



AMPED 2026

Adam Barkley, Ph.D.
CTO, SiC Devices

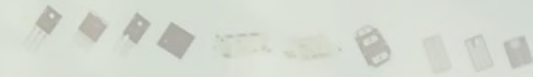
August 19, 2026
Energy Innovation Center, Pittsburgh

Advanced Magnetics for Power and Energy Development (AMPED) – 2022 Workshop

SiC Devices and the Demands they put on Magnetics

JOHN PALMOUR, CTO
Wolfspeed 10/6/2022

THE NEED



- Wolfspeed leads the pack in the development and commercialization of SiC power semiconductors. We are always chasing higher performance and reliability in our discrete, module, and bare die products.
- We are pushing the boundaries of SiC technology in a few magnetically-relevant areas of power electronic system performance.
- Generational improvements + technology innovation will continue to result in:
 - Lower reachable switching losses in hard switched converters/inverters → higher system efficiency, smaller/lighter/cheaper magnetics operated at higher switching frequencies.
 - Smaller parasitic transistor-level capacitances → Shorter resonant switching transitions for soft switched converters, higher frequency resonant tanks for fully resonant converters. New opportunities for high frequency integrated magnetics combining multiple functions.
 - Medium and High Voltage MOSFETs and beyond → Smart power electronics at utility grid transmission and distribution scale. New grid functionality, and radical miniaturization and balance of system design possible. Think MW at 50's of kHz, not 50/60 Hz.
- We challenge you to innovate with synergetic magnetics R&D to reach newer, bigger, and harder markets without breaking things:
 - Insulation robustness at high edge rates
 - Electromagnetic compatibility (EMC) and interference (EMI)
 - Core materials and construction methods
 - Solutions to practical magnetics power loss mechanisms at high operating frequencies
 - "60Hz steel and copper" levels of reliability

AMPED 2022: John Palmour (with slides from me 😊) gives Wolfspeed's Perspective and Asks

INTRODUCTION (AMPED 2022)



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!!! Medium and High Voltage MOSFETs and beyond Smart power electronics at utility grid transmission and distribution scale. *New grid functionality, and radical miniaturization and balance of system disruption possible. Think MW at 10's of KHz, not 50/60 Hz.*

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 - **Solutions to practical magnetics power loss mechanisms** at high operating frequencies
 - **“60Hz steel and copper” levels of reliability.**





10 kV SiC MOSFET Commercialization: The Semiconductor Foundation for a Resilient, 21st-Century Grid

Adam Barkley | CTO, SiC Devices | Wolfspeed

AC Grid. DC World. The Mismatch Is Getting Wider

- **Demand explosion**

Data center electricity: 415 TWh in 2024 to > 945 TWh by 2030

U.S. AI load grows 130% — beyond what low-voltage conversion can efficiently serve

