Utility-side storage

Thermal energy storage (TES) plays an important role in district heating and cooling systems (DHC), so is also in the case of the CELSIUS project. Within CELSIUS one can find several demonstrators integrating TES for the optimization of the heating and cooling supply.

The main findings and monitoring data of these projects can be access through the CELSIUS Toolbox. Under the different sections of the CELSIUS Toolbox a variety of information about TES can be found. For example, in the demonstrators' section, the main insights and the key performance indicators (KPI's) of each project can be accessed. Additionally, in the technical toolbox theoretical concepts have been compiled so that a complete understanding of the storage technologies can be provided. This information comprises description of basic principles and storage methods, operational benefits and market situation of storage technologies in Europe. Furthermore, case studies of centralized and local TES in other European district heating systems are shown in Thermal storage case studies, such is the case of Energiebunker, in Hamburg, Germany.

Assets

Two of the three new demonstrators using TES are implementing similar technology and are being operated in a way to achieve similar purposes. These two demonstrators are the heat hub in Rotterdam and the short term storage in London.

Benefits

With 5000 m³ of water capacity is the heat hub in Rotterdam the largest storage facility in CELSIUS. The heat hub is used to balance heat supply and demand of the Rotterdam's district heating. It stores hot water coming from several heat sources such as waste heat from an incineration plant and other combine head and power and boiler plants. The stored heat in form of hot water is then supplied to the Rotterdam's district heating network. The heat hub provides such flexibility to the heating network that heat from waste sources can be recover also in times of low or no heat demand. It also allows combine heat and power to operate more efficiently. TES are often used to cut the daily peak load in heating systems.

The TES system in London is integrated with one of the local heat networks in Islington. In this case, it will integrate the waste heat coming from two different heat sources. These two sources are a ventilation shaft of the London underground and an electricity substation. The importance of the TES in this demonstrator relies on the seasonal change of the temperatures of the heat sources, and the heat demand. And the fact that the TES can be load from the heating network makes that it can supply heat when waste heat is not available and vice versa. Moreover, as the heat storage is also coupled with a CPH plant, it can provide the necessary flexibility so that the CHP supplies electricity and heat all year long.

Overall heat storage provides interesting technical capabilities to the heat network that could mean lower prices for end users, reduction of GHG emissions and less operation costs for energy utilities.

