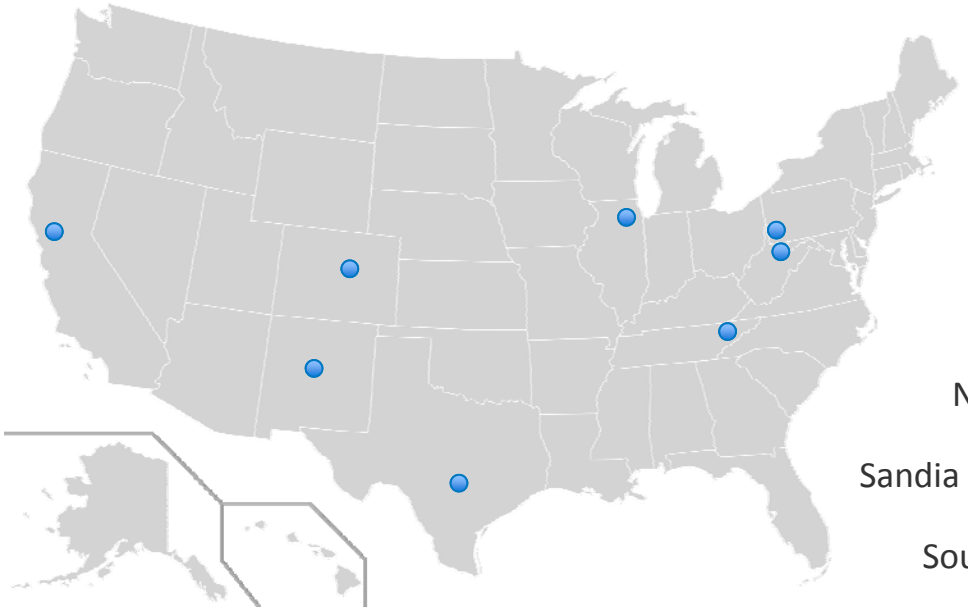
National Laboratory & Research Institute Panel



Argonne National Lab

Naval Nuclear Lab

National Energy Technology Lab

Oak Ridge National Lab

National Renewable Energy Lab

Sandia National Labs

Southwest Research Institute

NREL
NATIONAL RENEWABLE ENERGY LABORATORY

sCO_2 Power-Related Research at NREL

Craig Turchi

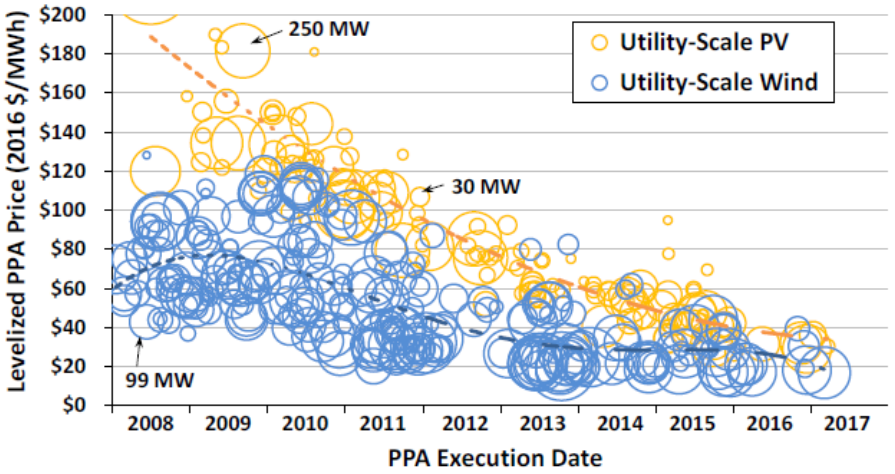
Supercritical CO_2 Power Cycles Symposium
Pittsburgh, PA

