National Laboratory of the Rockies

TMCES Capabilities and Projects at NLR

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TMCES

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The National Laboratory of the Rockies

South Table Mountain Campus
Golden, CO

Flatirons Campus
Arvada, CO

Alaska Campus
Fairbanks, AK

Washington, D.C.,

NLR offers distinct capabilities in foundational science, experimental facilities, component R&D, and systems integration. High-level TMCES capabilities include:

- Experimental and demonstration facilities
- Component R&D
- Datasets and tools for techno-economic analysis

(This presentation does not discuss NLR's biofuels or hydrogen capabilities. Please visit their respective websites for more information)

ARIES
by NATIONAL LABORATORY OF THE ROCKIES

ARIES provides a platform to test and demonstrate storage and control technologies at scale, integrated with physical hardware, and under replicated grid scenarios.

- MWe-scale HIL capabilities at Flatirons and ESIF
- Virtual options to include off-site installations
- Jen Kurtz presenting on ARIES tomorrow

Energy Systems Integration Facility

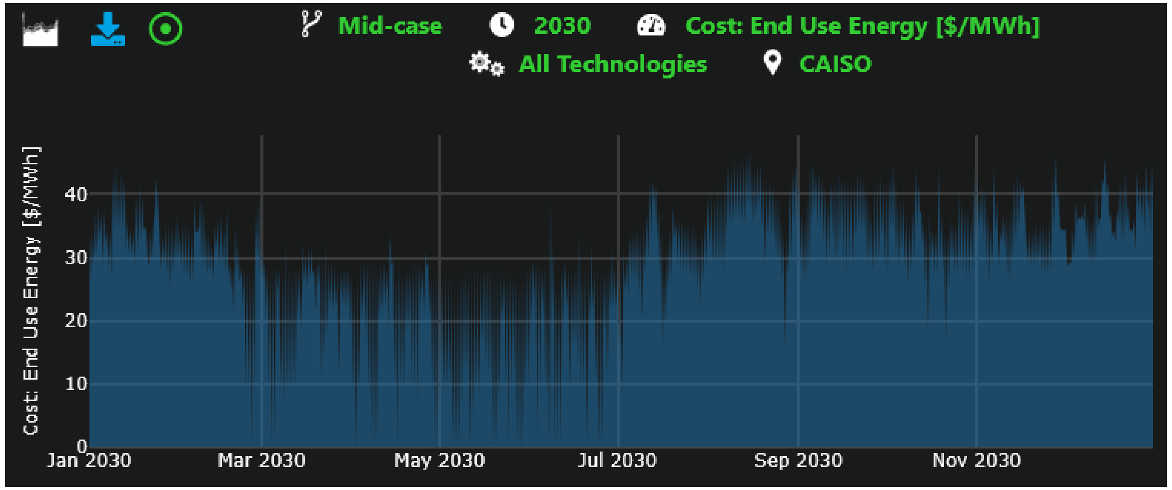
Flatirons Campus

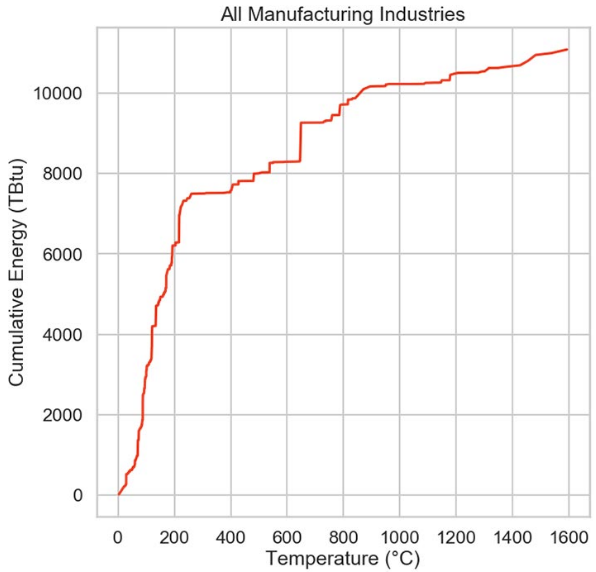
Virtual Emulation Environment

Datasets

Datasets provide easy access to standard inputs and scenarios to help emerging technology solutions estimate techno-economic performance for utility-scale and commercial applications

- Cambium: Dataset of hourly marginal costs in future grid scenarios
- Utility rate database (URDB)
- Annual technology baseline (ATB): current and projected cost of commercial technologies; e.g. PV, batteries
- Manufacturing thermal energy use in 2014: Estimates thermal energy use by end use, temperature, county, and facility employment size class for all U.S. manufacturing industries in 2014
- ComStock datasets: Estimate the timeseries and annual energy consumption of the U.S. commercial building stock



