Towards Giga-Scale Thermal Energy Storage for Renewable Districts in Austria

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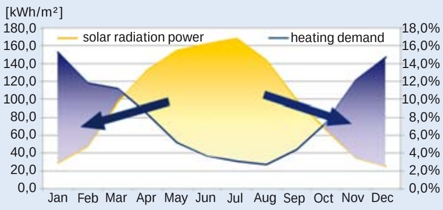
Summary

Towards 100% renewable energy supply, long-term energy storage becomes indispensable. Large-scale thermal energy storage in district heating systems provide a promising cost-efficient approach in this respect. As these systems need to be implemented in an urban environment, the required surface area should be minimised to compensate for the high land prices. These minimized costs can be achieved by moving the system below surface level and further decreased by allowing usage of the surface area. Presently, large-scale thermal storages have been built and are in operation in Germany and mainly Denmark, with recent storages having volumes of nearly 200,000 m³. The Austrian flag-ship project giga_TES targets at storage sizes up to 2 mio. m³. For that goal novel storage designs, construction technologies, materials, components and methods will be developed.

Introduction and Motivation

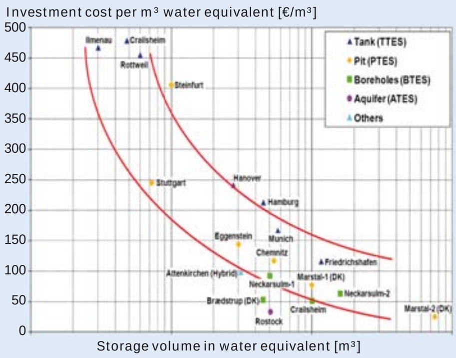
- Target 100% renewable energies
- Require long-term storage (summer to winter, see figure [1] below)
- Cost-efficient approach: Large-scale heat storage in district heating grid



Comparison of solar radiation power and heating demand over the course of a year

Why Large-scale Thermal Storage?

- A storage must be cheap
  → Economy of scales: The specific costs decrease with increasing storage size, see figure [2] below.
- A long-term storage must show low losses.
  → The thermal losses decrease with increasing size, provided that the storage is enlarged in all directions. I.e., not only the area, but also the depth of the storage is increased.



Investment costs per m³ water equivalent [€ / m³]

Experience in Denmark and Germany

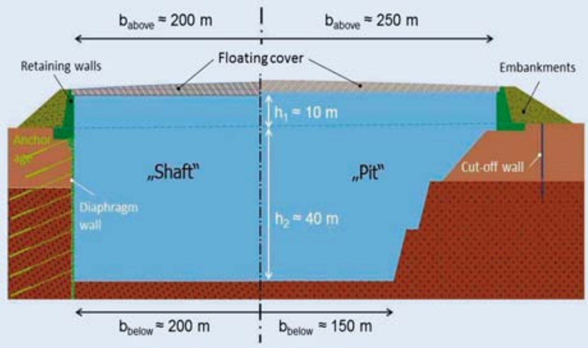
- Large-scale thermal energy storages are technologically and economically feasible . See figure [3] below.
- Require improved materials: insulation, sealing and durability at elevated temperatures.
- Require improved components: construction of lid to allow for usage of surface etc.
- Require optimized system integration: the performance of the storage depends largely on its design and operation in a given system

Project „giga_TES“

- Austrian flagship-project, funded by FFG
- 01/2018 to 12/2020
- 18 partners, of which 15 industry partners
- Coordinator: AEE INTEC
- Development of novel large-scale thermal storage concepts
- Development of new materials and components
- Development of new construction technologies
- Development of improved simulation models for storage and its sytsem intergration
- Assessment of impact on environment
- Consider storage sizes up to 2 mio. m³

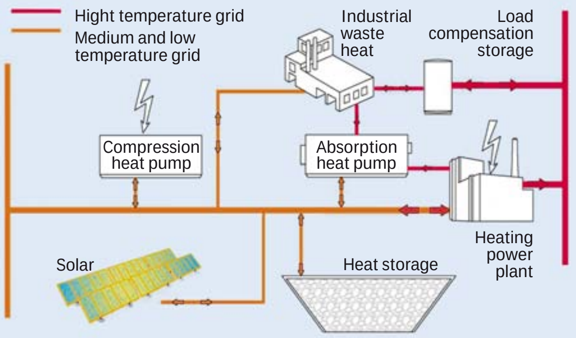
How to Build a Large-scale Thermal Storage in Austria?

- In most Austrian residential areas, the ground water level is close to the surface (about 3–15 m below ground).
  → Design storage wall and bottom for low thermal losses to the ground water.
- The required temperatures to feed into the district heating grid are sizeable.
  → Integrate a sorption heat pump to lift the temperatures and hence increase the effective storage capacity.
- Close to urban areas, the land prices are sizable.
  → Storage design with small area but increased depth of storage (see figure [4] below). This requires the development of a new storage design, dedicated components and also new construction technologies. An additional potential benefit is reduction of thermal losses.
  → Covering lid of the storage to be usable, e.g. as recreational area.



Integration of the Storage in District Heating Systems

- Multi-functional storage design for different combinations of:
  - Charging (base load / peak shaving)
  - Storage period (short / medium / long-term)
  - Discharging (base load / peak shaving)
  - Integration of waste heat / CHP / solar collectors
  - Integration of Power-to-Heat, use e.g. negative electricity prices
- Interplay with various sources / sinks and interests (see figure [5] below)
- Multi-objective optimization: Maximum integration of renewable energy and minimum costs



Sources

[1] C. Rohringer, Master thesis
[2] Solites
[3] Niras
[4] Step
[5] SOLID / AEE Intec

Acknowledgements

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