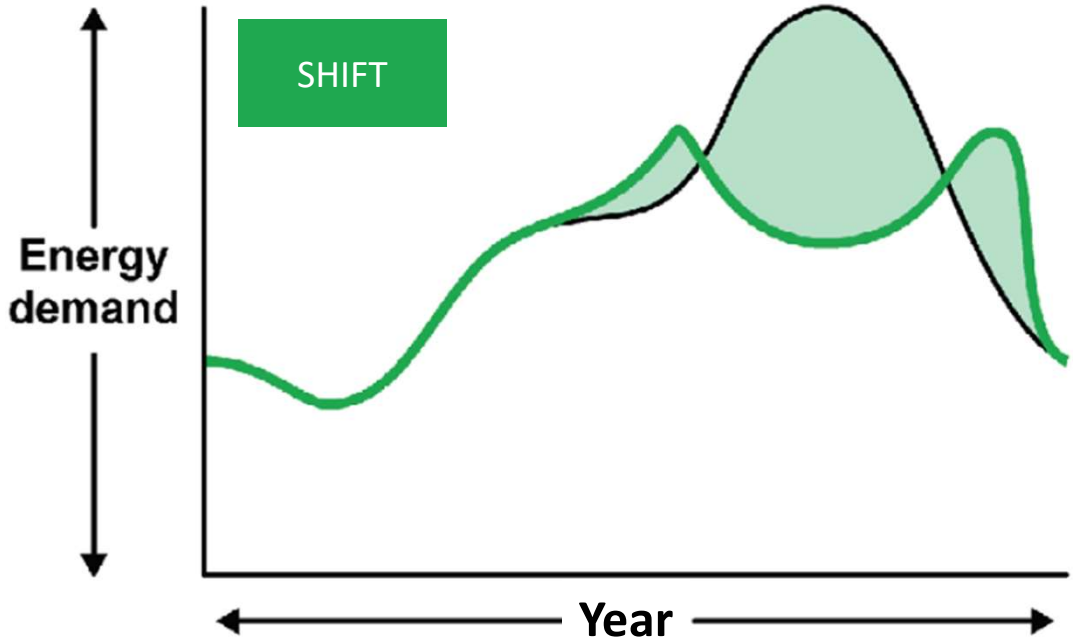
Underground Thermal Energy Storage

Office of Geothermal
Jeff Winick
July 29, 2026

U.S. DEPARTMENT of ENERGY | Hydrocarbons and Geothermal Energy Office

Underground Thermal Energy Storage is Valuable

- Addresses peak load
- Supports grid resilience and reliability
- Cost-effective at scale
- Time-shifting - arbitrage energy and price
- Flexible (seasonal or diurnal) energy storage



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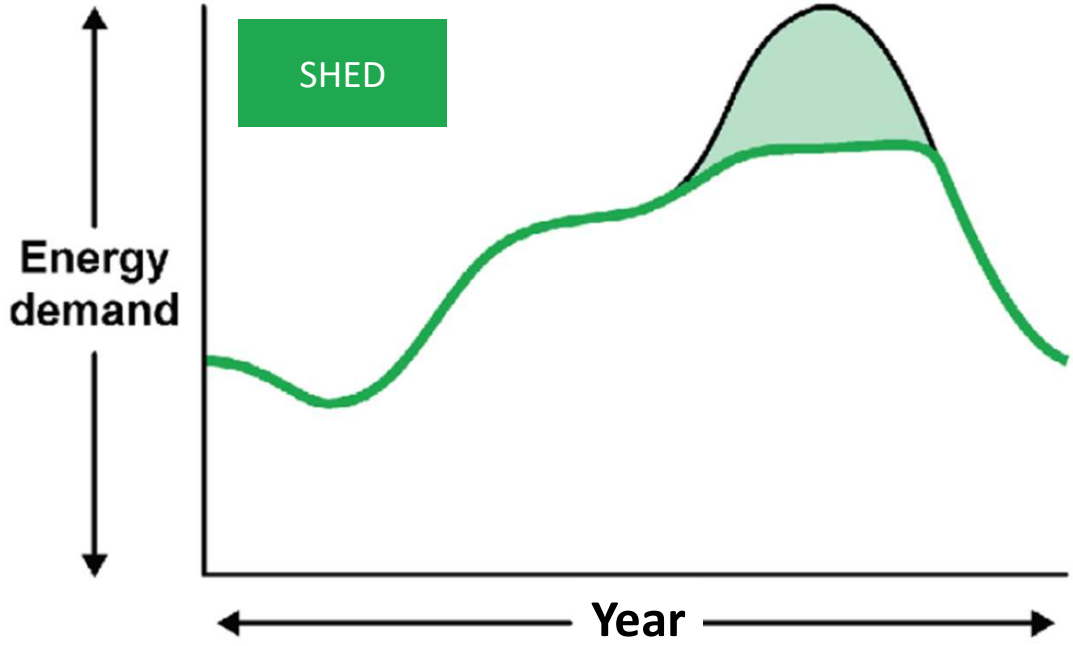

