Thermal Battery Power Output Using ORC or Supercritical CO_2 Turbine Generator at 40,000 BTU/kWh

Infinity Turbine LLC

[TEL] +1-608-238-6001 (Chicago

[Email] greg@infinityturbine.com

https://infinityturbine.com/infinity-turbine-sand-salt-battery-build.html

Explore how a 40-foot container thermal battery filled with sand and salt can generate electricity using an Organic Rankine Cycle or supercritical CO_2 turbine with a heat rate of 40,000 BTU per kilowatt-hour. Includes power output estimates for 1-hour, 12-hour, and 24-hour discharge cycles.

This webpage QR code

Thermal Battery Power Output Using ORC or Supercritical CO_2 Turbine Generator at 40,000 BTU/kWh

By converting thermal energy stored in a sand-salt thermal battery through an ORC or supercritical CO_2 turbine, a standard 40-foot container can produce nearly 1,250 kWh of electricity. Learn how this system performs over short and long discharge durations using a 40,000 BTU/kWh heat rate.

Thermal Battery Electricity Output Using ORC or Supercritical CO_2 Turbines

A 40-foot shipping container filled with a 50/50 mix of sand and salt can serve as a high-capacity thermal battery. By integrating this system with a turbine generator—either an Organic Rankine Cycle (ORC) or a supercritical CO_2 expander—the stored heat can be converted into usable electricity.

In this analysis, we calculate the expected power generation based on a standard heat rate of 40,000 BTU per kilowatt-hour (kWh), which is common for low• to medium-efficiency waste heat recovery turbines.

Stored Thermal Energy

The container holds approximately 16.95 million BTU of usable thermal energy, based on the thermal mass and a temperature swing from 100°F to 500°F:

BTU: 16,947,200
Metric equivalent: ≈ 4,965 kWh of heat energy

Heat Rate and Conversion to Electricity

Using the heat rate of 40,000 BTU/kWh, the maximum potential electric output is:

> 16,947,200 BTU ÷ 40,000 BTU/kWh = 423.68 kWh

This is the total electrical energy that can be extracted if the turbine generator maintains a 40,000 BTU/kWh heat rate.

Output by Timeframe

To understand how this energy can be used over time, we calculate the constant power output for 1-hour, 12-hour, and 24-hour periods.

1-Hour Discharge

Thermal Battery as Hydraulic Energy Source

Assessing your concept of using a thermal battery (sand-salt mixture in a 40-foot container) to heat CO_2 to supercritical conditions and then drive a hydraulic pump, we can evaluate:

1. Available thermal energy
2. CO_2 heating and expansion capacity
3. Mechanical output in terms of hydraulic horsepower (HP) and gallons per minute (GPM)
4. Feasibility for 1-hour, 12-hour, and 24-hour continuous discharge

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1. Thermal Energy Storage Recap

From your optimized container setup:

Stored thermal energy:
≈ 16.95 million BTU
≈ 4,965 kWh
≈ 17.9 billion joules (MJ: 17,900)

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2. CO_2 Expansion to Drive Hydraulic Pump

Supercritical CO_2 Key Properties:

Critical point: \~31°C (88°F) and 1,070 psi
Operating target: \~500°F (260°C), \~2,000–3,000 psi
Expansion drives turbine or piston, which powers a hydraulic pump

Let's assume:

CO_2 loop runs through a high-temperature heat exchanger inside the thermal battery
Supercritical CO_2 drives an expander (piston or turbine)
Expander is mechanically coupled to a hydraulic pump

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3. Efficiency Assumptions

We'll break the energy flow into conversion steps:

Step	Process	Efficiency Estimate
A	Heat → CO_2 mechanical energy	20–25%
B	Mechanical → hydraulic energy	90%
Overall	Thermal → hydraulic output	\~20% x 0.9 = 18%

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We'll break the energy flow into conversion steps:

Enhanced Power Output from Thermal Battery Using ORC or Supercritical CO_2 Turbine at 20,000 BTU/kWh

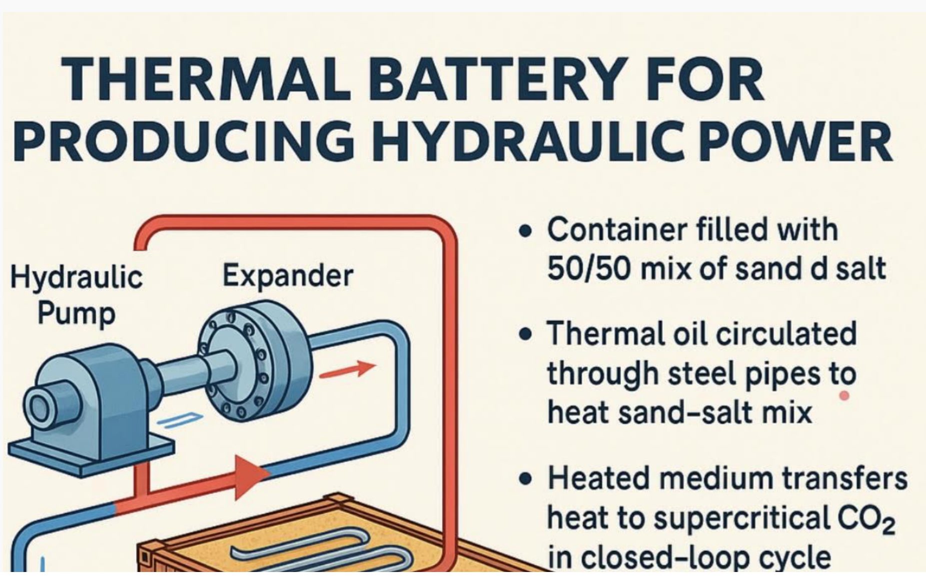
Page Title:
Enhanced Power Output from Thermal Battery Using ORC or Supercritical CO_2 Turbine at 20,000 BTU/kWh

