

PROJECT OBJECTIVES

Goal:

- Enable higher temperatures and greater efficiencies of concentrating solar power by developing an advanced falling particle receiver. Particles will be heated to $>650^{\circ}\text{C}$ by direct heating from concentrated sunlight and will provide cheap, efficient energy storage.

Innovations:

- Develop particle recirculation, air recirculation, and interconnected porous structures, which have not been tested before¹
- Advance particle materials to increase the solar absorptivity and durability²
- Design and improve particle thermal storage, heat exchange, and particle conveyance³

¹Tan and Chen, 2010, Review of study on solid particle solar receivers, Renewable & Sustainable Energy Reviews, 14(1), p. 265-276.

²Hellmann et al., 1987, Evaluation of Spherical Ceramic Particles for Solar Thermal Transfer Media, Sandia National Laboratories, SAND86-0981, Albuquerque, NM.

³Spelt et al., 1982, Heat-Transfer to Flowing Granular Material, International Journal of Heat and Mass Transfer, 25(6), p. 791-796.

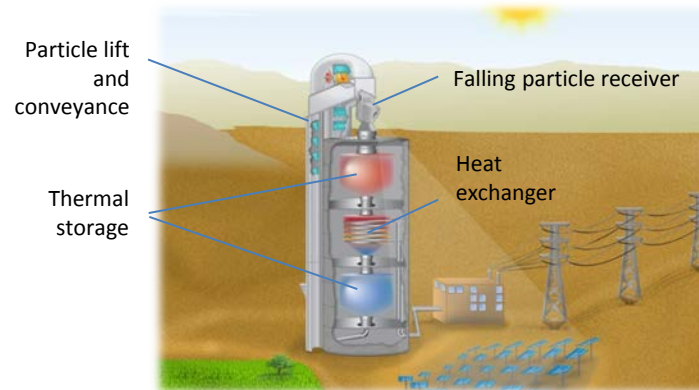
KEY RESULTS AND OUTCOMES

- A 6-m high prototype falling particle receiver with air recirculation was constructed
- CFD simulations of air and particle recirculation were performed to investigate means for higher temperature and efficiency
- Tests were conducted of particle flow through porous materials to confirm that clogging could be averted
- Changes in particle properties were characterized after heating
- Particle durability tests were performed to investigate attrition rates
- Prototype thermal storage bins were tested
- Small-scale and large-scale particle heat exchangers were constructed
- Over 10 conference papers/abstracts on this work have been submitted.



APPROACH

- This project employs modeling, design, testing, and optimization to further develop and improve key areas of falling particle receiver technology (see "Innovations") to achieve SunShot technical targets



PHASE 1 MILESTONES

- MILESTONE 1.1.1 – Complete the conceptual design of a lab-scale lift and recirculation system that will allow particles to be heated above 700°C
- MILESTONE 1.2.1 – Develop CFD model capable of simulating air recirculation, particle movement, and wind effects to minimize particle loss and heat loss
- MILESTONE 1.3.1 – Complete systematic study using mass measurements after successive particle passes through the porous structures
- MILESTONE 2.1.1 – Experimentally identify five or more candidate particle materials having steady-state solar weighted absorptivity in excess of 85%
- MILESTONE 2.2.1 – Identify particle parameters (e.g., size, density, material) that yield particle attrition that is less than 0.01% of the mass flow rate
- MILESTONE 3.1.1 – Deliver a ranked list of concept designs for Sandia on-sun storage testing
- MILESTONE 3.2.1 – Validation of the heat transfer model predictions with experimentally determined data
- MILESTONE 3.3.1 – Develop at least two viable designs for particle lift