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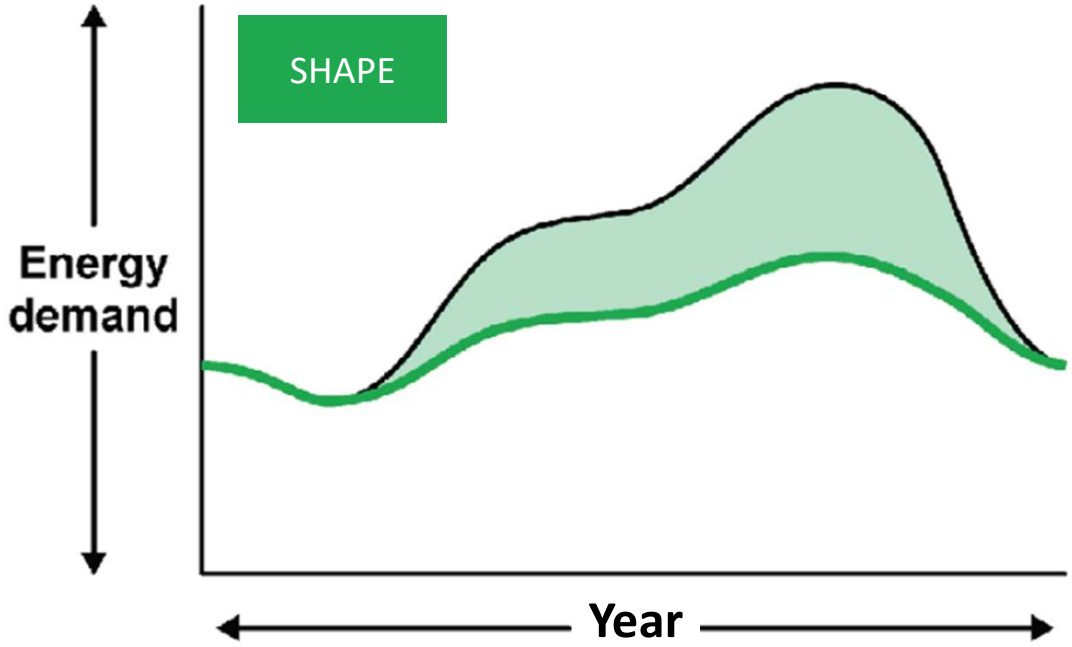