- **Infrastructure too old and too slow**

70% of U.S. grid assets are 25+ years old

New transmission lines take up to 20 years to build

- **Architectural mismatch**

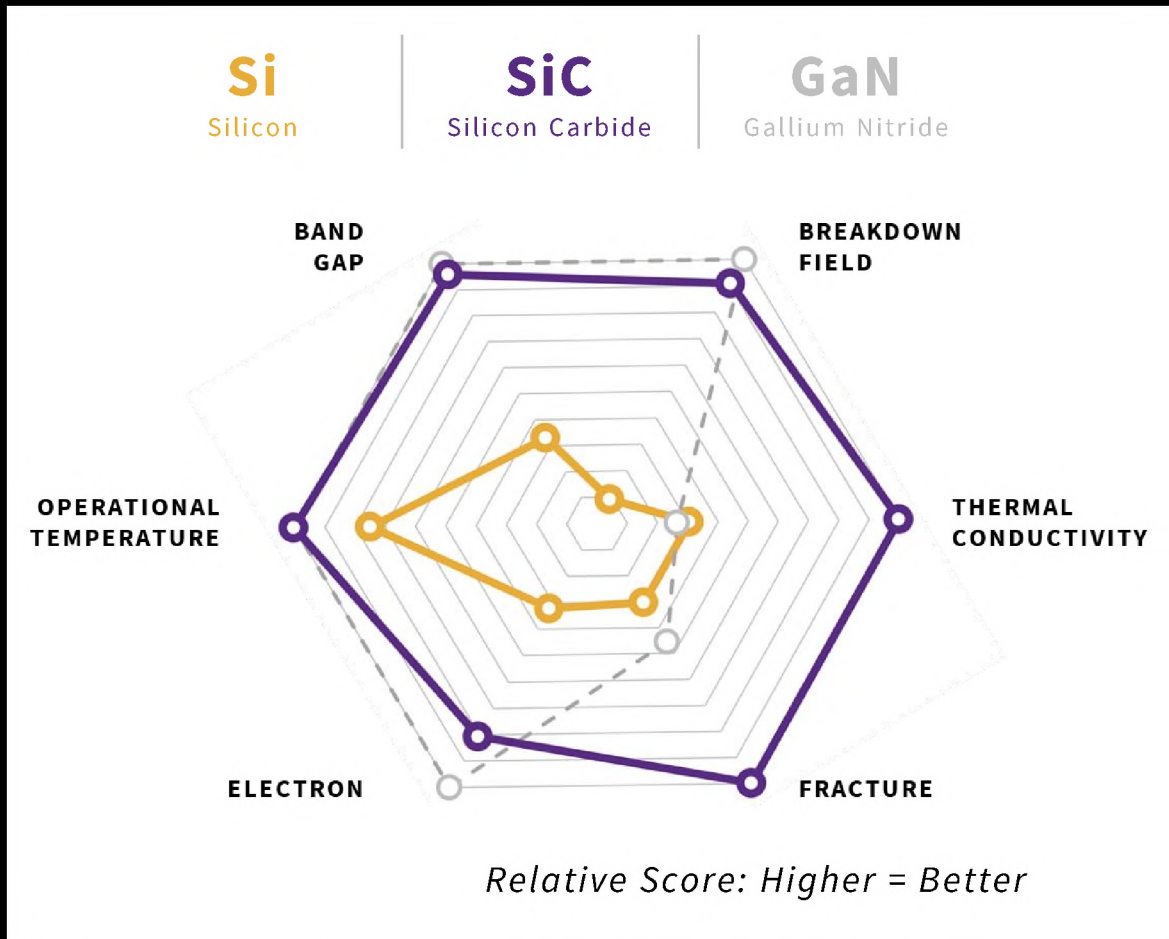
Built for unidirectional AC; modern loads demand bidirectional, controllable power flow

DC-intensive AI loads require a programmable medium-voltage conversion layer

The collision of 21st-century loads with a mid-20th-century grid demands a new class of power conversion—grounded in semiconductor innovation

