Integrating a 10 MW Supercritical CO2 Power Block into AI Data Centers

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Learn how integrating a 10 MW supercritical CO2 power block directly into AI data centers at the required voltage can eliminate transformers and achieve major cost savings per 10 MW of installed capacity.

This webpage QR code

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Introduction

Artificial intelligence data centers are among the fastest-growing consumers of electricity, requiring reliable and efficient power delivery at scale. Traditional approaches involve generating power at medium voltage and stepping it up or down through large transformers before delivering it to servers and cooling systems. A new design approach with a 10 MW supercritical CO2 (sCO2) turbine generator power block makes it possible to produce electricity at the exact voltage required by the data center, removing the need for costly transformer infrastructure.

Power and Voltage Requirements in AI Data Centers

Typical AI data centers operate their server racks and supporting systems at distribution voltages ranging from 415 V to 480 V three-phase AC, or in some hyperscale environments, at higher medium-voltage direct feeds (4.16 kV to 13.8 kV) to minimize line losses before local conversion.

Conventional power plants often generate electricity at lower or higher voltages than the data center consumes. This mismatch requires heavy transformers to step voltage up for transmission and back down for distribution. Each conversion adds:

Capital cost of transformers and switchgear
Electrical losses in the range of 2 to 4 percent per stage
Maintenance overhead and added footprint

By designing the sCO2 power block generator to output directly at the data center's required voltage level, transformers can be eliminated or drastically minimized.

Cost Savings per 10 MW Block Power

1. Transformer Capital Costs:
Large power transformers rated at 10 MVA typically cost $500,000 to $1 million each, and redundancy requirements often double this figure. By removing the need for step-up or step-down transformers, each 10 MW block can save approximately $1 to $2 million in hardware costs.

2. Electrical Loss Reduction:
At $0.10 per kWh, the annual output of a 10 MW block is about $8.76 million. Avoiding even a 3 percent transformer loss equates to an additional $262,800 per year in savings per block.

3. Operational and Maintenance Savings:
Eliminating transformer maintenance, oil testing, and cooling equipment can reduce annual O&M expenses by tens of thousands of dollars per block.

Strategic Advantages for AI Operators

• Efficiency Gains: Delivering power at the correct voltage minimizes conversion steps and maximizes usable electricity.
• Reduced Capital Expenditure: Avoiding transformer infrastructure lowers up-front costs and accelerates ROI.
• Smaller Footprint: Freeing space previously required for large transformers allows for more servers or cooling capacity.
• Higher Reliability: Fewer components in the power chain reduces single points of failure.

Conclusion