VERTIV

White paper

Descriptions of 800 VDC distribution architectures for AI data centers





Executive summary

Advances in AI computing have driven rack power densities beyond 100 kW/rack. As rack densities approach 1 MW, conventional data center IT distribution voltages, like 240/415 VAC, become impractical, even with three-phase IT rack power shelves. Increasing the voltage provides more power with the same conductors, thus requiring fewer power feeds and less copper. AI chip manufacturers and power infrastructure vendors are designing future data centers to run on 800 VDC, in part due to its maturity in the electric vehicle (EV) industry. In this paper, we present a roadmap for 800 VDC architectures: details such as where the AC-to-DC conversion takes place, battery backup, and the purpose of the various DC voltages within the IT rack.

Key takeaways

1. **AI chip roadmaps with their increasing power consumption are projecting MW rack densities and higher.** At these densities, it becomes impractical to route 400-480 VAC power cables into the IT rack. Increasing the voltage to 800 VDC reduces the number of cables and increases the power delivered per circuit.
2. **AI workload performance increases with more accelerators (e.g., GPUs) in a single IT rack.** In order to accommodate more IT components, the AC to DC power conversion must be removed from the IT rack and placed in a separate power rack.
3. **The electric vehicle industry has facilitated the transition to 800 VDC data centers** through its development of 400-800 VDC components and standards.
4. **800 VDC architectures differ mainly in where the AC to DC conversion occurs.** The conversion location is typically where battery backup is installed, but is not a requirement. For all architectures, the IT equipment must still convert ~50 VDC to 12 VDC and then to logic voltages (e.g., GPUs require ~1 VDC).

Introduction

The adoption of 800 VDC for AI data centers (sometimes called AI factories) has been driven primarily by AI chip roadmaps projecting 1 MW rack densities by 2027.[1] As IT rack densities increase to these levels, it becomes increasingly difficult to find the space for all the power circuits at 415 or 400 VAC.

Increasing the input voltage addresses this problem. For example, doubling voltage allows the same conductor to carry twice the power at the same current. This helps explain AI data centers' support for 800 VDC. But why 800 VDC instead of 800 VAC?[2] Primarily because 800 VDC is readily scalable thanks to the electric vehicle (EV) industry.[3] Components like connectors (IEC 62196-3), contactors (IEC 60947-4-1), and protective devices (IEC 60947-2) can be adapted for data center applications with substantially less standards development. EVs have also helped advance the performance of power semiconductors.

800 VDC can be implemented in multiple data center architectures. The available options are largely distinguished by where the conversion from AC voltage to 800 VDC occurs. The conversion location can range from adjacent to the compute rack to the data center's utility service entrance.

In this paper, we go into details such as where AC-to-DC conversion takes place, battery backup, and the purpose of the various DC voltages within the IT rack. With so many choices, it's natural to expect guidance on which architecture is best suited for certain applications. While this paper provides the foundation, the companion white paper, "800 VDC distribution for AI data centers: Architecture selection criteria and design elements," provides that guidance.



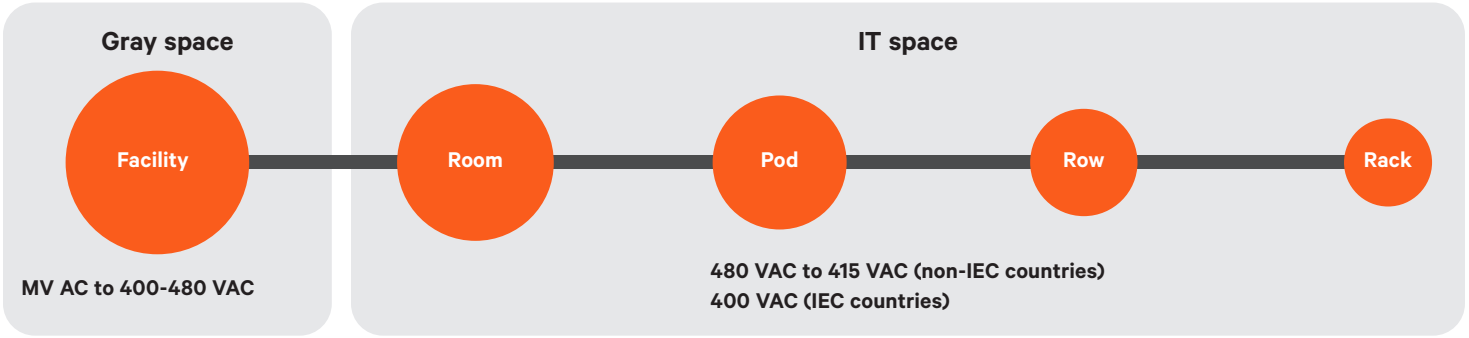
[1] Mathias Blake, et al., NVIDIA 800 VDC Architecture Will Power the Next Generation of AI Factories, 5/2025.