SiC key material properties

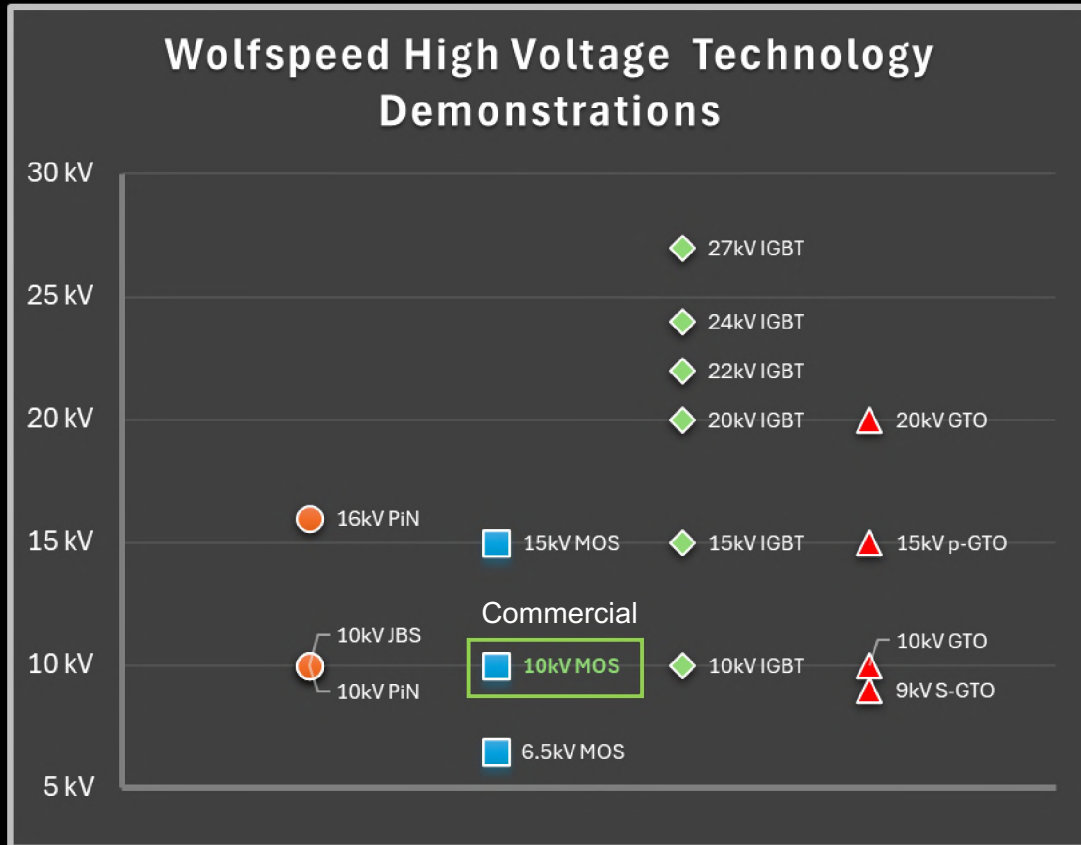
The superpower of medium and high voltage power electronics systems



- 10× higher breakdown field than silicon → lower resistance, higher voltage
- 3× higher thermal conductivity → simpler cooling, higher power density
- 10–50× faster switch at high voltage → smaller magnetics, new system architectures

Two decades of high-voltage SiC innovation

Wolfspeed has demonstrated every major power device architecture in SiC to 27+ kV



- **MOSFETs**— Up to 15 kV; 10 kV now commercially available
- **IGBTs**— Demonstrated from 10–27+ kV
- **GTO / S-GTO / p-GTO**— Demonstrated from 10–15 kV
- **PiN & JBS Diode**— Demonstrated from 10–15 kV

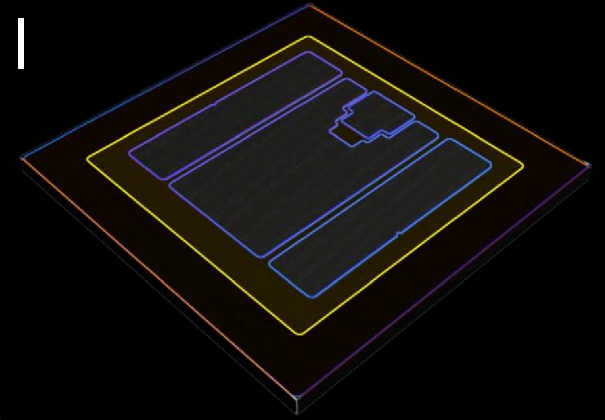
10 kV SiC MOSFET commercialization is the tip of the iceberg

A defining industry milestone: the world's first commercially available 10 kV SiC power MOSFET

Announced March 5, 2026 — Wolfspeed, Durham, NC.

