



Office of ENERGY EFFICIENCY
& RENEWABLE ENERGY

SOLAR ENERGY TECHNOLOGIES OFFICE

The Department of Energy's Concentrating Solar Power Thermal Energy Storage Initiatives

Dr. Matthew Bauer, Program Manager

6th TMCES Workshop

EPRI- Charlotte, NC. July 2024

energy.gov/solar-office

CSP is Deployed Worldwide



8.2 GW CSP deployed globally

1.5 GW CSP deployed in the U.S.

>40 GWh CSP TES globally



Examples of Domestic Commercial CSP

Solana's Mojave Solar Project (280 MW_e)



Solar Reserve's Crescent Dunes (100 MW_e)



SunVapor's Two Solar Industrial Process heat facilities for Dimethyl Ether Production & Almond Processing



LCOE of Concentrating Solar-Thermal Power (CSP)

The LCOE for CSP projects by technology and storage duration, 2010-2020



Source: IRENA, “Renewable Power Generation Costs in 2020.”
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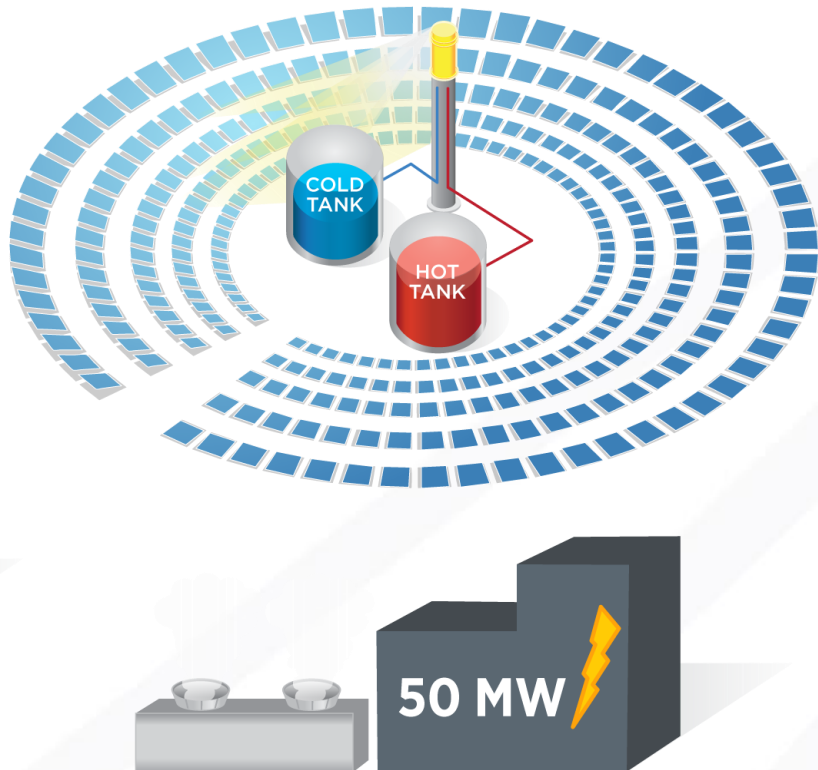
SETO CSP and CST for SIPH Program Targets

The value of CSP is direct generation of heat!

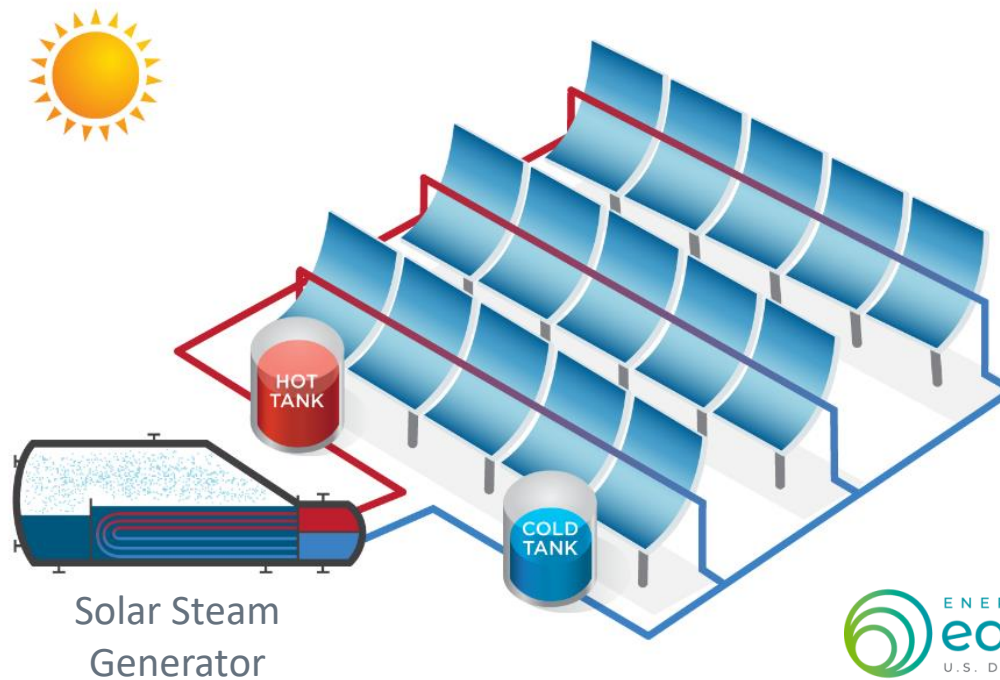
SETO programmatically targets a LCOE of 5¢/kWh_e with 12 hours of Thermal Energy Storage.

