High Temperature Pit Thermal Energy Storage (HT-PTES)

GENERAL DESCRIPTION

Mode of Energy Intake and Output

- Heat-to-heat
- Power to heat

Summary of the Storage Process

Pit Thermal Energy Storage (PTES) is a sensible storage designed for the storage of thermal energy. Pit storage uses water as a medium. It heats up this water to temperatures up to 90°C with sustainable sources like biomass, solar thermal, power to heat, etc. The purpose of the storage is to store heat whenever it is cheap to produce, or when it is in excess. The stored heat can then be used at a later point in time. These cycles can be hourly, daily, or even seasonal. When combined with heat pumps, the bottom of the pit can be as cool as 10°C, which allows for direct cooling, if there is a cooling demand.

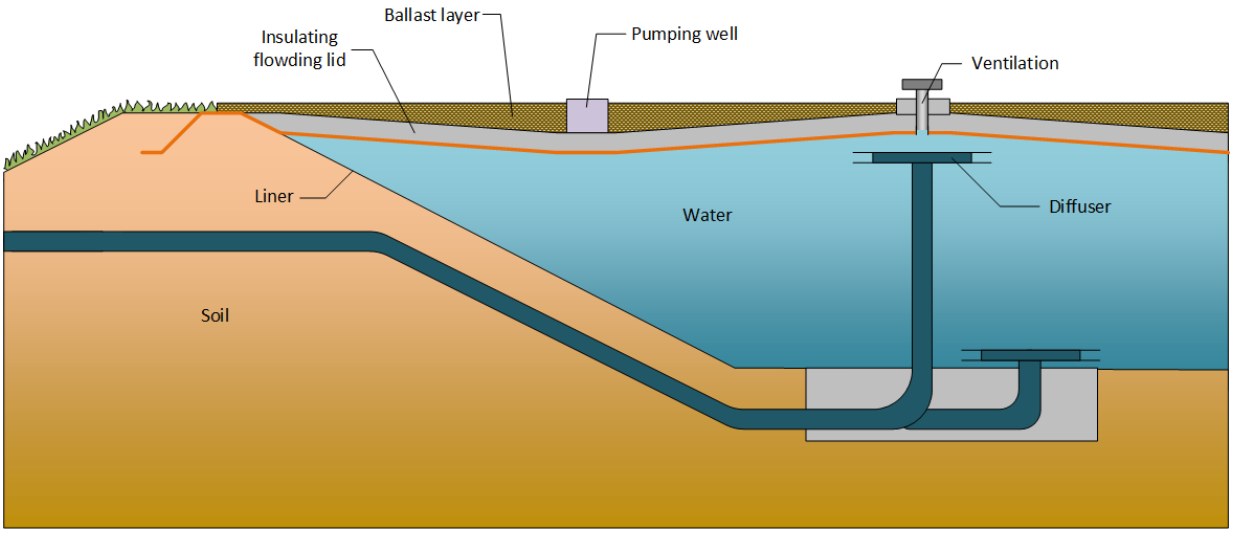

Figure 1: Schematic drawing Pit storage Aalborg, Denmark.

PTES structures consist of excavated pits covered with watertight liners. The inverted truncated pyramid shape optimizes soil balance and minimizes excavation costs. Lining materials are necessary for water tightness; these include polymer options (PP, PE), elastomers (EPDM), and metals (stainless steel, aluminum). The insulated floating cover safeguards the stored heat, while a ballast on top is used to keep the insulation in place. Pipe connections facilitate energy transfer, typically through the bottom or side, requiring meticulous sealing to prevent leakage. Water treatment is applied to the water to prevent corrosion risk to metal components.

Suitable fields of application

Pit Thermal Energy Storage (PTES) finds application in district heating systems, greenhouse heating, and datacentre cooling. Its ability to provide both seasonal and shorter-term storage makes it suitable for grid stability and load balancing in renewable energy systems.

Technology readiness level (TRL)

9

State of development

The technology has been commercially used in solar thermal systems since 2003 (TRL 9).

Topics with demand for R&D are cost reduction and increasing efficiency. Scale is important for limiting costs. Material use plays an important role in the further improving efficiency.

