TL-01
0.0,0.0

TR-01
1920.0,0.0

TO EXTERNAL GRID AC INPUT (415V/480V)

TO 800 VDC BACKBONE BUS

SYSTEM INTERCONNECT 1 (CYAN)

SYSTEM INTERCONNECT 2 (GREEN)

FEED TO PRIMARY SUBSTATION

HIGH-EFFICIENCY RECTIFIER LINK

THE GRID-TO-CHIP ODYSSEY: ARCHITECTING THE 800 VDC AI FACTORY

END-TO-END POWER DISTRIBUTION FOR NVIDIA KYBER AND NEXT-GENERATION 1MW RACK INFRASTRUCTURES

SYSTEM INTERCONNECT 1 (CYAN)

SYSTEM INTERCONNECT 2 (GREEN)

HIGH-EFFICIENCY RECTIFIER LINK

GRID SYNCHRONIZATION POINT

DIRECT DC DISTRIBUTION PATHWAY

SCALE 1:1

REF. PLAN B1

GRID SYSTEM REV. 1.2

BL-01
0.0,1080.0

BR-01
1920.0,1080.0

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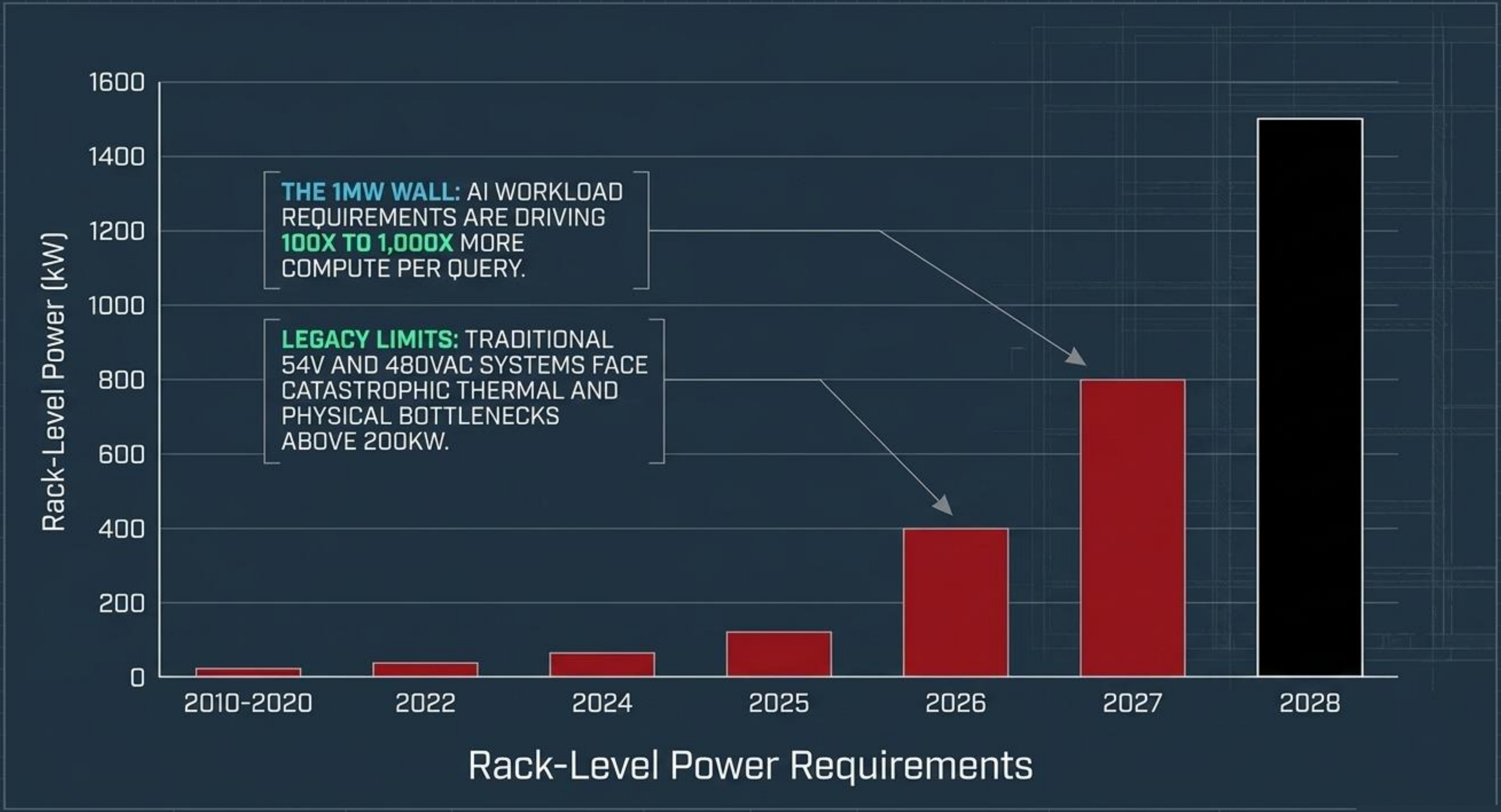

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THE GENERATIONAL ARCHITECTURE MATRIX

	Gen 1: Traditional	Gen 2: 54VDC Bus	Gen 3 / Next-Gen
Rack Input	277VAC	50VDC	800VDC
AC/DC Conversion	In-Tray PSUs	Power Shelf inside Rack	Moved completely outside to Sidecar/Power Room
UPS/Backup Location	Central Facility UPS	Local BBU in Rack	Hall Sidecar BBU/CBU
Rack Power Ceiling	20kW	~100kW	1MW+

Spec Tag

Spec Tag

Spec tag

Spec tag

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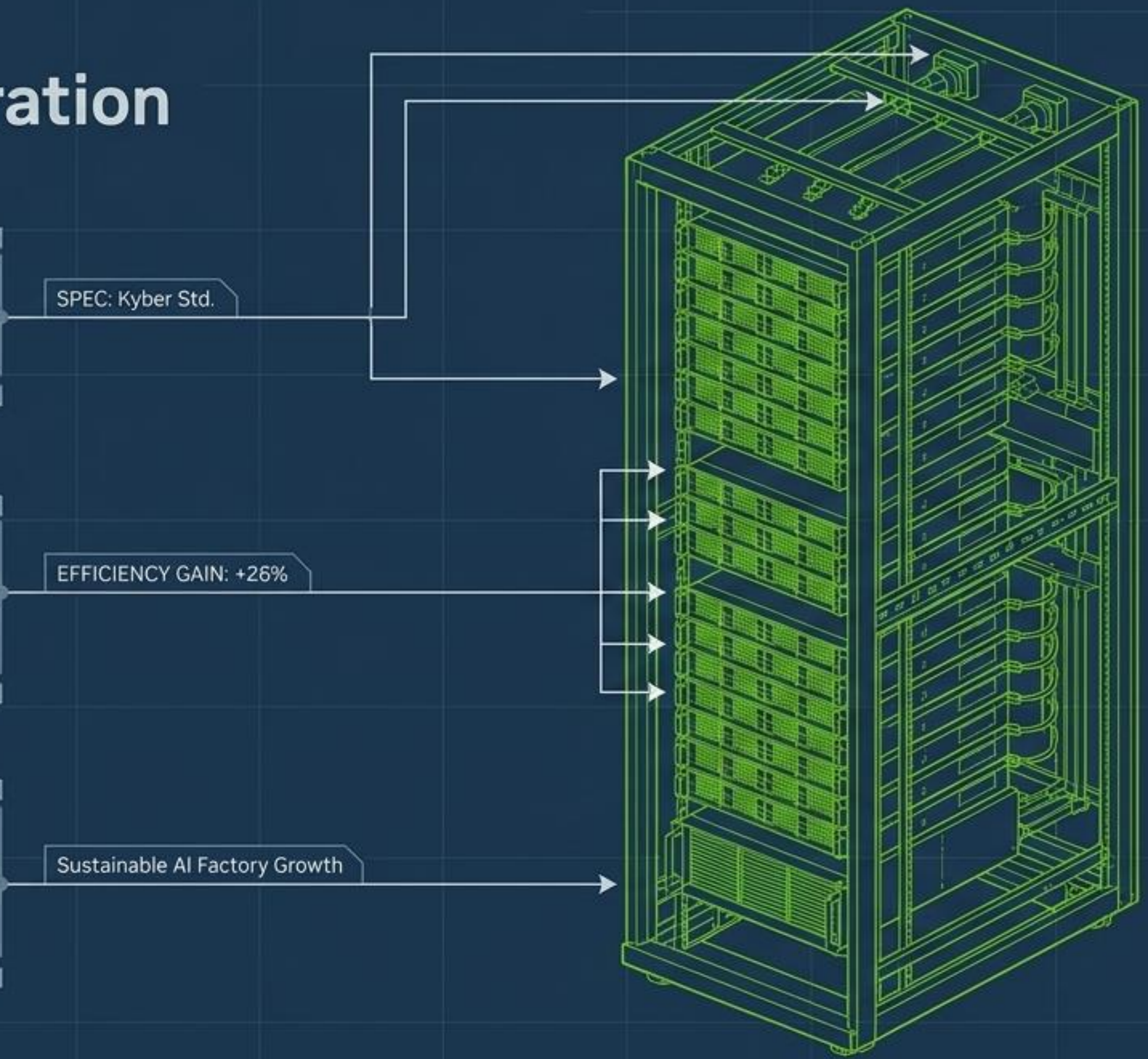
The Paradigm Shift: Native 800 VDC Integration

The Kyber Architecture:
NVIDIA's upcoming rack standard designed natively for 800VDC, launching in 2027.

