Fusion-Heated Supercritical CO2 Power Blocks for AI Data Centers A 50 MW Prime Power Reference Architecture with Integrated Cooling Cascade

Infinity Turbine
LLC

[TEL] 1-608-238-6001

[Email] greg@infinityturbine.com

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Laser fusion can supply extremely high-grade thermal energy, but converting that energy into reliable, efficient prime power for AI data centers requires a power block that is compact, controllable, and modular. This article presents a concrete 50 MW reference architecture using a supercritical CO2 Brayton cycle at 25 MPa, paired with a bottoming cooling cascade that maximizes total site efficiency while delivering both electricity and cooling from the same thermal source.

Why supercritical CO2 is the right interface for fusion heat

Laser-driven fusion systems can deliver heat at temperatures far beyond what any turbine or heat exchanger can tolerate. The practical engineering solution is therefore to down-temper fusion heat through a blanket and primary heat exchanger into a controlled supercritical CO2 loop.

Supercritical CO2 power blocks are uniquely suited for this role because they offer:

• High power density and compact turbomachinery.
• High efficiency in recuperated Brayton configurations.
• Low water consumption with dry cooling compatibility.
• Modular scalability for N plus one data center reliability.

For data centers, availability and controllability matter more than absolute peak thermodynamic efficiency. The supercritical CO2 Brayton cycle provides the best balance of these attributes for fusion-based prime power.

50 MW Reference Architecture Overview

Net electrical output

• 50 MW

• Maximum CO2 pressure

• 25 MPa

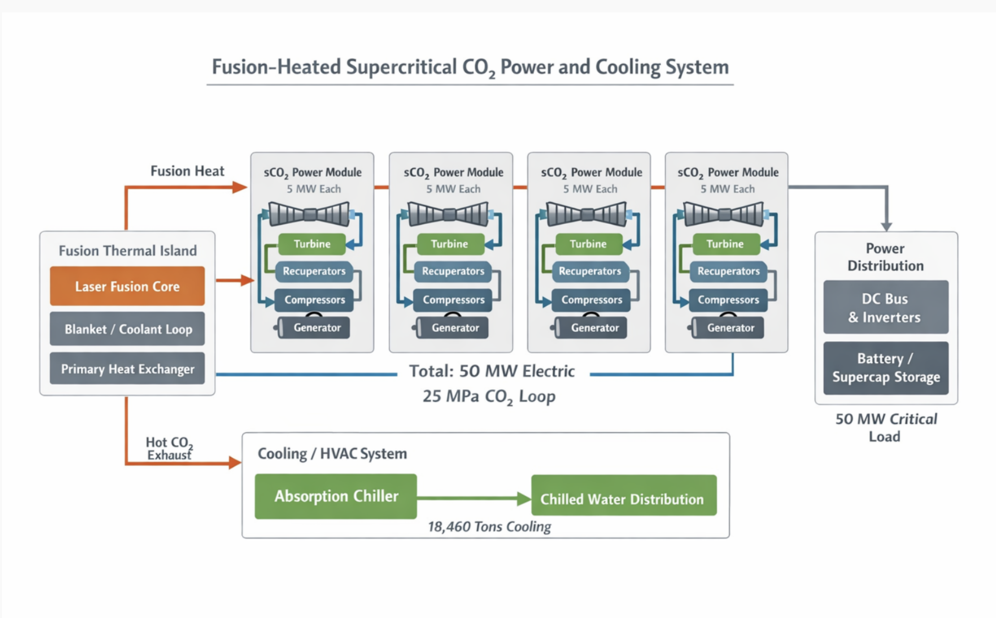
• Turbine inlet temperature target 700 to 800 degrees C class

