The Environmental Footprint of Wide Bandgap Semiconductors Versus Silicon in CRPS PSUs for AI Data Centers

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AI processors, such as NVIDIA's Blackwell and AMD's Epyc Zen4, may be getting significantly more efficient in terms in terms of the FLOPS per watt, but the sheer acceleration in adoption of generative AI services will likely leave global data center operators paying off a 1,000 TWh (or 1PWh) energy bill before the end of 2026. In the US, the data center sector is the fastest growing energy consumer of any that Goldman Sachs track and will itself race past the picowatt mark by 2030.

Putting this figure in context, based on the US's national average mix of energy sources each kWh produces 0.39 kg (0.86 lb) of CO_2 per kWh, or 389.8 metric megatons for this 1,000 TWh.

It's therefore no surprise the major AI developers – such as Microsoft, Amazon and Google – are seeking to reduce the emissions of these plants and are investing heavily in clean energy. Amazon, for example, is the world's largest purchaser of renewable energy, and has been for four years running. And Microsoft is looking to develop its own (zero-carbon) nuclear plants to power its data centers. In September, the company also signed a deal to restart production in part of Pennsylvania's Three Mile Island plant.

With the rise in energy consumption set to continue at a rate well beyond being mitigatable by processing efficiency gains, data center operators need to take a holistic view, with algorithms, cooling methods and layouts, as well as power supply efficiencies all under the spotlight.

Improved Efficiency and Power Delivery

Earlier this year, Navitas developed a 4.5 kW PSU in a CRPS185 form factor with an output of 54 V. This not only delivers the highest power density of any PSU (137 W/in^3), enabling it to meet the needs of servers running NVIDIA's Blackwell, but also enabled efficiencies of 97% at 50% of load – significantly exceeding 80PLUS specifications across the load.

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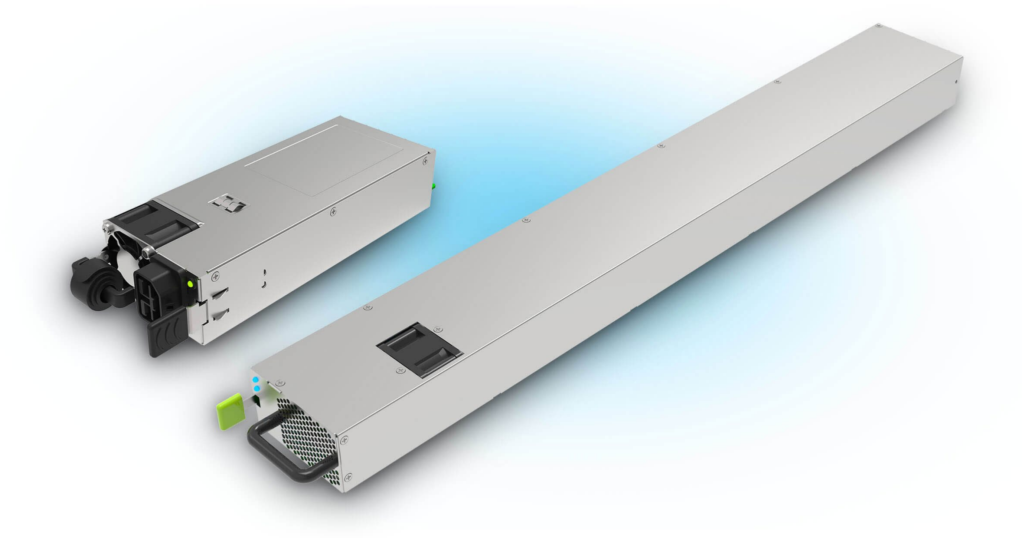
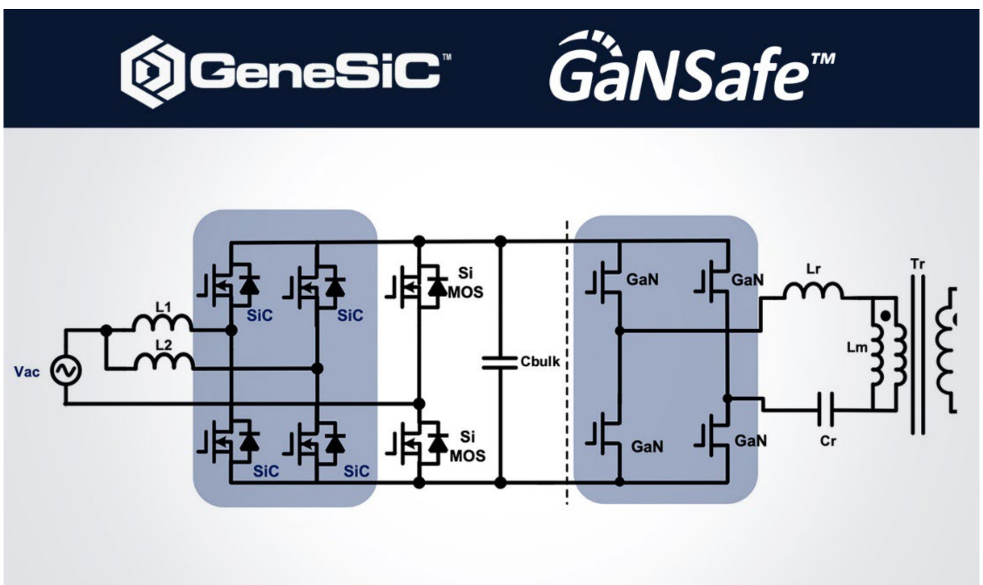