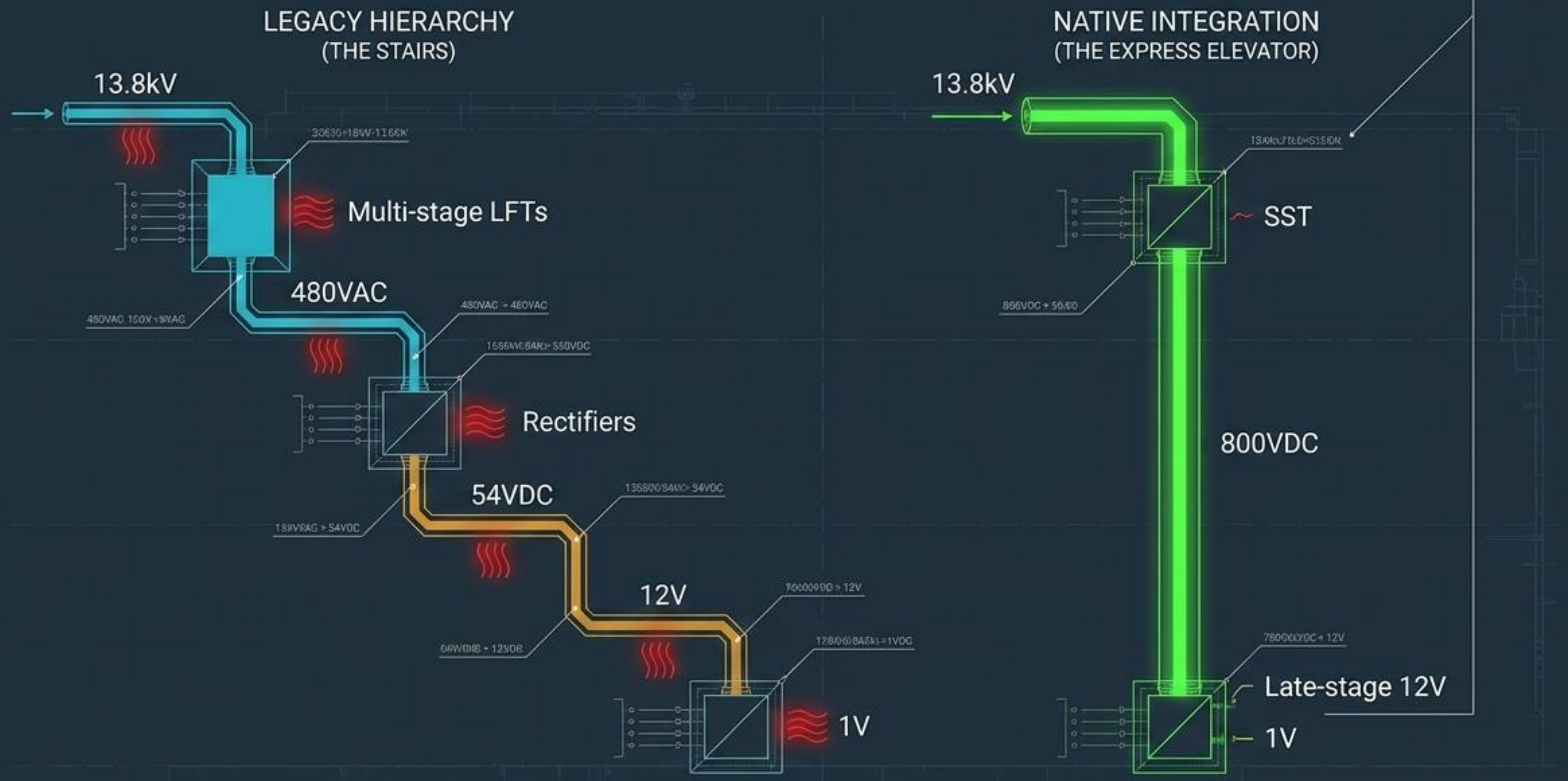
The Efficiency Multiplier:
Eliminates redundant in-rack conversions, freeing up 26% more real estate for pure compute.

TCO Impact:
Unlocks sustainable AI factory growth, cutting total cost of ownership by up to 30% through massive efficiency and cooling gains.

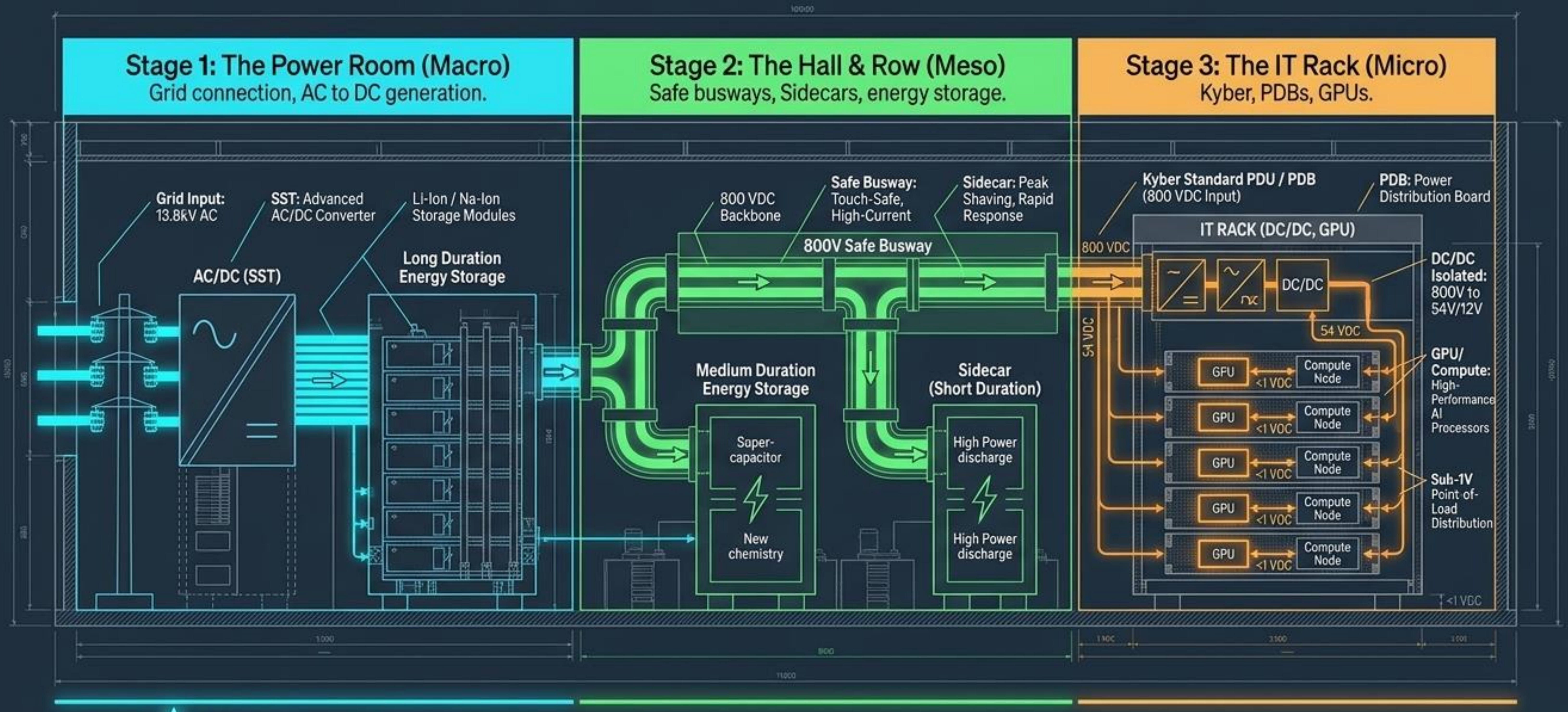


ENERGY DELIVERY COMPARISON: THE ENERGIZED BLUEPRINT

Every AC/DC and DC/DC conversion stage bleeds energy as heat. The 800 VDC architecture bypasses legacy facility transformers and rack-level PSUs, delivering high voltage directly to the compute node.