SETO targets a LCOH (Heat!) of 2¢/kWh_{th} for a broad range of industrial sector application and clean fuel production.

BASELOAD POWER



SOLAR PROCESS HEAT



- Desalination
- Agriculture and Food Processing
- Fuel and Chemicals Production
- Mining and Metals Processing
- Cement Production



ENERGY
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Industrial
Heat™



Solar Funding OPPORTUNITY

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ENERGY

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Solar-thermal Fuels
and Thermal Energy
Storage via
Concentrated
Solar-thermal Energy

CSP-TES Funding Opportunity Language

Definition	Target	Comments
Application	IPH Utility Power	Select application area to focus on temperature
Temperature for Focus Area	<350°C 350-550°C >550°C	Temperature of TES is determined by application and heat required for reaction/power
Temporal Requirements	Charge Time	Select based on application requirements
	Hold Time (user-defined)	
	Discharge Time (>10 hours)	
Objective/Goal	Target	Comments
Energetic Efficiency	Utility electricity 99% IPH user defined	Applicant needs to justify energetic- and exergetic-efficiency targets based on the application and scale
Exergetic Efficiency	Utility electricity 95% IPH user defined	
TES Capital Cost	15 \$/kWh	
LCOH Requirement	\$20/MW _{th}	LCOH cost definition includes collector field, receiver, and TES system
Temperature Stability: Equations (3), (4) $\Delta T_{(c,out,max)}, \Delta T_{(d,out,max)}$	10%	Modify if applications allow broader temperature
Thermocline Utilization Factor, ϵ , Equation (5)	70%	Only if thermocline used for TES

Selections Announced 7/25/24
(Last Thursday)

Examples of recent CSP-TES R&D given in the FOA

- 1) Commercial Nitrate Salt (Solar Salt)
- 2) Other Molten Salts
- 3) Flowing Particle Systems (Gen3 CSP)
- 4) Rock Bed TES
- 5) Solid-Liquid Phase Change TES
- 6) Thermochemical Energy Storage (TCES)

TES System Components: A complete TES system concept must account for:

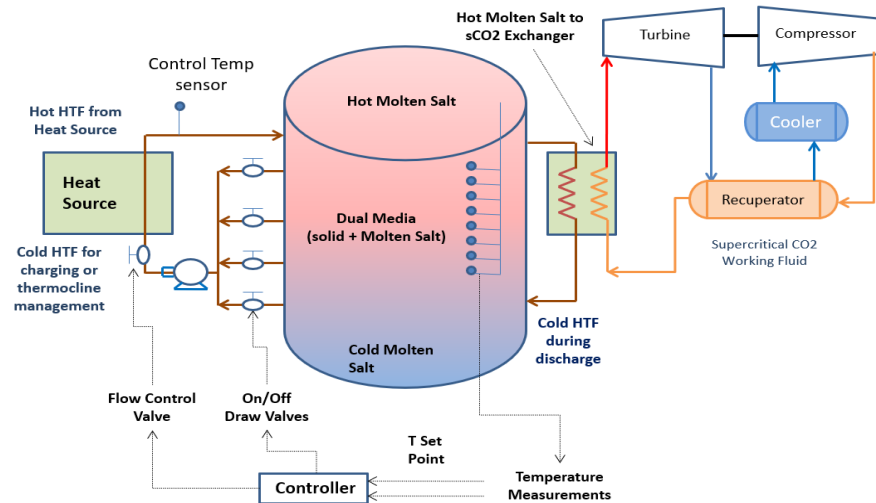
- The TES medium
- The TES containment vessels
- Any relevant heat exchangers, including heat exchange into the power cycle or process heat application working fluid
- Any associated chemical reactor or reactant storage for thermochemical energy storage
- Transport of the TES medium (e.g., salt pumps, particle conveyance systems)
- Piping, component interface, and auxiliary hardware
- Physical and operational integration with the full CSP plant