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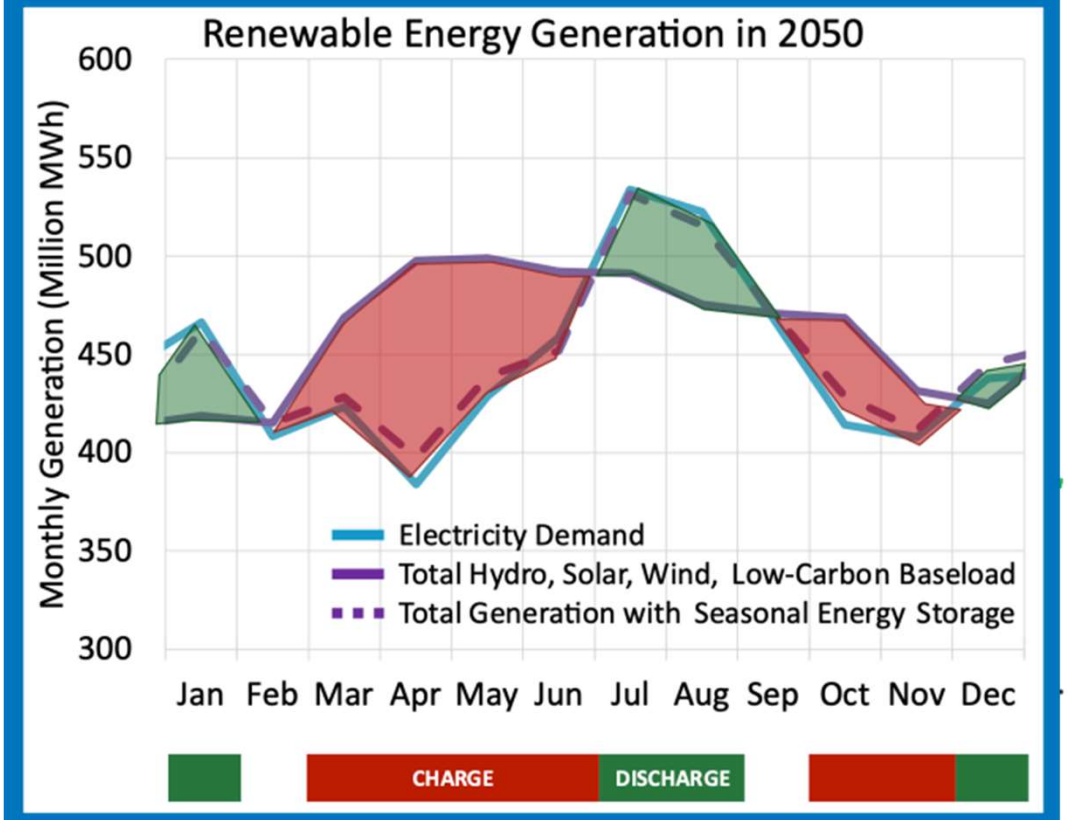
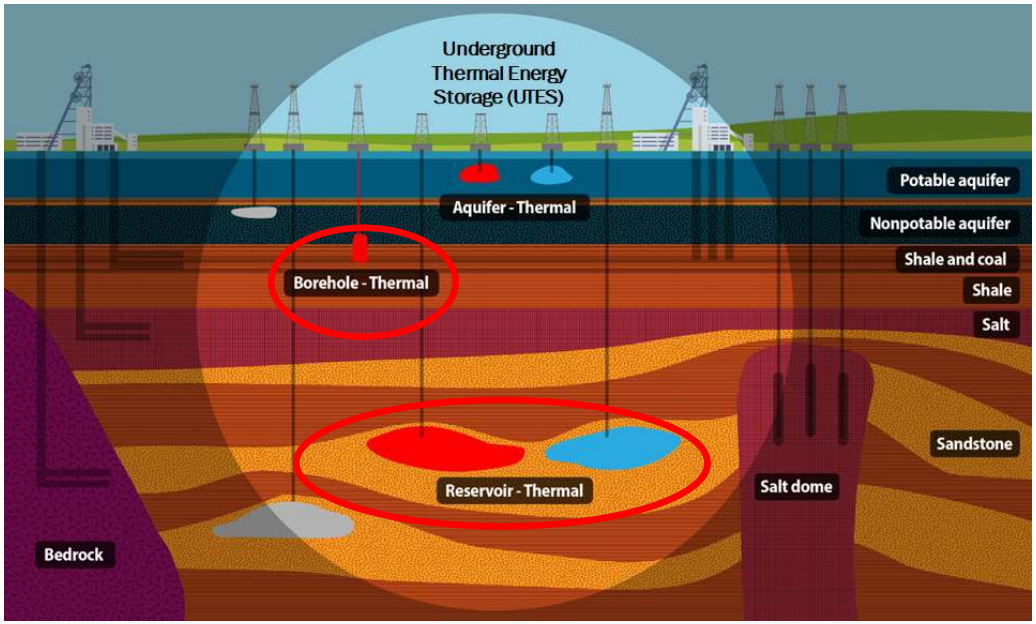


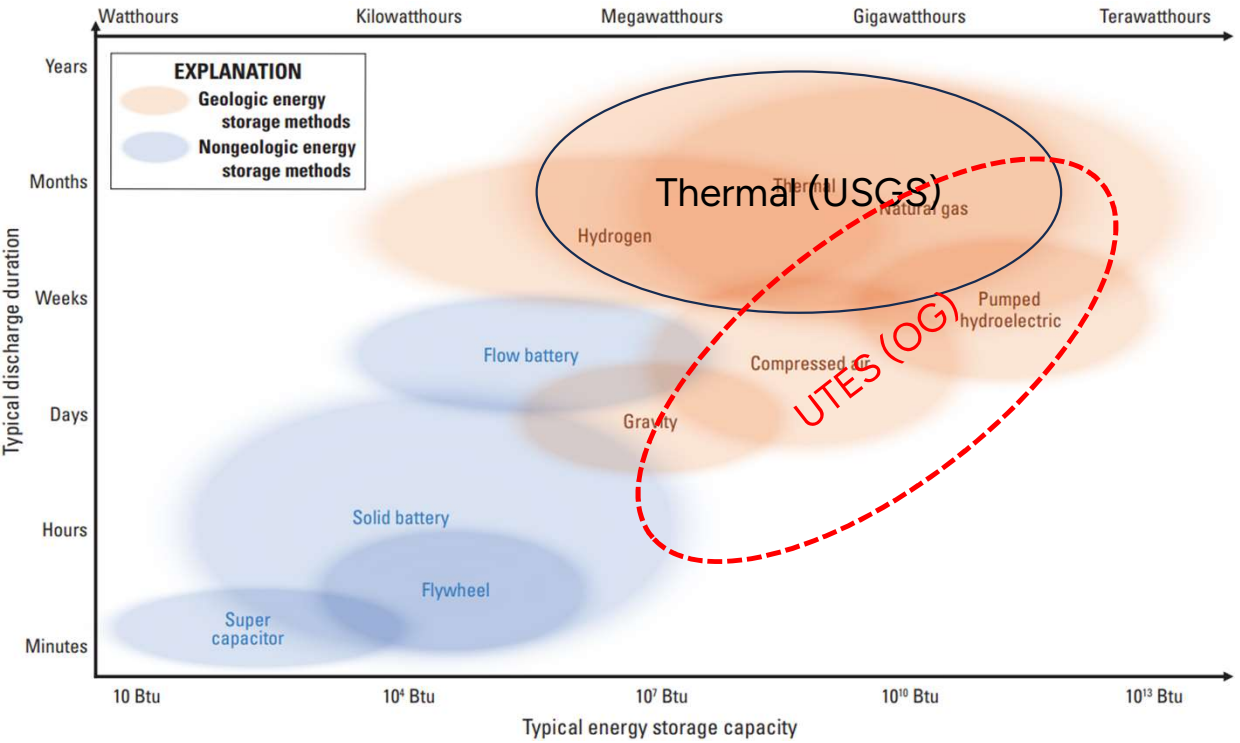
Seasonal Energy Storage, A Technical and Economic Framework
EPRI, 2022