[2] For a deeper understanding of why 800 VDC, read "Inside the 800VDC Revolution – Part 1." Bontigui, N., Ontiveros, J., Wang, K., et. Al., 2026. SemiAnalysis.

[3] Established electrical and mechanical interface standards include IEC 62196-3 and IEC 61851 series. Specific solution examples include high voltage interlock loop, pyrofuse, and higher power inverters.

800 VDC electrical architectures

The ultimate purpose of a data center's electrical power system is to deliver utility power reliably and safely to revenue-generating IT components like CPUs, network interface controller (NIC), memory, accelerators (e.g., graphics processing units or GPU, tensor processing units or TPUs, and application-specific integrated circuit or ASIC).[4] These components typically operate at voltages ranging from 12 VDC to less than 1 VDC. Because each voltage conversion introduces losses, the goal is to reach those logic voltages in as few steps as possible. Figure 1 illustrates the discrete points along the power train where conversion from AC to 800 VDC can occur, as well as the voltages present throughout a traditional power path. Architectures that convert to 800 VDC further from the IT load reduce conductor losses and eliminate intermediate conversion stages. The following sections describe the major architecture options.



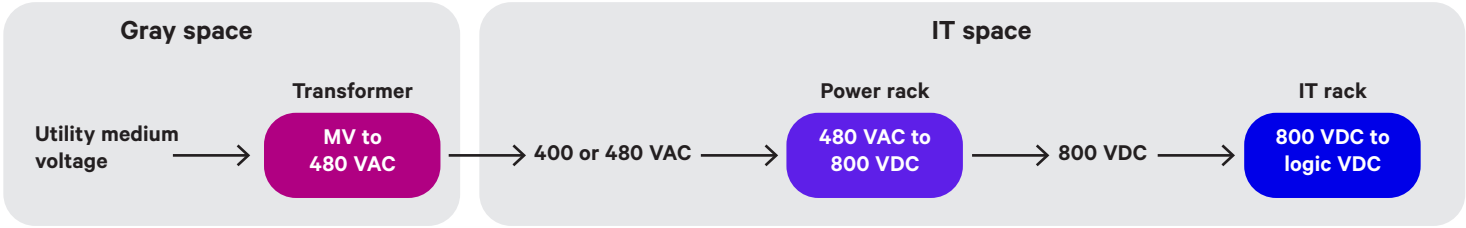
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Figure 1. Locations for conversion to 800 VDC and the associated voltages present in traditional architectures. Larger circles denote centralized power conversion, which requires fewer, higher-capacity converters than more distributed, lower-capacity ones. Source: Vertiv.

Rack-level conversion

Rack-level conversion is most similar to Open Compute Project (OCP)-type architectures, where IT equipment sleds are powered from a ~50 VDC busbar in the back of the IT rack. The VDC busbar is powered by power shelves that convert 400-480 VAC to ~50 VDC. As more servers are added to an IT rack, it eventually runs out of space. This leads to the rack-level architecture.

The rack-level architecture moves the AC-to-DC conversion stage (i.e., rectifiers) out of the IT rack and into the power rack (a.k.a. sidecar). These rectifiers convert 400-480 VAC to 800 VDC and distribute it directly to the adjacent IT rack(s) as illustrated in Figure 2. This means the DC/DC converters in the IT rack convert 800 VDC to 54 VDC. Moving the AC-to-DC conversion out of the IT rack frees up some space in the IT rack because converting 400-480 VAC to ~50 VDC requires more power electronics than converting 800 VDC to 54 VDC.



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Figure 2. Illustration of a rack-level architecture and the associated conversions. Source: Vertiv.

[4] Merritt, R., 2021. NVIDIA.