**Grid infrastructure | Solid-state transformers (SST) | AI datacenters |
Grid-scale energy storage | Industrial electrification**

- **~30% system cost reduction**— Enables 3-level → 2-level topology simplification; fewer cells, simpler architecture
- **>300% power density improvement**— Switching frequency: 600 Hz → 10,000 Hz; smaller magnetics, simplified gate drive
- **99% conversion efficiency**— Reduces thermal requirements by up to 50% vs. Si-IGBT

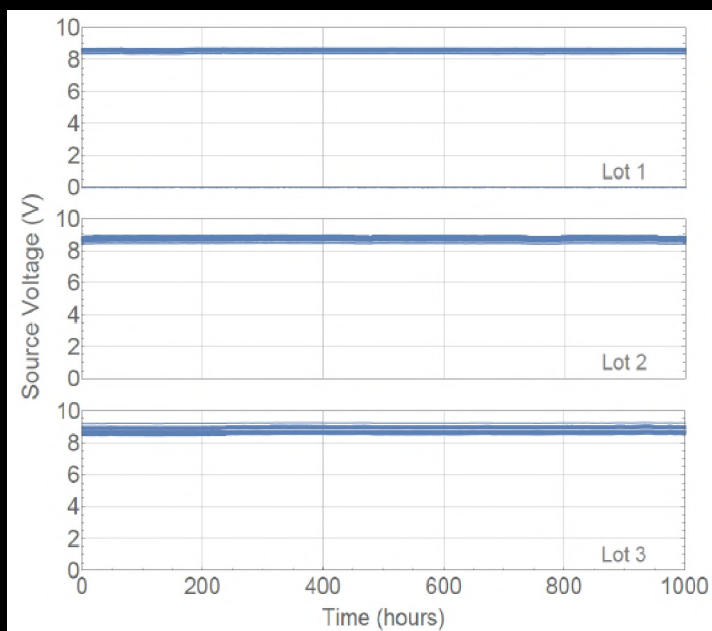


Industry's first — CPM3-10000-0300A
10,000 V | 20 A | 305 mΩ | Bare die |
Industrially qualified | Available now for
sampling & application qualification

10 kV SiC MOSFET commercialization solves three main problems

Bipolar degradation

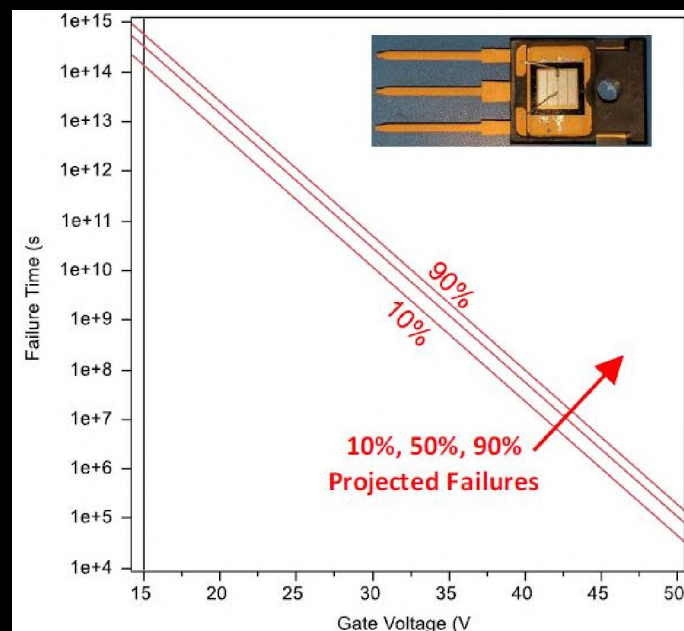
Body Diode Operating Life (BDOL)



> 1000 hours body diode continuous stress operation with no shifts

Gate oxide reliability

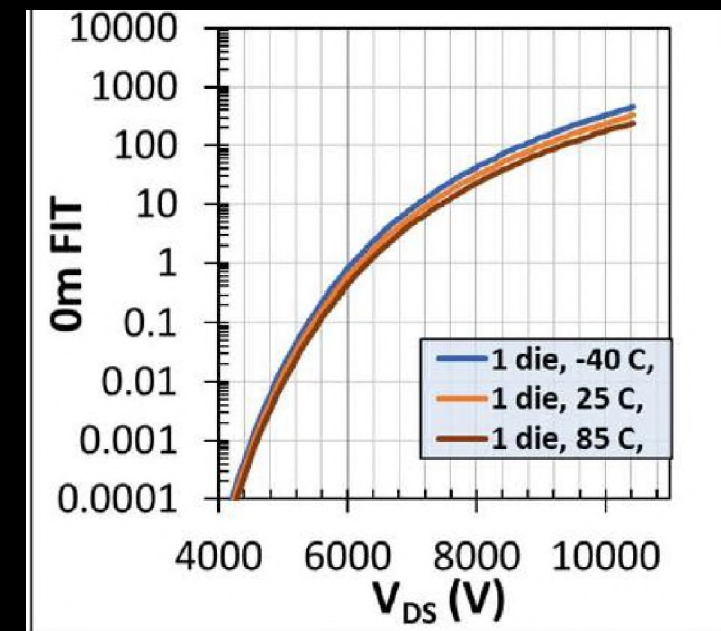
Time-dependent dielectric breakdown (TDDB)