The Spatial Anatomy of an AI Factory



Master Map Blueprint

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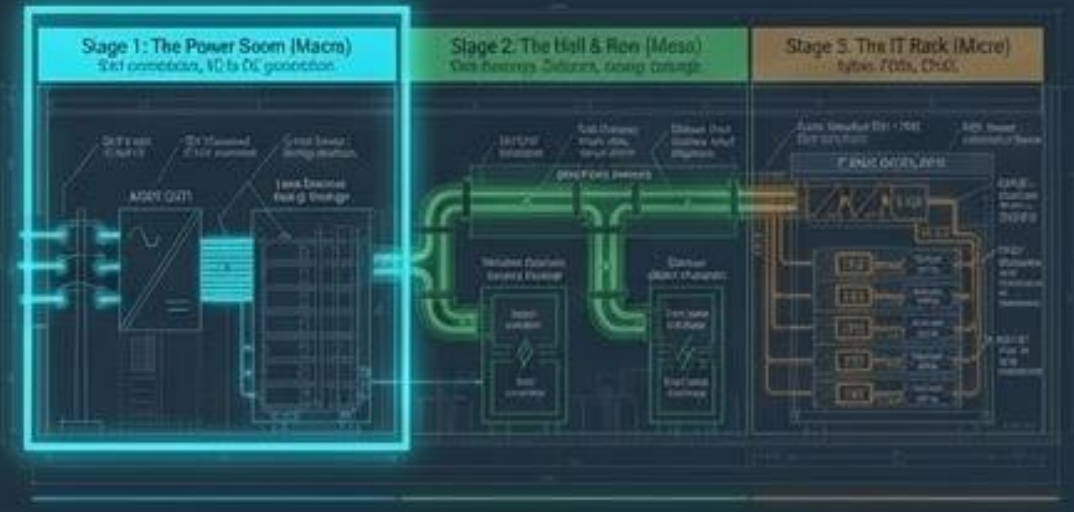
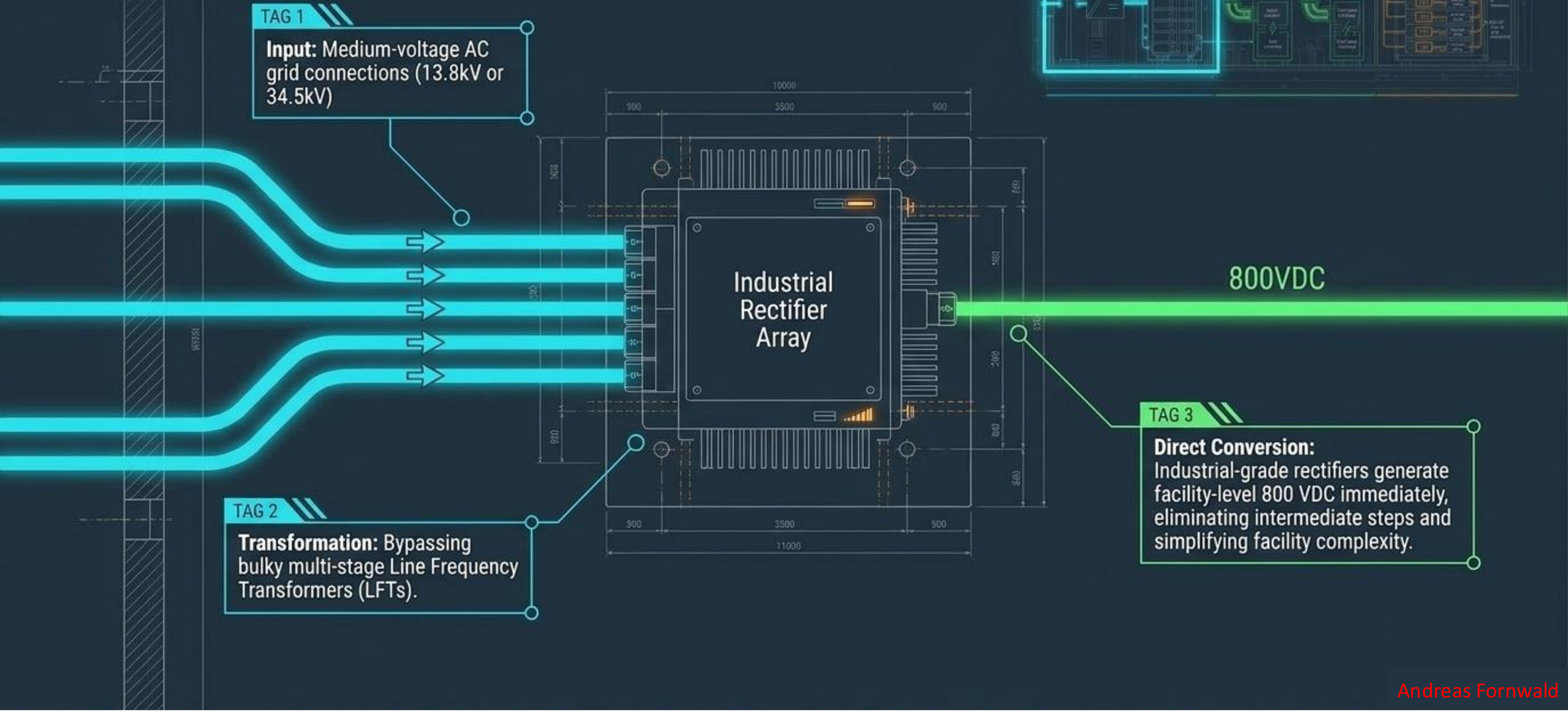
Stage 1: The Power Room

