# Hillcrest *True*-ZVS PCS1000: Engineering the Optimal Grid Interface for 800V OCP Data Center Architectures

**November 24, 2025**

Written by Emanuel Serban, Ph.D., P.Eng. | Vice President of Engineering at Hillcrest Energy Technologies

As AI workloads drive unprecedented power density requirements in modern data centers, power systems engineers are grappling with fundamental architectural challenges. At Hillcrest Energy Technologies, our ZVS PCS1000 (Zero Voltage Switching Power Conversion System) represents a purpose-engineered solution for the 800V DC distribution architectures being standardized by the Open Compute Project (OCP).

**The Engineering Case for 800V DC Distribution**

The Open Compute Project – with participation from companies such as Meta, Microsoft, Intel and NVIDIA has identified critical limitations in traditional 400V DC architectures that make them increasingly unsuitable for high-density AI workloads.

**Quantifying the 800V Advantage**

The shift to 800V DC distribution delivers measurable improvements across multiple system parameters:

**Conduction Loss Reduction**: At constant power, doubling bus voltage from 400V to 800V reduces current by half, yielding a 4× reduction in $I^2R$ losses. For a 1MW distribution system:

- 400V system: 2500A rated current
- 800V system: 1250A rated current
- Result: ~75% reduction in copper/busbar losses

**Simplified Power Chain**: The shift to 800V DC enables a streamlined conversion architecture:

MV Grid → AC-DC → 800V DC Bus → DC-UPS → Isolated DC-DC (800V→48/12V) → Server/GPU Loads

This eliminates the traditional multi-stage AC distribution:

- *No* 400/480V AC UPS
- *No* rack-level PFC/PSU conversions
- Reduced total conversion stages from 4-5 to 2-3

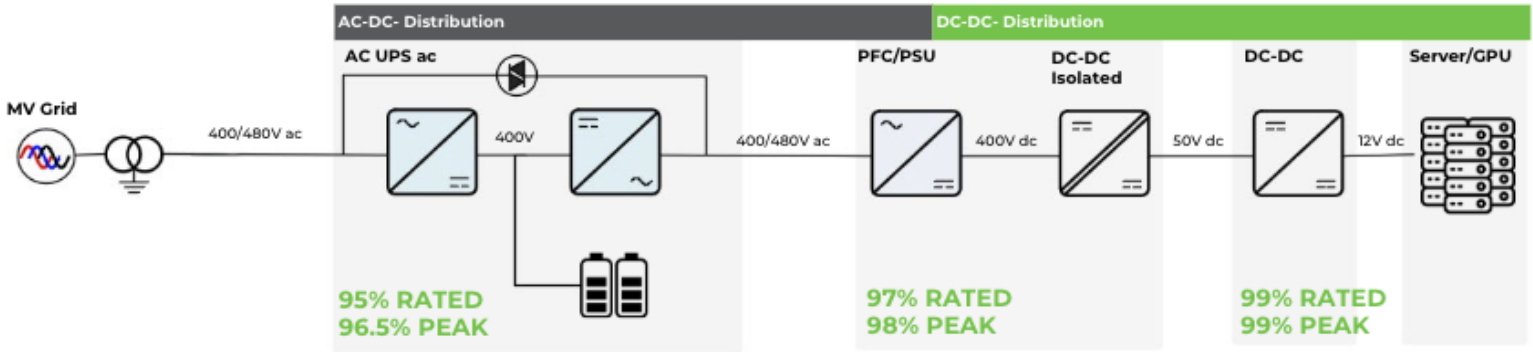
**System Efficiency**: As an example, end-to-end power conversion efficiency (MV grid → server loads) improves from 91.2-93.6% (400V) to 95.5-97.5% (800V). For a 10MW facility, this 4% efficiency gain represents approximately 400kW of reduced losses- equivalent to avoiding the need for substantial cooling infrastructure.

**Voltage Drop and Distribution Distance**: The reduced current enables practical distribution distances of 10-20m (versus < 5m for 400V), allowing more flexible rack layouts and reducing copper requirements per kW delivered.