March 26-29, 2018


Crescent Dunes Solar Energy Facility, Nevada

Vision: a secure and sustainable energy future

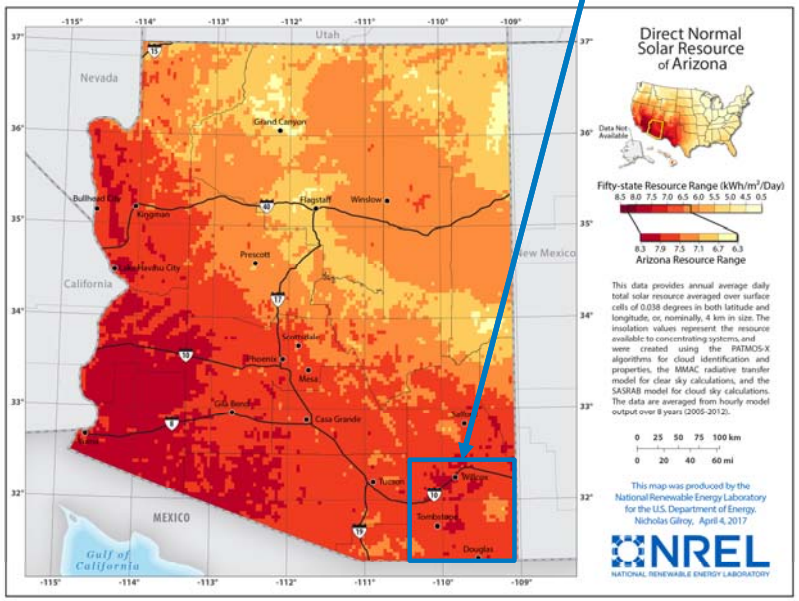
Renewable power prices continue to decline.



Recent Wind and PV power purchase agreement (PPA) prices. (These market PPAs reflect the impact of tax credits and other incentives.) [Wiser, Bolinger, and Seel 2017]

The United States has abundant energy resources of many types…

A single Arizona county receives enough solar energy to power the western U.S. interconnect.*



* Cochise County land with < 3% slope, 30% collector area, 16% solar-to-electric conversion efficiency

Role of CSP: Solar with affordable energy storage

But, CSP needs greater efficiency to be cost competitive.

- **Multiple hours of energy storage**
- **Dry cooling**
- **Dispatchable to grid demand**

SolarReserve's Crescent Dunes plant

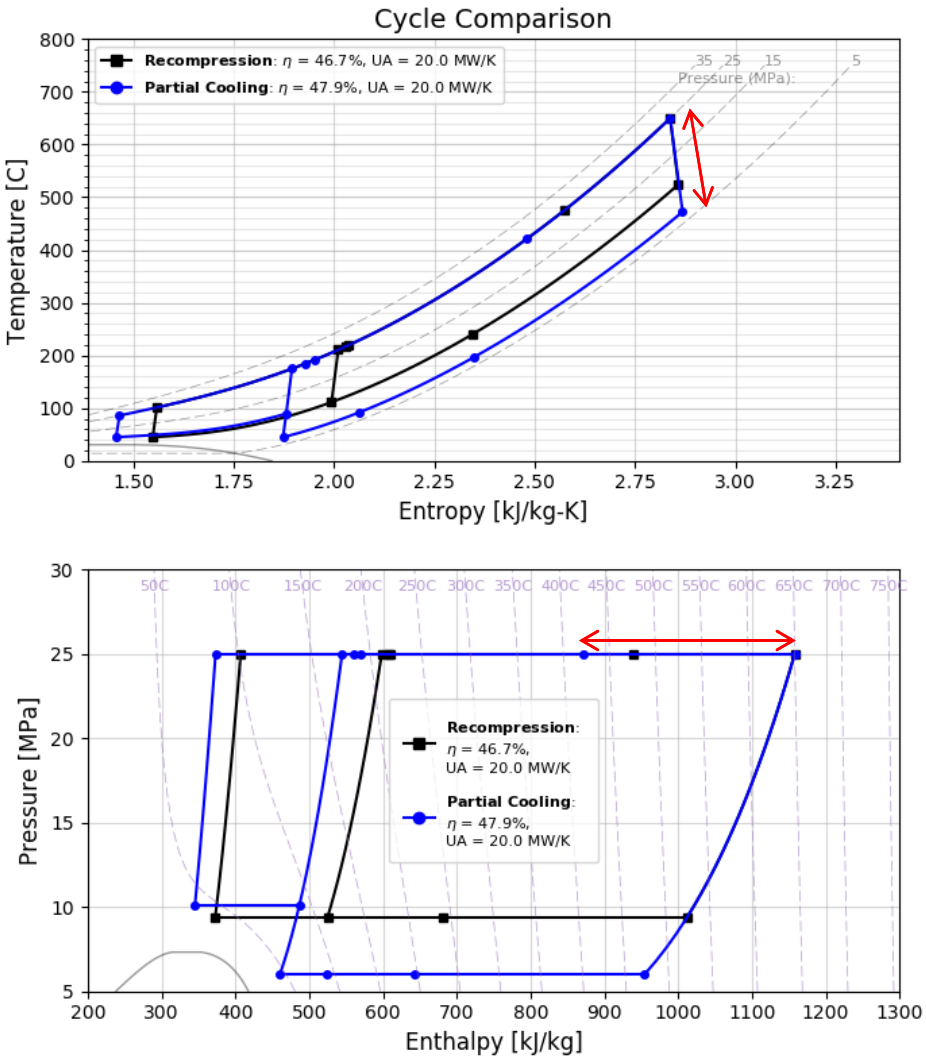
NREL Activities:
sCO_2 Cycle Design for CSP