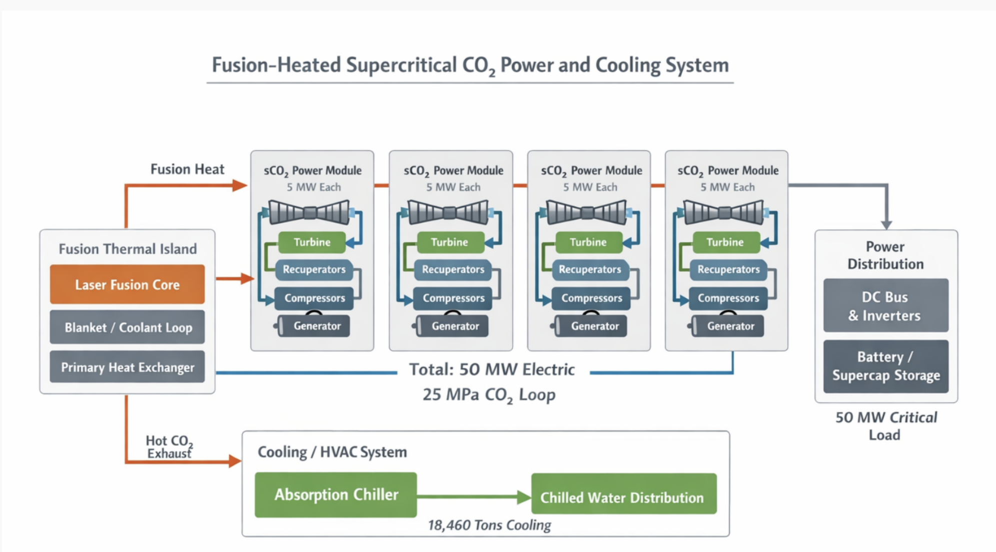
Architecture philosophy

Instead of one large turbine, the system uses modular blocks for redundancy and manufacturability.

• Ten identical power blocks rated at 5 MW each.
• Nine blocks operate continuously for 45 MW.
• One block remains in hot standby for N plus one redundancy.

This allows continuous maintenance without loss of data center power availability.





Fusion-Heated Supercritical CO2 Power and Cooling System
Fusion Heat
sCO2 Power Module
5 MW Each
Turbine
Recuperators
Compressors
Generator
Fusion Thermal Island
Laser Fusion Core
Blanket / Coolant Loop
Primary Heat Exchanger
Power Distribution
DC Bus & Inverters
Battery / Supercap Storage
50 MW Critical Load
Total: 50 MW Electric
25 MPa CO2 Loop
Hot CO2 Exhaust
Cooling / HVAC System
Absorption Chiller
Chilled Water Distribution
18,460 Tons Cooling

Financial Pro Forma 50 MW Fusion Heated Supercritical CO2 Prime Power Plant With Absorption Cooling Cascade for AI Data Centers

Below is a data-center-grade financial pro forma model for the 50 MW Fusion-Heated sCO2 + Absorption Cooling

Financial Pro Forma

50 MW Fusion Heated Supercritical CO2 Prime Power Plant
With Absorption Cooling Cascade for AI Data Centers

System Capacity Summary

Net electrical output
50 MW

Annual operating hours
8,500 hours

Annual electrical generation
425,000 MWh per year

Cooling output
65 MW cooling
Approximately 18,460 tons refrigeration

Capital Cost Assumptions

Fusion thermal island including blanket and heat interface
$150,000,000

sCO2 power blocks 10 modules at 5 MW
$2,500 per kW installed
Total $125,000,000

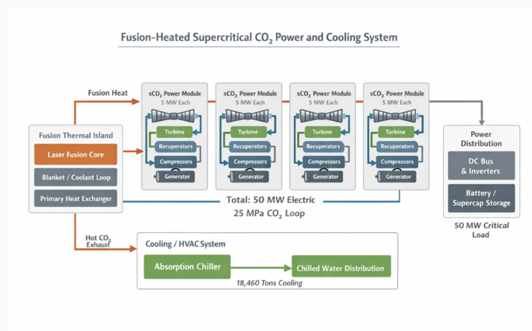
Absorption cooling plant and distribution
$800 per ton cooling
Total $14,800,000

Electrical power electronics and DC bus
$20,000,000

Balance of plant, installation, buildings, controls
[illegible]

Investor Executive Summary

Fusion Heated Supercritical CO2 Prime Power for AI Data Centers
Opportunity
AI data centers face three escalating challenges
Power availability
Cooling capacity
Grid reliability and cost volatility
The market requires a new class of on-site prime power that delivers both electricity and cooling from a single integrated energy platform.
Solution
A modular 50 MW fusion-heated supercritical CO2 Brayton power plant with an absorption cooling cascade.
Fusion provides high grade thermal energy.
Supercritical CO2 converts heat into electricity efficiently and compactly.
Remaining heat is converted directly into data center cooling.
This architecture converts nearly all thermal energy into useful site products.
System Overview
Net electric output
50 MW
Cooling output
65 MW cooling
Approximately 18,460 tons refrigeration
Architecture
Ten modular 5 MW sCO2 power blocks
N plus one redundancy



Fusion-Heated Supercritical CO_2 Power and Cooling System
Fusion Heat
Fusion Thermal Island
Laser Fusion Core
Blanket / Coolant Loop
Primary Heat Exchanger
sCO_2 Power Module
5 MW Each
Turbine
Recuperators
Compressors
Generator
sCO_2 Power Module
5 MW Each
Turbine
Recuperators
Compressors
Generator
sCO_2 Power Module
5 MW Each
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Recuperators
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5 MW Each
Turbine
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Generator
Total: 50 MW Electric
25 MPa CO_2 Loop
Power Distribution
DC Bus & Inverters
Battery / Supercap Storage
50 MW Critical Load
Hot CO_2 Exhaust
Cooling / HVAC System
Absorption Chiller
Chilled Water Distribution
18,460 Tons Cooling