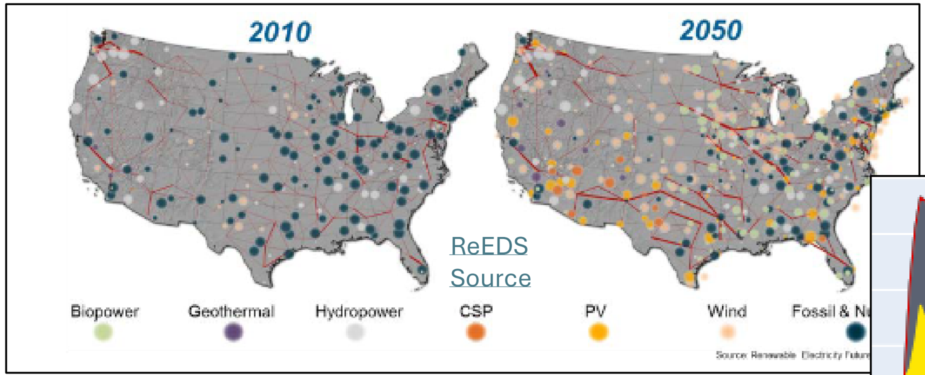


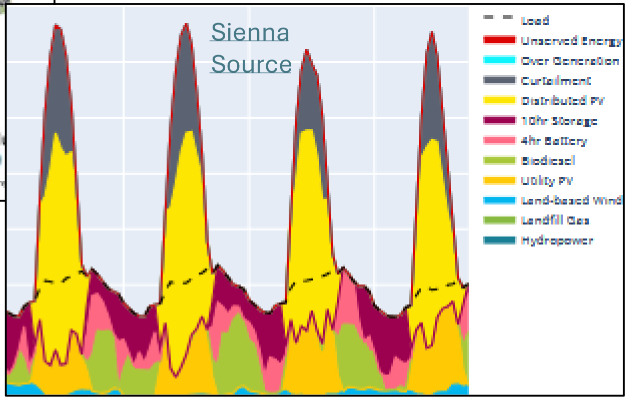
Source

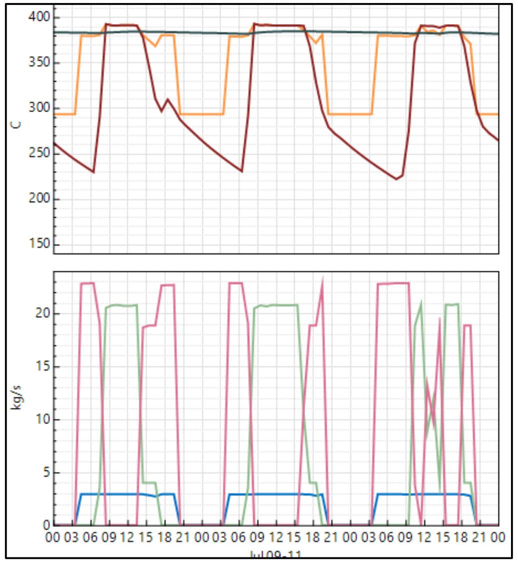
Modeling Energy Storage

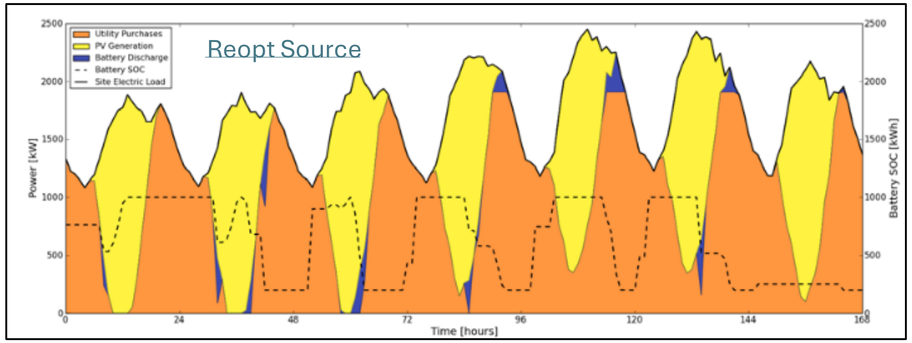
NLR develops tools to analyze grid planning, grid operations, distributed, and technology-level performance of ES technologies. LDES technologies can potentially provide new value streams that require modified modeling approaches to fully understand their value (e.g. longer dispatch horizons; unique performance characterization).

