Master thesis:

Life cycle cost and environmental impacts of seasonal thermal energy storages

Thermal energy storage is an essential element of energy storage, not only because its most common form - heat storage via hot water - is one of the most-widely applied thermal storage technology in the world, but also because in the last decade, other than pumped hydro storage, it has been the fastest-growing energy storage globally in terms of installed capacity, and further growth is expected in the near future [1]. Due to the temperature difference between summer and winter in Europe, much attention has brought to seasonal thermal storage (e.g. months) in order to reduce the peak heating demand in winter [2]. However, a quantitative and consistent assessment of technologies that are potential seasonal thermal energy storage in terms of cost and environmental impacts from a life cycle perspective is missing. In addition, heat is a form of special energy carrier that the same amount of heat can have different temperatures, which is often determined by application (i.e. use of heat) and adds one more dimension of complexity to the assessment.

This work will thus assess the life cycle cost and environmental impacts of seasonal thermal energy storages, considering various applications. It will compile cost and life cycle inventory data by reviewing the past literature on seasonal thermal energy storages, covering sensible-, latent-, and thermochemical- thermal storage technologies. By defining comparable systems, life cycle cost and greenhouse gas emissions will be quantified based on the data collected, and the assessment will be complimented by sensitivity and/or uncertainty analysis. The study will rank the technologies for each application considering both life cycle environmental and economic performance, and comparison with other non-thermal energy storage technologies that can be used for seasonal energy storage such as power-to-gas will be performed.

Reference

[1] Gardner P, Linden C, Senger R, Rümler R, Tenner S, Breisig V, et al. World Energy Resources E-Storage. 2016.

[2] Xu J, Wang RZ, Li Y. A review of available technologies for seasonal thermal energy storage. Sol Energy 2014;103:610–38. doi:10.1016/J.SOLENER.2013.06.006.

The thesis will be performed within the Technology Assessment group in the Laboratory for Energy Systems Analysis at Paul Scherrer Institute in Villigen, Switzerland. This thesis is part of the SCCER Heat and Electricity Storage (http://www.sccer-hae.ch/). Interested students are encouraged to submit an application to Xiaojin Zhang (xiaojin.zhang@psi.ch), including your latest resume and current grades.