable energy comes an increased need for energy storage in order to ensure the availability of clean energy when the wind is not blowing, or the sun is not delivering solar energy.

WHAT ARE THE ALTERNATIVES TO BATTERY STORAGE?



While battery storage technology is developing rapidly, there are alternatives that help meet the challenges of renewable energy intermittence and grid stability, for example thermal energy storage.

Thermal energy storage means heating or cooling a medium to use the energy when needed later. In its simplest form, this could mean using a water tank for heat storage, where the water is heated at times when there is a lot of energy, and the energy is then stored in the water for use when energy is less plentiful.

Thermal energy storage can also be used to balance energy consumption between day and night. Storage solutions include water or storage tanks of ice-slush, earth or bedrock accessed via boreholes and large bodies of water deep below ground.

WHAT TYPES OF THERMAL ENERGY STORAGE EXIST?



Many different technologies can be used to achieve thermal energy storage and depending on which technology is used, thermal energy storage systems can store excess thermal energy for hours, days or months.

Thermal energy systems are divided in three types:

- ✓ Sensible heat
- ✓ Latent heat
- ✓ Thermochemical

✓ Sensible thermal energy storage is considered to be the most viable option to reduce energy consumption and reduce CO₂ emissions. They use water or rock for storing and releasing heat energy. This type of thermal energy storage is most applicable for residential buildings.

WHAT TYPES OF THERMAL ENERGY STORAGE EXIST?



✓ Latent heat storage systems store energy without the medium changing in temperature but rather depends on the changing state of a medium. So called 'phase change materials' have been developed, which can store heat in their mass as latent heat. These materials are commonly used in solar applications and building materials, where they absorb and store excess building heat.

✓ Thermochemical heat storage systems, on the other hand, are based on chemical reactions.

TES STORAGE MEDIA



Chilled water storage

- Simple ~ but large tanks needed; lots of space. Requires 4 to 5 times the space of ice storage
- Typical water temperatures of 4 deg C
- Practical considerations for water storage tanks
 - Need to minimize mixing of warm return water with the cold water in storage
 - May need two tanks ~ if full capacity of a tank is needed. If temperature stratification of tank is used, the tank may need to be up to 20% bigger

TES STORAGE MEDIA



Ice Storage

- ✓ More complex tanks and auxiliary equipment needed; more complex to maintain
- ✓ Ice/water requires around 20 to 30% of the space needed for chilled water tanks
- ✓ Solid ice requires around 10% of the space needed for chilled water tanks
- ✓ Very low temperature water can be used ~ around 1 degree C
- ✓ Can use ice harvester, ice on coil, or ice/water (slush)

PROPERTIES OF STORAGE MEDIA

✓ Chilled water systems are typically operated in a manner to use only sensible heat storage and thus stores 4.2 kJ per kg of water for each °C of temperature difference between the stored water and the returned water.

✓ Ice systems are typically operated in a manner to use only latent heat associated with freezing and melting, and one kg of ice at 0° C absorbs 335 kJ to become 0°C water.



SIZING CHILLED WATER STORAGE TANKS

Assume that chilled water is stored at 4°C and is returned at the standard temperature of 12°C

✓ This is an 8° ΔT for the AC system

✓ Thus, one kg of water stores 33.6 kJ

✓ One kWh of AC is 3600 kJ

So, to store 1 kWh you need: kg of water; or, litres of water; or, cubic metres of water.



CAN WE MEET THIS LOAD WITH AN OPAC SYSTEM?

✓ What is the current chiller configuration

✓ Can we store enough kWh during off-peak hours to meet the daytime AC load without having to run the chiller at all during the day?



EFFICIENCY AND CAPACITY CONSIDERATION

- ☑ OPAC system is less efficient at lower water temperatures ~ but night time operation is more efficient ~ these might cancel each other
- ☑ We might suffer a 10 to 15% capacity reduction because the OPAC system has less capacity at lower water temperatures
- ☑ We might lose 5 to 10% of capacity because of storage losses



CONDITIONS THAT FAVOUR TES

High peak demand charges
Low cost of energy used at night
High on-peak loads
Low AC loads at night
Need for increased cooling system capacity



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