- ReEDS: Capacity expansion modeling (or investment modeling) can examine the long-term trade-offs of generation, storage, and transmission
- Sienna: Production cost modeling or dispatch modeling shows how different resources on the grid operate in real-time
- REopt and STEP 1 (solar thermal): Optimizes technology mix, sizing, and operation of *distributed* electricity and thermal energy and storage
- SAM: First-principles time-series performance modeling of renewable energy and storage technologies. Evaluate non-linear off-design performance with high level dimensional inputs. E.g. solar thermal, ETES, PTES



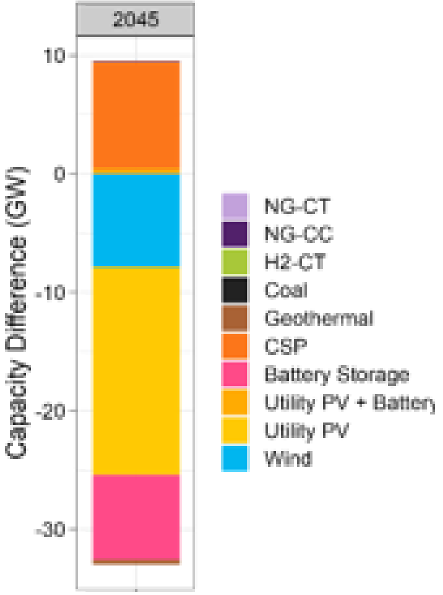




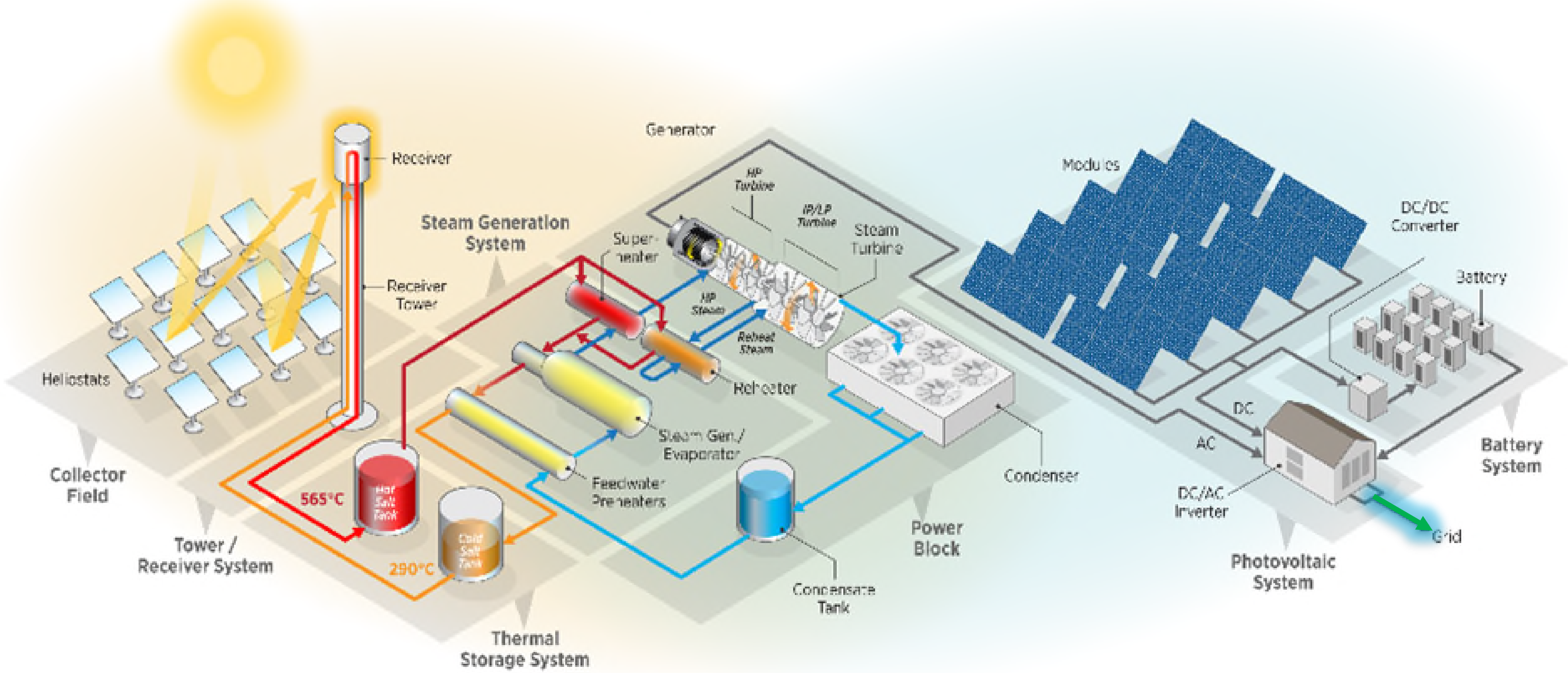


CSP as a LDES technology

- CSP+PV hybrids are the norm for recent international CSP deployment
- Direct heat to TES is a low-cost option to increase plant capacity factor
- Potential to hybridize TES uses (e.g. absorption chiller for cooling loads)

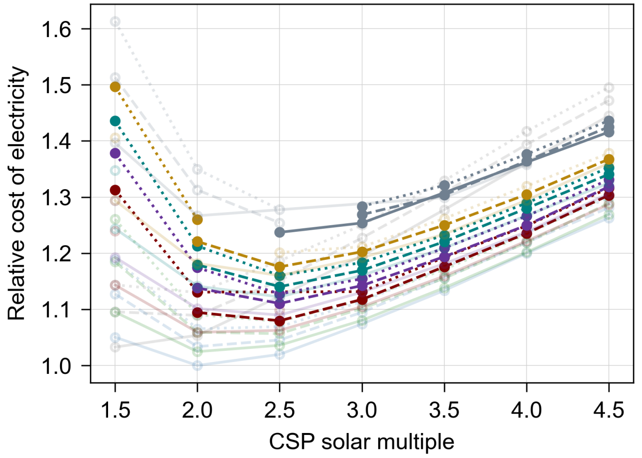


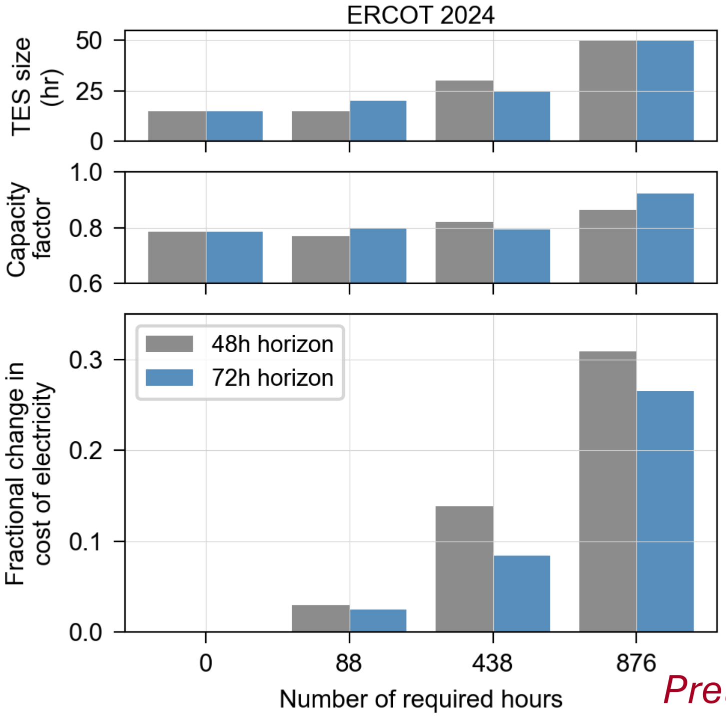
[Capacity expansion modeling](#) in US SW shows future “high renewables” scenarios require significantly less capacity if CSP is included in model.