CSP applications require:

- Integration with thermal energy storage (TES)

  $TES_{cost} \propto mC_p\Delta T$

- Dry cooling
- Annual performance simulations

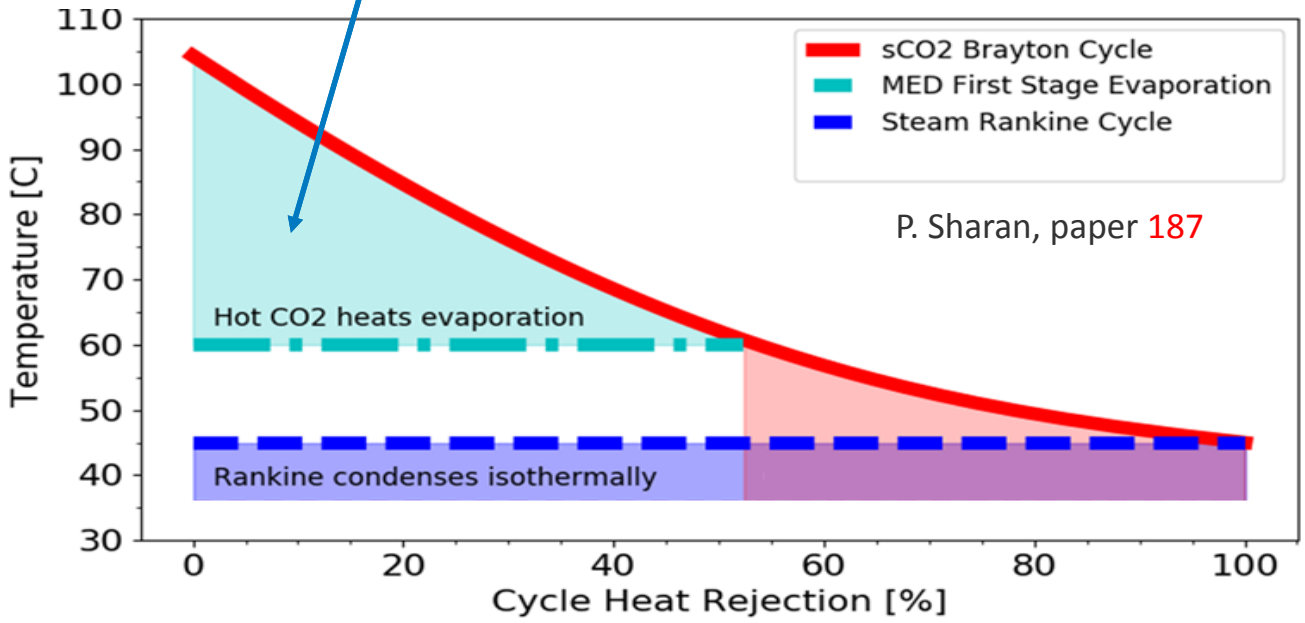


NREL Activities:
Cycle Cooling Options

Alternative cooling options:

- Dry cooling
- Integration of thermal desalination for cycle cooling + water production

Usable heat for thermal desalination



NREL Activities:
Integration with Molten Salt TES

CSP/sCO_2 Materials:

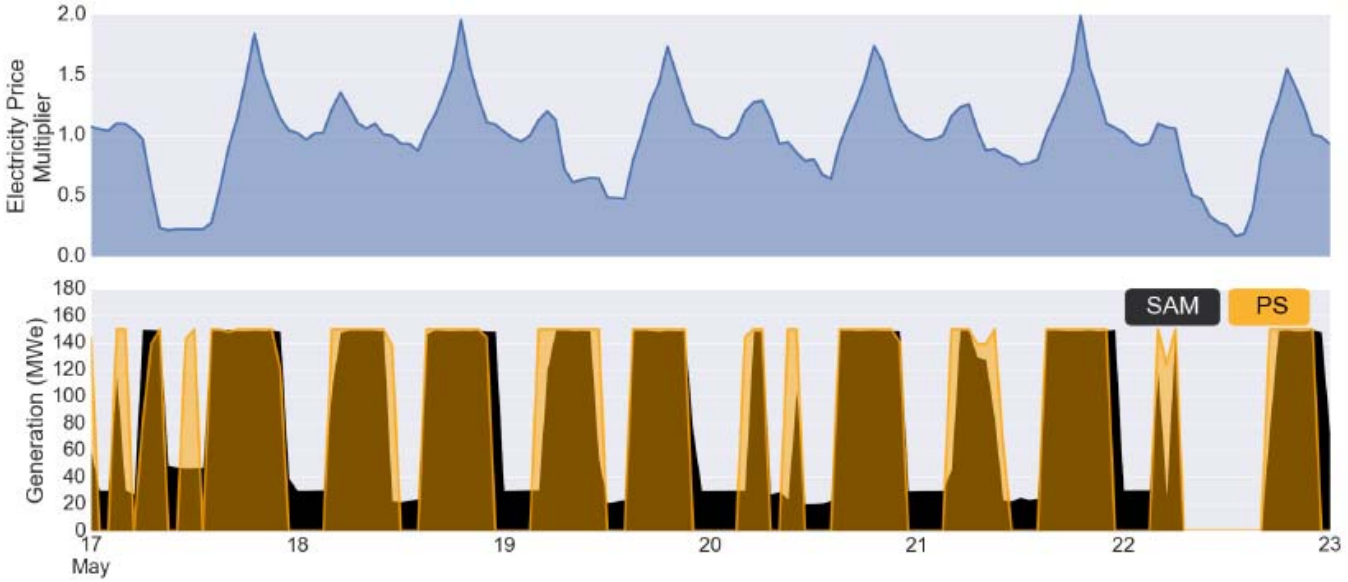
- Characterization of thermal energy storage materials
- Material compatibility and corrosion in molten salts

High-temperature Molten Salts

Purification	*Establish procedures to produce purified salts at commercial scale*
Chemical Optimization	*Optimize thermophysical properties for heat transfer and storage efficiency while minimizing corrosion and cost*
Property Data	*Validated data in the open literature*
Handling Protocols	*For preparation, purification, chemical optimization, and thermophysical properties testing*
CSP Community	*Balance near-term CSP industry needs with long-term objectives to meet SunShot cost targets for Gen3 CSP*

