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INDUSTRY





Thermal Energy Storage – Molten Salt

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A brief history...

- The first use of molten salts dates to the 1950s and research into nuclear powered aircraft engines using molten salts noting that the salts would not decompose at the high temperatures associated with nuclear power.
- In solar, the first use for molten salts for energy storage was in 1993 in the Mojave Desert in California, Solar Two at 10 MW and 3 hour.
- Scale ups from Solar Two include, Gemasolar (Solar Tres) in Spain (300 MWh), many other trough projects in Spain (typically around 350 MWh each), and Solana in Arizona (1680 MWh) with other projects now proposed, under construction, and commissioned worldwide.



Why Molten Salt...

- Salt is an abundant and relatively cheap energy storage medium that can be integrated with thermal processes to store energy and produce electricity without degradation leading to a low LCOS.

Low Installed Cost

- Solar salt costs range from \$1/kWh_{th} to \$6/kWh_{th}
- Storage system costs range from \$30/kWh_e to \$200/kWh_e

Lifecycle Cost is Minimal with No Salt Replacement

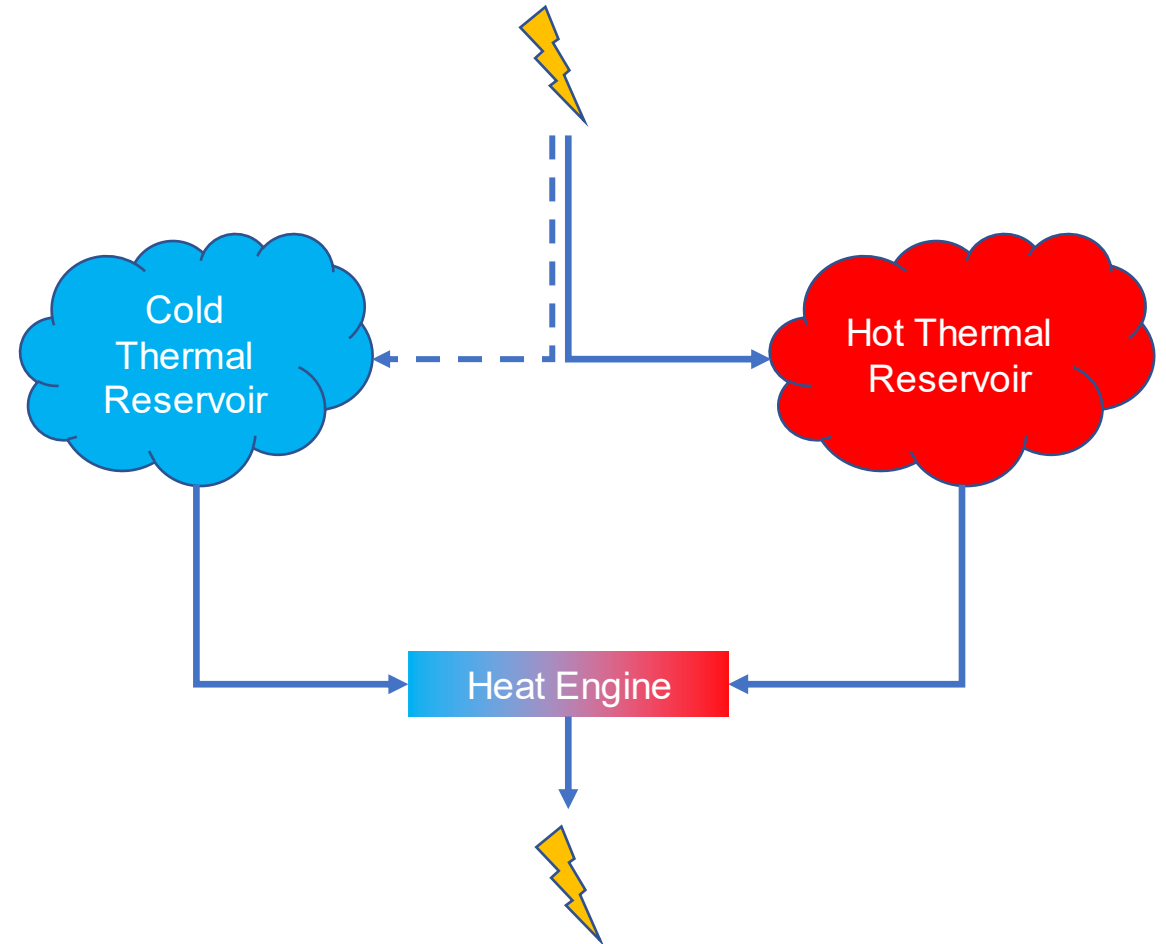
- Salt doesn't require replacement over the life of the asset
- Thermal O&M leverages well-known industry standards with proven cost structures.

Can be Integrated with a Variety of Processes

- Modifying existing CSP projects
- Retrofitting existing thermal power plants to be energy storage.
- New energy storage concepts being developed throughout industry.

What is next...

