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Materials Today: Proceedings 5 (2018) 1571–1577

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PMME 2016

Parametric Simulation and Economic Estimation of Thermal Energy Storage in Solar Power Tower☆

Axel Gottschalk[a], Umesh Ramamoorthi[a] *

[a] *Bremerhaven University of Applied Sciences, Institute of Process Engineering, An derKarlstadt 8, 27568, Bremerhaven, Germany*

Abstract

The alternative for fossil fuel generated energy is energy from solar plants. A solar power tower system, which is a type of concentrating solar power (CSP), is simulated with the SAM (System Advisor Model) to help in decision-making on whether or not to include a storage system in it. Addition of thermal storage in a solar power tower system brings sustainability and dispatch ability of the power produced. Since solar power tower systems require high investment costs to be established, the percentage contribution of Thermal energy Storage (TES) on the installation costs are found. In this paper, different locations are chosen from India, Germany and Mediterranean countries to simulate a solar power plant of 100 MWe capacities. Initially, the excel sheet with pre-built functions of SAM are custom modified. Then the parameters related to the direct costs and installation costs are determined, which are then used as input in the SAM software to do a parametric simulation.
The dependence of the following are estimated with the help of SAM and customizing the SAM excel model:

- Dependence of turbine gross output on total installed costs
- Dependence of thermal energy storage hours of two tank storage system on total installed costs
- Dependence of thermal energy storage hours of latent heat storage on total installed costs

Selection and Peer-review under responsibility of International Conference on Processing of Materials, Minerals and Energy (July 29th – 30th) 2016, Ongole, Andhra Pradesh, India.

Keywords: Solar Power Tower, Thermal Energy Storage, Economic evaluation, Parametric simulation

* Corresponding author. Tel.: +49 471 4823-260
E-mail address: agottschalk@hs-bremerhaven.de

2214-7853
Selection and Peer-review under responsibility of International Conference on Processing of Materials, Minerals and Energy (July 29th – 30th) 2016, Ongole, Andhra Pradesh, India.

1. Introduction

A Solar power tower (also called a central receiver system) is a type of concentrating solar power (CSP) system that consists of a heliostat field, tower and receiver, power block, and optional storage system (Figure 1). The field of flat, sun-tracking mirrors called heliostats focus direct normal solar radiation onto a receiver at the top of the tower, where a heat-transfer fluid is heated. Then it is pumped to the power block. The power block generates steam that drives a steam turbine and generator to convert the thermal energy to electricity. This is one of the key technologies used to generate electric power in the recent past. The power tower uses a Thermocline storage tank or a two-tank system to store the heat energy generated. The thermal energy stored is dispatched at required intervals to generate electricity. This thermal energy storage (a two-tank system or a latent heat thermal storage system) influences the cost of the construction of this solar power tower plant. Since solar power towers are highly cost intensive investment, it becomes important to get knowledge about the impact of a storage system economically on the plant before even venturing in to the project. In this paper, the total installed costs and the dependence of the storages is estimated to help understand the contributions of each one of them in the costs.

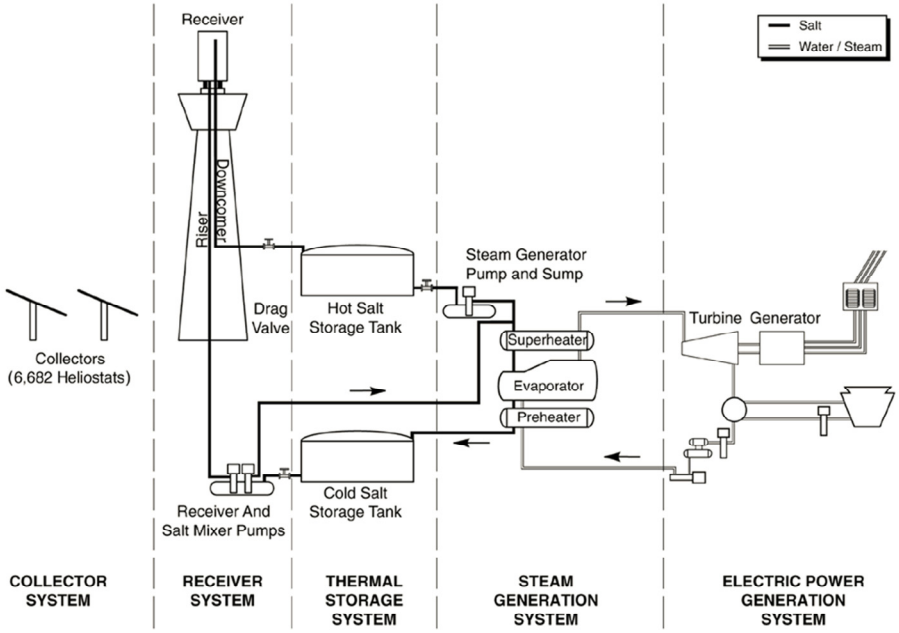

Figure 1 Schematic of a molten salt power tower showing major sub-systems [1]

Nomenclature

TES	Thermal Energy Storage
LHTES	Latent Heat Thermal Energy Storage
SPTP	Solar Power Tower Plant
MWe	Megawatt electricity
SAM	System Advisor Model
LCOE	Levelized Cost of Electricity
CEPCI	Chemical Engineering Plant Cost Index
PPI	Producer Price Index
DC	Direct Cost
EPC	Engineering Procurement Construction