Thermal storage systems as key elements for a sustainable energy future

Markus ECK
German Aerospace Centre in Helmholtz Association, Stuttgart, Germany

Thermal energy storage units increase efficiency by compensating the temporal mismatch between demand and availability of heat flows within energy systems. While thermal energy storage was traditionally related to low temperature heating applications, the focus of current research activities is on the development of storage concepts with operation temperatures between 100 – 1000 °C which are able to provide heat flows in the Multi-MW power range. The interest in this technology has been sparked by the coming increased role of renewable energies and energy efficiency. Pilot applications for medium and high temperature storage systems have been power plants operated by concentrated solar radiation. Here, thermal storage is needed to compensate cloud transients and for matching the production of electricity to demand. Today, commercial storage systems enable solar thermal power plants to provide electricity 24h/day. In parallel to the development of innovative concepts, this storage technology is now being transferred into other application areas including process industry, storage of electricity and energy management for cars. The development and utilization of thermal energy storage systems have to consider several requirements. Among others it has to be:

1. adapted properly to the characteristics of the energy source and the energy consumer, 2. designed in order to be cost effective and 3. operated in order to meet the requirements of the demand side.

The presentation will focus on items 1 and 2. State of the art large scale thermal energy systems use a nearly eutectic mixture of $NaNO_3$ and KNO_3. At present, systems with a thermal capacity of 1GWh are in operation. The molten salt is heated up to a temperature of up to 565°C and stored in a hot tank. During discharge, the hot salt is pumped through a heat exchanger where the heat is transferred to the process. In doing so, the salt is cooled down to approx. 280°C and finally stored in a cold tank. This so called two-tank molten salt storage technology is proven but still has some potential for cost reduction. Current approaches for cost reduction will be presented and future activities will be identified.

As mentioned above, thermal energy systems are used to compensate the temporal mismatch between demand and availability of heat flows within energy systems. If traded at the electricity exchange, the demand of the energy can be expressed by its price. In this case an energy system with integrated storage capacity can be operated in order to maximize the systems revenues. A methodology has been developed that determines the optimal operation strategy of the system based on forecasts of the demand side and the supply side. The presentation will describe the methodology and estimate the potential profits.