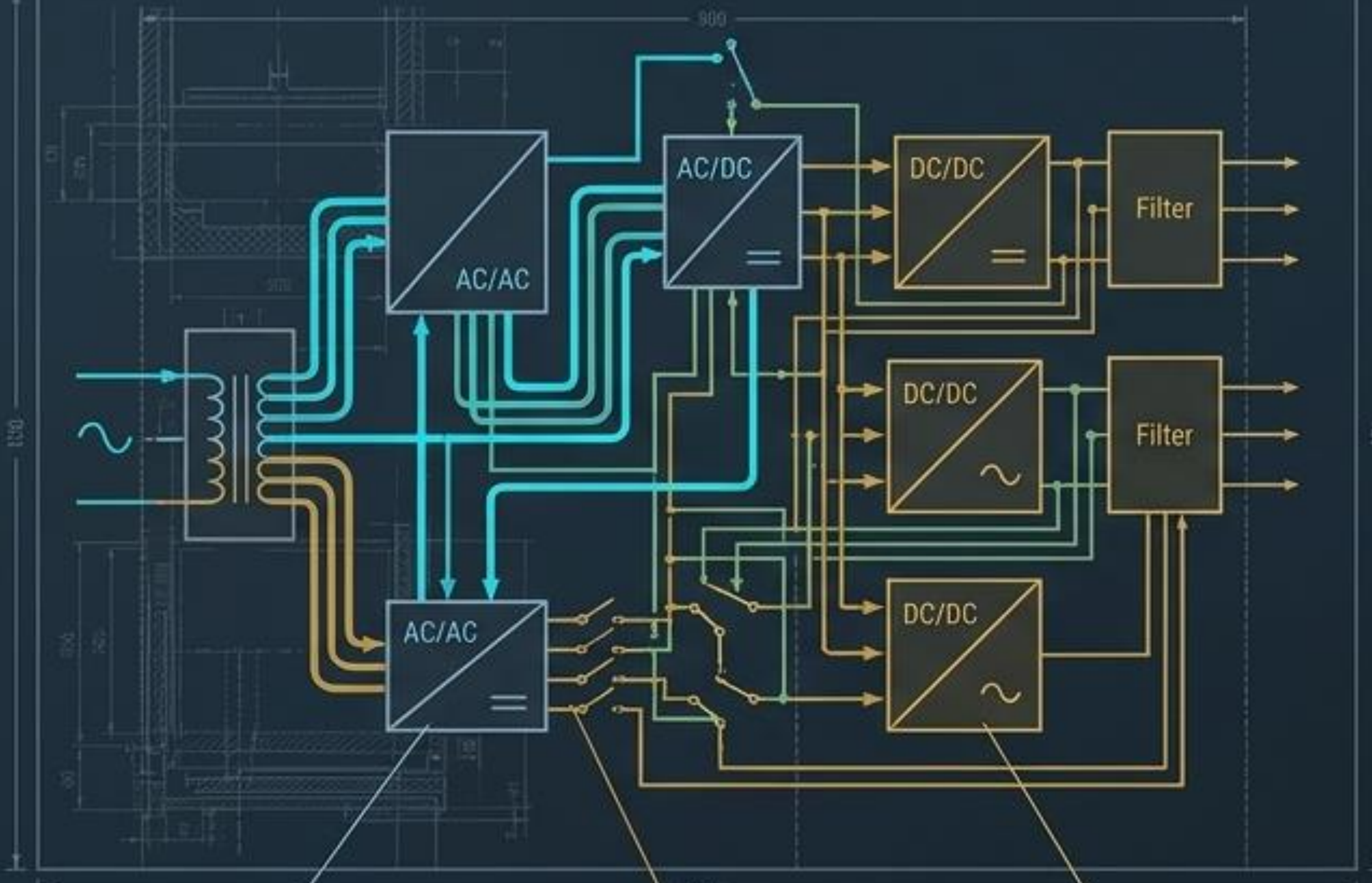




Power Conversion Topology Comparison

Legacy LFT

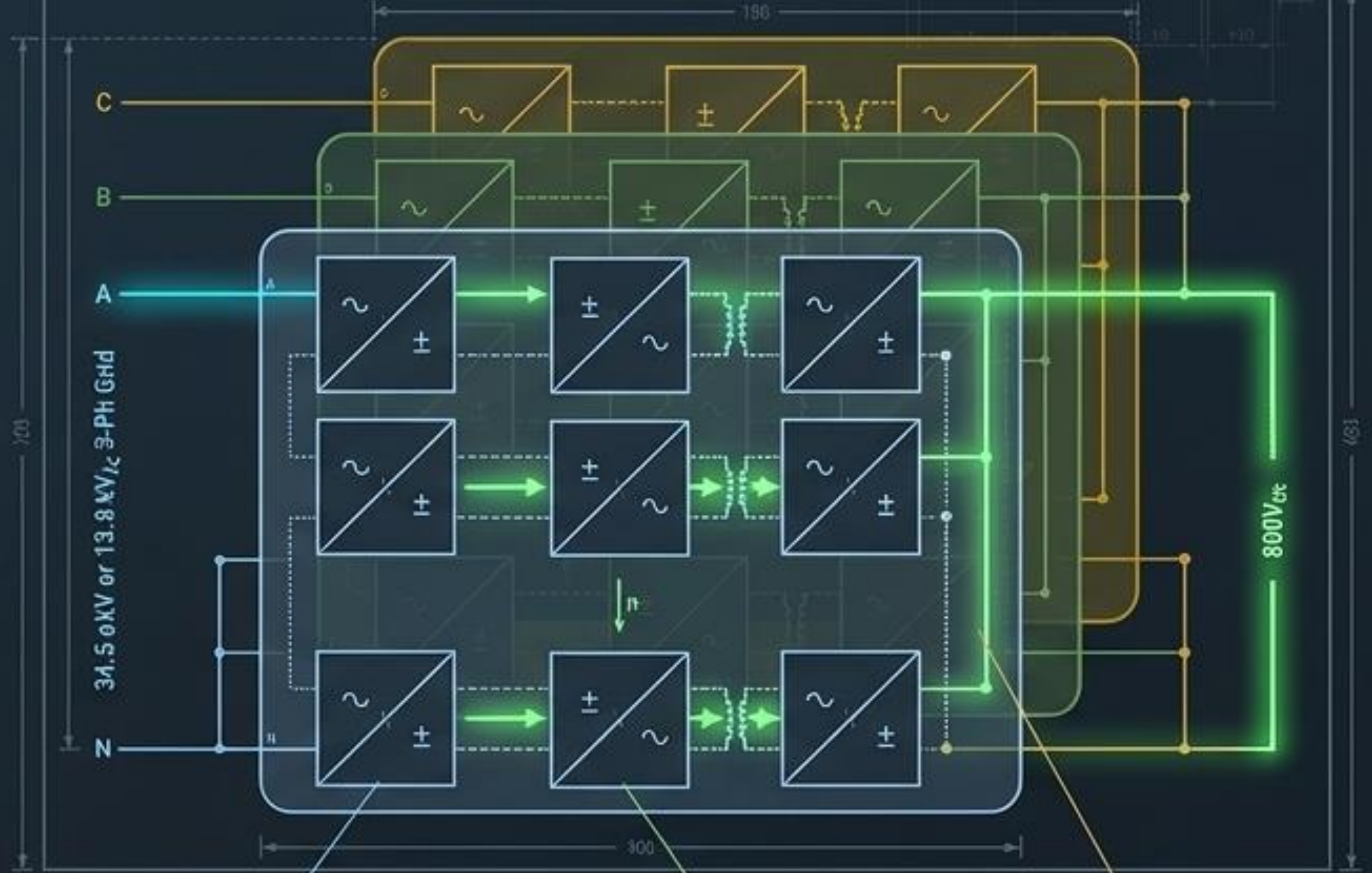
Line Frequency Transformers + Multi-Stage Rectifiers



- Bulky footprint
- Lossy AC distribution
- Complex switching

SST with SiC

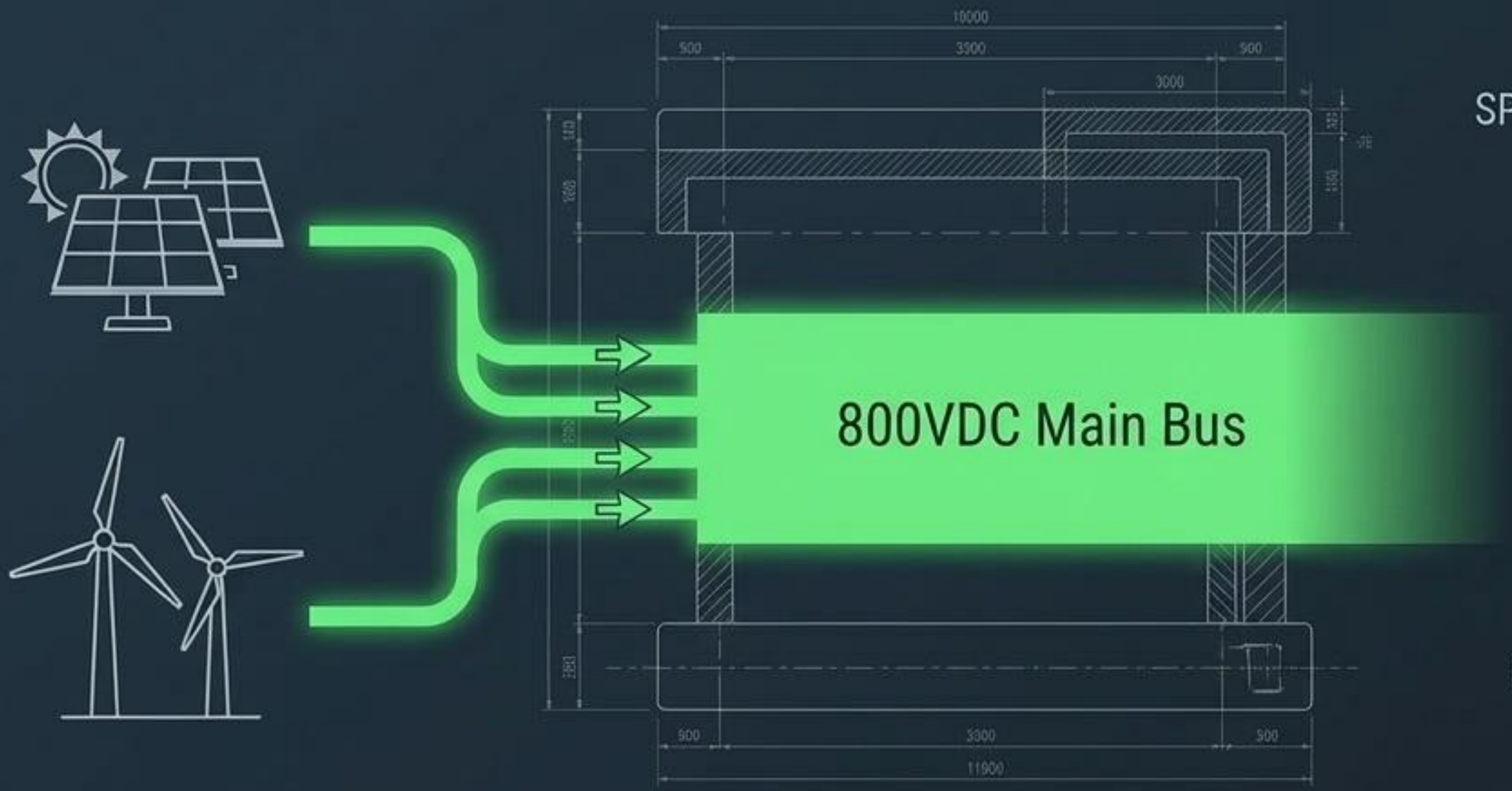
Solid State Transformers (SST)