This reference design is already being adopted by a number of our data center customers and a far more in-depth look at this reference design, including how the issue of GaN's relatively fragile gates is solved, can be seen [here](). But in short, these power densities and efficiencies have been enabled by the use of wide bandgap semiconductors. On one side, the reference design integrates bridgeless interleaved totem-pole PFC that is based on GeneSiC Gen3-Fast silicon carbide (SiC) MOSFETs, which minimize switching losses well beyond those possible through silicon alone. This is coupled on the other side with high-power GaNSafe ICs, using an LLC resonant converter with a full-bridge square wave generator.



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The Environmental Footprint of GaN and SiC

The use of GaN and SiC are pivotal in delivering this level of power density, but these wide bandgap materials come with an added advantage to help reduce the CO_2 footprint of these plants.

In addition to the 'in-use' efficiency benefits, these materials have a greatly reduced manufacturing and transportation footprint, which give significant savings in the manufacturing of downstream products.

In 2022, Navitas partnered with the lifecycle assessment sustainability organization Earth-Shift Global to understand the cradle-to-grave emissions of wide bandgap semiconductors and how these compare to silicon. These independent calculations showed that each GaN power IC reduces CO_2 emissions by over 4 kg versus legacy silicon chips.

The major reason for this reduction is that that GaN is much more efficient than silicon, and this enables the essential die size to be much smaller for any given power or current capability, creating more power IC units per wafer... so a lower per-chip footprint from the same amount of energy, CO_2 and chemicals used in wafer processing.

Furthermore, the report also showed the move to SiC MOSFETs had an even more significant effect, with the system efficiencies and dematerialization associated with SiC creating an overall estimated reduction in CO_2 versus Silicon of 25.2 kg.

The calculations by Earth-Shift Global for this report also showed that upgrading from legacy silicon to high-efficiency GaN in the data center industry has the potential to reduce electricity use by up to 10%. In the US, this would be a reduction of 100 TWh by 2030. Based on today's share of each energy source, this would be a CO_2 reduction of 39.0 metric megatons.

And of course, in addition to data centers needing to remain as sustainable as possible, power currently represents (and likely will continue to represent) 60-70% of the total operation cost of a data center. Based on today's target price of $0.05 USD per kWh and Goldman Sach's 1,000 TWh energy consumption prediction for 2030, the switch from silicon represents a saving for US data centers in annual electricity costs of approximately $5 billion USD.