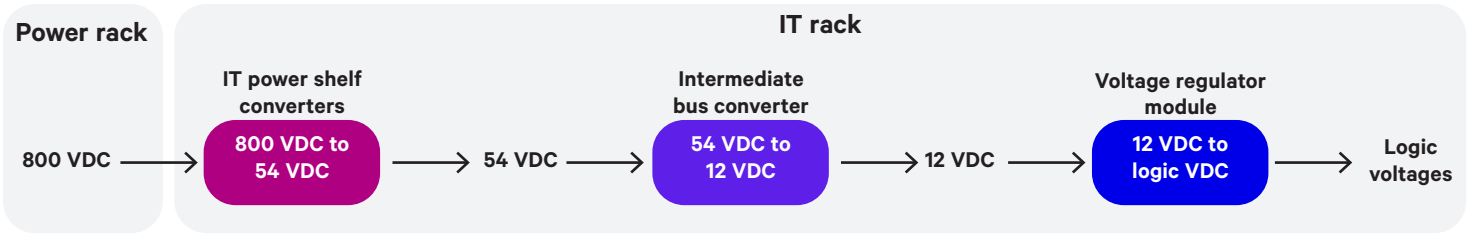
The latest power racks (Figure 3) use 110 kW three-phase power shelves that can supply over 600 kW, supporting a single or multiple IT racks depending on the IT rack density. 800 VDC cables connect the power rack rectifiers[5] to converters in the IT rack, which step down the 800 VDC to 54 VDC as shown in Figure 4. Intermediate bus converters (IBC) on the server board then step the 54 VDC down to 12 VDC, where a voltage regulator module (VRM) on the motherboard steps this down to logic voltages. Logic voltages directly supply the IT components, like the CPU and the GPU. Examples of logic voltages are 5, 3.3, and 1 VDC.[6]

This architecture can be implemented with either a centralized uninterruptible power supply (UPS, upstream of the power rack) or battery backup units (BBUs) installed in the power rack. BBUs reduce the power rack's rated capacity because there's less space to install power shelves housing the rectifiers. Figure 5 shows an example of a 1U 90 kW 800 VDC to 54 VDC IT power shelf with six converters. Note, battery solutions (BBUs or battery cabinets) use integrated DC-to-DC converters to maintain a steady DC bus voltage. Without regulation, the bus voltage continuously drops as the batteries discharge in backup mode, causing voltage instability at the downstream IT load. This applies to all architectures.



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Figure 3. Example of an AC to 800 VDC power rack. Source: Vertiv



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Figure 4. Illustration of conversions that occur in the IT rack (applies to all architectures discussed in this paper). Source: Vertiv.



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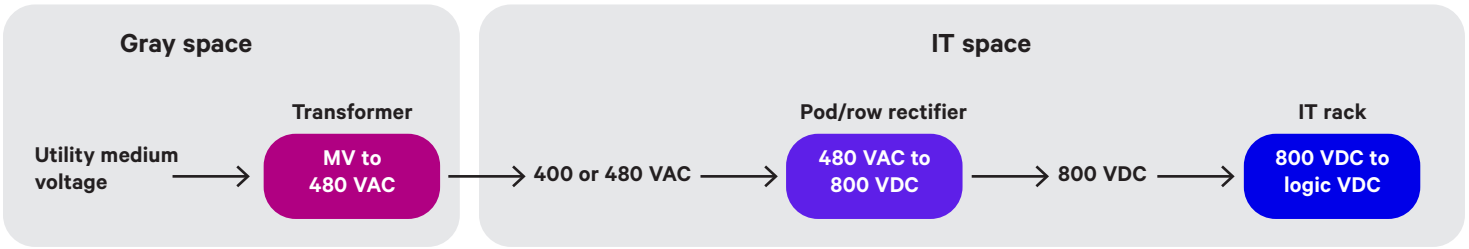
Figure 5. Example of a 1U height 90 kW IT power shelf with six converters (800 VDC to 54 VDC). Source: Vertiv.

[5] Converter is a generic term for devices that manipulate electricity. Rectifiers are a specific type that convert AC to DC voltage. DC-to-DC converters change the input DC to a different output DC, for example, 800 VDC-to-54 VDC.

[6] The conversions in the IT rack remain the same for all architectures discussed in this paper.

Pod or row-level conversion

As we move upstream, AC-to-DC systems are usually installed adjacent to one or two rows of racks in the IT space. The AC to 800 VDC rectifier capacities typically increase, thereby increasing the rated capacity of the conversion system (Figure 6). This means that pod or row-level architectures can support more IT racks than rack-level architectures. Battery backup is usually built into the conversion system either internally or as a separate cabinet. The distribution to the IT racks is accomplished with either 800 VDC power whips (wires) or overhead busway. Figure 7 shows an example of a pod-level deployment in which the conversion occurs within the rectifier racks at the end of the pod.



