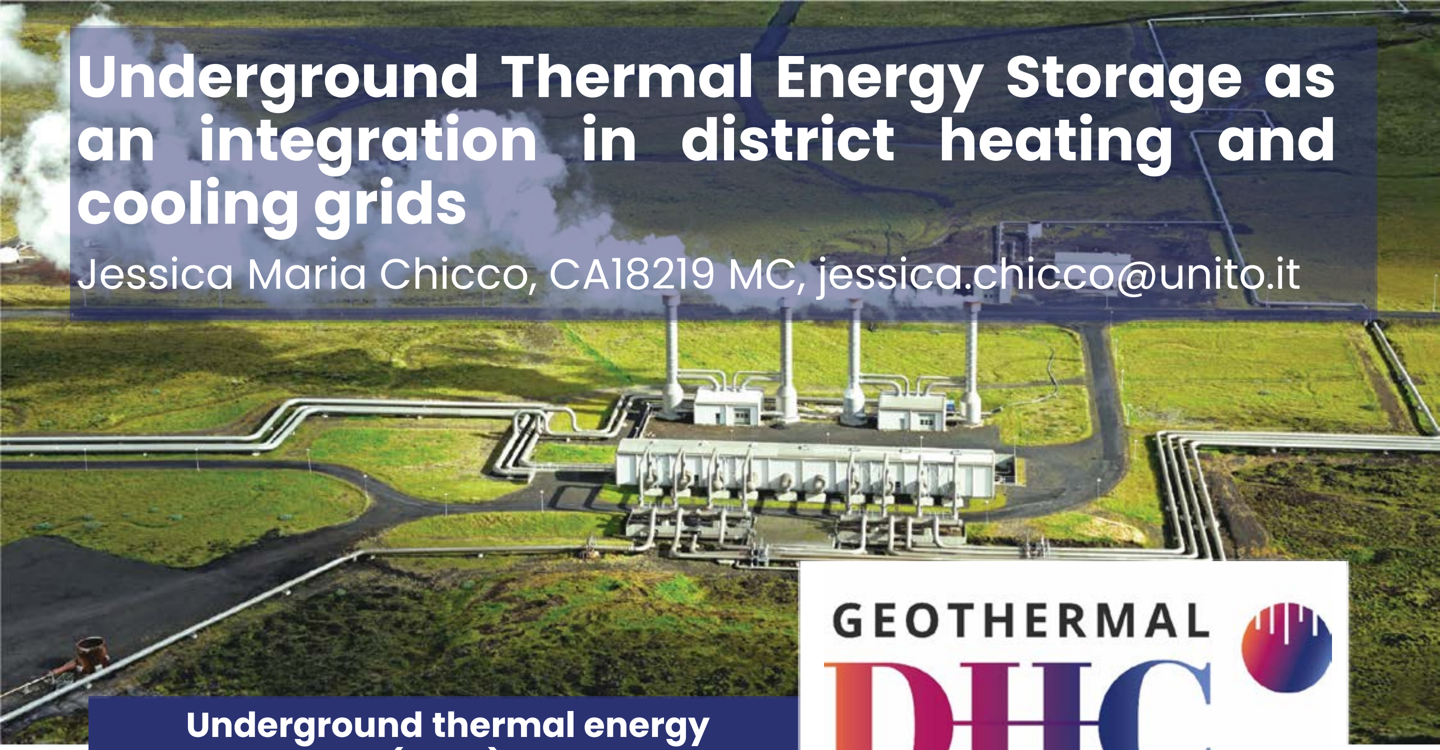

Underground Thermal Energy Storage as an integration in district heating and cooling grids

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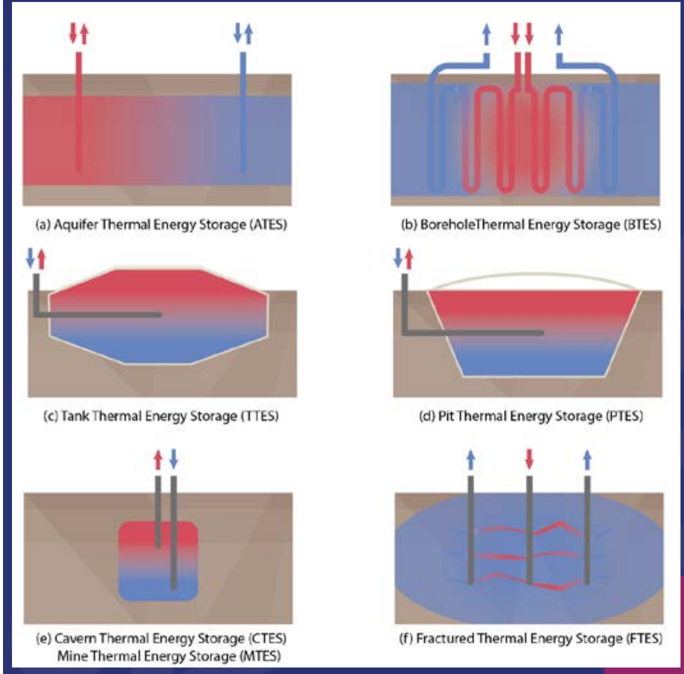
Underground thermal energy storage (UTES) systems are divided in 6 main typologies