Variants of Underground Thermal Energy Storage

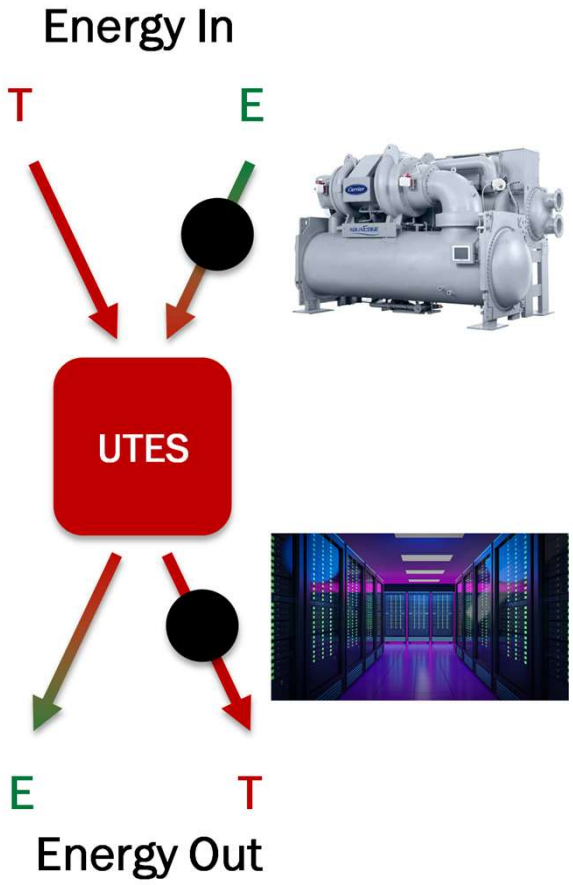
- Relies on heat capacity of the rock
- Can store heat or cold
- 3 Basic Types: ATES, BTES, RTES
- Broad geographic applicability



Energy Storage Costs, Duration, and Capacity



https://pubs.usgs.gov/fs/2022/3082/fs20223082.pdf



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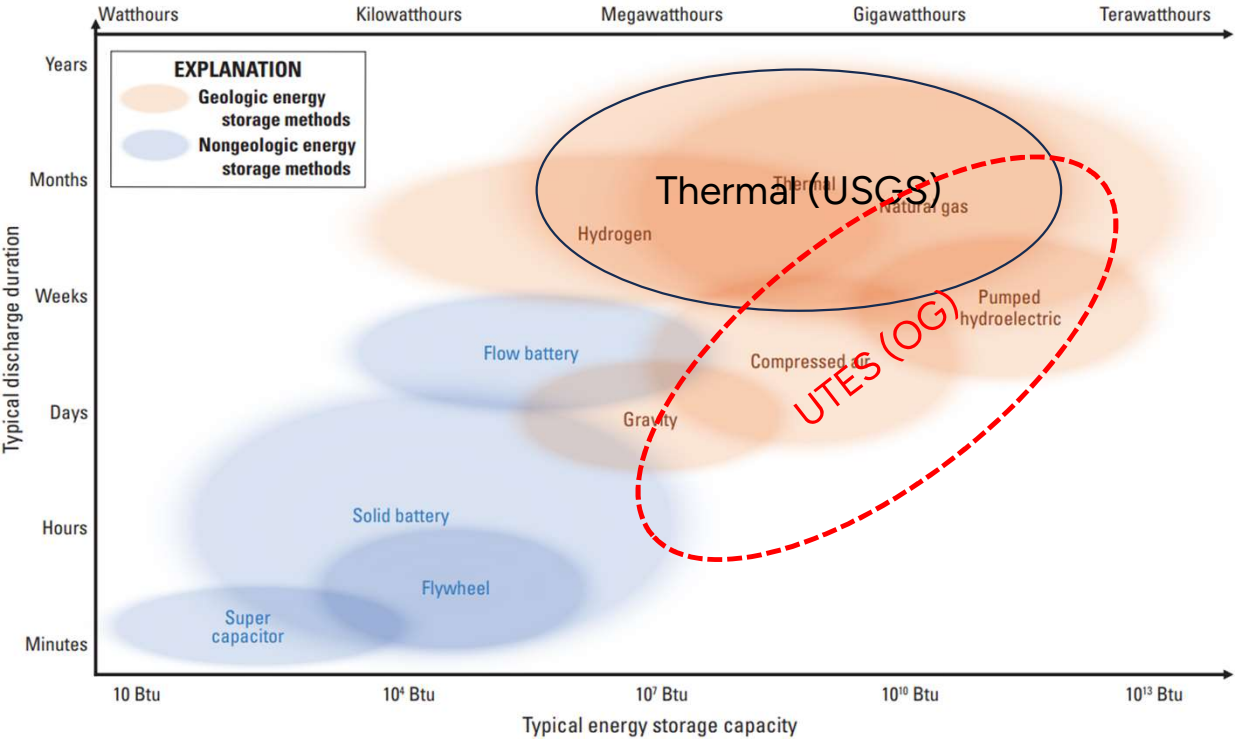