Predicted lifetime of 158,000 years at continuous 20 V_{GS} at 175°C

Cosmic FIT robustness

Sea-level terrestrial neutron failure in time



4× to 7× higher FIT rate capability than current industry typical requirements

Packaging: the enabling layer

Device performance is necessary but not sufficient



Typical module packaging stack

- **SiN AMB substrate**— superior thermal shock resistance and thermal performance vs. Al₂O₃
- **Baseplate**— Cu for increased power density or AlSiC for higher reliability and lower weight
- **Cu source interconnect**— increased ampacity and power cycling capability vs. Al wire bond
- **Sintered die attach**— dramatically increases lifetime for power cycle vs. solder

Additional constraints at 10 kV

- **Partial discharge:** voids in encapsulant ionize at high e-field— zero tolerance
- **Creepage & clearance:** IEC standards scale with voltage— impacts layout geometry significantly
- **Switching transients:** gate drive and package parasitics to be co-optimized
- **Gate drivers:** not a power module per se, but a key enabling technology

Wolfspeed U.S.-based vertical integration



Marcy, NY
Device Fabrication



Fayetteville, AR
Advanced Packaging,
Manufacturing



Durham & Siler City, NC
Substrates & Epitaxy

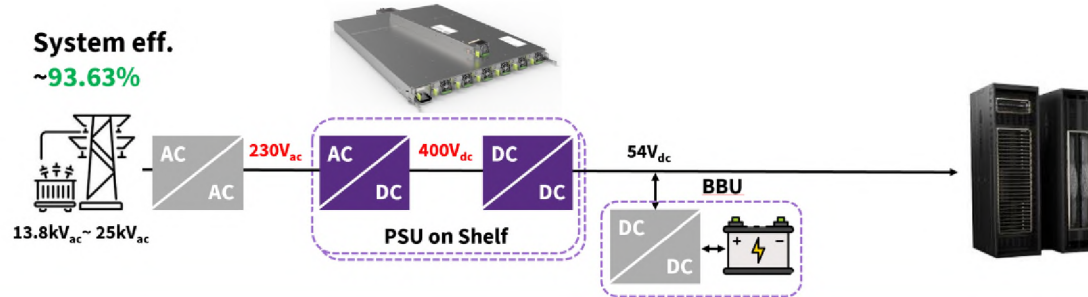
- Full vertical integration: Crystal → wafer → epitaxy → device → module
- Rooted in 200 mm state of the art and scalable SiC manufacturing
- Energy security dimension: Domestic SiC manufacturing is strategic infrastructure

AI datacenter needs

- **Scale demands medium voltage (MV) entry**
Rapid power scaling: GB200 at 132 kW (today) → Rubin Ultra ~600 kW (2027+) → NVIDIA roadmaps 1 MW racks
GW-scale AI campuses connect at 13.8–35 kV
- **Power density and efficiency break down at low voltage**
1 MW at 54 VDC demands ~18,500 A
NVIDIA reports that 800 VDC cuts copper by 45%
MV SiC-based SSTs convert 13.8–35 kV directly to 800 VDC in a single stage at up to 99% efficiency
- **Deployment speed creates market pull**
IEA: 20% of AI data center projects delayed by grid constraints
2 – 3 years lead times for MV substation transformers
SSTs offer faster deployment plus power quality control (reactive compensation, harmonic filtering, etc.)

