peak

SOLUTION BRIEF

NANOPLEX™ CAPACITORS FOR DC DATA CENTERS

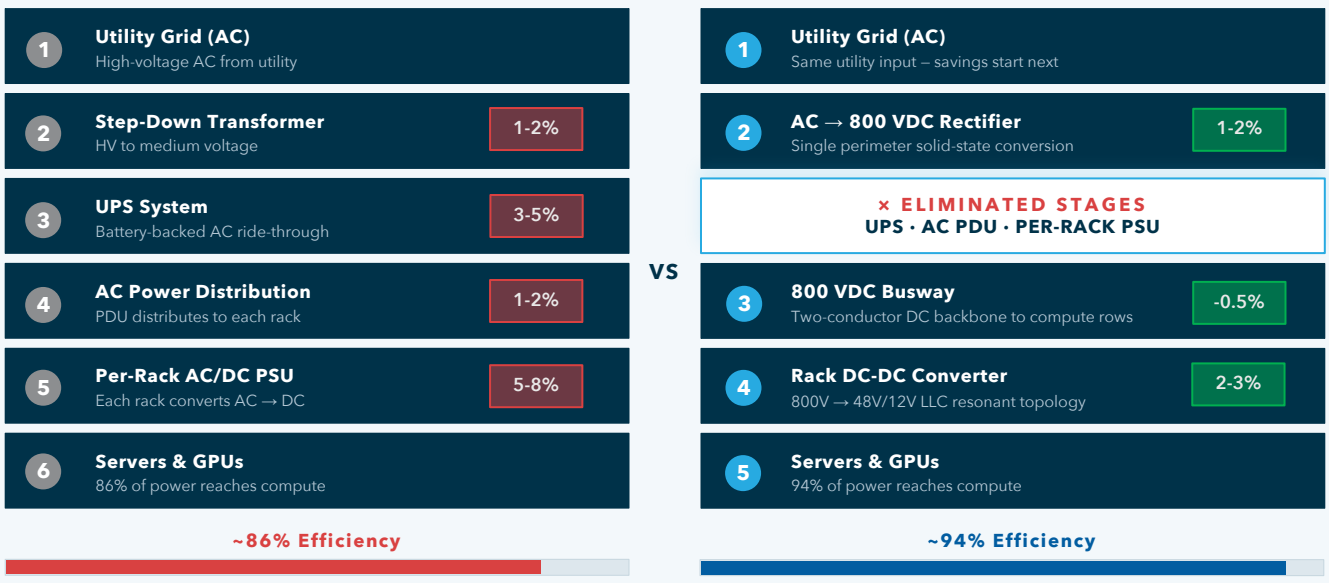
ADVANCED FILM DIELECTRICS FOR CAPACITORS POWERING 800 VDC AI FACTORIES

THE SHIFT FROM AC TO DC POWER DISTRIBUTION

AI workloads have shattered the power model data centers have used for decades. GPU rack densities have surged from 5 kW to over 200 kW today, with NVIDIA's Kyber rack targeting 600 kW to 1 MW by 2027. At these densities, the legacy AC power chain encounters inefficiencies that limit scalability: 12–15% cumulative energy losses, 200 kg of copper per MW-class rack, and up to 64U of wasted rack space.

The industry is moving to 800-volt direct current (VDC) distribution, which eliminates three conversion stages, cuts losses to 5–7%, reduces copper by 45%, and reclaims rack space for compute. NVIDIA's Vera Rubin DSX AI Factory reference design formally establishes 800 VDC as the standard, and major infrastructure vendors including Delta, Eaton, ABB, and Schneider Electric are already shipping 800 VDC busway products. Every stage of the new DC power chain requires advanced film capacitors that standard BOPP cannot deliver.