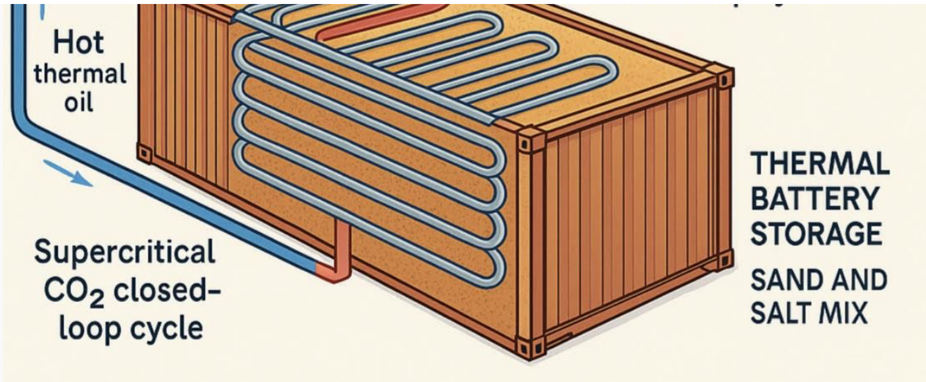
Meta Description:
Assess how a sand-salt thermal battery inside a 40-foot shipping container can generate over 840 kWh of electricity using an ORC or supercritical CO_2 turbine with a heat rate of 20,000 BTU per kilowatt-hour. Includes power delivery profiles for 1-hour, 12-hour, and 24-hour discharge cycles.

Teaser:
Using a turbine generator with a heat rate of 20,000 BTU per kWh, the thermal battery in a 40-foot shipping container can produce more than 840 kWh of electricity. Discover how this high-efficiency conversion method affects power output over different operating durations.

High-Efficiency Thermal Battery Power Generation Using 20,000 BTU/kWh Heat Rate

A 40-foot shipping container filled with a 50/50 mixture of sand and salt functions as a high-density thermal battery. By coupling this system with a high-efficiency Organic Rankine Cycle (ORC) or supercritical CO_2 turbine, stored thermal energy can be converted into electrical energy. In this article, we evaluate the power output using a heat rate of 20,000 BTU per kilowatt-hour, reflecting an efficient turbine design.





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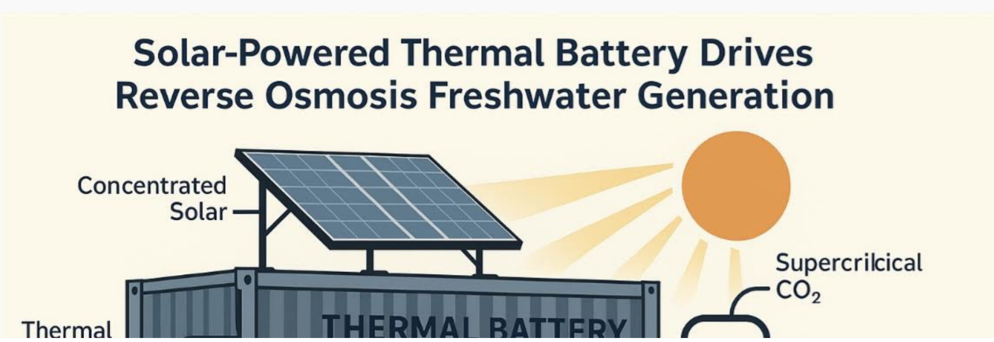

Solar Thermal Battery Drives High-Capacity Chilling for Off-Grid Cooling

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Solar Thermal Battery Drives High-Capacity Chilling for Off-Grid Cooling

Meta Description:

Discover how a 40-foot sand-salt thermal battery with concentrated solar input can power thermally or electrically driven chillers, delivering over 1,500 tons of cooling-hours—ideal for off-grid or industrial cooling.