**Thermal Management**: Lower $I^2R$ losses reduce heat generation in distribution systems, simplifying thermal management and enabling higher rack densities without proportional cooling infrastructure expansion.

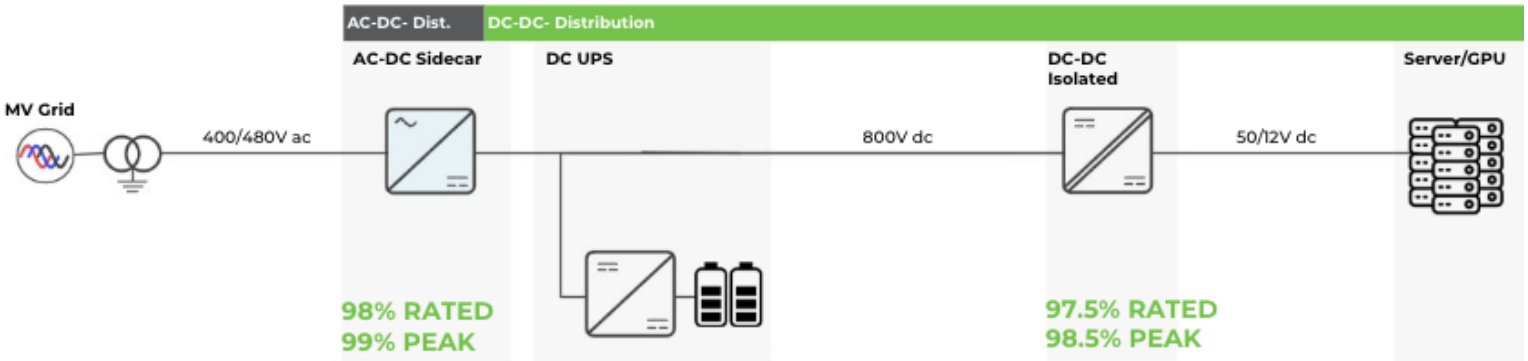
## 400V Architecture

**~91.2% RATED | 93.6% PEAK SYSTEM EFFICIENCY**




## 800V Architecture

**~95.5% RATED | 97.5% PEAK SYSTEM EFFICIENCY**



**Hillcrest ZVS Technology: Advanced Soft-Switching for High-Efficiency Power Conversion**

Our proprietary Zero Voltage Switching topology addresses fundamental switching loss mechanisms that limit conventional hard-switched converter efficiency at high voltages and power levels.

**ZVS PCS1000 Architecture Benefits**

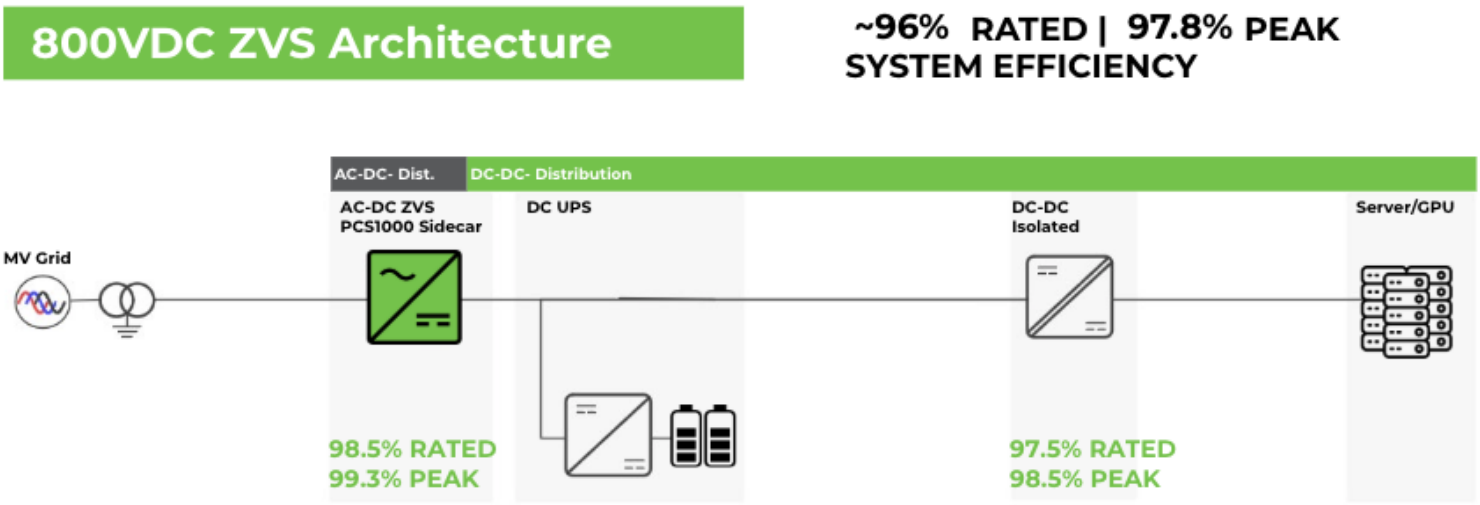
The Hillcrest ZVS PCS1000 system is specified with:

- **Peak conversion efficiency: > 99%** (AC grid → 800V DC bus)
- **Rated efficiency: 98.5%** across typical load profiles
- **System-level efficiency improvement: Up to 0.5%** versus state-of-the-art 800V AC-DC architectures
- **Rated power module: 150kW/200kW**
- **Scalability: 150kW/200kW to 1.2+ MW** through parallel configuration
- **Rated current capability: 1250-1500A at 800V DC**

The additional efficiency gain from ZVS technology - while seemingly modest at 0.5% - becomes significant at scale. In a 100MW data center, this represents 500kW of reduced losses, translating to substantial operational cost savings and reduced cooling requirements.

**System Integration: ZVS PCS1000 in 800V Sidecar Architecture**

The OCP 800V sidecar architecture consolidates AC-DC conversion and energy storage into a dedicated power rack adjacent to IT equipment racks. This topology eliminates redundant conversion stages while enabling rack-level backup power and power quality management.



**ZVS PCS1000 as the Optimal AC-DC Interface**

**Voltage Compatibility**: The ZVS PCS1000 (three-phase MV-LV grid connection) rated power and 800V DC output align with next-gen data centers sidecar specifications.

**Modular Power Scaling**: At 200kW per unit, the ZVS PCS1000 maps efficiently to rack-level power requirements:

- Single unit: 150kW/200kW → supports scalability
- Redundant N+1 configuration
- Multi-unit sidecar: Up to 1.2MW+ for high-density pods

**Thermal and Efficiency Implications**: Fewer conversion stages mean:

- Reduced cumulative conversion losses
- Simplified cooling architecture (concentrated heat rejection at sidecar)
- Lower maintenance burden (fewer power electronics assemblies)
- Improved system MTBF

**Engineering Advantages: ZVS Topology vs. Conventional Hard-Switched Converters**

**Switching Loss Mitigation**

Conventional hard-switched converters experience simultaneous high voltage and high current during switching transitions, resulting in switching losses proportional to:

$$E_{sw_{loss}} = \int_{t_{on}} v_Q(t)\, i_Q\, dt + \int_{t_{off}} v_Q(t)\, i_Q(t)\, dt \rightarrow \mathbf{0}$$

ZVS topology eliminates this loss mechanism by ensuring switches transition at zero voltage, leaving only conduction and magnetic losses as primary loss mechanisms. At 800V output voltage and switching frequencies in the 40-100kHz range, this provides measurable efficiency improvements.

**EMI and Power Quality**

Zero voltage switching inherently produces lower dv/dt and di/dt, reducing electromagnetic interference and simplifying filter requirements. This translates to:

- Smaller, lighter input filters
- Better power quality upstream
- Simplified compliance with grid codes and EMC standards

**Thermal Stress Reduction**

Lower switching losses reduce junction temperatures and thermal cycling in power semiconductors, improving reliability and extending operational lifetime—critical factors in 24/7 data center operations where maintenance windows are limited.