AI datacenter power architectures

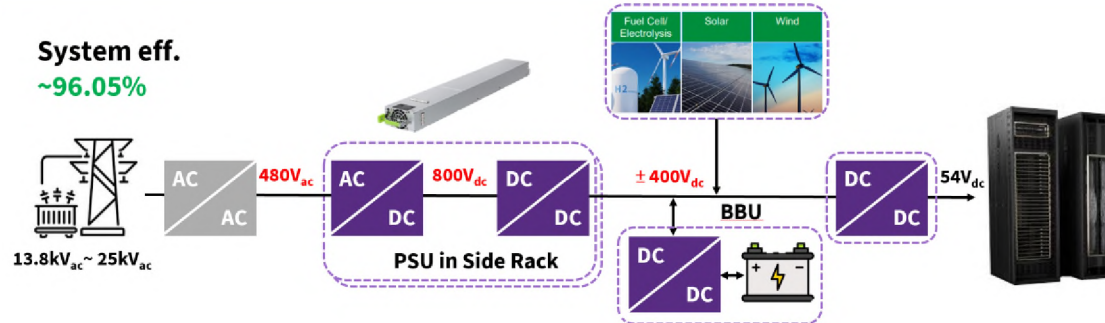
System eff.
~93.63%



Gen 1 — ORv3 / 48 V

- Well-established OCP standard
- Fully deployed

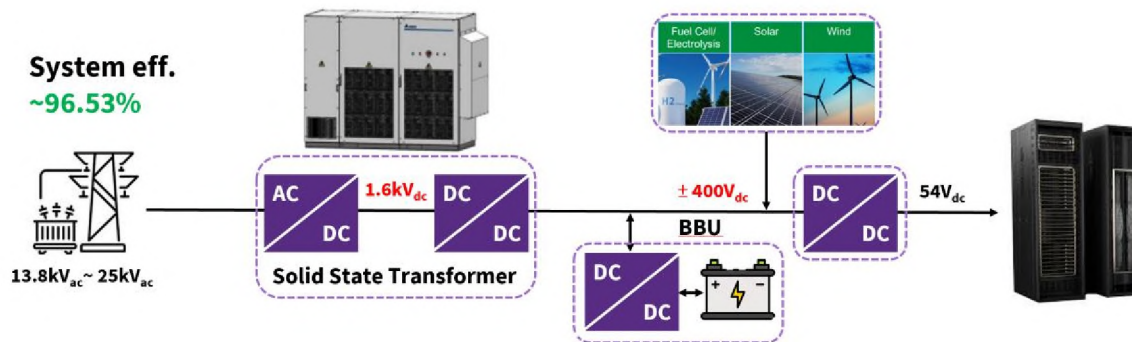
System eff.
~96.05%



Gen 2 — HVDC ± 400 V / 800 V

- Voltages and architectures are evolving
- 2026–2028 transition underway

System eff.
~96.53%



Gen 3 — MV SST

- Agreed end-state
- Enabled by 10 kV SiC technology
- Timing: 2029+

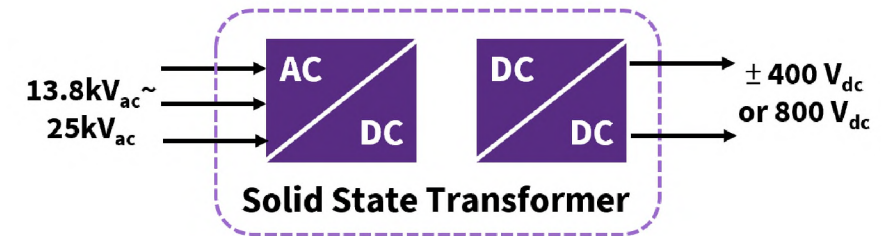


Solutions for entire MV power electronics ecosystem

Enabler of Gen 3 AI datacenter power architecture

- **200–300 kW building block**— Multi-level topologies dominate, scalable, PCB used as main power interface, various voltage levels needed.
- **MW Units**— Two-level topologies dominate, Cu busbar used as main power interface, high-voltage high-current modules