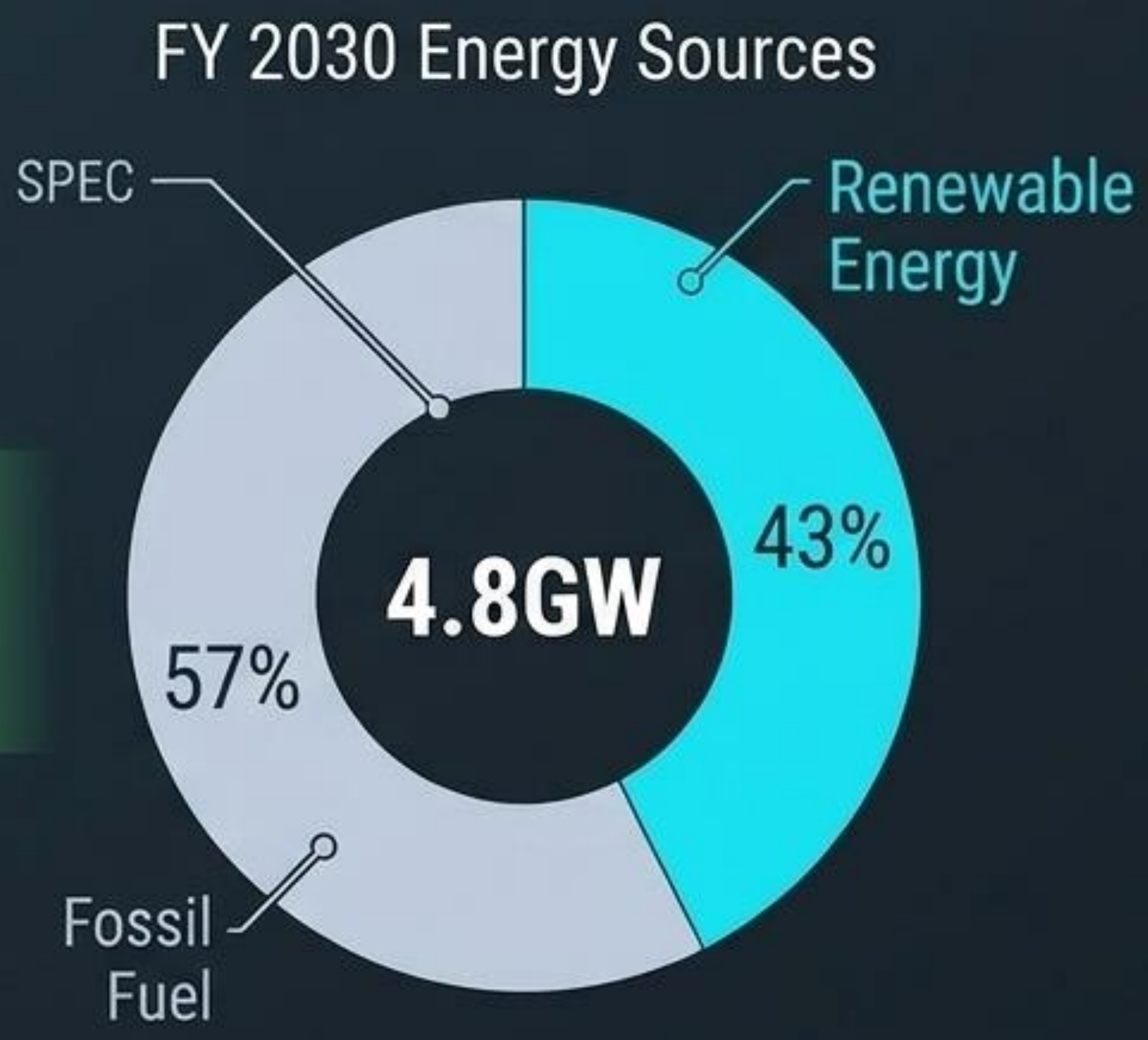


- Powered by high-voltage (1200V+) Silicon Carbide (SiC) semiconductors.
- Converts 34.5kV/13.8kV directly to 800 VDC.
- Minimizes electrical complexity and maintenance.

Global alignment with the IEC's low-voltage DC (LVDC) classification (≤1,500 VDC)

Native Renewable Integration





TAG 1

The AI power mandate requires a massive shift to renewables (projected 43% of AI energy mix by 2030).

TAG 2

An **800 VDC** grid provides the ideal native framework for direct integration of DC-generating solar and wind resources.

TAG 3

Enhances sustainability while eliminating inverter conversion losses.

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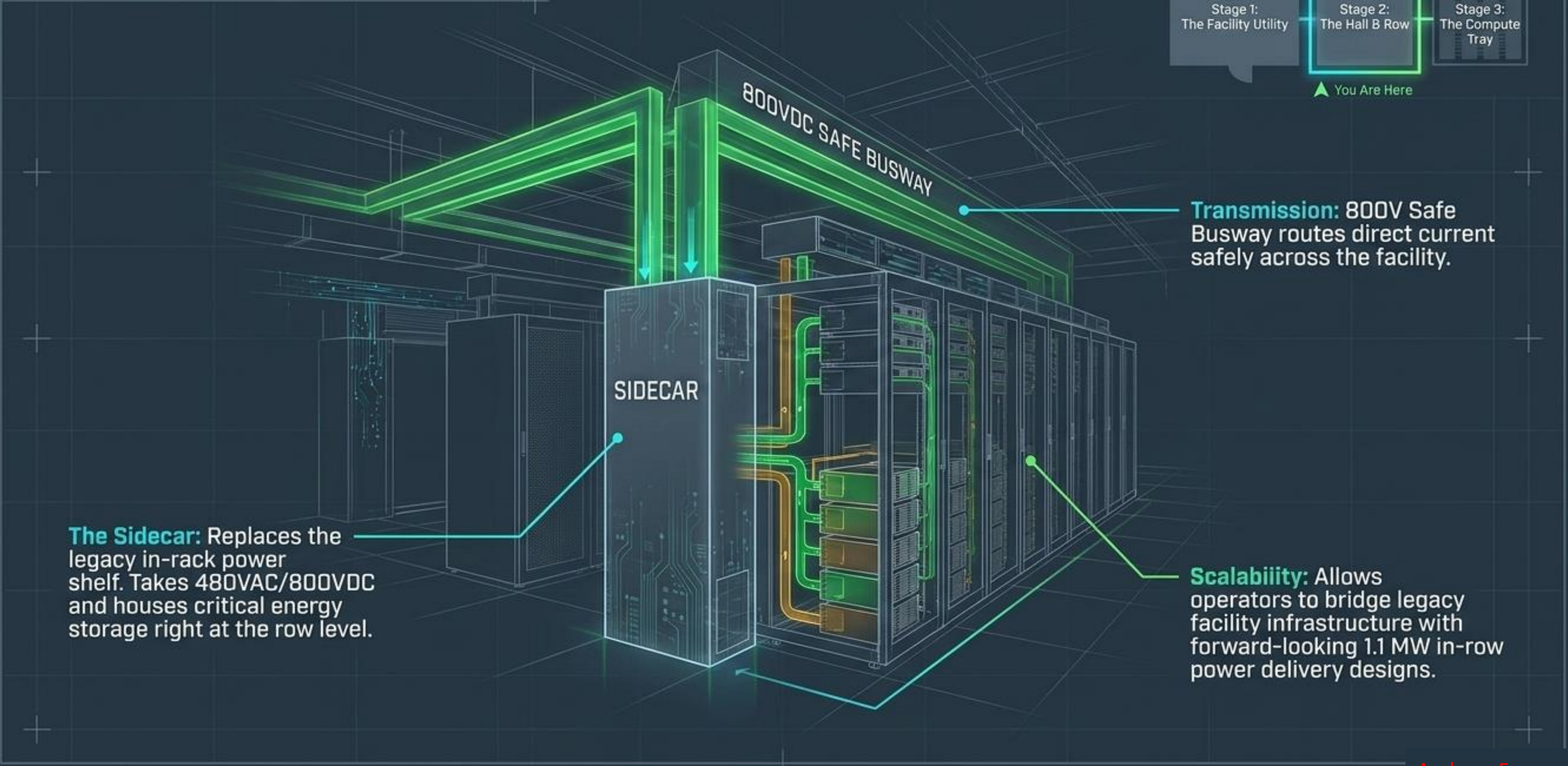
Stage 2: The Hall & Row