[1] Modified after Janiszewsky et al., 2019

In *winter*, buildings are heated with a heat pump (HP) which extracts heat previously stored by solar collectors

In *summer*, the cooling capacity created during the winter, is used to cool the building, by storing the excess heat in the storage volume [2]

Key messages

- ✓ Waste heat and cold can be stored
- ✓ UTES bridge the gap between production and consumption
- ✓ UTES integration in District heating and cooling grids (DHC) increase the overall efficiency

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May 2024

Technological overview of the main used UTES systems

	Borehole-TES	Aquifer-TES
Technology readiness level	8 – 9	5 – 6 (HT) 7 – 8 (LT)
Storage depth	30 - 1.000 m	10 – 1.000 m
Temperature range	Up to 30°C for shallow and 100°C for deep systems	Up to 20°C for shallow and 100°C for deep systems
Specific thermal capacity	15-30 kWh/m³	30-40 kWh/m³
Strengths	Low development risk Small surface footprint	High efficiency rate Small surface footprint
Weaknesses	Higher investment costs Risk of aquifer and boreholes interference Slow reaction during charging and discharging	Only applicable in aquifers Moderate risk of clogging/scaling Risk of aquifer and wells interference

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ATES and BTES are the most used thermal energy storage systems because of their greater suitability in almost all geographical locations

- ATES uses naturally groundwater bodies
- BTES uses closed loop vertical BHE, with a single or double U configuration

Common characteristics for ATES and BTES

- The deeper the reservoir, the higher the "geological" risk
- Storage temperature usually up to 90°C
- Lack of specific regulations in most of the EU Countries

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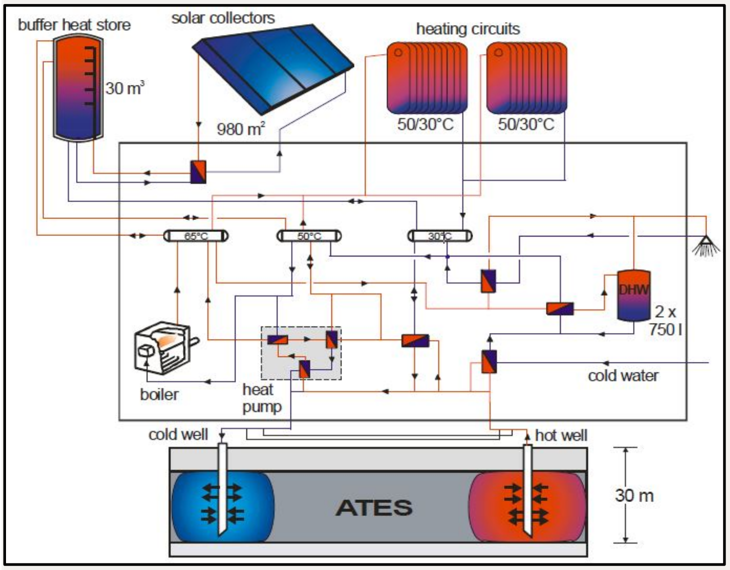
May 2024

Operative and successful case studies across Europe: ATES

There are about 100 large-scale ATES systems worldwide integrated in DHC networks: a growing number consists of LT ATES systems. This is probably due to market incentive programs and the open-mindedness of certain Authorities [3]

➢ Case study 1: LT-ATES – Rostock (Germany)



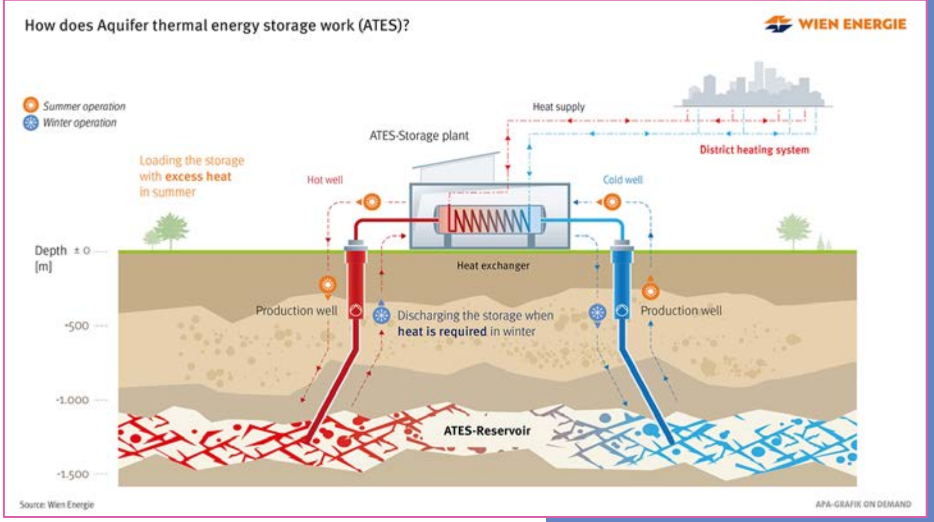
[4] Schmidt et al., 2004

The system supplies space heating a multifamily house with an area of 7000 m² in 108 apartments.
On the roof of the building 980 m² of solar collectors are mounted.

