UNDERGROUND THERMAL ENERGY STORAGE
STORING EXCESS ENERGY UNDERGROUND TO IMPROVE SYSTEM EFFICIENCY
Underground Thermal Energy Storage (UTES) is the concept of storing excess heat in the ground in the summer, to then be extracted in the winter. Renewable energy sources such as solar thermal produce most of their heat when it is not required and hence, it is wasted. For this reason, it is becoming increasingly common to use integrated seasonal heat storage to improve the total system efficiency.
Alongside the three main components above, the system would typically require a short-term buffer tank (for peak loads), a high temperature ground source heat pump (GSHP) and a peak load boiler is often used as a backup for peak times.

REHAU, together with our partners, can assist in assessing the feasibility of a UTES scheme. Please contact REHAU to discuss your project requirements.
Solar Thermal

The most commonly used heat source on UTES schemes are solar thermal panels. With large scale solar thermal arrays, there are often economies of scale and in addition to this, the Renewable Heat Incentive (RHI) will provide income for solar thermal installations for every kWh produced. The main advantage of solar thermal is the high temperature achieved but a large solar array can be a significant proportion of the total system cost.

Solar Absorbers

Another way of capturing solar energy is through solar absorbers, where pipework is installed just below a concrete or asphalt surface. Although this doesn’t reach as high temperatures as solar thermal, it can be a more cost-effective installation. REHAU offers two types of pipework for these applications, RAUWAY Stabil and RAUWAY Flex.

RAUWAY Stabil is a multilayered PE-Xa pipe with an outer PE layer, which is suitable for installations in cast and rolled asphalt at temperatures of up to 240°C.

RAUWAY Flex is a PE-Xa pipe with outer PE layer, suitable for installations in concrete (max. 95°C). Both these pipes can also be used for any outdoor surface de-icing for infrastructure applications, such as roads. (example shown to the right)

Waste heat from CHP/Industry

Combined heat & power (CHP) units are an efficient way of producing space heating and electricity and are often linked with district heating schemes. In some cases, only the electricity output is used and the heat produced is ejected into the atmosphere, wasting huge amounts of energy. Instead, this waste heat can be stored in boreholes to be used in a UTES system. The same concept applies to chillers and condensers which typically eject heat into the atmosphere via the roofs of commercial buildings such as supermarkets and offices.

To discuss if your heat source is viable for a UTES Scheme, please contact REHAU to discuss your project.
The optimum method of storing heat underground is by using ground source probes due to the greater depths involved. However, the choice of probe material is critical for a successful operation. Standard PE 100 material has a temperature range of -20°C to +40°C, whereas for BTES systems, the heat is often stored in the ground using water at 60-80°C, therefore outside the operating range of PE 100.

**The solution:**
RAUGEO PE-Xa probes are ideal for BTES applications due to their high temperature resistance (-40°C to +95°C) and robust design. Due to the improved bending radius of PE-Xa, the unique probe tip is jointless, offering excellent reliability.

**Benefits of PE-Xa probes**
- High temperature resistance
- Jointless probe tip offers highest reliability
- Excellent resistance to point loads and notches & grooves
- Uses the leakproof Everloc jointing system
- 10 year consequential loss warranty for every PE-Xa probe installed

A BTES probe field differs from a standard GSHP application as the main objective is to store heat effectively, therefore the design is based around these key considerations:
- Installation depth typically 30-50m
- No groundwater flow
- Probe spacing 3-4m (normally 6m)
- Insulation above the probes to reduce heat losses
RAUTHERMEX:
- Closed cell polyurethane (PU) foam for optimum insulation
- No thermal expansion
- Generation II shroud system removes need for hot works
- No water ingress if LDPE outer jacket is punctured
- 25-160mm UNO and 25-63mm DUO pipes available

RAUVITHERM:
- Open cell cross-linked PE foam for high insulation
- High flexibility due to open cell design
- Robust HDPE outer jacket to prevent damage on site
- Outer insulation layer bonded to outer jacket to prevent water ingress
- 25-125mm UNO and 25-63mm DUO pipes available

For a UTES scheme with a large number of separate buildings, such as a housing development, a district heating (DH) network would be the preferred choice for transporting the excess heat from the solar thermal panels to the boreholes in the summer and then distributing the heat in winter around the dwellings.

REHAU is one of the UK market leaders in pre-insulated pipe and has been involved in many community and district heating schemes across the UK and Europe. Modern low-temperature DH systems are increasingly using polymer due to the benefits of high flexibility, simpler installation and the long coil lengths offered. REHAU have two pre-insulated cross-linked polyethylene (PE-Xa) pipes for district heating, RAUTHERMEX and RAUVITHERM. Both are suitable up to 95°C and 6 bar and use the renowned leakproof REHAU EVERLOC™ compression sleeve technology.

REHAU can assist in pipe sizing and materials list for your DH schemes. Please contact your local REHAU sales office for further information.
**Crailsheim, Germany**

This is one of the largest seasonal heat storage projects in Germany, supplying heat to 260 houses and local community buildings, in total 4,100 MWh/a. There is over 7,000 m² of solar thermal collectors and a 750 kW heat pump with supplementary heat coming from a district heating network. The BTES storage is 43,200 m³, comprising of 80 RAUGE® PE-Xa probes and associated short term buffer tanks.

**Braedstrup Solar District Heating, Denmark**

Braedstrup Solar District Heating scheme is one the largest of its type in Europe, comprising of 1400 homes requiring 40 GWh/a of heat. The 18,000 m² solar thermal panels are now linked up to a BTES system of 50 RAUGE® PE-Xa probes at depths between 45-50m over an area of 225m². In phase one the solar fraction is estimated to go from 10-20%. (More information can be found at [www.braedstrup-fjernvarme.dk](http://www.braedstrup-fjernvarme.dk)).

**Drake Landing Solar Community, Okotoks, Canada**

This 52 house community integrates 800 roof mounted solar thermal collectors (approx. 2,300 m²) with a BTES system of 144 RAUGE® PE-Xa probes at 35m depth. Live performance data can be found on their website at [www.dlsc.ca](http://www.dlsc.ca). The temperatures being stored in the probes often exceeds 50-60°C, showing why PE-Xa has to be used for BTES projects.

**Suffolk One College, England**

In conjunction with one of our partners, ICAX, this sixth form college in Suffolk used a 1,560 m² bus turning area as a solar absorber (approx. 14 km of 25 mm RAUGE® PE-Xa pipework) and 10 PE-Xa probes at 100m depth for the BTES system. For more information on this project and other similar schemes, see [www.icax.co.uk](http://www.icax.co.uk).