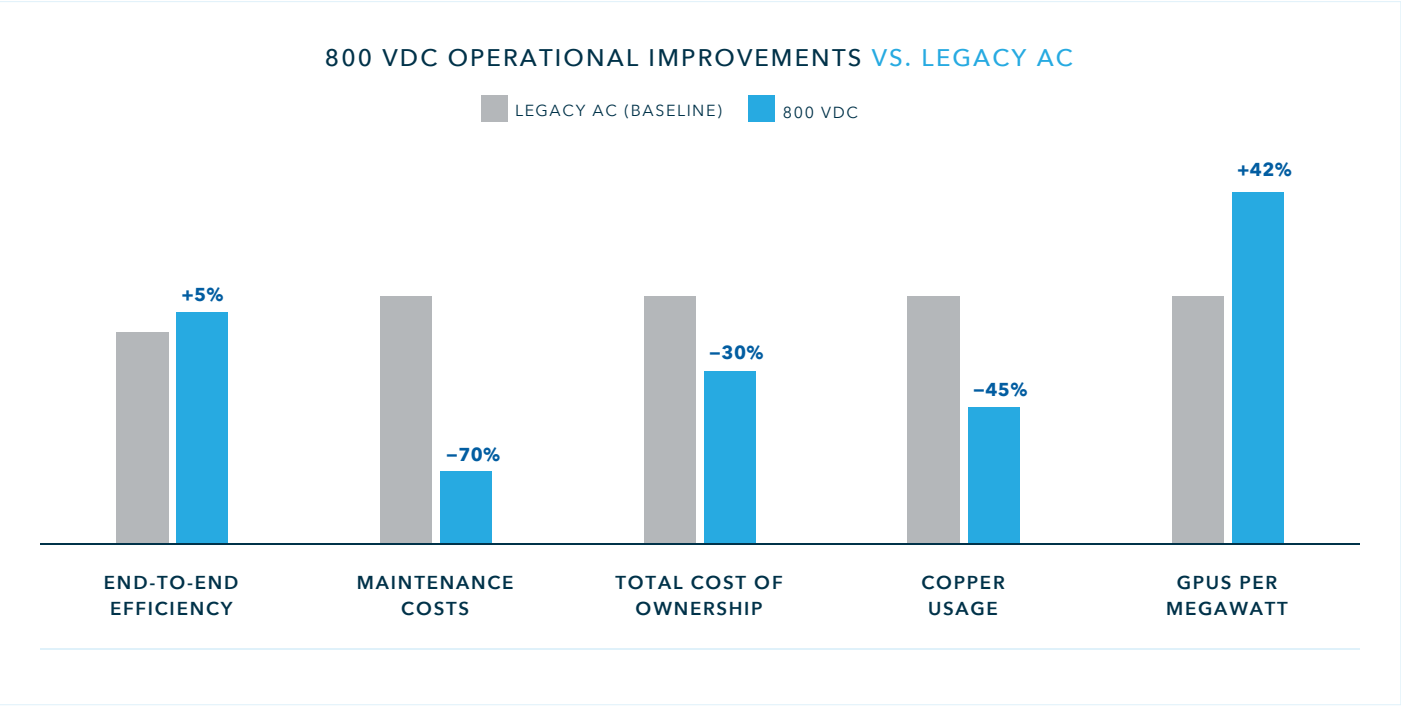
AC VS. DC DATA CENTER POWER ARCHITECTURE



8% more power reaching GPUs = 42% more GPUs per megawatt with NVIDIA DSX Max-Q

OPERATIONAL IMPROVEMENT: MORE GPUS PER MEGAWATT

The efficiency difference between AC and DC architectures translates directly into GPU deployment density. A legacy AC facility operating at 86% end-to-end efficiency wastes 14% of every megawatt on conversion overhead. At 94% with 800 VDC, losses drop to 6%. Combined with NVIDIA's DSX Max-Q software, which dynamically provisions power across the cluster to deliver approximately 30% more GPU density per megawatt, the total improvement reaches 42% more GPUs deployable per megawatt. At gigawatt scale, a 1 GW AI factory on 800 VDC delivers the compute capacity of a 1.42 GW legacy AC facility, avoiding 420 MW of wasted infrastructure. Maintenance costs drop by up to 70%, total cost of ownership decreases by 30%, and copper requirements fall by 45%. The compounding savings make the business case for DC overwhelming at any scale above 10 MW.



COMPOUNDING SAVINGS AT GIGAWATT SCALE

30%

LOWER TCO

Fewer conversion stages, less copper, smaller footprint

70%

LESS MAINTENANCE

Solid-state DC eliminates UPS battery replacement cycles

45%

COPPER REDUCTION

Two-conductor DC busway vs. three-phase AC distribution

10MW+

PAYBACK THRESHOLD

Business case becomes overwhelming at any scale above 10 MW

THE ROLE OF CAPACITORS AND INVERTERS

Capacitors are the most critical passive component in a DC data center, ensuring voltage quality across every stage of the 800 VDC power chain. A typical 100 MW DC facility contains 130,000 to 220,000 pounds of capacitors. NVIDIA's MGX rack architecture specifies capacitors – not batteries – for rack-level Intelligent Power Smoothing at 400 joules per GPU. The 800 VDC architecture also introduces new power conversion and conditioning stages: perimeter AC-DC rectifiers, rack-level DC-DC converters, and bidirectional charge controllers. Each stage requires specialized film capacitors for DC link filtering, LLC resonant tank operation, SiC/GaN snubber protection, and EMI suppression.