**Scalability and Redundancy Architecture**

The modular nature of the ZVS PCS1000 enables flexible redundancy configurations:

**N+1 Configuration**: Base load distributed across N units with one additional unit for redundancy. Provides single-fault tolerance with minimal overhead.

**2N Configuration**: Full parallel redundancy. Each unit operates at 50% capacity, enabling maintenance without service interruption.

**Distributed Redundancy**: Multiple sidecars per pod with cross-connection capability, providing both component-level and system-level redundancy.

All configurations support hot-swap capability, enabling field servicing without load interruption—essential for maintaining uptime SLAs in mission-critical facilities.

**Alignment with OCP Roadmap and Industry Adoption**

Major hyperscale operators and colocation providers are accelerating 800V deployments:

- NVIDIA's reference designs increasingly specify 800V distribution
- Microsoft Azure and Meta infrastructure teams are investigating 800V architectures
- Schneider Electric and Vertiv working for 800V-compatible power distribution units

The ZVS PCS1000 positions Hillcrest as a critical technology enabler in this ecosystem, providing the high-efficiency grid interface that maximizes the benefits of 800V distribution.

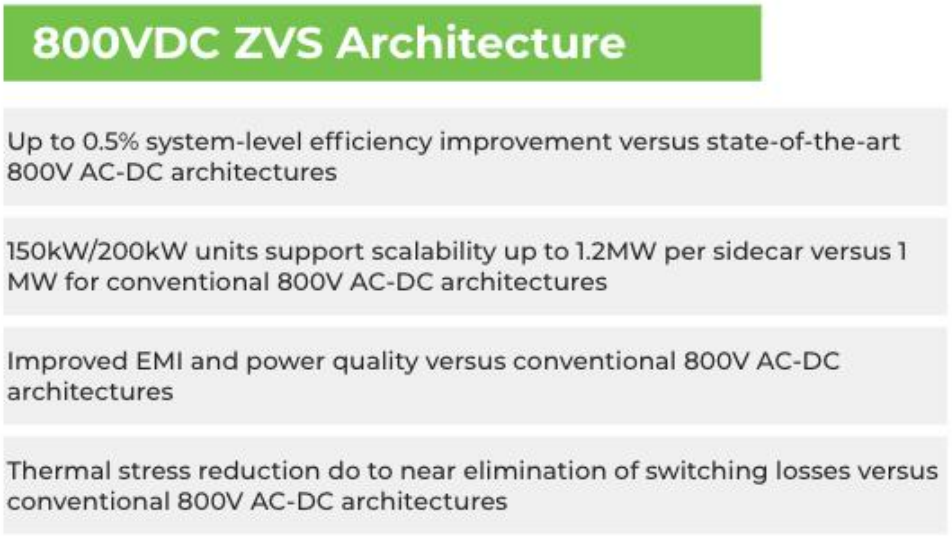
**Forward-Looking Engineering Considerations**

As rack power densities continue their trajectory toward 150kW+ and liquid cooling becomes standard for AI accelerators, several engineering challenges emerge:

**Fault Current Management**: 800V DC systems require careful attention to fault protection and arc flash mitigation. The ZVS PCS1000 incorporates fast fault detection and current limiting protections.

**Grid Integration**: High-power AC-DC converters must maintain power quality, provide reactive power support, and ride through grid disturbances. The ZVS PCS1000 architecture enables these grid-support functions (e.g. UL1741/IEEE1547) while maintaining high efficiency.

**Battery Integration**: The sidecar architecture naturally accommodates DC-coupled battery systems. The ZVS PCS1000's bidirectional capability is in development and is expected to enable seamless integration of energy storage for both backup power and grid services.





**Conclusion: Engineering Excellence for Next-Generation Infrastructure**

The transition to 800V data center architectures represents sound engineering: it addresses fundamental physics ($I^2R$ losses scale with current squared), improves system efficiency, and enables the power densities required for AI workloads.

The Hillcrest ZVS PCS1000 provides the optimized grid interface this architecture requires. By combining advanced *True*-ZVS topology with 1000V AC input and 800V DC output, our system delivers measurable efficiency improvements, simplified thermal management, and the modular scalability that modern data center infrastructure demands.