NREL Activities:
System Value

- Determine CSP value to grid
- Optimize CSP dispatch

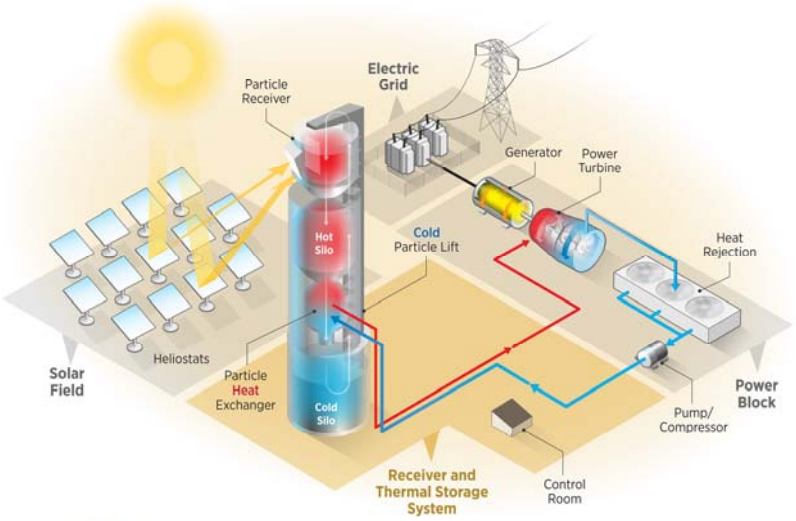


Grid price signal

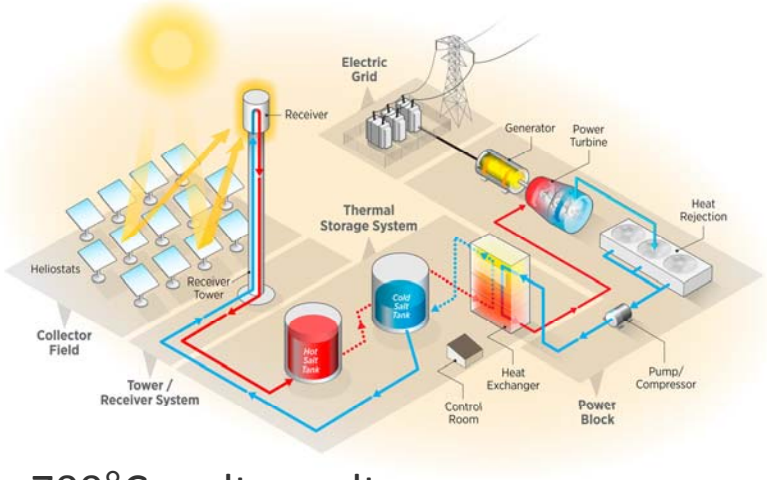
Black generation profile is a profit-maximizing dispatch schedule versus a simpler block-dispatch algorithm

NREL Activities:
Gen3 System Development

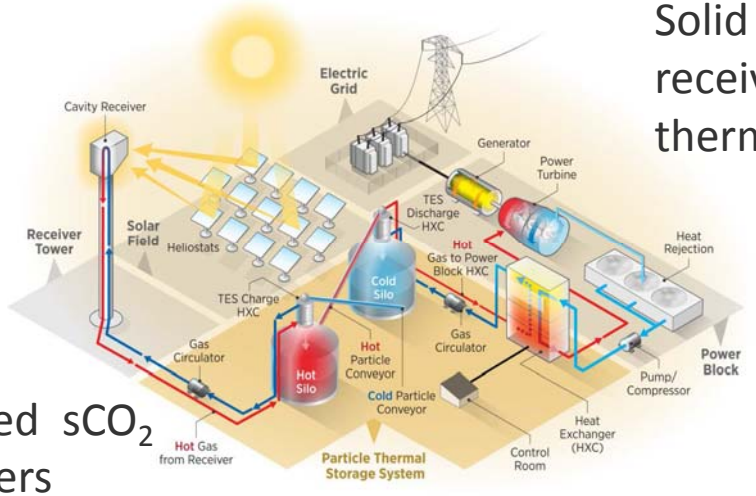
CSP Gen3 technologies are all designed to mate with sCO_2 power



Solid particle receivers and thermal storage



700°C molten salts



Direct-heated sCO_2 solar receivers

Thank you

www.nrel.gov

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