SETO New TES project Selections

Actively Managed Dual Media Thermal Energy Storage for Low-Cost Solar Thermal



SOUTHWEST RESEARCH INSTITUTE



The team proposes to test an advanced dual media energy storage (DMTES) system that uses liquid molten salt and solid storage in a thermocline, providing heat to a supercritical carbon dioxide system through a heat exchanger.



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Low-Cost Pressurized Water Storage for CSP Applications

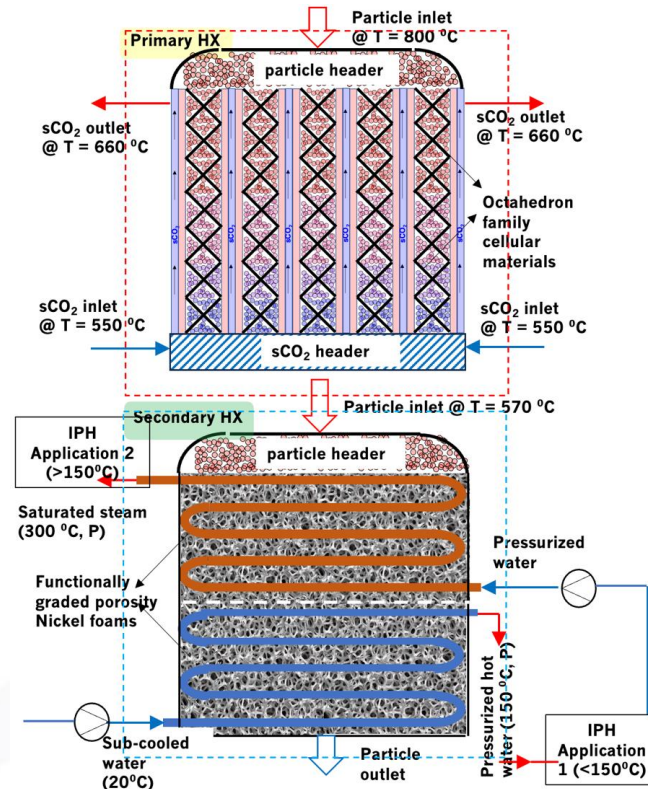
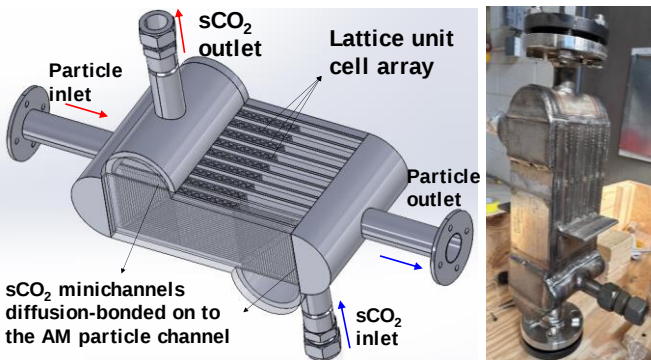


The HeatTrap™ storage system stores energy in the form of pressurized hot water, combining established pipeline technology from the oil & gas (O&G) sector with a translating piston system and controls to separate each storage pipe into distinct high and low temperature regions.

SETO New TES project Selections



High performance cascaded additively manufactured heat exchangers for clean and low-cost power generation and industrial process heating

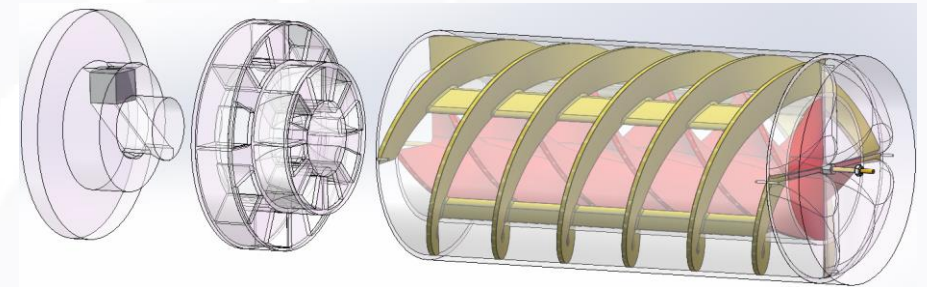


The project goal is to develop and demonstrate an integrated concept where CST energy is used for both, sCO2-based low LCoE power generation and meeting over 60% of IPH applications through energy recovery and efficient reuse.

