Direct sCO_2 Turbine–Saltwater Battery Integration for Low and High Temperature Energy Sources

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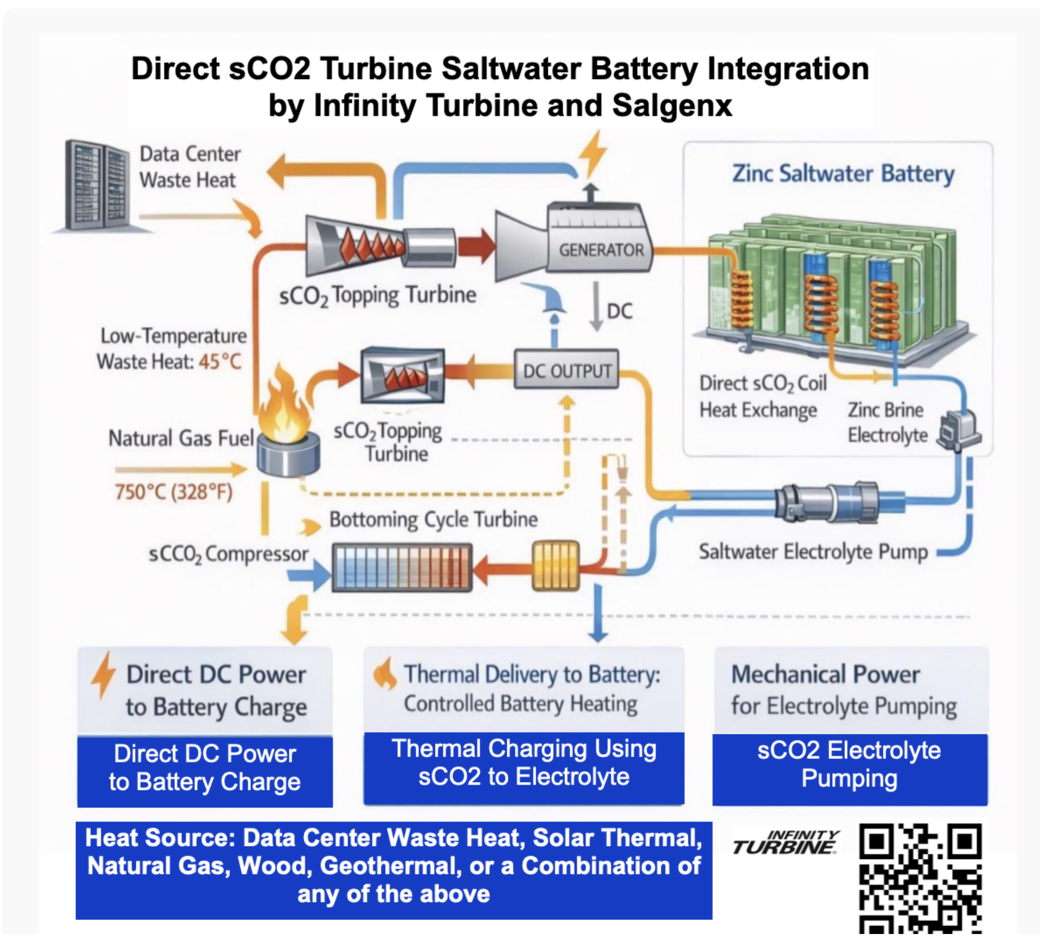
https://salgenx.com/salgenx-turbine-zinc-flow-battery-technology.html

Direct supercritical CO_2 turbine system integrated with zinc-based saltwater batteries, comparing low-temperature waste heat operation at 45 °C and high-temperature firing at 750 °C with a bottoming cycle.

This webpage QR code

PDF Version of the webpage (maximum 10 pages)


Direct sCO2 Turbine Saltwater Battery Integration
by Infinity Turbine and Salgenx
Data Center
Waste Heat
sCO2 Topping Turbine
GENERATOR
DC
Zinc Saltwater Battery
Low-Temperature
Waste Heat: 45°C
DC OUTPUT
Natural Gas Fuel
sCO2 Topping
Turbine
750°C (328°F)
Direct sCO2 Coil
Heat Exchange
Zinc Brine
Electrolyte
Bottoming Cycle Turbine
sCCO2 Compressor
Saltwater Electrolyte Pump
Direct DC Power
to Battery Charge
Thermal Delivery to Battery:
Controlled Battery Heating
Mechanical Power
for Electrolyte Pumping
Direct DC Power
to Battery Charge
Thermal Charging Using
sCO2 to Electrolyte
sCO2 Electrolyte
Pumping
Heat Source: Data Center Waste Heat, Solar Thermal,
Natural Gas, Wood, Geothermal, or a Combination of
any of the above
INFINITY
TURBINE

Direct sCO_2 Turbine–Saltwater Battery Integration for Low and High Temperature Energy Sources

By directly coupling supercritical CO_2 turbine generators with zinc-based saltwater battery cells, electrical, thermal, and hydraulic energy streams can be unified into a single high-utilization system—scalable from low-grade data center waste heat to high-efficiency natural gas–fired combined cycles.