Sub-Second Load Volatility & Energy Storage

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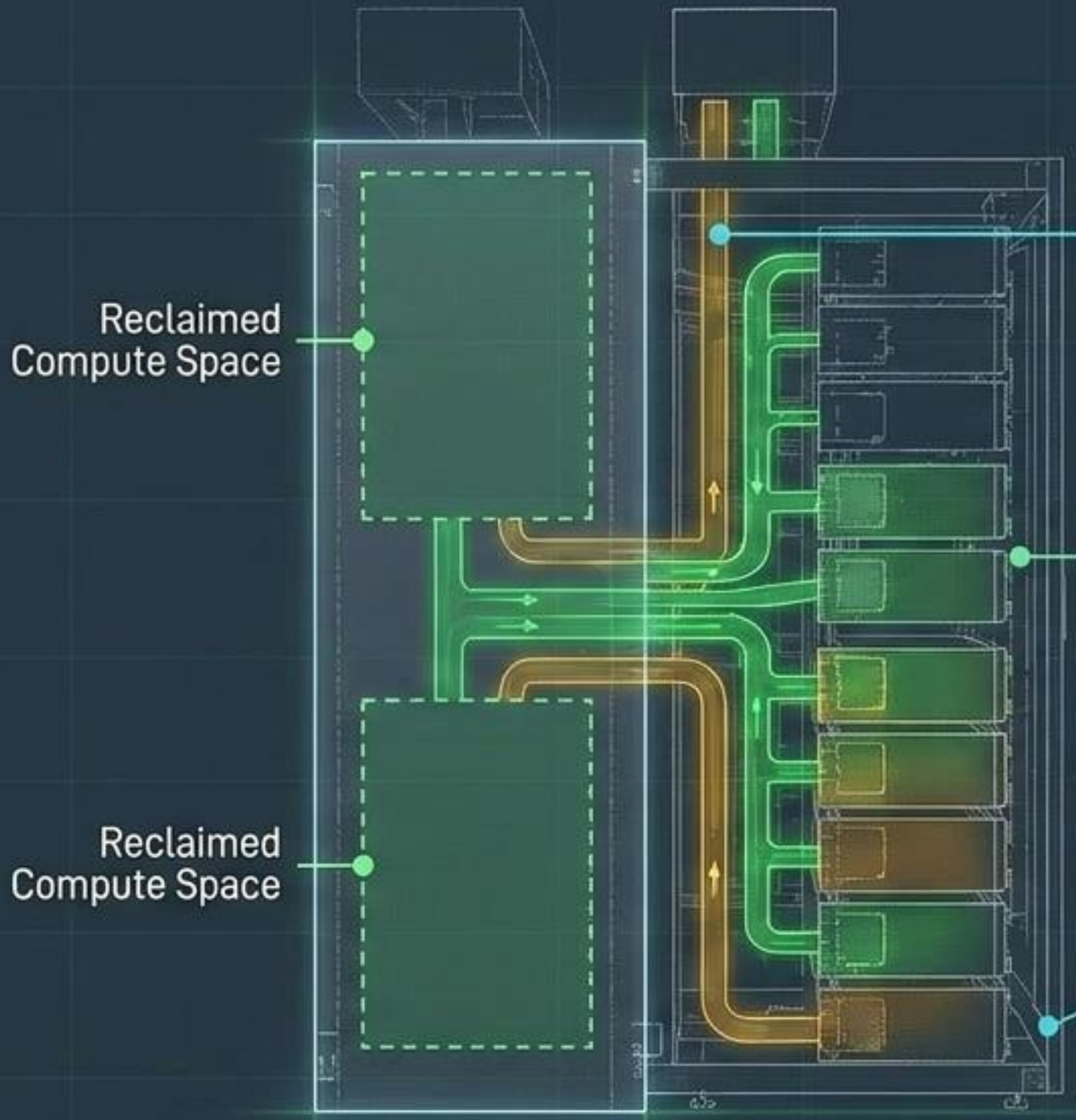
Stage 3: The NVIDIA Kyber IT Rack

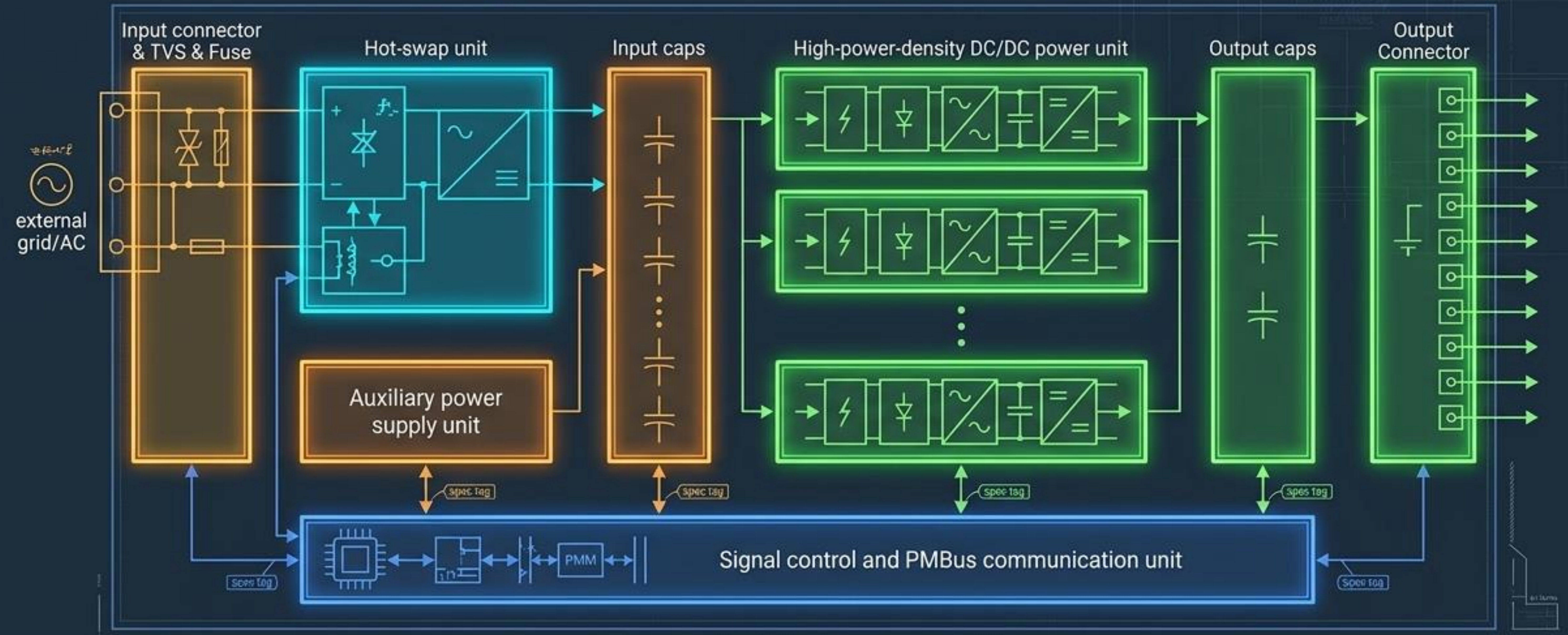


Direct 800V Input: The rack accepts a two-conductor 800V feed directly, eliminating all bulky integrated AC/DC conversions.

The Density Dividend: Removing power conversion hardware allows for ultra-dense GPU configurations and dramatically improves liquid cooling implementation.

Maintenance: Fewer internal Power Supply Units (PSUs) reduces rack-level maintenance costs by up to 70%.

The PDB: The High-Voltage Critical Hub



Function

SPEC TAG

Distributes the central high-voltage 800VDC into multiple tailored output channels.

Protection

SPEC TAG

Integrated input connectors, TVS (Transient Voltage Suppressor), and fuses guard downstream components against overvoltage and overcurrent.

Intelligence

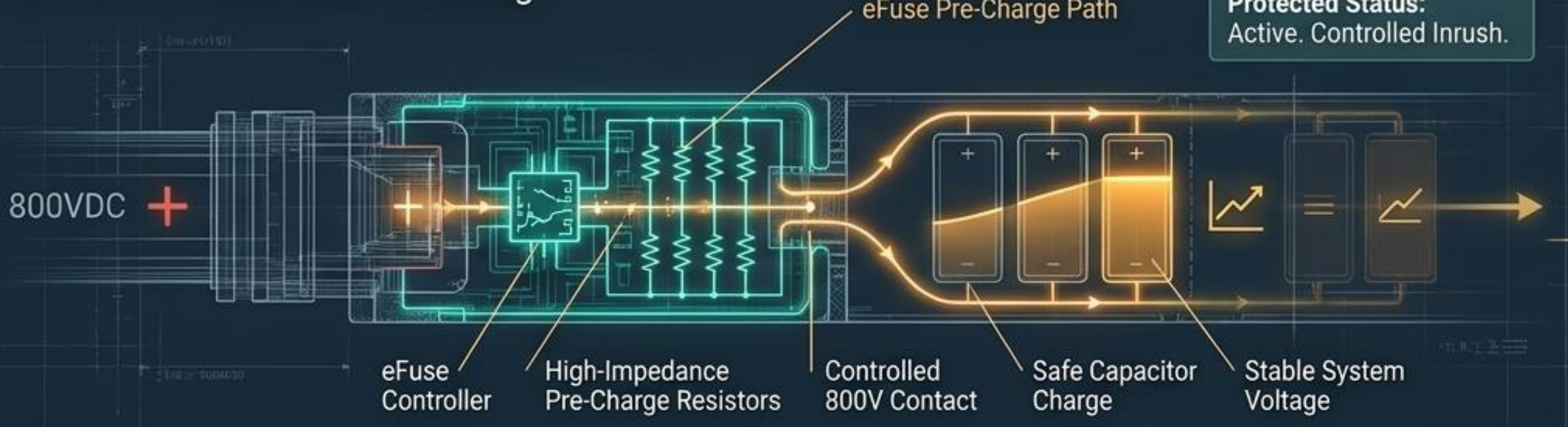
SPEC TAG

PMBus (Power Management Bus) controls regulation and monitors real-time voltage, current, and thermal telemetry.

