Thermal energy storage system examples

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Thermal energy storage (TES) is a critical enabler for the large-scale deployment of renewable energy and transition to a decarbonized building stock and energy system by 2050.

Take for example modern solar thermal power plants, which produce all of their energy when the sun is shining during the day. The excess energy produced during peak sunlight is often stored in these facilities - in the form of molten salt or other materials - and can be used into the evening to generate steam to drive a turbine to produce electricity. Alternatively, a facility can use "off-peak" electricity rates which are lower at night to produce ice, which can be incorporated into a building"s cooling system to lower demand for energy during the day.

A well-designed thermos or cooler can store energy effectively throughout the day, in the same way thermal energy storage is an effective resource at capturing and storing energy on a temporary basis to be used at a later time.

To store electricity, the electrical energy drives a heat pump, which pumps heat from the "cold store" to the "hot store" (similar to the operation of a refrigerator). To recover the energy, the heat pump is reversed to become a heat engine. The engine takes heat from the hot store, delivers waste heat to the cold store, and produces mechanical work. When recovering electricity the heat engine drives a generator.

PHES requires the following elements: two low cost (usually steel) tanks filled with mineral particulate (gravel-sized particles of crushed rock) and a means of efficiently compressing and expanding gas. A closed circuit filled with the working gas connects the two stores, the compressor and the expander. A monatomic gas such as argon is ideal as the working gas as it heat/cools much more than air for the same pressure increase/drop - this in turn significantly reduces the storage cost.

Liquid Air Energy Storage (LAES) uses electricity to cool air until it liquefies, stores the liquid air in a tank, brings the liquid air back to a gaseous state (by exposure to ambient air or with waste heat from an industrial process) and uses that gas to turn a turbine and generate electricity.

LAES systems use off the shelf components with long lifetimes (30 years +), resulting in low technology risk. Liquid Air Energy Storage (LAES) is sometimes referred to as Cryogenic Energy Storage (CES). The word "cryogenic" refers to the production of very low temperatures.

Liquid Air Energy Storage (LAES), also referred to as Cryogenic Energy Storage (CES), is a long duration, large scale energy storage technology that can be located at the point of demand. The working fluid is liquefied air or liquid nitrogen (~78% of air). LAES systems share performance characteristics with pumped hydro and can harness industrial low-grade waste heat/waste cold from co-located processes. Size extends from around 5MW to 100s+MWs and, with capacity and energy being de-coupled, the systems are very well suited to long duration applications.

Although novel at a system level, the LAES process uses components and sub-systems that are mature technologies available from major OEMs. The technology draws heavily on established processes from the power generation and industrial gas sectors, with known costs, performance and life cycles all ensuring a low technology risk.

Cold Recycle - During stage 3, very cold air is exhausted and captured by a proprietary high-grade cold store. This is used at a later time during the liquefaction process to enhance the efficiency. Alternatively, the system can integrate waste cold from industrial processes such as LNG terminals.

Thermal store - The low boiling point of liquefied air means the round trip efficiency of the system can be improved with the introduction of above ambient heat. Highview Power Storage''s standard LAES system captures and stores heat produced during the liquefaction process (stage 1) and integrates this heat to the power recovery process (stage 3). The system can also integrate waste heat from industrial processes, such as thermal power generation or steel mills, at stage 3, recovering additional energy.

LAES plants can provide large-scale, long-duration energy storage, with 100s of MWs output. LAES systems can use industrial waste heat/cold from applications such as thermal generation plants, steel mills and LNG terminals to improve system efficiency. LAES uses existing and mature components with proven long-life times (30 years +), performance, and O& M costs.