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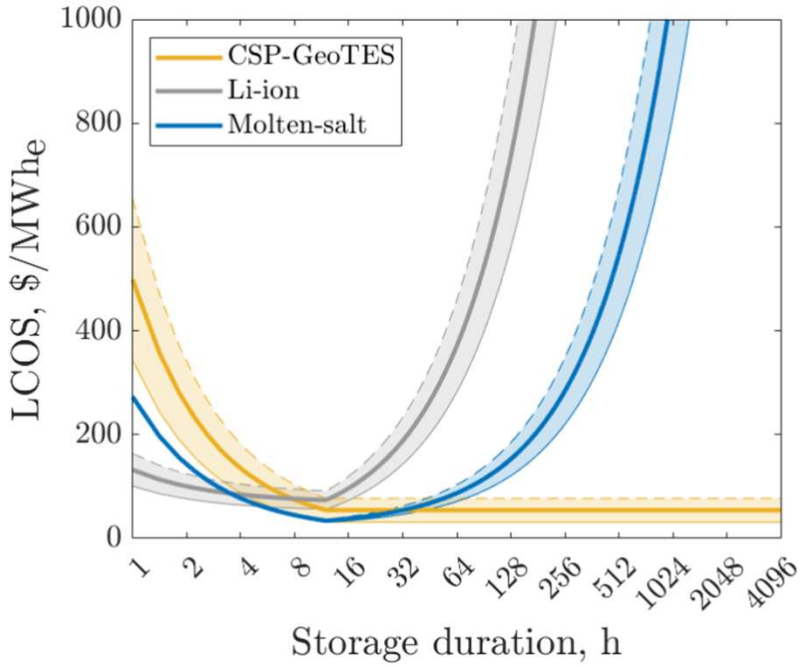
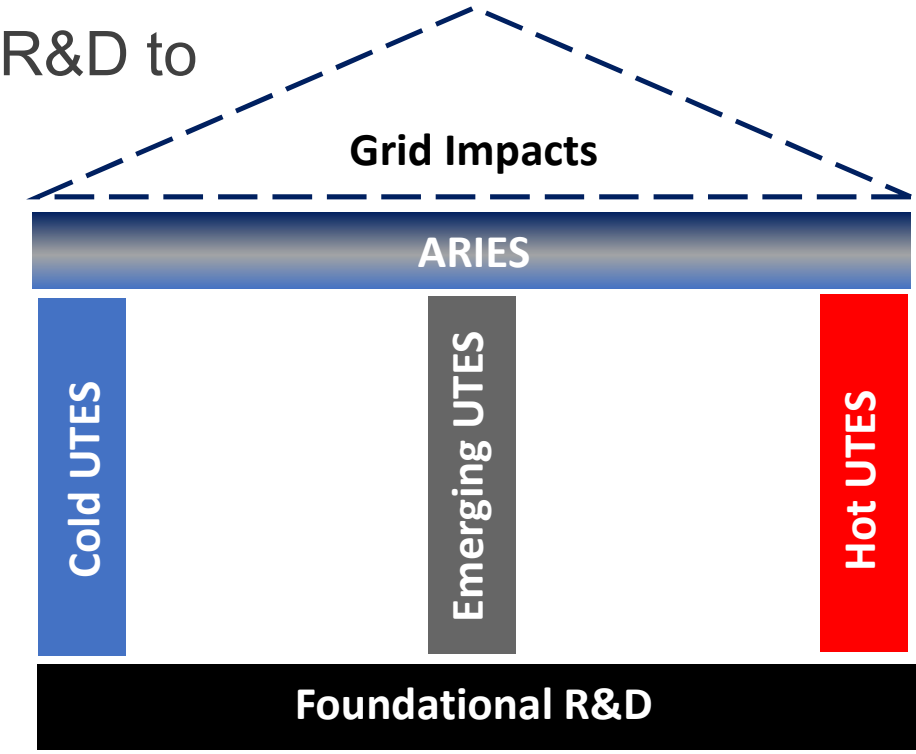


