Project ID: Economic Weekly and Seasonal Thermochemical and Chemical Energy Storage (08991)

A System Solution for Year-Round Dispatchable Solar

1. Impact

We suggest that achieving low-cost, reliable, resilient, and dispatchable concentrating solar power (CSP) will require multilayer system integration. At the plant level, three integrated and frequently used storage layers provide for power dispatchability: (1) short- (< 8 hrs or thermal), (2) medium (> 8 hrs; < 30 hrs; thermochemical to cover weeks with poor solar), and (3) long duration (> 30 hrs, chemical storage for seasonal balancing). At the economy level, chemical storage in the form of hydrogen (H_2) integrates with other energy and material end uses, to generate year-round value and revenue. The produced O_2 may also provide revenue from integration into near-by industrial eco-systems.

2. Project Goal

Develop the necessary component level technologies and system level analyses as well as control strategies for multi-layer energy storage that uses off-peak grid electricity and integrates with Gen3 supercritical CO_2 CSP plants with particle storage.

3. Method(s)

We are developing four core component level technologies: (1) thermochemical energy storage, (2) an electrically driven thermochemical H_2 production reactor, (3) an energy recovery reactor to transfer stored thermochemical energy to sCO_2 on demand, and (4) a heat-integrated thermally driven inert gas separation unit. System-level tools include component sizing, optimization, control, performance evaluation, and techno-economic analyses to determine strategies to minimize cost and maximize resource utilization and revenue.

4. Outcome(s)

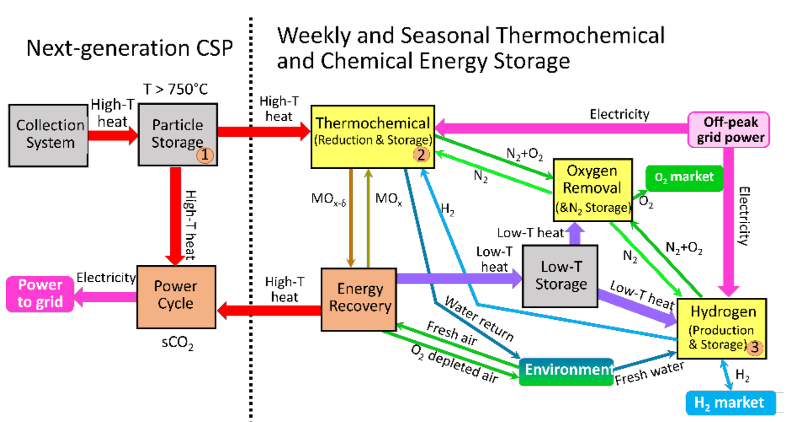
Key outcomes: integrated system with H_2 production at < \$100/kW_H_2 and 75 kWh/kg_H_2 (with improved materials from baseline CeO_2); TCES at < \$15/kWh_{th}; energy recovery unit using reduced TCES particles designed to heat sCO_2 from 550 °C to 720 °C at a pressure of 25 MPa; auxiliary sweep gas purification unit capable of reducing O_2 concentrations to < 100 ppmv.

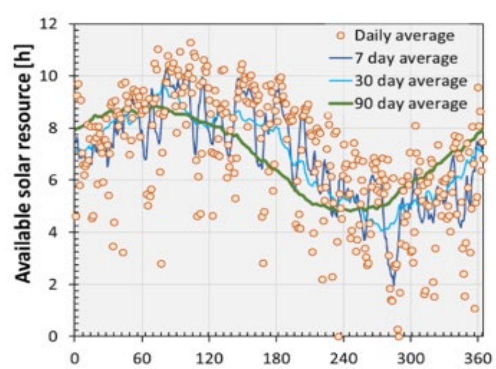
5. Conclusion/Risks

System and subsystem design for optimization and integration are vital to achieve both fit for purpose and cost effective year-round dispatchability.

6. Team

Arizona State University, Siemens Corporate Technology, Oregon State University, Southwest Research Institute, and Sandia National Laboratories.





Left: Simplified system process diagram with multilayer energy storage for Gen 3 CSP. Yellow (orange) components operate in charge (discharge) mode. Right: Typical solar variability at a solar rich site.