Performance. Reliability. Simplicity. Long Lifetime

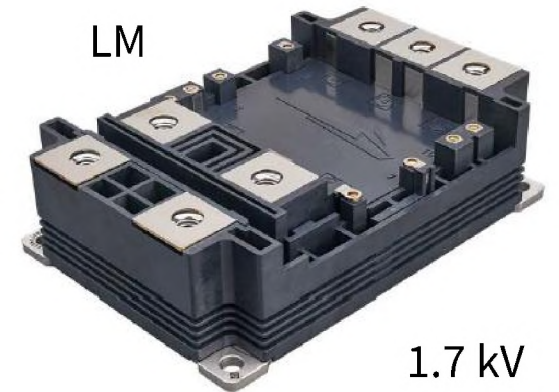


GM



1.2 kV
2.3 kV
3.3 kV

LM



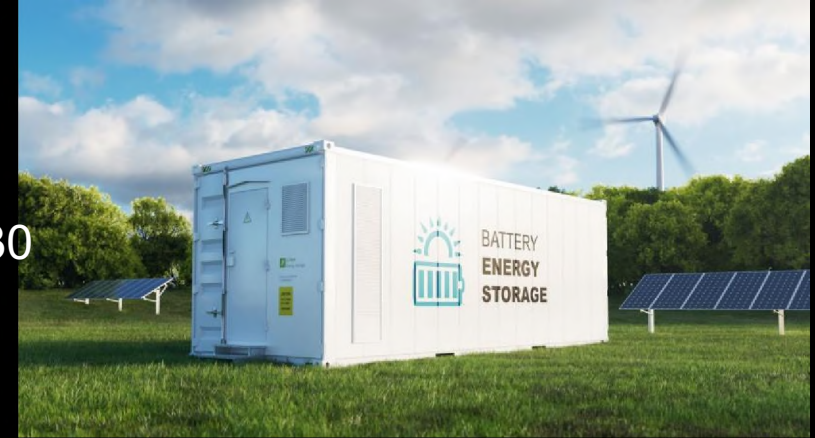
1.7 kV
3.3 kV
10 kV



SST for AI datacenters: Commercialization forcing function

Broader market landscape

- **MV bidirectional converter (grid-scale energy storage)**
IEA Net Zero Emissions Scenario projects ~970 GW globally by 2030
18+ GW in U.S. in 2025 alone (>50% YoY increase vs. 2024)
- **MV motor drives (industrial + railway)**
\$1.8B MV drives global market— 10 kV SiC delivers 1–3% efficiency gains over Si-IGBT
\$12B railway traction motor market— 15–25 kV AC direct application for high-frequency, lightweight SiC converters
- **Emerging applications**
AI datacenter SST (MV → 800 VDC)— AI is a big focus now
MVDC microgrids— Very broad and structurally significant emerging ecosystem of MV systems
DEW/HEL power conditioning / Naval MVDC— Highly strategic market



Three focus areas

Accelerating transition and leading the transformation

- **Sustaining the R&D pipeline**— The next voltage frontier (15–35 kV IGBT / thyristors)
- **Modernizing the standards environment**— An opportunity to get ahead
- **Building supply chain resilience**— A lesson worth learning proactively



Summary

- **The grid is at an inflection point**— AI-driven demand colliding with aging infrastructure demands a new class of power conversion.
- **10 kV SiC has crossed the commercial threshold**— Proven performance and reliability; in volume production at Wolfspeed's 200 mm Mohawk Valley Fab— this is now a grid-deployable platform.
- **The semiconductor alone is not enough**— Packaging, manufacturing scale, and domestic supply chain turn device performance into system reality.
- **The next frontier is already in sight**— Investment in the 15–35 kV pipeline, proactive standards development, and supply chain resilience will determine who leads the transformation.

10 kV SiC has crossed from curiosity to platform. Grid transformation is no longer a question of if — only of who leads it. The semiconductor is ready. Power electronic systems must follow.



Thank you

Adam.Barkley@Wolfspeed.com