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Thermal Energy Storage and Exchange with Integrated Rotating Media Transport



A novel particle based CSP design integrating storage, media transport, and heat exchange into a single vessel

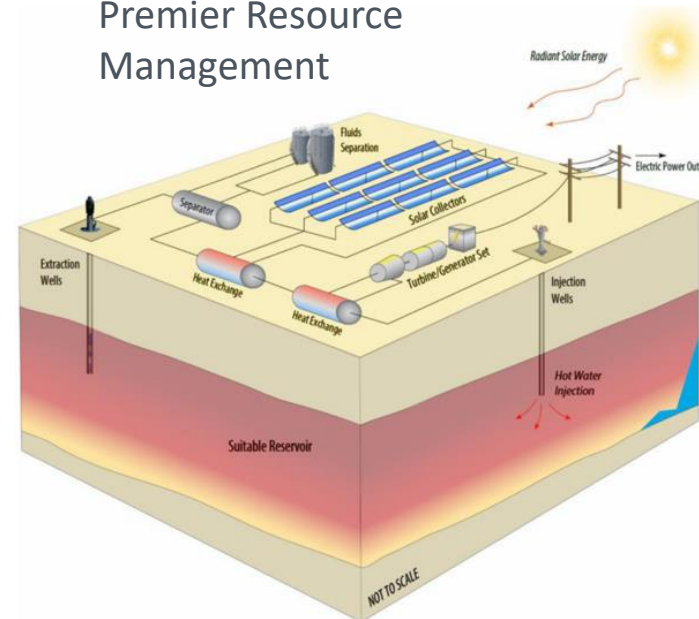


SETO New TES project Selections



Premier Resource Management

Daily and Long Duration Storage for CST using Geological Thermal Energy Storage: Pilot Plant and Techno-Economic Analysis



The project will install a $>100 \text{ kW}_e$ pilot plant using a 2 MW_{th} parabolic trough installation to demonstrate daily and long duration storage in geological TES. This project will demonstrate that CST-GeoTES can manage daily and seasonal variations in energy demand using low-cost energy storage.



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Brewing for Tomorrow
FIRESTONE WALKER

Concentrated Solar Thermal Heat Energy and Steam Storage System for Net-Zero brewing operations

This innovative project will feature a $12,700 \text{ m}^2$ solar field system coupled with integrated Thermal Energy Storage (TES).

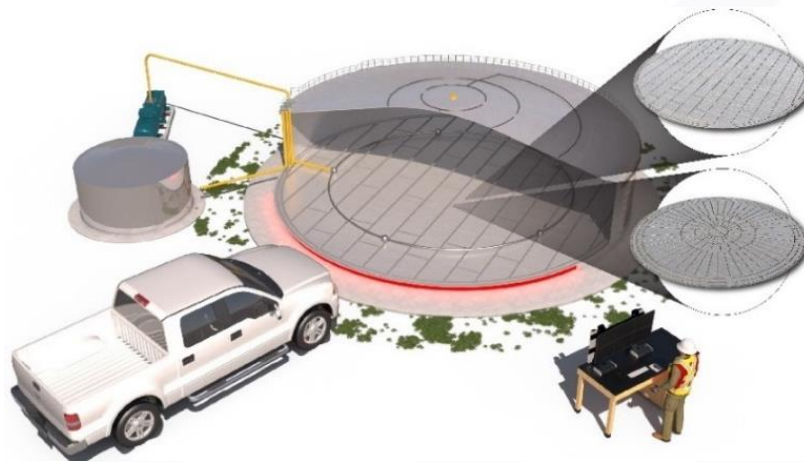


New Projects from SETO's National Laboratory Call



Addressing Failures in Molten Nitrates Thermal Energy Storage Tanks Through the Design and Fabrication Optimization of the Tank floor and Experimental Validation

