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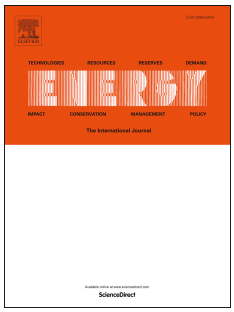

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Techno-economic assessment of solid–gas thermochemical energy storage systems for solar thermal power applications

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Abstract

Thermochemical energy storage (TCES) systems are a promising alternative to conventional molten salt systems for integration with solar thermal power plants. TCES systems can offer high storage densities and high storage temperatures. Thus, they have the potential to increase the efficiency and reduce the levelized cost of electricity of solar thermal power plants. The present study investigates reacting systems with alkaline carbonates and hydroxides and metal oxides performing redox and chemical looping combustion reactions for their near-term deployment potential. 17 solid–gas TCES systems are identified from the initial set of 21 systems for techno-economic assessment. A quantitative assessment methodology based on techno-economic performance indicators (TPIs) is proposed for the comparative analysis. The techno-economic analysis indicates that energy consumption by auxiliary equipment and the cost of the feedstock are the most important factors affecting the system capital cost. Eight TCES systems are identified as competitive with molten salts in the near term, with an estimated capital cost lower than \$25 MJ^{-1}: hydroxide looping with $Ca(OH)_2$/CaO, $Sr(OH)_2$/SrO and $Ba(OH)_2$/BaO; carbonate looping with $CaCO_3$/CaO and $SrCO_3$/SrO; redox with BaO_2/BaO and chemical looping combustion with Fe_3O_4/FeO and NiO/Ni.

Keywords: thermal energy storage, solar, power, techno-economics.

1. Introduction

Concentrated solar thermal power (CSP) technologies can become cost competitive with conventional power generation technologies within a decade through a combination of