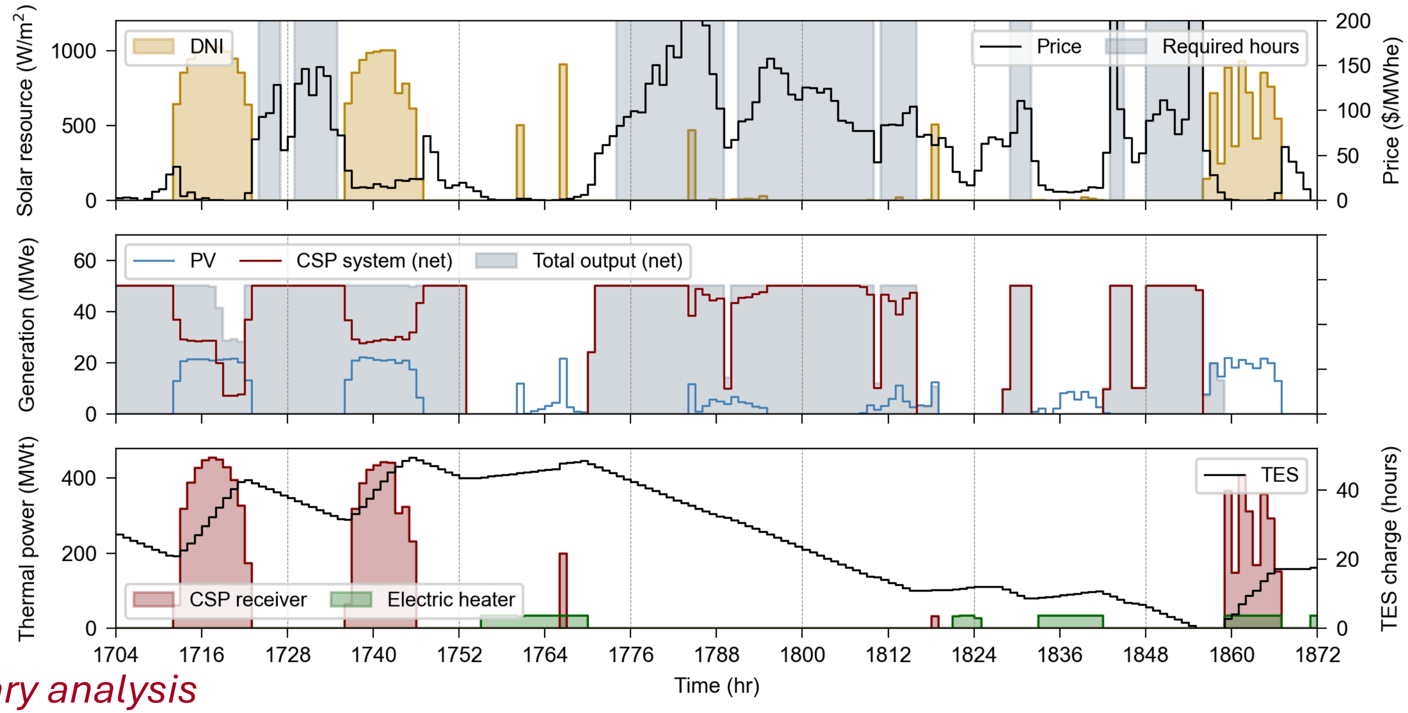
CSP LDES as a Reliable Generators

- 2024 LMPs and hourly weather from west Texas
- Plant operated to always generate nameplate output at selected percentile of highest annual LMPs
  - Parametric sweep of key design parameters to find lowest cost-of-energy solution that meets constraints
- Hybrids can generate in all high stress periods by adding TES and solar field, with a ~25% increase in cost-of-energy relative to unconstrained optimal to generate during top 10% highest LMPs