SolarDynamics



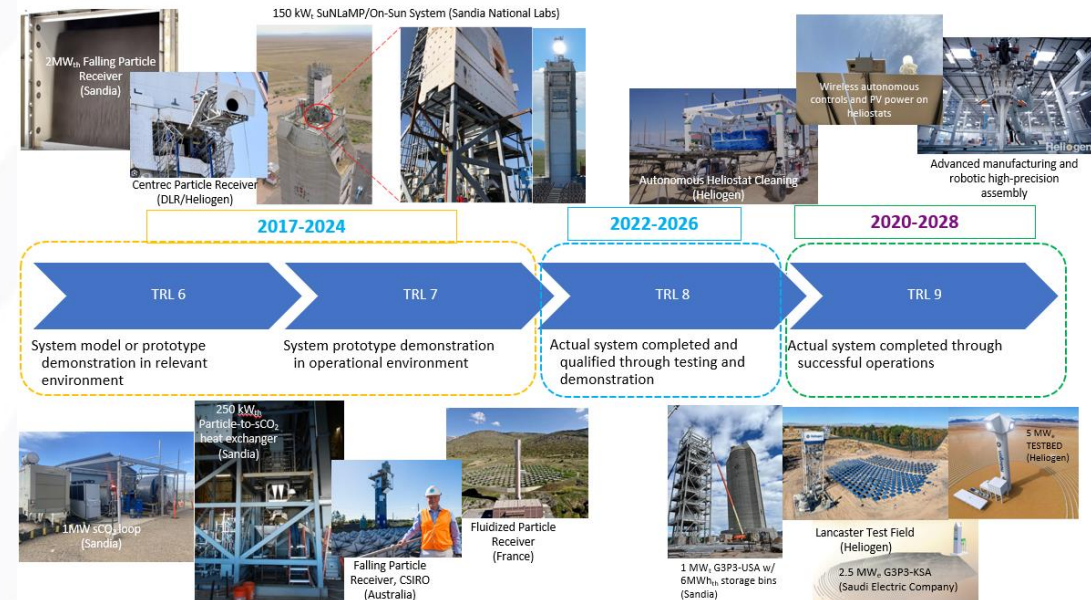
Improve tank's floor design, fabrication procedures, and implementation for new plants. We will provide guidelines to inform CSP stakeholders on proper design, fabrication, and implementation procedures to support the future deployment of reliable and cost-effective CSP thermal energy technologies.



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Advanced Solar Generation And Resiliency Deployment (ASGARD) Front End Engineering Design Study

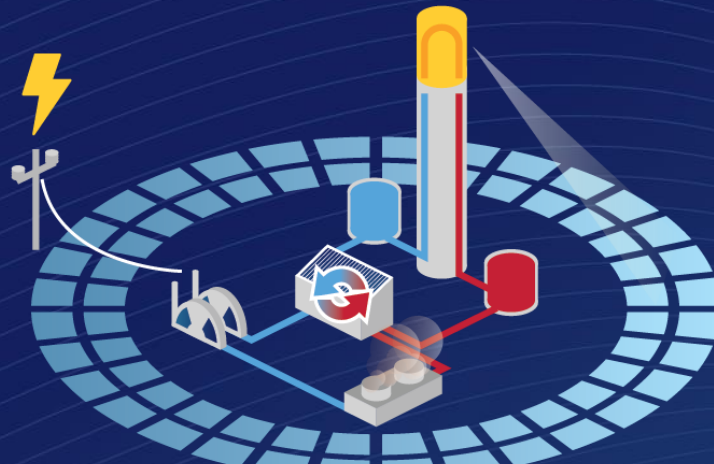


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Apply for funding through the

SMALL INNOVATIVE PROJECTS IN SOLAR (SIPS) PROGRAM

Think outside the box. Nearly any solar energy technology idea is eligible. SIPS aims to improve:



**Funding up to
\$400,000**

Concentrating Solar-Thermal Power

- Thermal energy storage
- Solar-thermal industrial processes
- Solar-thermal fuels
- Solar collectors (e.g. heliostats)
- Turbomachinery



**Funding up to
\$250,000**

Photovoltaics

- Power conversion efficiency
- Field performance
- Service lifetime
- Manufacturability
- Reuse and recycling



**Produce
significant
results in
12-18 months**



**Quickly
validate
novel
concepts**



**Lay the foundation
for later-stage
research and
development**

Learn more:

energy.gov/eere/solar/small-innovative-projects-solar-sips-program

Heliostat Consortium



U.S. Department of Energy

HelioCon

Heliostat Consortium for
Concentrating Solar-Thermal Power

Objectives of the \$25 million consortium:

- Develop strategic roadmaps for improving the cost and performance of commercial heliostats, to substantially reduce the cost of capturing solar-thermal energy
- Develop key testing capabilities to validate and optimize industrial heliostat technologies
- Fund collaborative research on heliostat innovation
- Form U.S. centers of excellence focused on heliostat technology
- Promote workforce development of the next generation of CSP researchers and industry



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