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Figure 6. Illustration of a pod or row-level architecture and the associated conversions. Source: Vertiv.

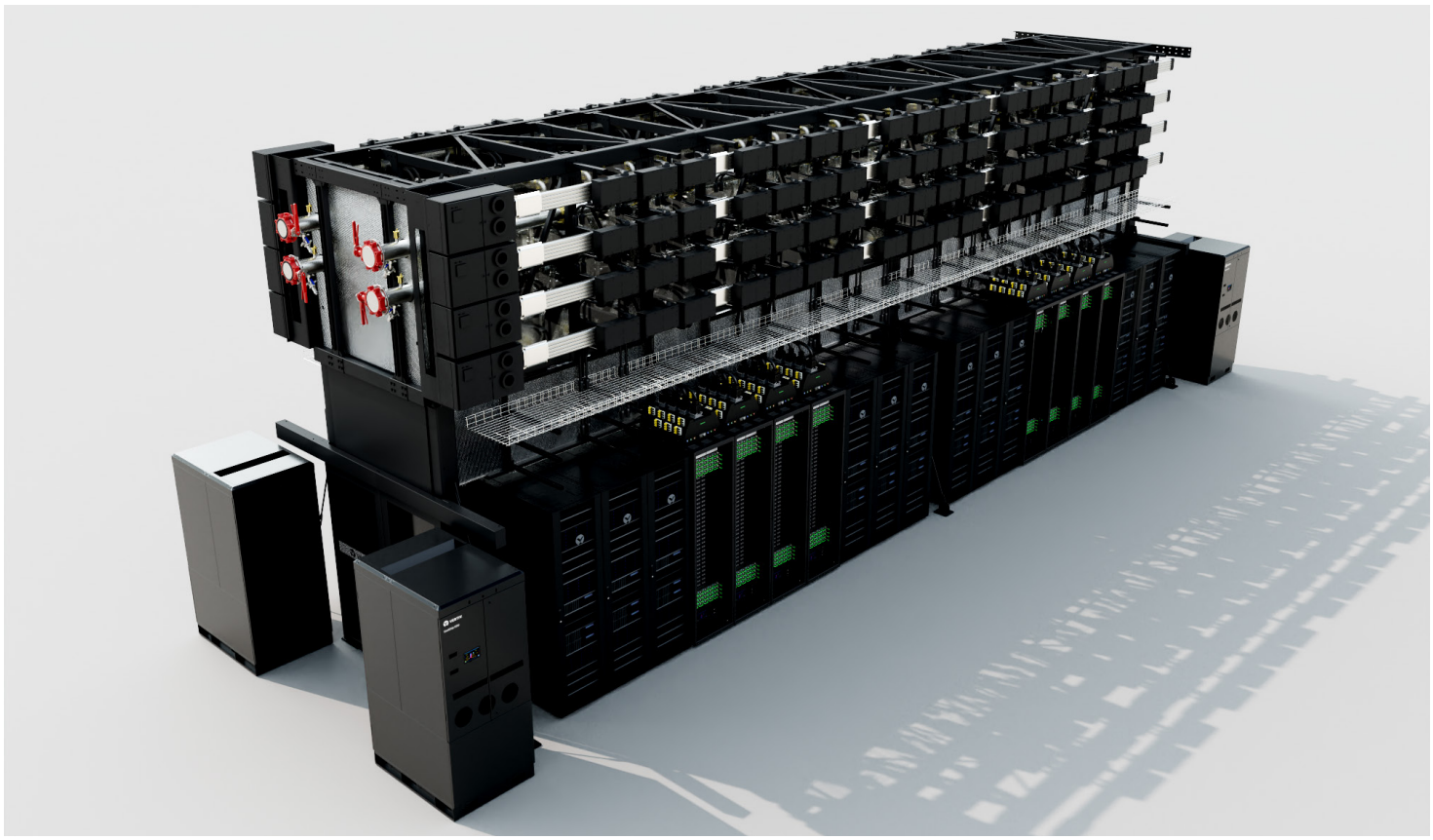
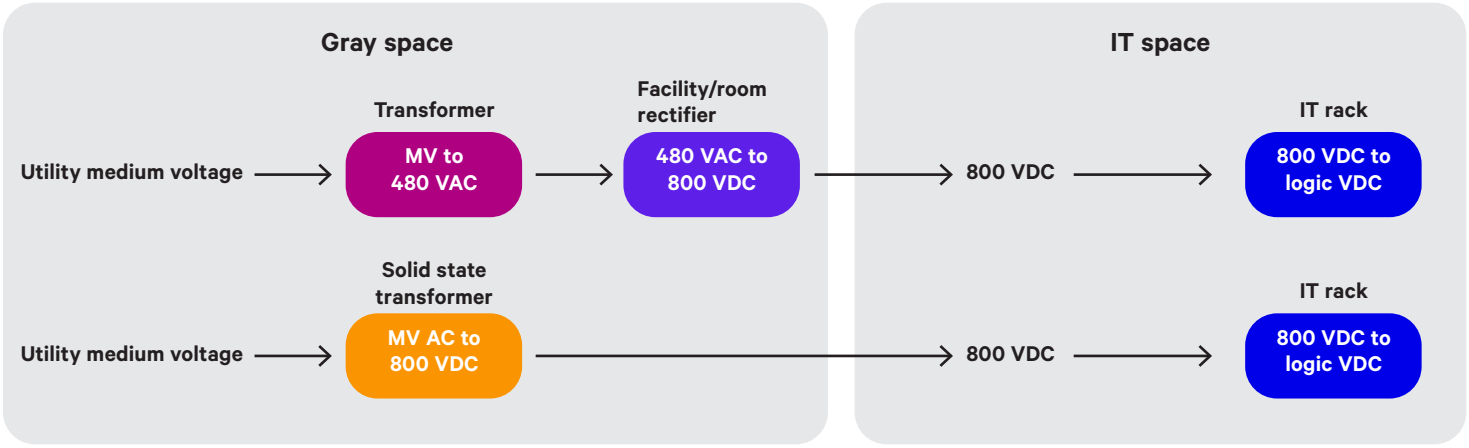