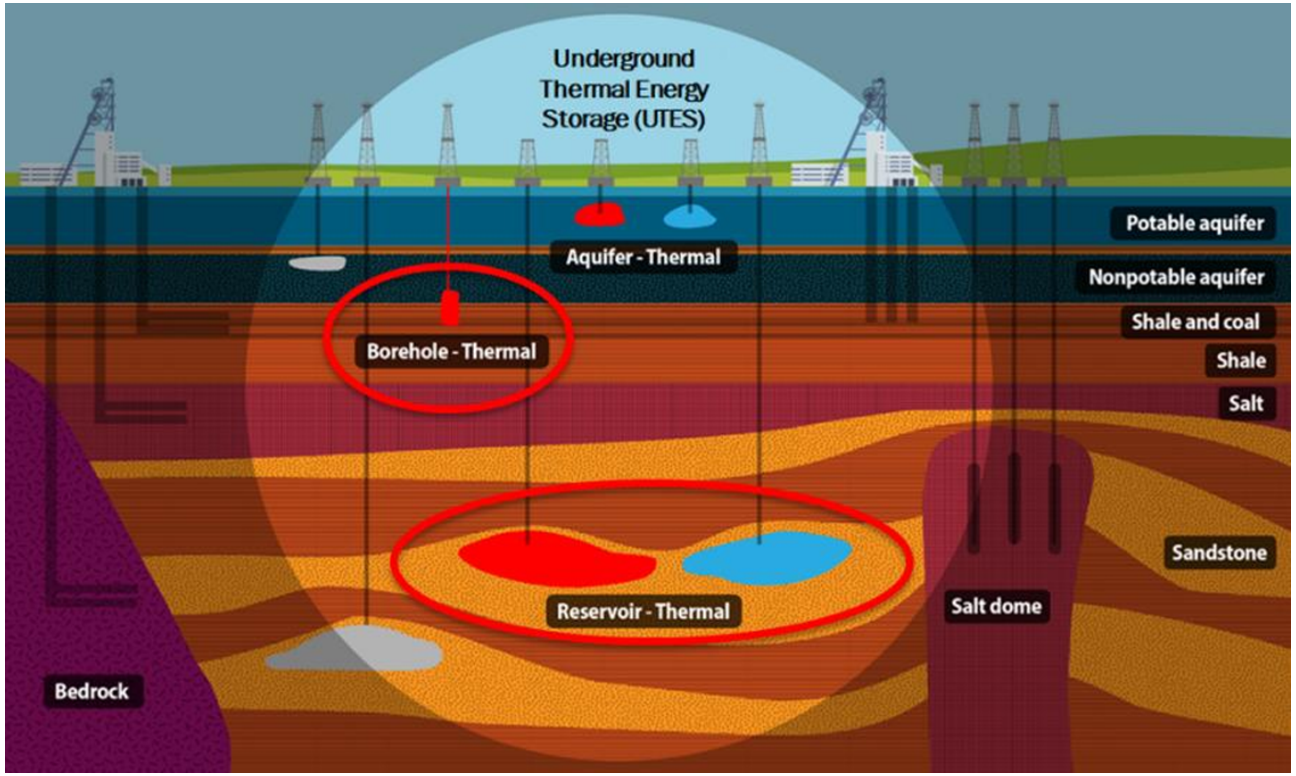


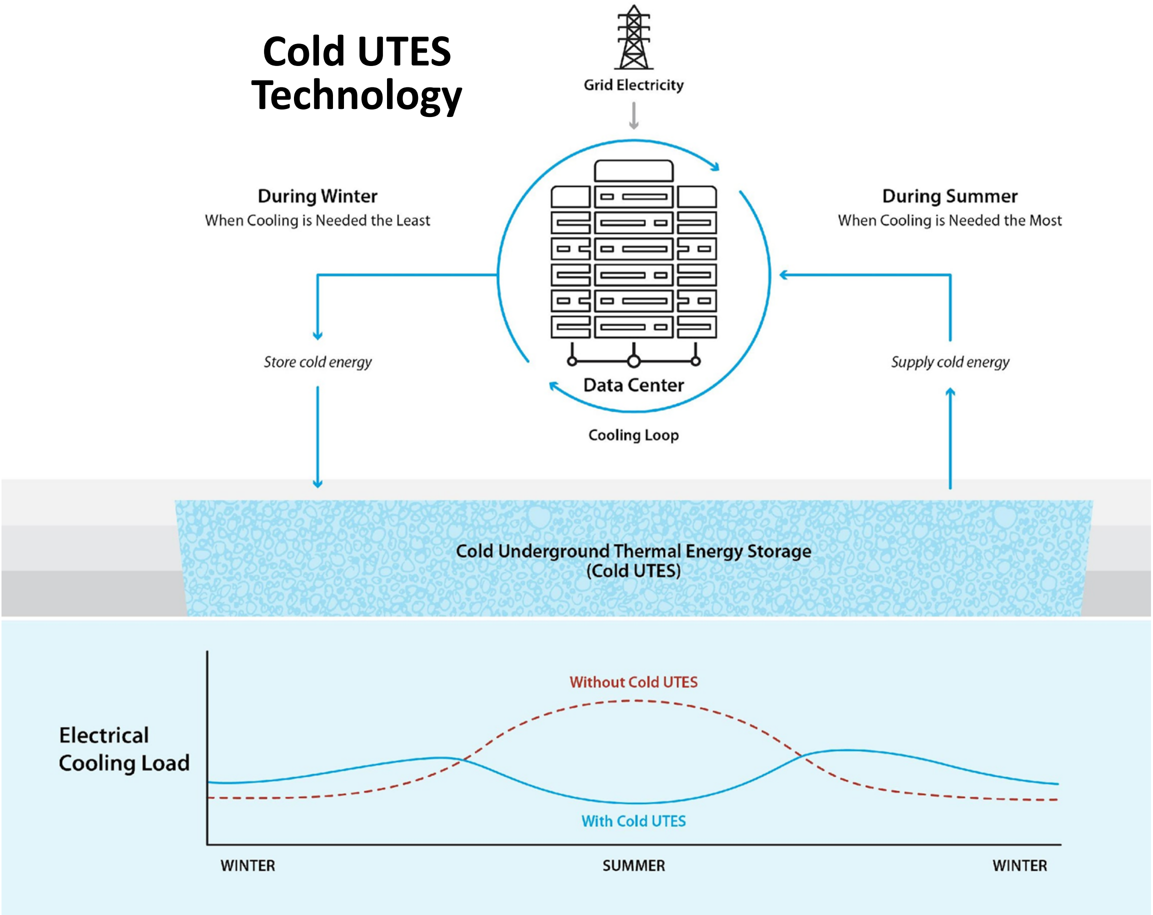
Preliminary analysis



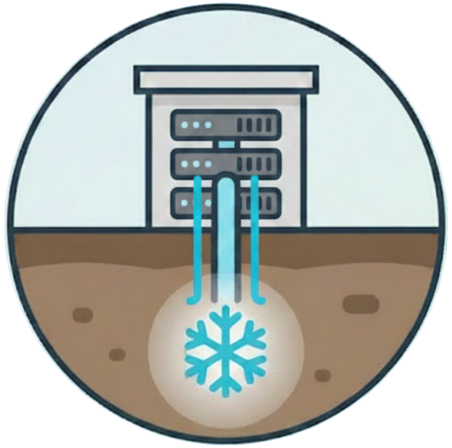
Reducing Data Center Peak Cooling Demand and Energy Costs With Cold Underground Thermal Energy Storage (Cold UTES)

Develop a no-water-consumption, seasonally dispatchable geothermal cooling technology





Key Takeaways from Project Phase 1



Offers solution for data center cooling

Cold UTES can provide dispatchable, economic cooling taking advantage of seasonal temperature variation

System & grid level models

System level models assess performance, dispatch, and cost while grid models assess impact on capacity buildout and costs