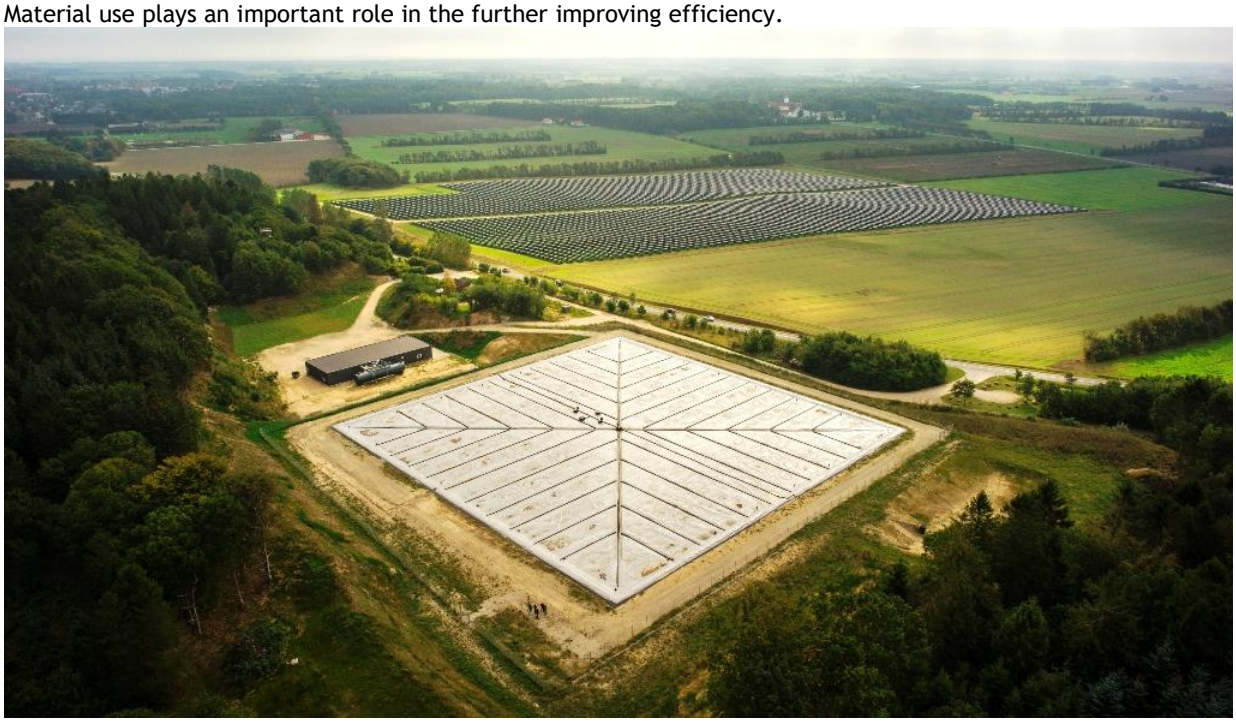

Figure 2: Pit thermal storage in Dronninglund, Denmark

TECHNICAL SPECIFICATIONS

These technical specifications are derived from projects that either already exist, or projects that have considered feasible by experts.

	HT-PTES
Temperature range	10°C – 90°C
Maximum output power range	10 – 300* MW
Operating range	10% – 100%
Storage size	1 – 50* GWh
Discharge Time	Hourly – seasonal
Service life	Multiple decades
Response Time	minutes
Storage efficiency	55-95%
Specific energy storage density	10 – 90 kWh/m^3

**No technical upper limit for these values*

ECONOMIC SPECIFICATIONS

Based on the experiences from the implemented storages in Denmark, a trend can be seen in the cost of PTES. Going from 60.000 m^3 to 500.000 m^3, the expected specific costs are reduced by more than 20%. The specific investment costs of currently operational systems are between 0,4 and 0,6 €/kWh.

However, it should be noted that the storage costs are very much depending on local conditions and storage/lid construction.

Operating and maintenance costs

The operating and maintenance costs may vary between 1 and 3% of the investment costs. These costs may vary depending on the materials used and the size of the system.

FURTHER INFORMATION

- Pfeil M, Koch H. High performance–low cost seasonal gravel/water storage pit, Solar Energy Volume 69, issue 6 https://doi.org/10.1016/S0038-092X(00)00123-7
- Schmidt T, Pauschinger T, Sørensen PA, Snijders A, Djebbar R, Boulter R, et al. Design aspects for large-scale pit and aquifer thermal energy storage for district heating and cooling. Energy Procedia 2018;149:585–94 https://doi.org/10.1016/j.egypro.2018.08.223