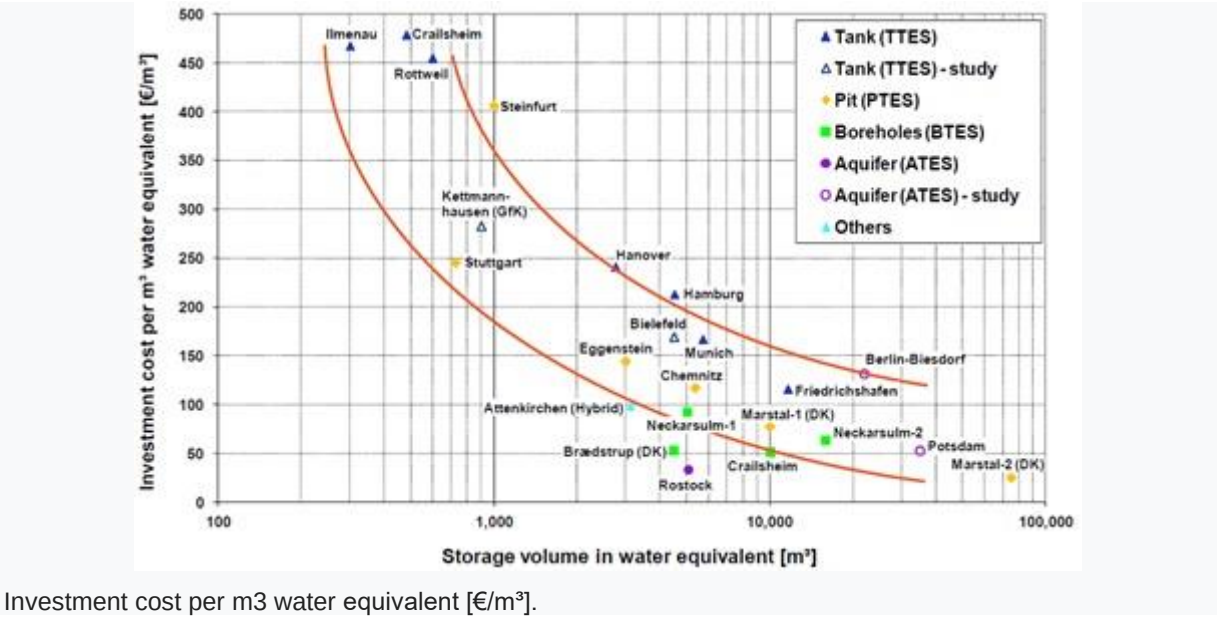
Replicability

The replicability potential of the demonstrators under this section can be evaluated with a general medium and high score, according the replication matrices of the short-term storage and the heat hub demonstrators. The heat hub shows the higher replication potential, as it scores almost the higher values for the different monitored fields. For example, in the fields adaptability to different climate conditions, easy to implement (no needs of specific technical requirements), easy to operate (No needs of specific technical requirements) and opportunity of integrating waste energy sources, it scores the higher value, while only in the fields authorization easiness and CAPEX needed for the deployment of the solution scores the medium ones.

Stakeholders

The key players on this topic are the energy utilities as they are the ones who have to detect the opportunities that thermal energy storage can offer not only to the heat network but also to the end user and the environment. As network operators they should identify the business case and together with the municipality integrate it maybe with a support policy framework. In the case of the London short-term storage the energy utility has a strong policy support from the 'London plan ' and also from the local planning guidance, which allows the utility to have planning conditions. In this case the city authorities play also an important role.

Finance



Investment cost per m3 water equivalent [€/m³].

These kinds of thermal energy storage use sensible heat, i.e. hot water as medium material. These systems are rather inexpensive in comparison with electricity storage. Systems with a water capacity of between 5,000 and 10,000 m3 have an investment cost of 50-200 €m³ which represent a0.5 -3.0 /kWh. Countries like Denmark are choosing larger TES, as the investment cost decreases with the size of the storage size. Further cost reductions for the utility can be achieved when using the TES in a smart way, for example for peak shaving or coupled with CHP plants.

The financial aspects of both demonstrators can be found under heat hub/financial section and short-term storage London/financial section

Challenges and Risks

The market maturity of sensible storage is not anymore a barrier. The reliability of the technology is not a challenge. There are plenty [[Interactive Thermal Energy Storage Map| thermal energy storages in Europe], where the technology can be verified. TES is often associated with cogeneration, which has higher implementation rate in New building constructions around 10.2%. Here, the challenge is to find the different heat resources e.g. waste heat, biomass, solar, etc. and plan the optimal combination of these resources with heat storage.

List of large-scale Solar Plants in Denmark Pit Storage Thermal projects.[3]

No.	Project Name	Area (m2)	year	Supplier
1	Dronninglund	37 573	2014	ARCON
2	Marstal	32 943	1996/2012	ARCON/other
3	Ringkoebing	30 240	2010/2014	ARCON
4	Nykoebing Sj.	20 084	2014	ARCON
5	Graasten	18 988	2012	ARCON
6	Braedstrup	18 612	2008/2012	ARCON

7	Tarm	18 585	2013	ARCON
8	Vojens	17 500	2010	Other
9	Jaegerspris	13 300	2010/2013	Other
10	Sydlangeland	12 500	2012	Other
11	Sydfalster	12 096	2011	Arcon

The implementation of TES is also being successful in Danish district heating systems, where its main application is to increase the solar fraction and to shift the heat from summer to autumn or winter Most of the challenges are presented in other storage mediums like in the phase change materials and thermos-chemical storage, which can be used for other applications as for seasonal storage. These technologies are still not enough mature, and the costs are still relative high.

Challenges and risks of CELSIUS demonstrators can be found in the Challenges and risks of the heat hub and in Challenges and risks of the short-term storage in London

Read more

Technical Toolbox

- Thermal energy storage
  - Types of Seasonal Thermal Storage
  - Methods of Thermal Energy Storage
  - Technical Capabilities Provided by TES
  - Thermal storage case studies
- Strategies for decreasing peak loads and energy use

Case Studies

- The Heat Hub in Rotterdam
- Aquifer thermal energy storage for cooling and heating in Maastoren, Rotterdam
- Short-term thermal storage, London

References

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2. IEA-ETSAP and IRENA. (2013). Thermal Energy Storage / Technology Brief. Retrieved from www.irena.org/Publications
3. J. Frey, “Large Scale Solar Heating,” presented at the Gleisdorf SOLAR 2014, Jun-2014.