# THERMAL ENERGY STORAGE

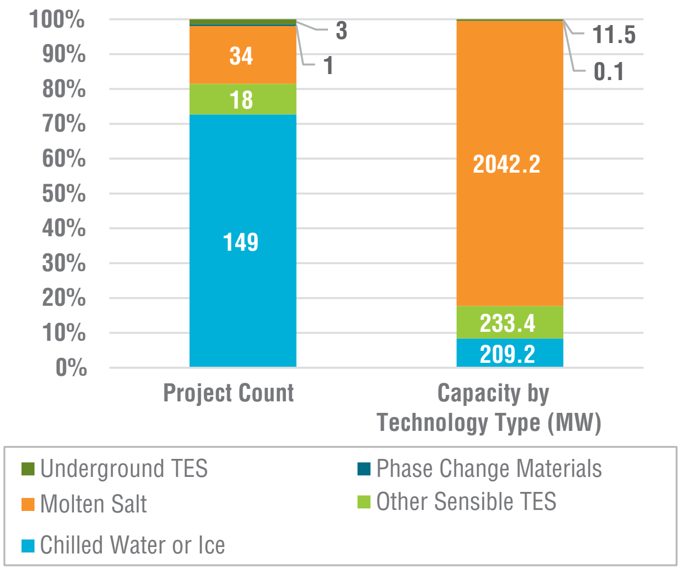
## TECHNOLOGY USE EXAMPLES

**DEFINITIONS:**

- **Sensible Thermal Energy Storage (TES):** sensible heat is stored and released by heating and cooling a storage medium
- **Latent TES:** latent heat is stored via phase change materials [PCMs]
- **Thermochemical TES:** chemical reactions store and release heat

TES systems are widely used for residential and commercial water heating and space heating and cooling; however, this brief focuses on power applications. Commercialized power applications of TES are largely isolated to CSP plants, though chilled water TES systems have been paired with fossil power plants.

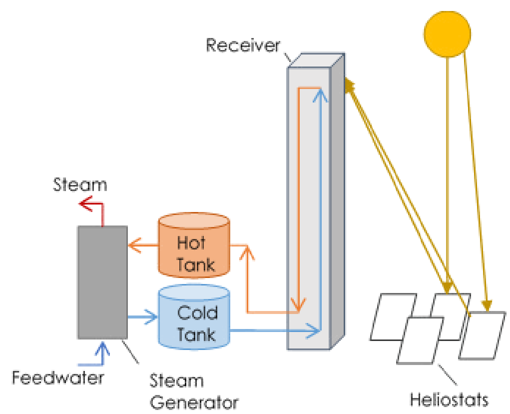
**DOE Global Energy Storage Database Operational TES Projects***




*Source: National Technology & Engineering Sciences of Sandia, LLC (NTESS):DOE Global Energy Storage Database. Available: https://www.sandia.gov/ess-ssl/global-energy-storage-database/

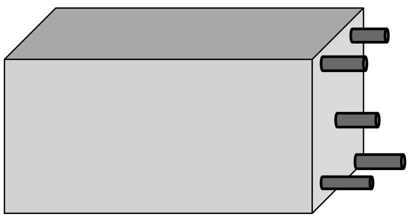
## MOLTEN SALT TES

**Often utilized by concentrated solar power (CSP) plants, molten salt is a popular medium choice for sensible TES systems due to its stability at high temperatures (~600°C). The molten salt is heated and stored in an insulated tank and can later be pumped through a heat exchanger unit to raise steam for a turbine.**




## CONCRETE TES

**In concrete TES, steam or hot exhaust gas is sent through encased piping to heat the surrounding concrete blocks. To discharge the stored thermal energy, feedwater is sent through the concrete blocks to raise steam for a steam cycle. A pilot project is underway to test a 10 MWe concrete TES system at an operational power plant.**



## CHILLED WATER TES

**IChilled water TES, often used for commercial or residential cooling needs, can be utilized for turbine inlet air chilling (TIAC). TIAC helps to maintain or increase the power output of combustion turbines during periods of elevated ambient temperatures and TES allows power producers to shift the power required to run the TIAC system to off-peak times.**

# ADDITIONAL INFORMATION

## THERMAL ENERGY STORAGE

| TES Technology | Advantages | Disadvantages and Challenges |
|---|---|---|
| TES in General | • Can be relatively inexpensive<br>• Long discharge durations achievable (hours-days)<br>• Relatively long lifetime | • Temperature limits for TES materials may be misaligned with application<br>• Commercial application of long duration TES at power generation facilities is largely limited to CSPs<br>• TES may be more difficult to integrate with existing plants compared to other ES options<br>• Passive heating may be required during downtime |
| Sensible TES | • Typically, materials are relatively low cost<br>• Long duration storage is achievable<br>• Typically, not geographically limited | • Discharge temperatures of sensible TES systems may decrease over discharge duration<br>• Sensible storage materials have the lowest energy density of all TES materials (50-100 times smaller than PCMs) |
| Phase Change Materials (latent) | • High energy densities<br>• Discharge temperatures are constant over discharge time<br>• Materials may be expensive and rare<br>• Typically, not geographically limited | • PCMs are corrosive; protective coatings and exotic materials required for corrosion resistance<br>• PCMs generally have poor thermal conductivity<br>• Must have very specific properties for desired application (e.g., phase-transition temperature compatibility with operating temperatures); this requires extensive research for each application |
| Thermo-chemical | • Decomposed products may be stored separately; this results in a theoretically infinite storage period with no heat loss<br>• Highest energy density of all TES technology types<br>• Typically, not geographically limited | • Storage material may degrade overtime due to sintering and grain growth during charging<br>• The rate of dehydration reactions is relatively slow; methods to increase charging rate is an area of potential research |

| TES Technology | Round Trip Efficiency (%) | Demonstrated Scale (MW) | Duration of Discharge (hours) | Lifetime (years) | Technology Readiness Level |
|---|---|---|---|---|---|
| Molten Salt (sensible) | 40-93[3] | 100[4] | 10-15[4] | 30[5] | 9[3] |
| Concrete (sensible) | 50-90[3] | -- | 4[2] | 25[2] | 6[3] |
| Phase Change Materials (latent) | 75-90[3] | <1[3] | -- | 10-30[3] | 4[3] |
| Thermochemical | 80-99[3] | <1[3] | 1-24[3] | 10-30[3] | 5[3] |

## REFERENCES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