Figure 7. Example of pre-engineered pod-level conversion at the end of the pod with overhead 800 VDC distribution and integrated direct-to-chip liquid cooling. Source: Vertiv.

Facility or room-level conversion

At the facility or room level, the rectifier and battery systems move into the gray space (Figure 8). They may also be located on the perimeter of a data room or hall, or in the data room's maintenance corridor. The capacity of AC-to-DC systems and their rectifiers is further increased to support a larger number of IT racks. The concept is the same as pod or row-level, but with higher rectifier capacities and DC-to-DC battery converters, in the multi-megawatt range.

An alternative architecture, shown at the bottom of Figure 8, replaces the medium voltage (MV) isolation transformer and the rectifier system with a solid-state transformer (SST). The SST performs both functions: isolation and AC-to-800 VDC rectification, using power electronics and small high-frequency isolation transformers rather than a conventional iron-core transformer. SSTs have a self-contained liquid cooling system that uses a radiator and fan to reject the heat. As with the other architectures, the IT rack conversions remain the same.



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Figure 8. Illustration of a facility or room-level architecture and the associated conversions. An alternative architecture is shown with an SST. Source: Vertiv.

Next steps

- Read the companion white paper that evaluates the 800 VDC architectures, proposes the best option for near-term 800 VDC deployments, and provides design guidance for rack-level architectures. See the Vertiv white paper, 800 VDC distribution for AI data centers: Architecture selection criteria and design elements.
- For companies not familiar with OCP-style architectures, learn about the OCP design concepts such as compute trays/sleds, IT rack busbars, DC connectors, and DC/DC converters. These concepts transfer directly to 800 VDC architectures.



References

Vertiv white paper, 800 VDC distribution for AI data centers: Architecture selection criteria and design elements

Appendix:

This white paper was initially generated with the assistance of AI technology, but reviewed, referenced, and edited by professionals in Vertiv using the following platforms:

- Google. (2026). Gemini 3.1 Pro (Feb 19 2026 version) [Large language model]. https://gemini.google.com/.
- Anthropic. (2026). Claude Opus 4.8 (May 28, 2026 version) [Large language model]. https://claude.com/.
- Anthropic. (2026). Claude Sonnet 5 (June 30, 2026 version) [Large language model]. https://claude.com/.
- Anthropic. (2026). Claude Opus 5 (July 24, 2026 version) [Large language model]. https://claude.com/.

The platform was used for the following topics and purpose prompts:

- Outline organization and story flow
- Organization, drafting, and editorial refinement
- 800 VDC development for AI factories (i.e., AI data centers)
- Explanation of technical topics
- Finding sources for specific technical values, such as circuit breaker disconnection times
- Review of the paper for clarity, conciseness, grammar, logic, and factual integrity

AI-generated content was reviewed, fact-checked, and approved by Vertiv subject matter experts prior to the final draft and publication.



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