https://www.osti.gov/servlets/purl/2474842

UTES Collab

UTES Collab

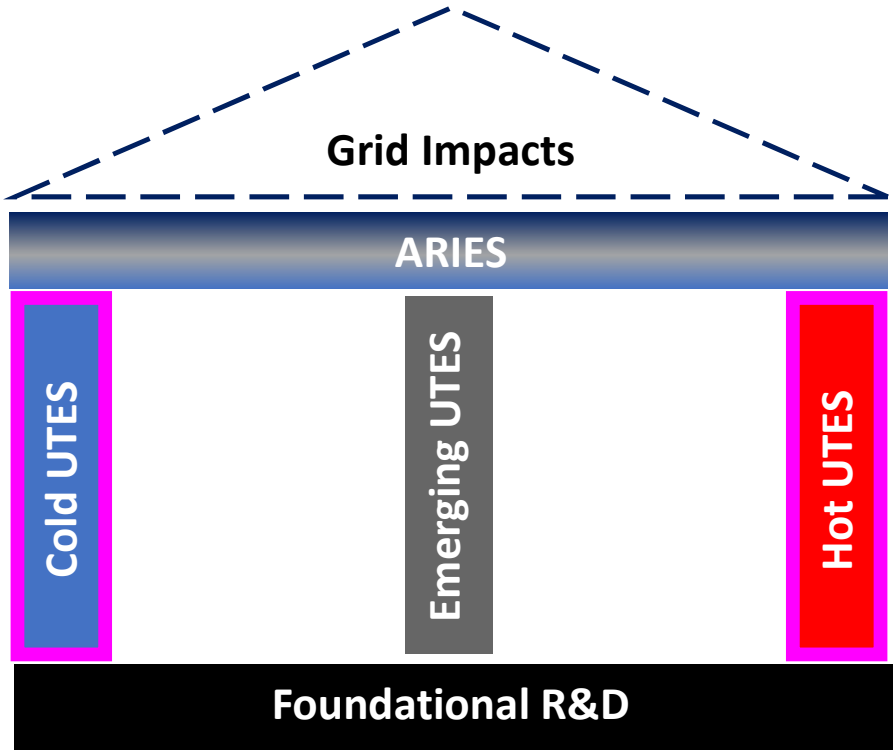
- OG built substantial UTES research foundation, spanning multiple technologies and temperature regimes.
- Coordinated strategy needed to progress R&D to demonstration.
- National labs lead the initiative, advancing Cold UTES, Hot UTES, and Emerging UTES pathways with impact and value on the grid.



UTES Demonstrations

Hot UTES Demonstration Underway OG-IESO Partnership DE-EE0011495 FY23 Solar-thermal Fuels and Thermal Energy Storage Via CST

Major near-term goal is a commercial-scale Cold UTES technology demonstration, for Data Center applications



Cold UTES For Data Centers

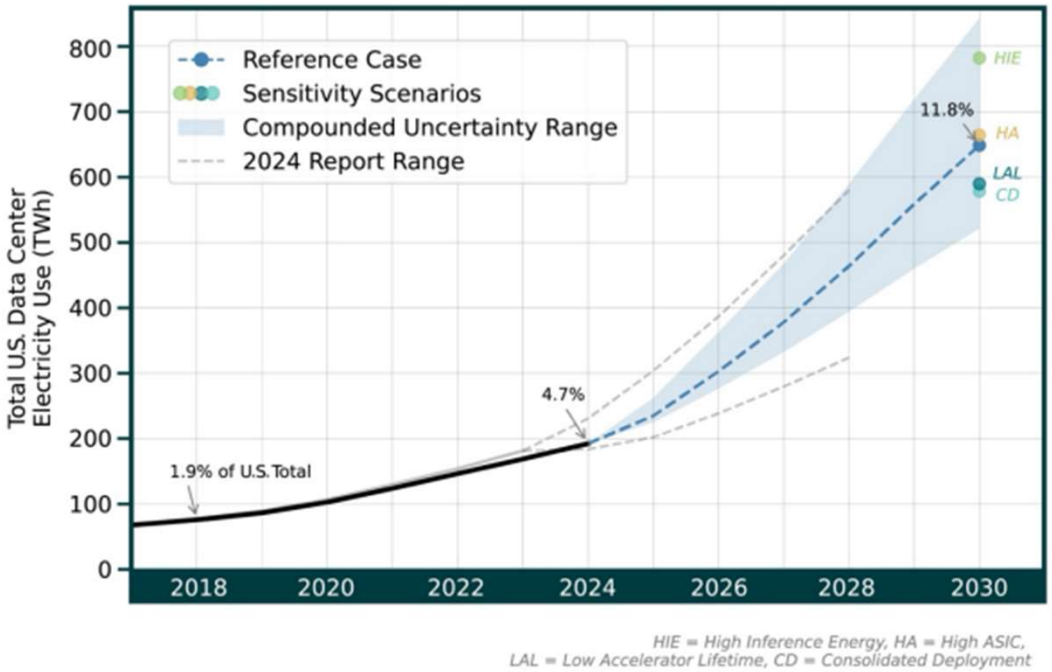
Data Center Growth Projections – United States