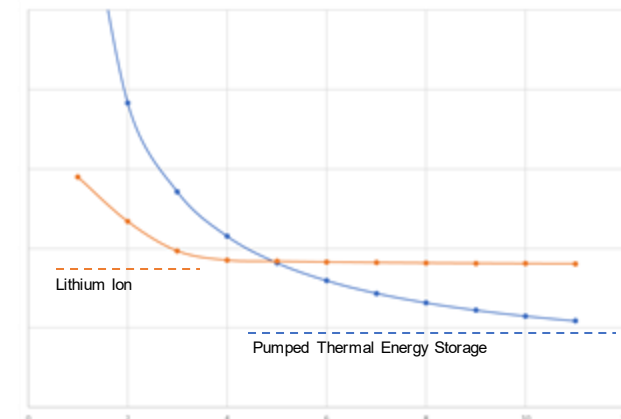
- Stand alone energy storage configuration using molten salt are advancing with industry investment growing.
- Many variations exist and share the same basic thermodynamic principles.
 - Energy “in” creates either a hot or a hot and cold thermal reservoir.
 - When needed, the stored thermal energy is used to produce electricity.
- The goal for energy storage is not to have just low CapEx, OpEx, or Efficiency but to arrive at the lowest LCOS.



Who is advancing...and why?

- Malta Inc. utilizes a heat pump and an air Brayton cycle combination that increases efficiency while leveraging existing technologies.
- Store2Power (RWE) utilizes resistive heating and a Rankine cycle combination that can retrofit existing thermal power plants.
- Echogen Power Systems utilizes a heat pump and sCO₂ power cycle at lower temperatures.
- MAN utilizes a heat pump and sCO₂ power cycle at lower temperatures.
- Other concepts, other than molten salt, include Siemens Gamesa (resistively heated volcanic rocks), primarily applicable for retrofitting existing power plants.

LCOS Comparison (2025)



An opportunity exists for elegant thermal energy storage systems to significantly undercut lithium ion batteries at longer durations by leveraging the cost and durability of molten salt.

Benefits of Thermal Solutions...

Traditional Attributes

Typical applications involve synchronously-connected machines

- Synchronously-connected machines, such as steam turbines and gas turbines, offer inertia and when powered by stored thermal energy offer the same types of services as traditional fossil fueled solutions.
- More wind and solar can be more easily adapted with a healthy mix of synchronous machines.

Known Standards

The grid architecture is designed for traditional assets

- Interconnection, reliability standards, and the physical construction of the grid are designed to integrate traditional assets.

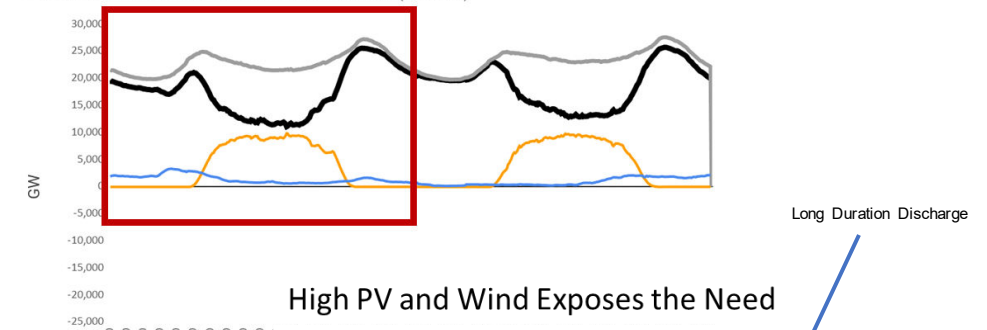
Decoupled Systems

The current electrical system is decoupled from fuel supply

- Electrochemical energy storage systems (such as Li-ion) are largely linked between energy and power, limiting the design flexibility.
- Thermal systems are decoupled, power can scale independently from energy and charge power can scale independently from discharge power.

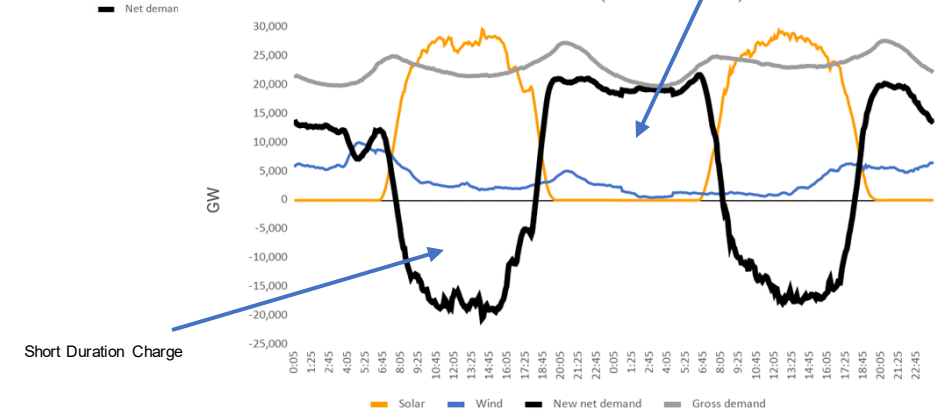
Expand the view past the typical “Duck Curve”

48 hour California Grid Demand & Generation (Current)



High PV and Wind Exposes the Need

48 hour California Grid Demand & Generation (4x wind & solar)



About Us

BlüNebü, founded in 2016, is a professional services company specializing in energy-related infrastructure businesses.

Our team has over forty years' experience in all phases of energy project development and management, including a broad range of technical, legal, financial, marketing, and operational functions.

BlüNebü's expertise allows us to develop creative solutions for energy deployment that often involve innovative ownership and financing mechanisms and the integration of multiple technology solutions. The team's collective experience includes developing and constructing some of the most complex, utility-scale solar and storage projects completed in the world to date.

We work closely with our clients to identify areas of cost saving and performance improvement. Our goal is to help maintain a safe work environment while identifying opportunities to optimize the overall financial results of the assets.

Our exclusive focus on the energy sector means that we bring a sophisticated understanding of industry trends, market drivers and regulatory policy to provide insight into a host of critical decision-making factors.





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