A New Simulation Tool for Large-Scale Solar Thermal Heat Plants with Seasonal Storage

Solar thermal heat plants have already been successfully applied in greater numbers in Denmark to supply district heating systems and industry with cheap, emission-free and reliable heat. Suntrace is now able to evaluate the techno-economic feasibility of large-scale solar thermal collector fields in combination with seasonal storages.

After the development of the electricity grid towards renewable power, the transformation of the heat supply systems is the next important step towards carbon-free and sustainable Energy. Domestic heating has a big share in the total heat consumption and heat grids are the most economic and efficient solution to supply urban areas. Solar thermal heat plants combined with seasonal storages are able to deliver more than 60% of the annual heat demand with competitive costs.

The behaviour of solar thermal collector is well known, and simulation is highly standardized. But large-scale systems and especially long-term storages with complex geometry and thermal stratification are quite new and few tools exist to model the complete systems behaviour.

Suntrace therefore developed a new tool to simulate the operation and determine the feasibility of those plants. Besides the simulation of the solar thermal collectors it is able to regard a non-uniform distributed insulation of the long-term storage as well as the effects of thermal stratification inside the water body. Since EbsilonProfessional® is used as a platform, piping losses in the collector field can be regarded and the behaviour of all standard components like heat exchangers and pumps is described quite accurately. The time solution is fixed, but variable from 1 minute to 1 hour.

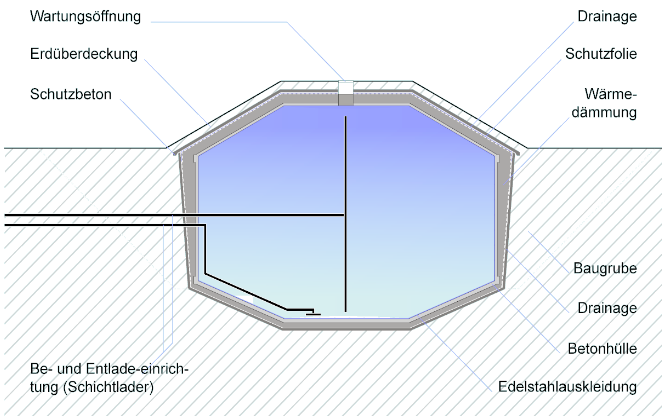
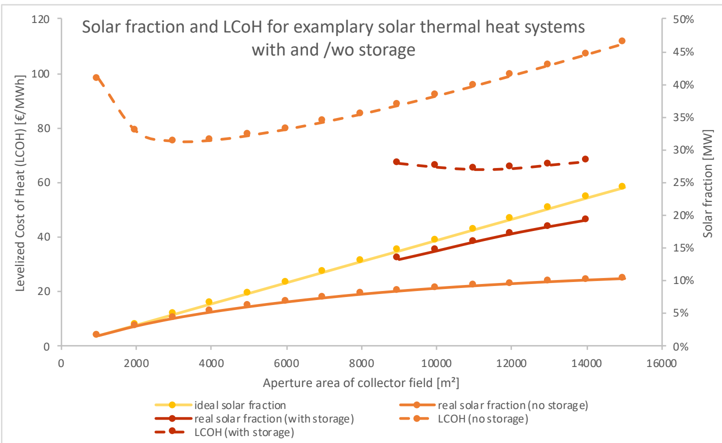


Figure 1 - Typical pit thermal energy storage



The first application was a general examination of the techno-economic feasibility of solar thermal plants in Germany. The influences of different locations, different heat grid temperature levels and varying system configurations were examined. It could be shown that even small buffer storages are able to increase the yield of the collector field by at least 80% compared to systems without any storage. Solar shares of up to 60% can be economically feasible if a large-scale pit thermal energy storage is integrated in the system. Systems with a share of 20% reach the lowest overall Levelized Cost of Heat (LCoH) when equipped with a buffer storage and are able to cover the complete demand in the summertime.