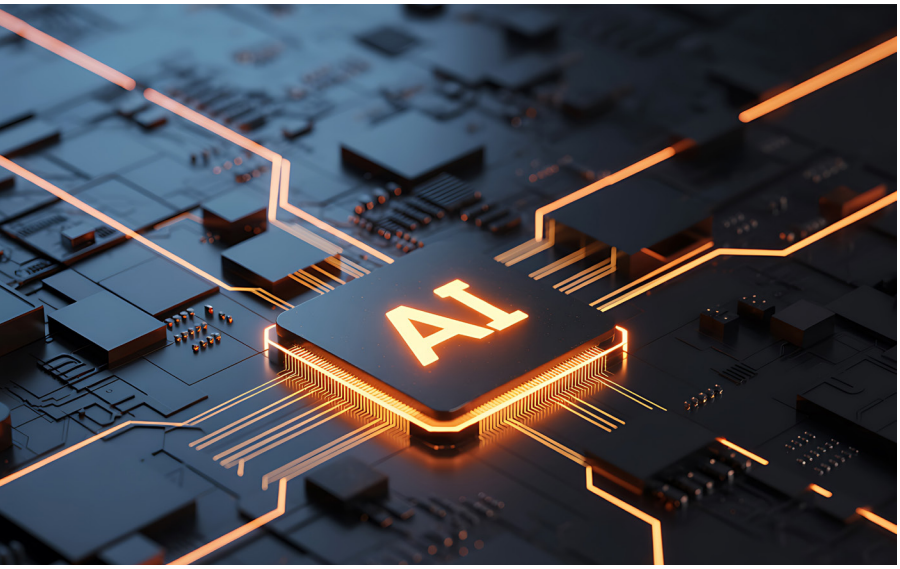
WHITE PAPER

REDEFINING POWER INFRASTRUCTURE FOR AI: THE ROLE OF 800 VDC IN DATA CENTERS



800 VDC power architectures will support the introduction of 1 megawatt server racks. Delivering this level of power efficiently requires advancements in power distribution technologies and architecture.

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01 As AI demand grows worldwide, data centers need new power distribution designs that are simpler and higher efficiency

The rapid expansion of AI applications is driving server rack power demands into the megawatt range, placing unprecedented strain on traditional AC power systems. These high-power requirements are pushing AC infrastructure to its physical limits. With multiple power conversion stages inherent in AC distribution, the ratio of grey space (infrastructure) to white space (computing) is reversing — undermining the energy efficiency and footprint of electrical distribution for large AI data centers.

As power loads increase, so do the challenges of cable management and distribution losses due to high currents. Existing voltage levels necessitate oversized conductors, inflating both capital and operational expenditures.

While AC distribution remains ideal for legacy data centers based on CPU workloads, the emerging higher power density GPU workloads for AI data centers will require different power system architectures. This industry shift to higher power density makes low-voltage direct current (LVDC) distribution at 800 VDC a more suitable and efficient choice, especially for advanced AI-optimized data center architectures.

Since 2013, marine vessels use LVDC systems with 1000 VDC and up to 20 MW, reporting 20–40% energy savings and up to 30% lower maintenance costs1. In other sectors, LVDC has improved conductor utilization by up to 20%[2] and reduced feed-in power requirements by a factor of two to five[3]. These systems offer immediate benefits in power availability, distribution efficiency, and infrastructure density, with proven reliability in real-world operations.

Transitioning from traditional 480 VAC or 415 VAC to 800 VDC[4] distribution enables a more efficient, resilient, and scalable power architecture — essential for the next generation of AI-driven data centers. The use of 800 VDC also reduces conductor size and material usage (copper and aluminum), enhancing both cost and resource efficiency.

Operating safely within the internationally recognized LVDC envelope, 800 VDC (or +/- 400 VDC) is supported by industry alliances such as OCP, ODCA, and Current/OS, which provide implementation frameworks and best practices.

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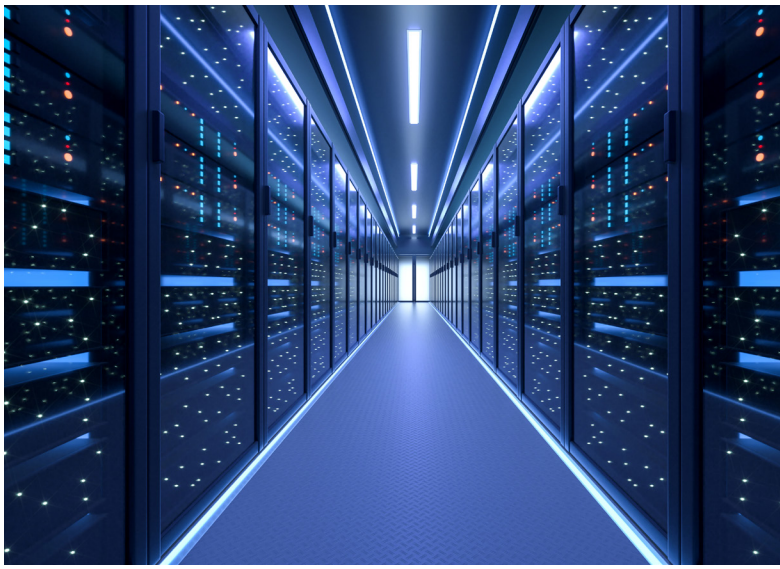
01 The SACE Infinitus is the world's first IEC-certified circuit breaker, designed to make DC viable in high voltage environments



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02 From source to rack, ABB's portfolio ensures continuous operations and optimizes energy use for AI servers

This is the first of a series white papers that will deep-dive into the key technologies required for 800 VDC implementation, including:

- High-efficiency MVAC-to-LVDC converters
- Fast, selective circuit breakers
- Safe, reliable distribution equipment (e.g., switchgears, switchboards, busway)
- Energy storage and advanced monitoring systems for dynamic AI workloads

For over a decade, ABB has been at the forefront of LVDC innovation, delivering enabling technologies across marine, EV charging, industrial, and building sectors. ABB's comprehensive portfolio — including power conversion, electromechanical and solid-state breakers, power distribution and uninterruptible power supplies — combined with deep expertise in both physical and digital infrastructure, supports the design of scalable, resilient AI factories.

ABB's Infinitus solid state breaker exemplifies this technology leadership. Industry leaders like NVIDIA have already embraced 800 VDC architectures, as highlighted in their technical publications — underscoring the urgency and relevance of this transition.

References

1. ABB, "ENERGY EFFICIENCY HANDBOOK TOWARD ZERO EMISSION: 5.7 Onboard DC GridTM," https://new.abb.com/marine/energy-efficiency/energy-handbook, 2023. Link

2. Y. Neyret, "DIRECT CURRENT: THE SMARTER CONSUMPTION SOLUTION TO SOLVE THE ENERGY CRISIS?," Current O/S, 2025.

3. Hartwig Stammberger and Johann Austermann, "DC-INDUSTRIE2 System Concept," Open DC Alliance (ODCA), 2024.

4. NVIDIA 800 VDC Architecture Will Power the Next Generation of AI Factories | NVIDIA Technical Blog Link

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