Teaser:

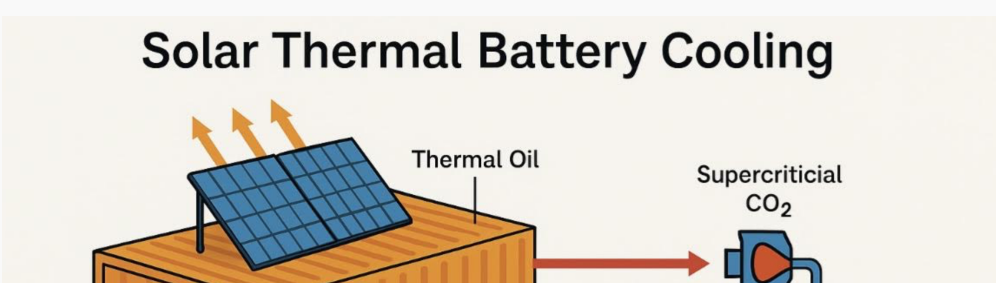
A single thermal battery using sand-salt storage and rooftop solar collectors can provide over 1,500 tons of cooling, delivering up to 127 tons per hour using high-efficiency chillers. This scalable system offers renewable-driven cooling for industrial or remote applications.

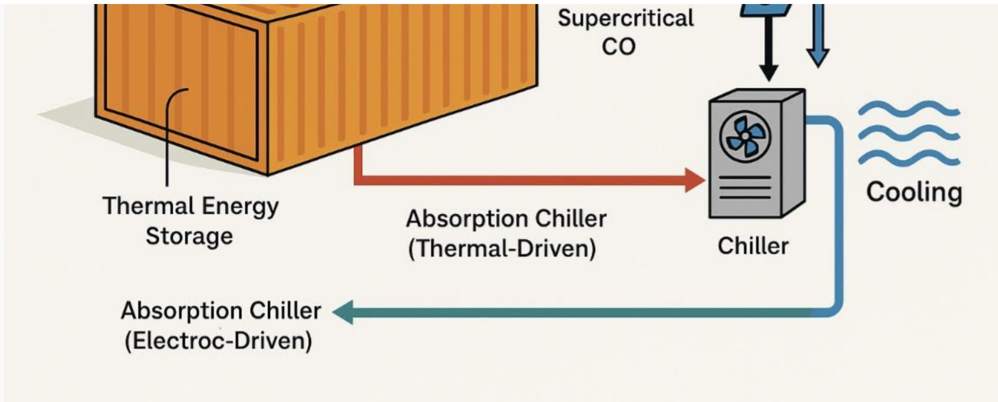
Solar Thermal Battery as a Renewable Cooling Source
A 40-foot shipping container filled with a 50/50 sand and salt mixture, equipped with concentrated solar panels and internal thermal oil piping, becomes a robust off-grid thermal battery. When paired with a chiller system—either thermally or electrically driven—it delivers substantial and sustained cooling capacity.

Two Approaches to Cooling
Absorption Chiller (Thermal-Driven)
Uses thermal energy directly via lithium bromide absorption system
COP: ~0.7
Cooling output: ~989 tons of cooling-hours
Ideal for locations where electricity is limited
Electric Chiller (Power-Driven)
Uses power generated from heated supercritical CO_2 driving a turbine
COP: ~6.0
Cooling output: ~1,525 tons of cooling-hours
Delivers up to 127 tons/hour over 12 hours
Cooling Delivery Profiles

System Type	1-Hour Burst	12-Hour Avg	24-Hour Avg
Absorption Chiller	989 tons	82.4 tons/hr	41.2 tons/hr
Electric Chiller	1,525 tons	127.1 tons/hr	63.5 tons/hr

Use Cases
Data center cooling
Cold storage in agriculture
Emergency or disaster zone chilling
Industrial HVAC in off-grid regions
Conclusion
This integrated solar thermal battery system delivers flexible, scalable cooling power using stored heat and smart conversion technology. Whether you need high-power bursts or round-the-clock





To compare the thermal energy density of sand, salt, and a 50/50 sand-salt mixture, we evaluate:

1. Density (mass per unit volume)
2. Specific heat capacity (energy per unit mass per °C or °F)
3. Thermal energy density (energy stored per unit volume per °C or °F)

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1. Material Properties

Property	Sand	Salt (NaCl)	50/50 Mix
Bulk Density (kg/m³)	\~1,600	\~1,200	\~1,400
Specific Heat (kJ/kg·K)	\~0.80	\~0.85	\~0.825 (average)
Specific Heat (BTU/lb·°F)	\~0.19	\~0.22	\~0.205

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2. Thermal Energy Density (per m³)

> Thermal Energy Density = Density × Specific Heat

Metric (kJ/m³·K):

Sand: 1,600 × 0.80 = 1,280 kJ/m³·K
Salt: 1,200 × 0.85 = 1,020 kJ/m³·K
50/50 Mix: 1,400 × 0.825 = 1,155 kJ/m³·K

Imperial (BTU/ft³·°F):

> Convert using:

> 1 kg/m^3 × 0.00006243 = lb/ft^3
> 1 kJ = 0.9478 BTU

Sand:
\~100 lb/ft^3 × 0.19 = 19 BTU/ft^3·°F
Salt:
\~75 lb/ft^3 × 0.22 = 16.5 BTU/ft^3·°F
50/50 Mix:
\~87.5 lb/ft^3 × 0.205 = 17.94 BTU/ft^3·°F

Summary: Thermal Energy Density

Material	kJ/m^3·K	BTU/ft^3·°F
Sand	1,280	19.0
Salt	1,020	16.5
50/50 Mix	1,155	17.94