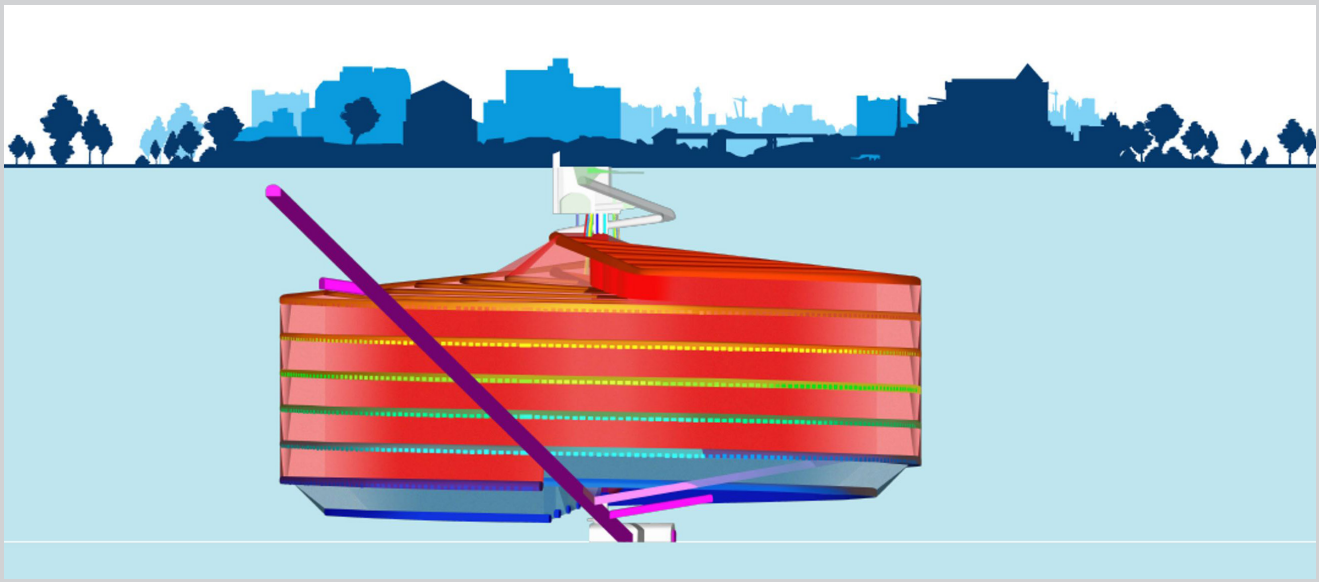
SKANSKA TES – THERMAL ENERGY STORAGE



In a Skanska TES facility, both heat and cold can be stored on a large scale. Illustration: Circus Communication.

Summary of the project

Skanska TES is a concept in which heat and cold can be stored in the same rock facility under a city. Energy is supplied to the storage when there is a surplus and is used when demand is high. The size and compact shape of the storage mean that losses to the surroundings are small.

A thermal energy storage facility built in the rock under a city can make a considerable contribution to supplying the city's heating and cooling needs. Uses of thermal energy storage include the balancing of energy demand between day-time and night-time, weeks, months and seasons, i.e. storing summer heat for winter heating or storing winter cold for summer cooling.

LARGE ROCK FACILITY

The storage consists of a spiral of tunnels, linked by connecting tunnels. Holes are drilled between the tunnels so that the surrounding rock can be either heated up or cooled down by circulating water. The top of the storage is approximately 100 m below the ground surface.

For efficient operation, a TES facility needs to be large. This makes the surrounding area relatively small in comparison to the storage volume, thereby reducing heat losses to the surroundings.

"SKANSKA TES WITH A DIAMETER OF 200 M CAN ATTAIN A SEASONAL STORAGE CAPACITY OF 50 GWH, WHILE A STORAGE WITH A DIAMETER OF 550 M CAN STORE UP TO 1 000 GWH PER YEAR"

The key feature of the concept is based on the natural ability of water to form thermal layers based on temperature differences. The hot water will be located at the top part of the storage, while the cold water will be located at the bottom, with intermediate temperatures in between. Water can be extracted from the storage at the level where the needed temperature is located at any point in time.

ENERGY GAINS

In areas with a cold climate, surplus energy from existing CHP plants (Combined Heat and Power), factories, data centres, etc. can be stored in a thermal storage facility, primarily via district heating and cooling systems. Energy from intermittent energy sources, primarily wind and solar, can also be stored when there is an energy surplus available.

In warmer climates, cold can be stored during cooler periods and used for cooling when needed.

EFFICIENT USE OF ENERGY

A large storage to redistribute heat and cold at different times, means that large quantities of energy can be reused in a city's energy system instead of being wasted. Temporary electricity surpluses from, for example, wind and solar energy plants, can be used to operate the heat pumps in the storage to convert low-value energy to high-value heating and cooling.

The heat pumps circulate water in the storage, charging energy for heating and cooling. Charging/discharging from/to the external district heating and cooling system is performed via heat exchangers direct from the water in the storage.

The heat pump module consist of two heat pumps each including two compressors utilizing R1234ze as refrigerant. By operating compressors in serial mode and using water at +45°C the heat pumps create 30 MW heating at +99°C and 22 MW cooling at +3°C. COP = 5,5 including both heating and cooling.

By operating in parallel mode using water at +70°C for the evaporators and at +45°C for the condensers, the heat pumps create 130 MW heating at +95°C. COP = 6 including heating.

Depending on external system and the size of the thermal storage, several heat pump and heat exchanger modules can be included in the storage concept.

Large electricity surpluses can also be stored as heat directly in the storage via electric boilers/heat exchangers with high power, over 1 000 MW.

HIGH STORAGE CAPACITY AND THERMAL EFFICIENCY

The design of the storage is scalable both in term of size and performance to match the requirements of the district heating and cooling system. Calculations show that a storage with a diameter of 200 m can attain a seasonal storage capacity of 50 GWh, while a storage with a diameter of 550 m can store up to 1 000 GWh per year. This corresponds to the approximate annual heating needs of 5 000 and 100 000 apartments respectively. The thermal efficiency in such a system is nearly 100% because of the small heat losses. The total annual energy turnover rate is 3-10 times the seasonal storage capacity, however depending on the external district heating and cooling system.

Conclusion

Thermal energy storage is a sustainable solution for energy storage that can support the transition towards an energy system based on renewable energy sources. The energy storage can also strengthen the link between the electricity market and the district heating and cooling market, thus increasing the efficiency throughout the energy system. Power-to-Heat and Heat-to-Power integrated with energy storage is a solution that will improve the efficient use of energy in the society.

FACTS ABOUT THIS PROJECT

Water filled spiral of tunnels and hole drilled in rock

Seasonal storage capacity Ø200m: 50 GWh

Seasonal storage capacity Ø550m: 1 000 GWh

Thermal Efficiency nearly 100%

Heat pumps 30 MW/22 MW heating/cooling, 130 MW heating in parallel (per module).

Large electricity surplus can be stored as heat, over 1 000 MW capacity possible.

Contact information

Skanska Sverige AB, SE-112 74 Stockholm
☎ +46 10 448 00 00

IEA HPT

IEA Technology Collaboration Programme on Heat Pumping Technologies (HPT TCP)