The ATES operates with one doublet of wells and is located at a depth of 15 to 30 m below ground surface.

➢ Case Study 2: HT ATES - Vienna (Austria)

This systems will contribute to the decarbonization of Vienna's district heating grid



Ongoing project: evaluation of aquifers in a depth of 1000 – 1500 m with the aim of storing temperatures of ~100°C.
The heat could be provided by deep geothermal wells that are currently beeing developed

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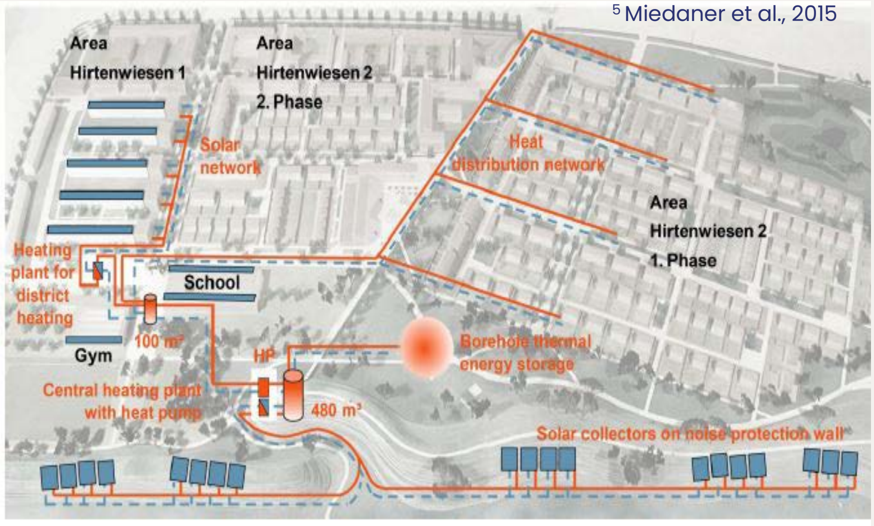
Operative and successful case studies across Europe: BTES

Currently there are few BTES installations, even if they are becoming very popular because of their greater suitability for seasonal storage of thermal energy than other facilities

➢ Case study 1: BTES – Crailsheim (Germany)



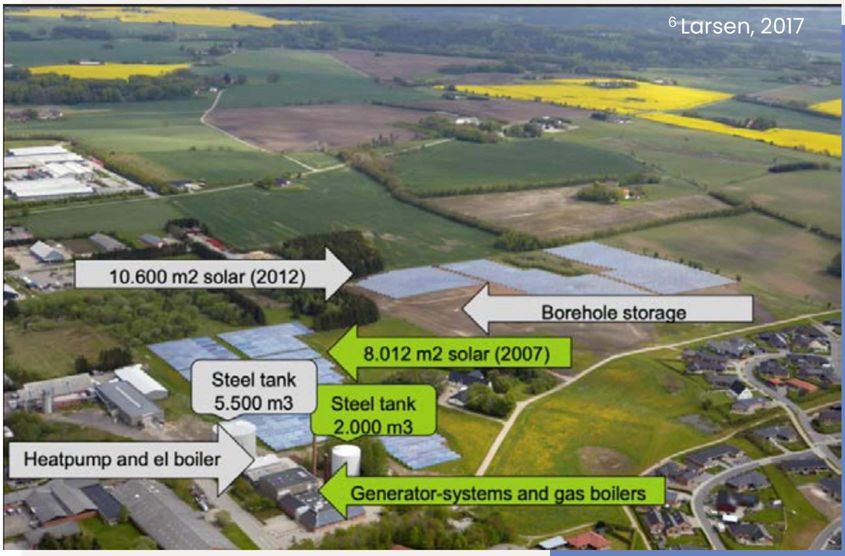
[5] Miedaner et al., 2015

7300 m^2 of solar collectors provide 50 % of the heat for a housing area with 260 units.

Heat is stored in two water tanks and in a seasonal borehole storage with 37.500 m^3

➢ Case study 2: BTES – Braedsturp (Denmark)

The system was installed in 2007: it supplies heat from 18.000 m^2 of solar thermal panels to an array of 50 boreholes 47-50 m in depth, and with a distance of 3 m each other installed across 15 m wide area.



[6] Larsen, 2017

This system provides 20% of the heat to 14.000 homes.

During the charging phase, the storage hot water flows from the center towards the periphery while when discharging, cold water circulates in the opposite direction.

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