Energy Storage in Concentrating Solar Technologies – Current Research and Future Integration into the Smart Energy Economy

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Abstract

Renewable energy resources, particularly solar and wind, show tremendous potential to complement and eventually substitute fossil-based and nuclear energy technologies. They are abundant, essentially carbon neutral, and they constitute a comparably minor health risk. However, in contrast to conventional chemical and nuclear energy carriers they are inherently transient, exhibiting a combination of stochastic and deterministic fluctuations on multiple time and length scales. Furthermore, renewable energy resources are often dispersed, requiring significant land areas for large-scale deployment. This necessitates efficient storage and transport technologies for solar and wind derived energy.
Concentrating solar technologies convert solar radiation to heat via mirror arrays, such as, parabolic troughs or heliostat field. The heat is then further converted to electrical power (Concentrating Solar Power – CSP) or stored chemically as a fuel (Solar Thermochemistry). CSP plants are ideally suited to integrate short and medium term thermal storage and thus provide an interesting alternative to conventional base-load power generation. CSP is currently being demonstrated on the scale of tens of Megawatts. Solar thermochemistry is an innovative approach to produce synthetic fuels via high temperature endothermic chemical reactions that use solar energy to produce carbon neutral fuels from water and CO2. While solar thermochemistry is still in its infancy, it provides a promising alternative to biofuels as it has significantly higher theoretical efficiency limits, while not competing for arable lands with food-crops.
The paper gives an overview on the state-of-the-art in CSP and solar thermochemistry based energy storage and discusses their potentials within a future smart energy economy.

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