Hot-Swap Anatomy & eFuse Technology

Without eFuse: Catastrophic Inrush Current

With eFuse: Controlled Pre-Charge

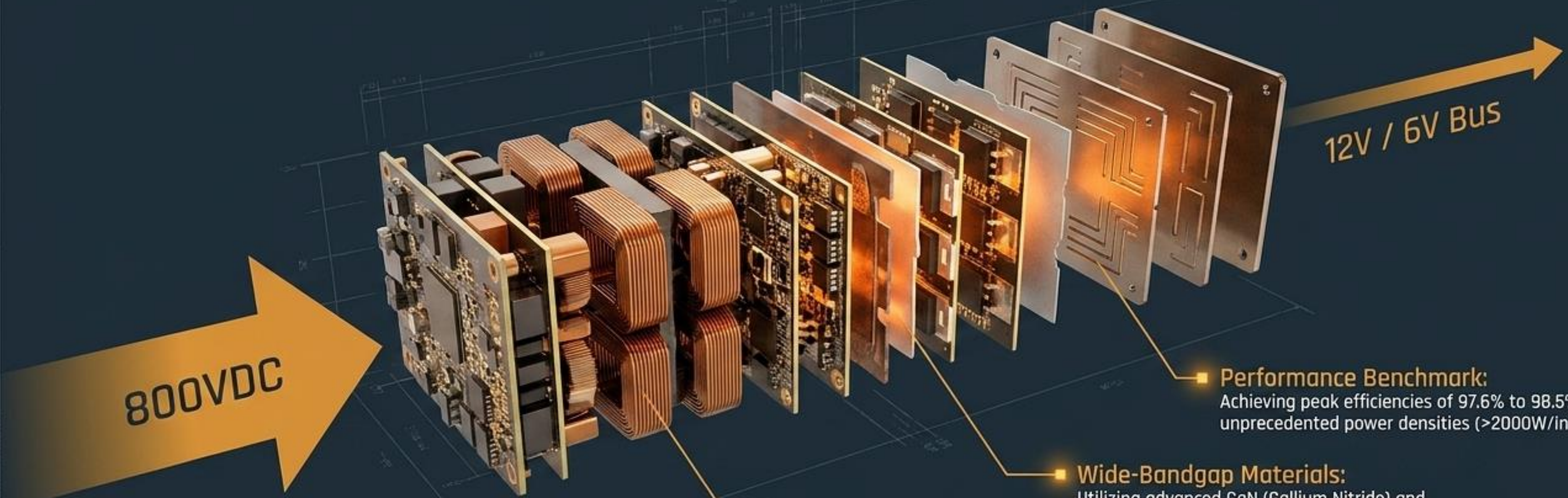


The Physics of Insertion: Inserting an uncharged capacitor directly into an 800VDC bus acts as a short circuit, creating an inrush current strong enough to blow fuses and drop system voltage.

The eFuse Solution: Hot-swap controllers use a high-impedance pre-charge path to safely limit inrush current.

Operational Impact: Enables live maintenance of 800V systems without disrupting adjacent server trays. Slashes Mean Time To Repair (MTTR) by 90% (down to 10-15 minutes), preventing tens of thousands of dollars in downtime losses.

The 64:1 LLC Converter Engine

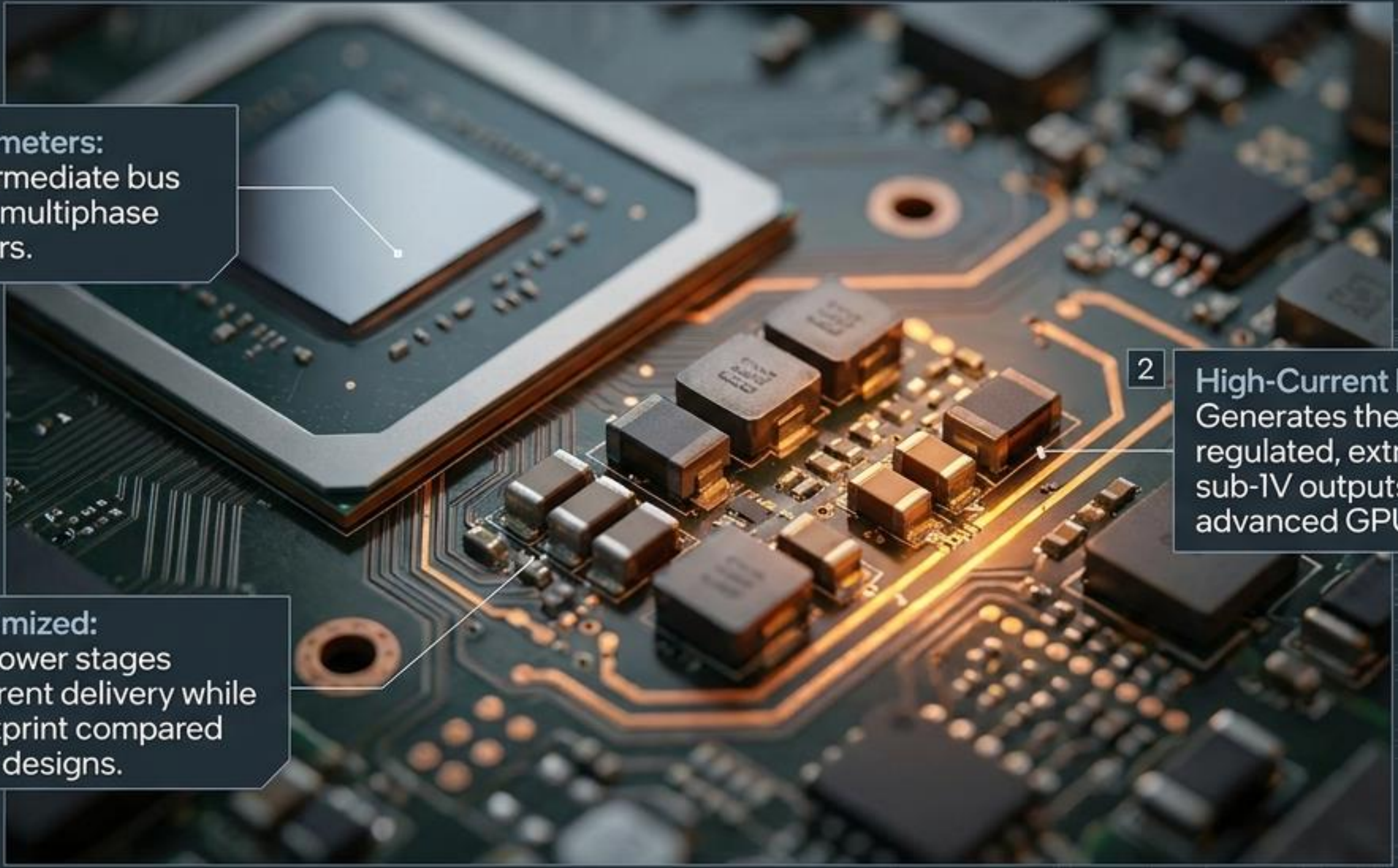


Performance Benchmark:
Achieving peak efficiencies of 97.6% to 98.5% with unprecedented power densities (>2000W/in^3).

Wide-Bandgap Materials:
Utilizing advanced GaN (Gallium Nitride) and SiC (Silicon Carbide) power stages.

The Final Step-Down:
Late-stage, high-ratio 64:1 isolated LLC converters take the 800V input and drop it precisely to an intermediate 54V, 12V, or 6V bus.