Load Growth - A Big Challenge

- 9.5 – 15.3% of total power use by 2030
- Grid and BTM generation timeline

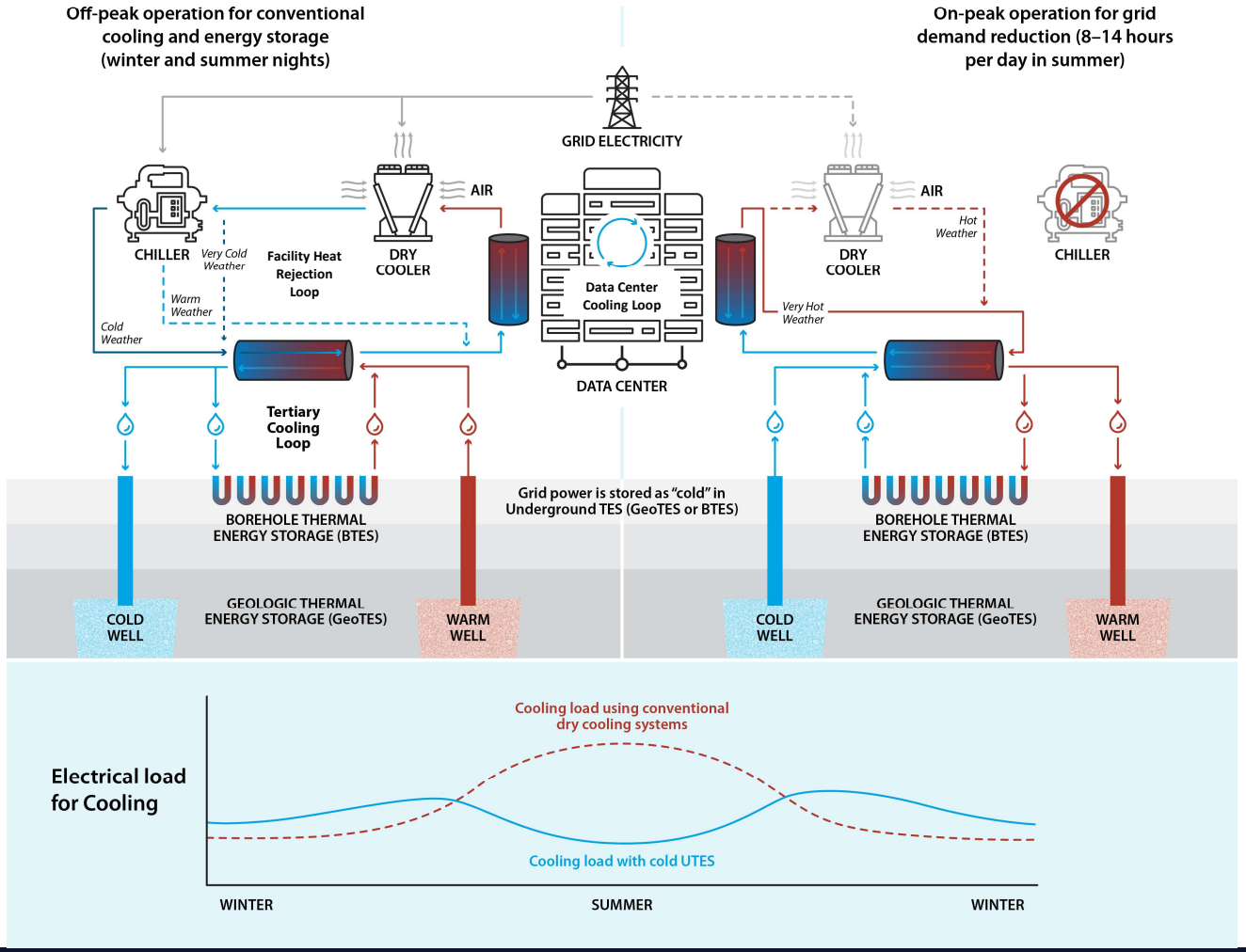
Peak Demand - Even Bigger

Cold UTES Addresses Both



Smith et al., 2025 (LBNL) - United States Data Center Energy UsageReport: 2025 Update

How to Cool a Data Center with Cold UTES



Project Outcomes

- Quantification of Cold UTES benefits to data centers and grids
- Development of annual performance model of data center cooling load system
- Validation of grid-impact models
  - ReEDS (NLR), GenX (Princeton)
- Justification of future technology advancement