Multiple value streams

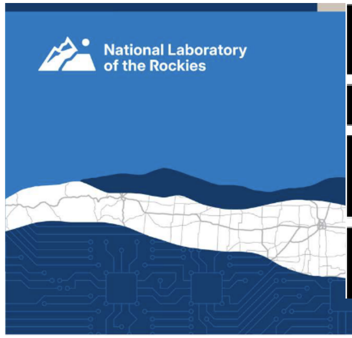
↓ peak loads

↓ water consumption

↓ electricity consumption & cost

↑ IT capacity

↑ grid savings

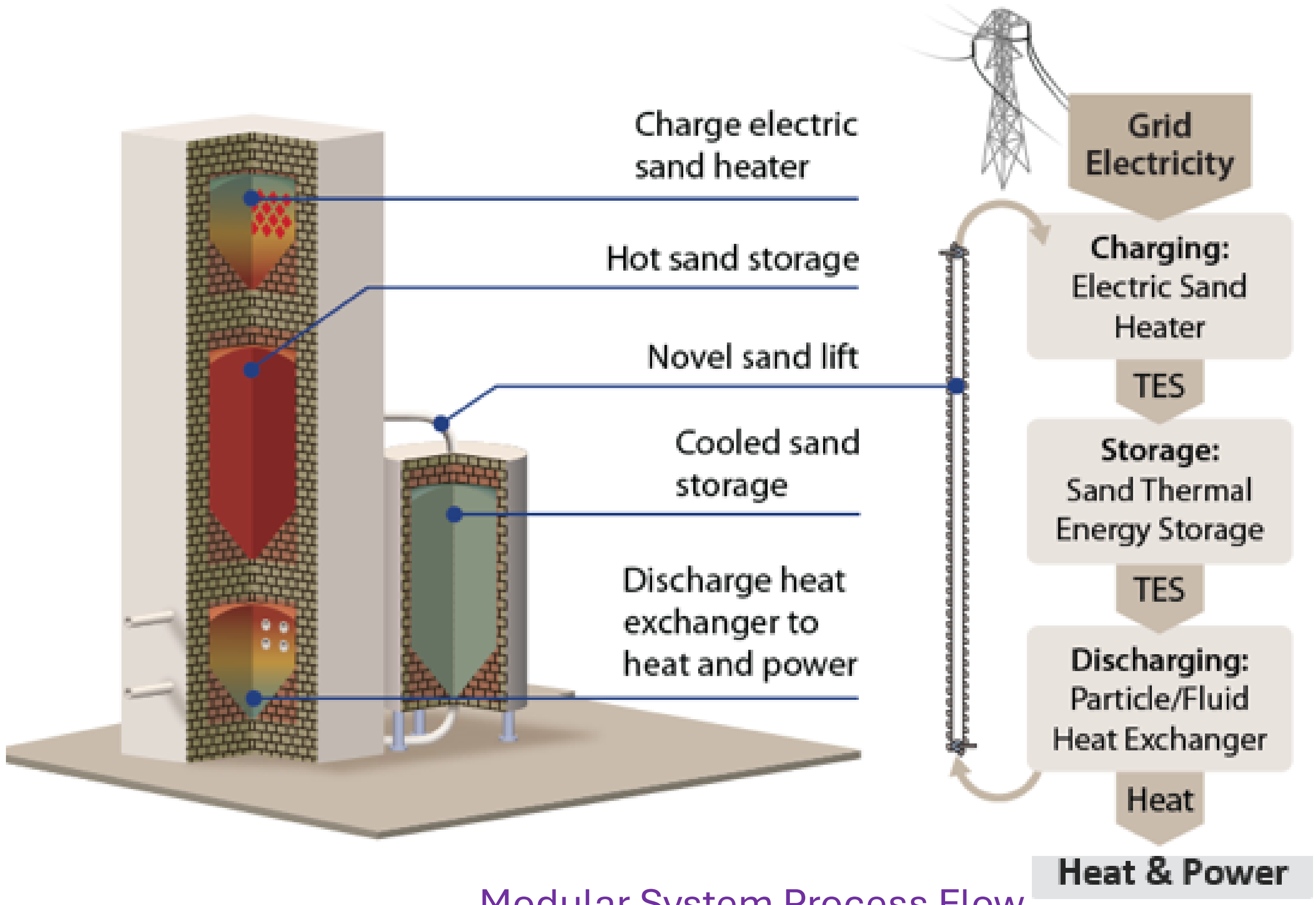


Project Phase 1 Report:
Reducing Data Center Peak Cooling Demand and Energy Costs With Cold Underground Thermal Energy Storage (Cold UTES)

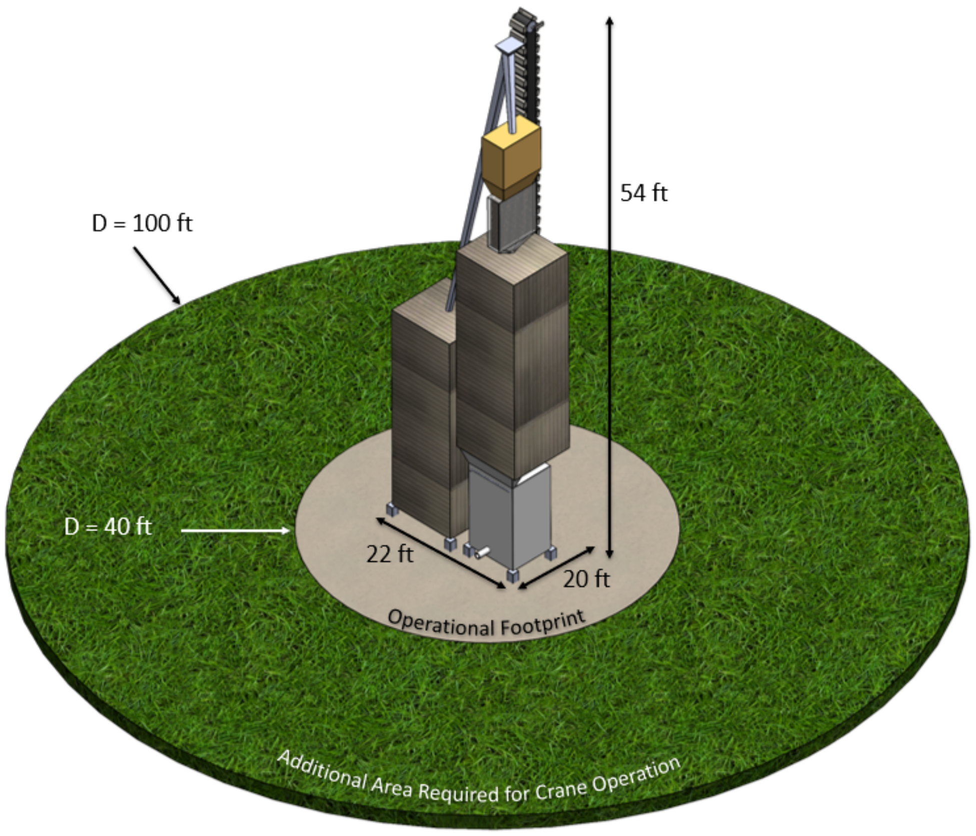
Project Report

- Summarizes methods
- Facility models
- Grid models
- Partnerships
- Gaps and next steps

Modular System Development & Demonstration Plan



Modular System Process Flow



Modular TES Demonstration Pan

Demonstrating a modular system is key to supporting market acceptance

Thank you!

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