Introduction: Converging Power Generation and Electrochemical Storage

Conventional power systems treat electricity generation, thermal management, and energy storage as separate subsystems connected by layers of conversion, power electronics, and auxiliary equipment. Each interface introduces losses, cost, and operational complexity.

The proposed architecture collapses these boundaries by integrating supercritical CO_2 (sCO_2) turbine generators directly with zinc-based saltwater battery cells. Electrical output is delivered natively to the battery DC bus, turbine exhaust heat is used for controlled battery thermal management, and turbine shaft work assists electrolyte pumping. The result is a tightly coupled electro-thermo-mechanical system optimized for total energy utilization rather than peak standalone efficiency.

Two operating regimes are considered:

1. Low-temperature operation (45 °C turbine inlet) using data center waste heat.
2. High-temperature operation (750 °C turbine inlet) using natural gas or other high-grade heat, with an integrated bottoming cycle.

System Overview: Direct sCO_2 to Zinc Saltwater Battery

The battery chemistry consists of zinc, salt, and water electrolytes, typically benefiting from:

improved ionic conductivity at elevated temperature,
reduced electrolyte viscosity,
stable operation within a controlled thermal window.

The sCO_2 turbine block provides three simultaneous functions:

DC electrical output for direct battery charging,
thermal delivery to the battery via heat-exchanger coils integrated into modules,
mechanical or hydraulic power for electrolyte circulation.

This configuration minimizes parasitic electrical loads and enables an exergy cascade from high-value work to low-grade thermal conditioning.

Scenario 1: Low-Temperature Operation at 45 °C Turbine Inlet

Thermodynamic Characteristics

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Scenario 1: Low-Temperature Operation at 45 °C Turbine Inlet

Thermodynamic Characteristics

Power Production Analysis

1. Per 1.0 MW of input heat (1,000 kWth), and
2. Per 1.0 MMBtu of input heat (where 1.0 MMBtu/hr = 293.07 kWth; so values shown in kW are also kWh per hour).

Because you did not specify detailed cycle pressures, recuperator effectiveness, compressor inlet temperature control strategy, or battery thermal limits, I am using reasonable engineering assumptions consistent with your intent:

45 °C turbine inlet: very low-exergy heat source → low electrical conversion, with the primary "win" being thermal utilization + parasitic reduction.
750 °C turbine inlet + bottoming sCO_2: a true combined-cycle sCO_2 package → high net electric fraction, with the remainder split between useful thermal delivery to the battery and final rejection.

Assumptions used (explicit)

Scenario A: 45 °C sCO_2 module (waste heat mode)

Net electric to DC bus: 2% of input heat
Direct mechanical/hydraulic pumping power recovered: 1%
Useful thermal delivered to battery thermal management (warming electrolyte/cell jacket): 60%
Remaining rejected (dry cooler / ambient): 37%

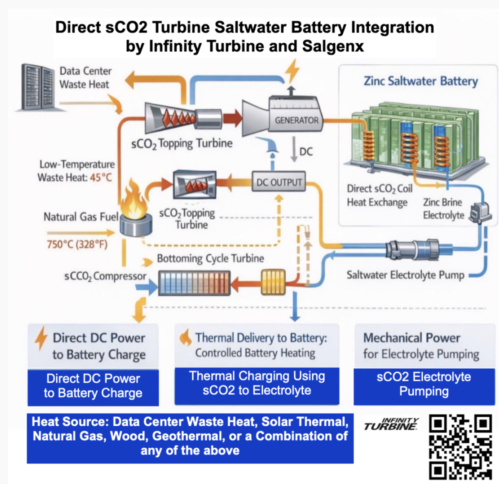
Scenario B: 750 °C topping sCO_2 + bottoming sCO_2 (direct-fired combined cycle)

Net electric to DC bus: 52% of input heat
Direct mechanical/hydraulic pumping power recovered: 2%
Useful thermal delivered to battery thermal management: 25%
Remaining rejected: 21%

These splits sum to 100% in each case.

1) Energy balance per 1 MW of input heat (1,000 kWth)

Output bucket	Scenario A: 45 °C sCO_2	Scenario B: 750 °C + bottoming sCO_2
Net electric to battery DC bus	20 kWe (2%)	520 kWe (52%)
Direct shaft/hydraulic power to electrolyte pumping	10 kW (1%)	20 kW (2%)
Useful thermal into battery modules (controlled heating)	600 kWth (60%)	250 kWth (25%)
Rejected to ambient (dry cooler)	370 kWth (37%)	210 kWth (21%)
Total	1,000 kWth	1,000 kWth



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