Point of Load: Driving the AI Core

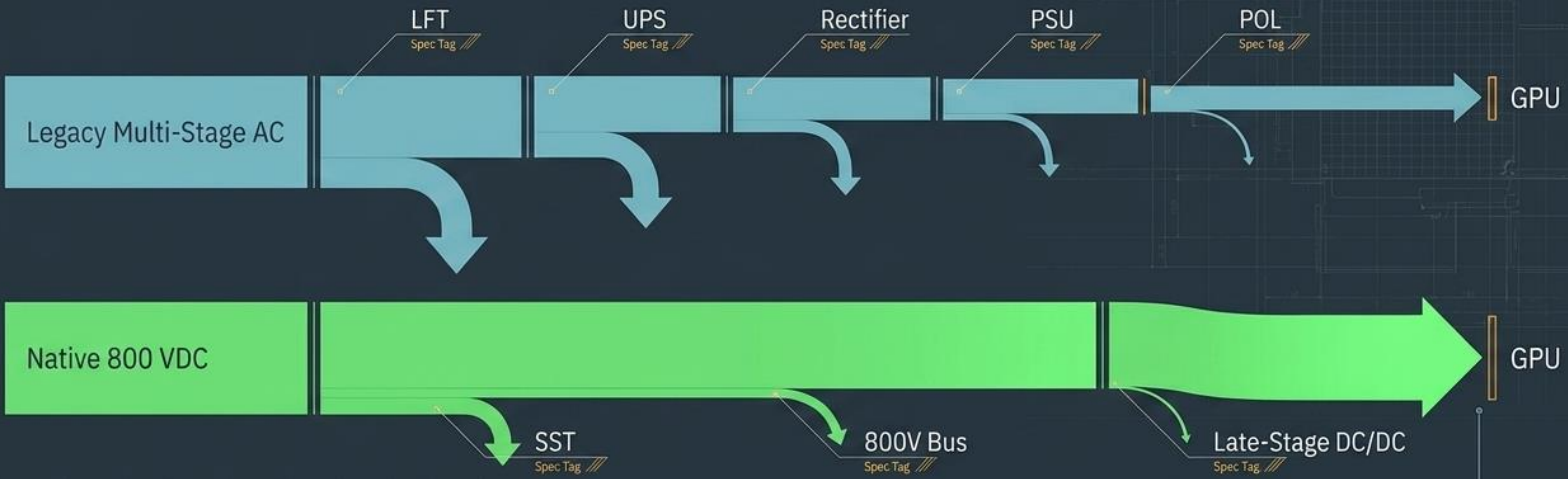


1 **The Final Millimeters:**
6V or 12V intermediate bus is delivered to multiphase buck converters.

2 **High-Current Delivery:**
Generates the highly regulated, extreme-current, sub-1V outputs required by advanced GPU cores.

3 **Spatially Optimized:**
Dual-phase power stages maximize current delivery while shrinking footprint compared to legacy 12V designs.

The Power Density Waterfall



By eliminating redundant AC/DC and DC/DC conversion stages, the native 800 VDC architecture improves total end-to-end efficiency by up to 5%, maximizing AI tokens generated per watt.

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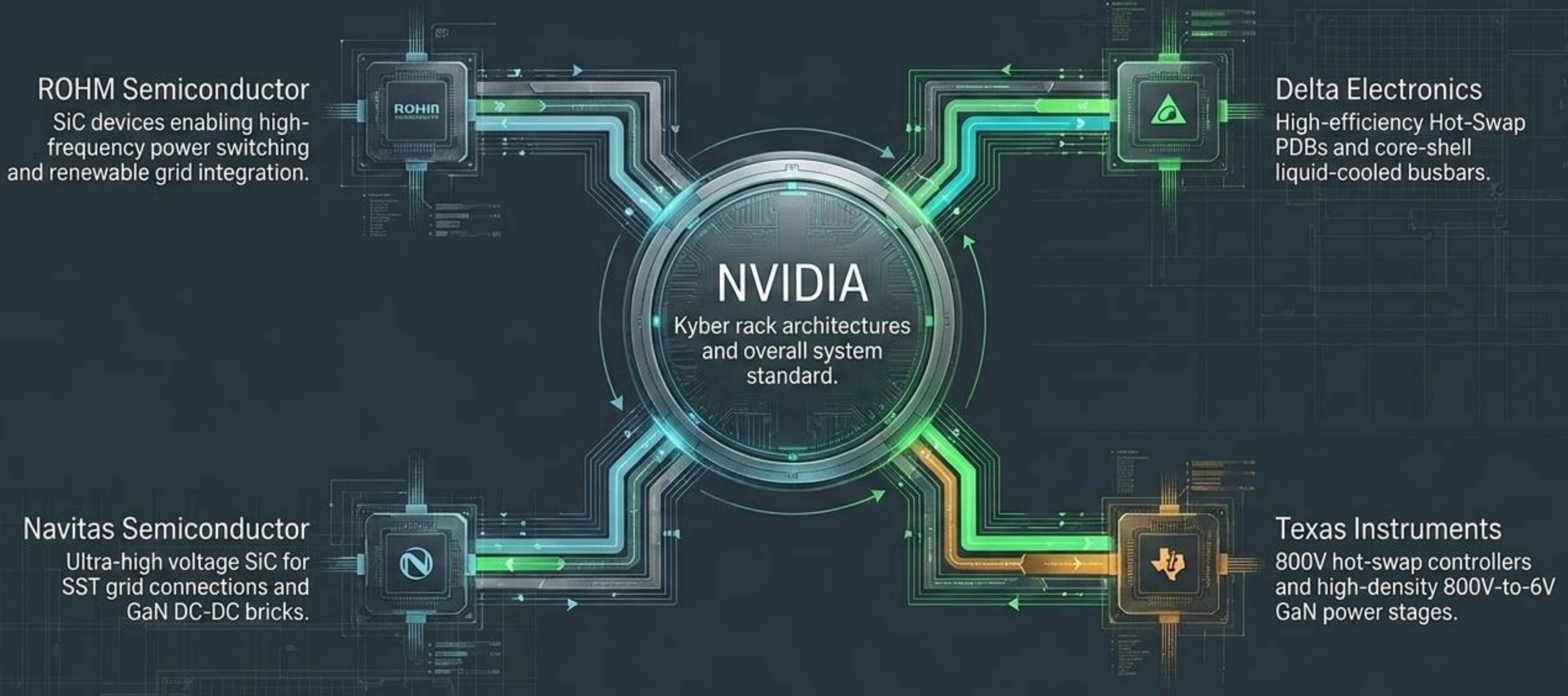
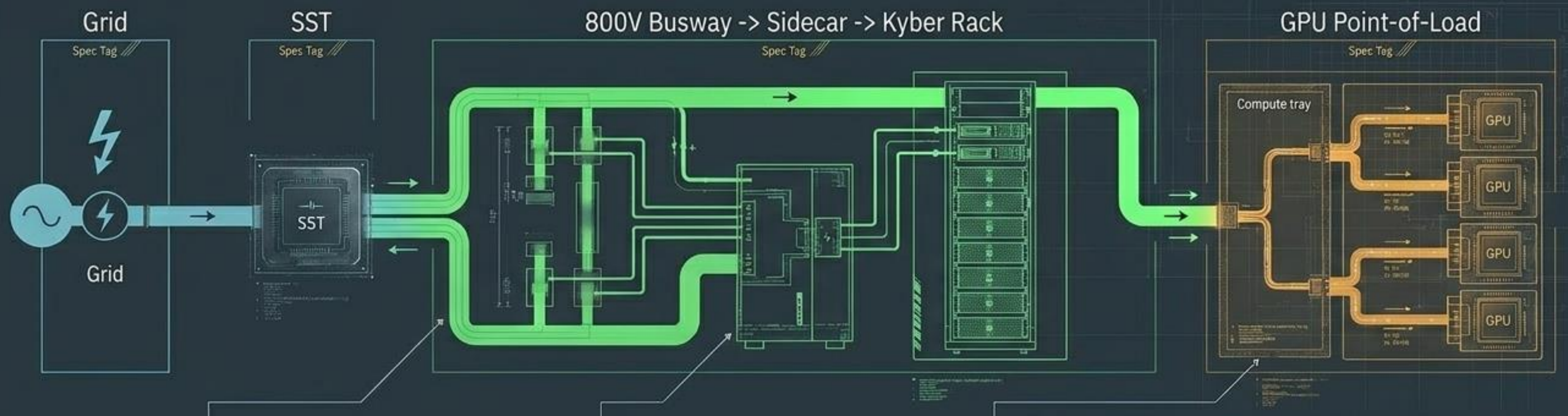
A Unified Industry Ecosystem



The 1MW AI Factory Blueprint



Spatial Un-bottlenecking:
Moving AC/DC out of the rack reclaims space for pure compute density.

Thermal Un-bottlenecking:
Reducing conversion stages dramatically lowers ambient facility heat.

Token Un-bottlenecking:
Maximum power delivered directly to the GPU core at 5% higher end-to-end efficiency.

The Bottom Line:
800 VDC is not just a voltage upgrade; it is the fundamental physical prerequisite for the future of artificial intelligence.