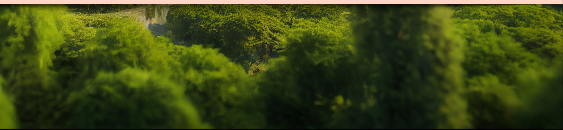


**TES SYSTEMS AND CHP SYSTEMS
CEM REFRESHER TRAINING**

KRISHNAJI PAWAR, LEED AP BD+C, GSAS CGP, ISO 14001:2015, GCP
FOR ENERGY MANAGEMENT AND EFFICIENCY PROFESSIONALS





**TES TERMINOLOGY AND BASIC
DESIGNS**

FOR ENERGY PROFESSIONALS

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ENERGY SPECIALIST CURRICULUM



WHAT SHOULD YOU LEARN





Introduction

Basic Principle and Thermal Energy Storage Methods

Methods of Thermal Energy Storage

Motivations for Implementing Thermal Energy Storage in District Heating and Cooling Systems

Process and Technology Status

INTRODUCTION

To manage peaks in district heating and district cooling, one method is to store hot or cold water in insulated tanks to use when demand is increasing – so called thermal energy storage (TES). In this way no additional production units must be started, which will significantly reduce the environmental impact and reduce costs.

Thermal energy storage (TES) is one form of energy storage. In this case, a material gains energy when increasing its temperature, and loses it when decreasing. Taking advantage of this property makes it possible to use different materials with different thermal properties and achieve various results which can lead to different thermal energy storage applications (e.g. heating and cooling).

TES can help to balance energy demand and supply on a daily, weekly and even seasonal basis, presented in thermal systems. TES can also reduce peak demand, energy consumption, CO₂ emissions and costs; while also increasing the overall efficiency of energy systems.



BASIC PRINCIPLE AND TES METHODS

The basic principle is the same in all TES applications. Energy is supplied to a storage system for removal and use at a later time. What mainly varies is the scale of the storage and the storage method used. The process of storing thermal energy can be described in three steps, referred to as a cycle. These steps are charging, storing and discharging.

The storage cycle applies to sensible, latent and chemical storage; the differences between these methods are the material, the temperature of operation and a few other parameters. Water, for instance, is the more commonly used medium for sensible storage, but this varies depending on the application methods are the material, the temperature of operation and a few other parameters. Water, for instance, is the more commonly used medium for sensible storage, but this varies depending on the application.



BASIC PRINCIPLE AND TES METHODS +

Another important aspect to know about TES systems is the length of time the energy is stored. Depending on the duration of the time that the heat or cold is stored, TES is usually classified as short or long term (seasonal storage). A buffer tank can be used daily to reduce the peak power of heat generators in DHC systems. The heat or cold stored in the buffer tanks provides part of the thermal demand presented commonly during the mornings or evenings in the thermal systems, which reduces the thermal power of gas boilers or CHP plants.

This case can be classified as short-term storage, but thermal energy storage can be used for longer periods of time (weeks or months) as well. To tackle seasonal temperature variations, heat can be collected during the warm summer, for example in large water ponds (e.g. 60,000 m³), using solar thermal collectors. It can then be stored and later released to dwellings in the winter. Conversely, a cold store can be charged in winter and then provide cooling during summer.



BASIC PRINCIPLE AND TES METHODS +

TES can also be classified into decentralized and centralized TES. Centralized energy storage can be found in district heating and cooling networks, large industrial plants, combined heat and power plants and renewable energy power plants – while decentralized TES are found commonly in domestic and commercial buildings, where it's used to store solar energy for hot water and space heating applications.

METHODS OF THERMAL ENERGY STORAGE

TES applications may use different material properties to achieve energy storage. According to the thermal mechanism used to store energy, TES can be classified in three types: Sensible (e.g., water and rock), Latent (e.g., water/ice and salt hydrates) and Thermo-chemical reactions (e.g., chemical reactions and sorption processes).

Sensible storage happens when the temperature of a material is raised or lowered, whereas latent storage occurs when the phase of a material is changed (solid to liquid or liquid to vapor) without a change in temperature. Both mechanisms can occur in the same material. The third mechanism, a chemical reaction or a sorption process, takes place on the surface of a material. In all cases heat can be either absorbed or released from the material.

MOTIVATIONS FOR IMPLEMENTING TES

District heating and cooling (DHC), together with thermal energy storage (TES), are potential technologies for the integration of renewable energy and the reduction of CO₂ emissions in the European Energy Sector and the interaction and development between both technologies is of significant importance.

DHC and TES, together with for example hybrid systems and heat pumps, are identified as cross-cutting technologies by the renewable heating and cooling platform – meaning that are key enabling technologies for fully decarbonizing the heating and cooling sector by 2050. TES can maximize the benefits that DHC provides to the energy system.

MOTIVATIONS FOR IMPLEMENTING TES +



One of the major challenges for future energy systems is to overcome the mismatch between supply and demand caused by the increasingly strong deployment of intermittent renewable energy sources. By interlinking the electricity sectors and the heating and cooling sectors, and by deploying thermal storage, the mismatch and intermittence problems can be addressed.

These new operational constraints in future energy systems also require the development and deployment of energy management tools in both electric and thermal networks. This intelligent management is achieved with new information and communication technologies and a new smart energy system approach.



MOTIVATIONS FOR IMPLEMENTING TES +



The way TES contributes to solving the mismatch between supply and demand is by providing management capabilities to the system. TES can also help to integrate intermittent RE into the DHC systems and, furthermore, by adding TES into DHC systems (with CHP and waste heat), increase the energy efficiency of the whole system.

The effective integration of TES into heating and cooling energy systems can lead to benefits such as:

- ✓ Reduction of energy consumption
- ✓ Increase of energy efficiency
- ✓ Increased energy security
- ✓ Increased energy reliability
- ✓ Reduction of energy costs
- ✓ Reduction of GHG emissions



PROCESS AND TECHNOLOGY STATUS



Energy storage systems are designed to accumulate energy when production exceeds demand and to make it available at the user's request. They can help match energy supply and demand, exploit the variable production of renewable energy sources (e.g. solar and wind), increase the overall efficiency of the energy system and reduce CO₂ emissions. This brief deals primarily with heat storage systems or thermal energy storage (TES). An energy storage system can be described in terms of the following properties:

- ✓ **Capacity:** defines the energy stored in the system and depends on the storage process, the medium and the size of the system;
- ✓ **Power:** defines how fast the energy stored in the system can be discharged (and charged);



PROCESS AND TECHNOLOGY STATUS +



✓ **Efficiency:** is the ratio of the energy provided to the user to the energy needed to charge the storage system. It accounts for the energy loss during the storage period and the charging/discharging cycle;

✓ **Storage period:** defines how long the energy is stored and lasts hours to months (i.e. hours, days, weeks and months for seasonal storage);

✓ **Charge and discharge time:** defines how much time is needed to charge/ discharge the system; and

✓ **Cost:** refers to either capacity (€/kWh) or power (€/kW) of the storage system and depends on the capital and operation costs of the storage equipment and its lifetime (i.e. the number of cycles).





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