Project Phase 1 Report:

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

Josh McTigue,[1] Wesley Cole,[1] Hyunjun Oh,[1] Rebecca Barney,[1] Erik Witter,[1] Abra Gold,[1] Claire Halloran,[1] Sarah Smith,[2] Milica Grahovac,[2] Mohan Ganeshalingam,[2] Andrew A Chien,[3] Wedan Emmanuel Gnibga,[3] Jesse Jenkins,[4] Qian Luo,[4] Dasun Perera,[4] Greg Schivley,[4] Jeff Winick,[5] Kevin Kitz,[6] Lindsey Baker,[7] Guangdong Zhu[1*]

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The National Laboratory of the Rockies is a national laboratory of the U.S. Department of Energy, Office of Critical Minerals and Energy Innovation, operated under Contract No. DE-AC36-08GO28308.

This report is available at no cost from the National Laboratory of the Rockies (NLR) at www.nlr.gov/publications.

Technical Report
NLR/TP-5700-100780
June 2026

Key Findings - Cold UTES Can:

- Reduce Peak Electrical Cooling Load
  - 200MWe peak load reduction on a 1GWe hyperscaler (VA)
- Increase Computing Capacity
  - Facilitates increase in IT capacity ~10%
- Reduce Annual Energy Costs
  - 70% reduction in annual costs ($20M/y)
- Reduce Cooling System Costs
  - Can partially or entirely eliminate need for mechanical chillers

Increase Computing Capacity

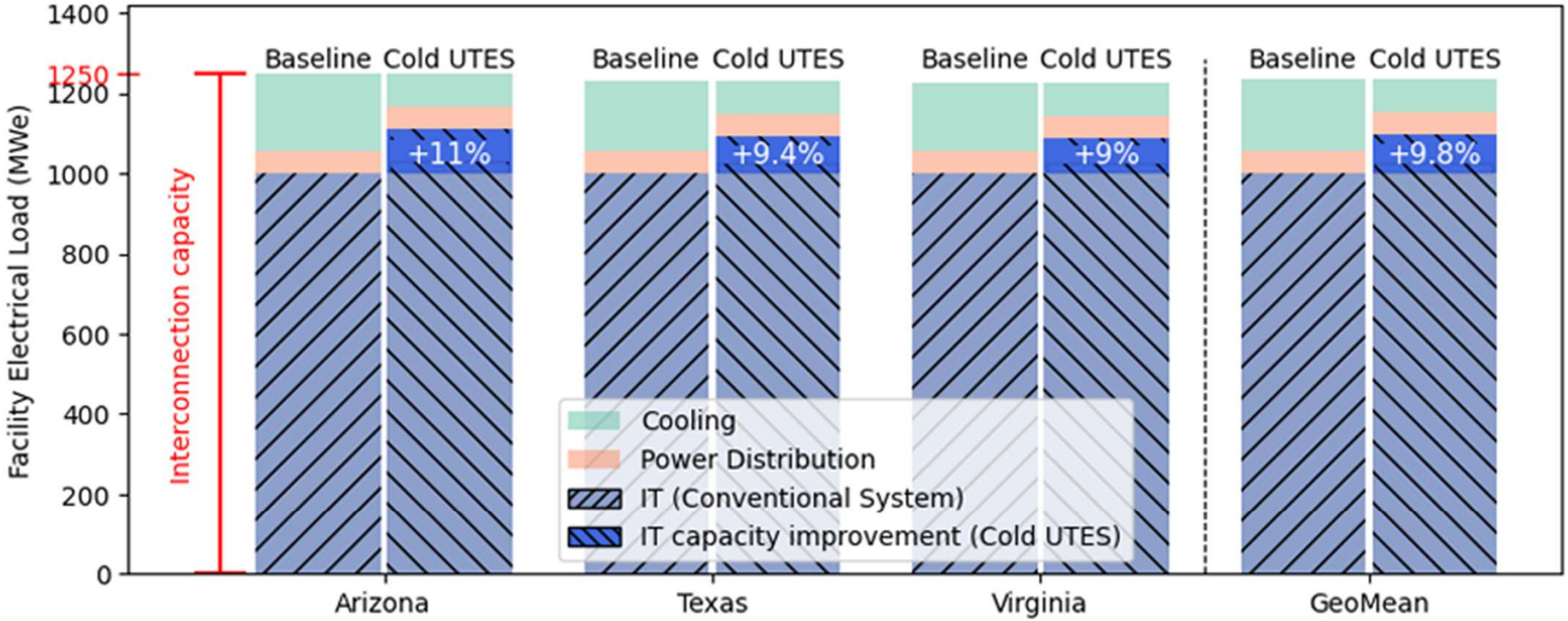

Figure ES-9. Increased IT load from freed power capacity for cooling for the baseline data center in Arizona, Texas, and Virginia. The geomean summarizes the average potential benefit.

Thank you!