CONVERTER TYPE	VOLTAGE	ROLE IN DSX	CAPACITOR REQUIREMENT
AC-to-800 VDC Rectifier	415 VAC → 800 VDC	Perimeter building-level conversion	MPPF AC filter caps, DC bus film caps (NanoPlex HDC)
800V-to-48V Isolated DC-DC	800 → 48 VDC	Rack-level voltage step-down	LLC resonant tank, snubber, DC bus filter (NanoPlex LDF)
Bidirectional DC-DC	800 VDC ↔ supercap	Rack energy storage management	High-voltage MPPF DC link film caps (NanoPlex LDF + HDC)
Grid-Tied Inverter (BESS)	800 VDC → 415 VAC	BESS discharge to grid	High-power DC link, AC filter film caps (NanoPlex HDC)
48V Point-of-Load	48 → 12 → 5 VDC	Board-level GPU/CPU rails	MLCC, aluminum polymer output caps (not film)

NANOPLEX LDF

CONTINUOUS-DUTY DC APPLICATIONS

NanoPlex LDF (Low Dissipation Factor) is a nanocomposite dielectric film optimized for the high-ripple, high-temperature, continuous-duty positions in the 800 VDC power chain. It delivers up to 4× the energy density of standard BOPP, operates continuously at 135°C with no derating and provides up to 5× the service life with no electrolytic wear-out mechanism. Its ultra-low dissipation factor (tan δ) minimizes self-heating, directly preserving power budget for NVIDIA's DSX Max-Q token-per-watt optimization.

APPLICATION	KEY SPECIFICATIONS	WHERE IN THE DC DATA CENTER
800V DC Link Capacitor	800–1200 VDC · 100–4700 µF · low ESR / ESL · high ripple current	Rack power units and perimeter rectifier DC bus filter
LLC Resonant Tank	600–1200 VDC · ±2% tolerance · high Q · <100 ppm/°C TCC	800V-to-48V converters in every compute rack
SiC/GaN Snubber	400–1200 VDC · 0.1–10 µF · >10,000 V/µs · <2 nH ESL	Switching device protection in DC-DC converters & rectifiers
Rack Energy Storage	800 VDC · 400 J/GPU · supercap hybrid · µs response	Energy Variance Appliance (EVA) – Intelligent Power Smoothing
48V Bus Filter	48 VDC · high capacitance · 10-15 year service life	Intermediate bus – replaces electrolytics for extended reliability

NANOPLEX™ HDC

HIGH-VOLTAGE & PULSED-POWER APPLICATIONS

NanoPlex HDC (High Dielectric Constant) is designed for positions in the 800 VDC data center that require extreme voltage headroom and pulsed-power capability. With dielectric strength exceeding 600 V/µm, HDC provides a single-material 800–1200 VDC rating that eliminates the need to stack multiple 450–600V BOPP film grades. This reduces ESL, physical size, and cost. HDC is specified for busway protection modules, BESS inverters, and AC-side filtering stages where standard BOPP cannot meet lifetime requirements under the thermal and electrical stress of continuous AI factory operation.

APPLICATION	KEY SPECIFICATIONS	WHERE IN THE DC DATA CENTER
Busway Protection & Surge Suppression	80000 VDC continuous · >600 V/µm dielectric strength	800 VDC busway modules – Delta, Eaton, ABB, Schneider Electric
BESS Inverter DC Link	800 VDC ↔ 415 VAC · 1–10 MW · bidirectional cycling	Facility BESS – discharges storage to building bus or grid via DSX Flex
AC EMI Filter	480–900 VAC · X-rated · IEC 60384-14 safety certified	Perimeter rectifier input – EMI suppression on AC side
Solar/ DG Inverter Interface	Variable DC → 800 VDC · 500 kW–10 MW	Onsite generation integration – solar / gas to 800 VDC bus

PEAK POWERS THE DC DATA CENTER

EFFICIENT POWER DELIVERY

NanoPlex LDF's ultra-low dissipation factor and 135°C continuous operation deliver maximum power to GPUs with minimum conversion loss.

REDUCED CAPACITOR THERMAL FAILURES

A single capacitor thermal failure can knock out an entire rack of GPUs. The 135°C continuous operation rating of both NanoPlex HDC and NanoPlex LDF minimizes the likelihood of thermal failures versus BOPP-based capacitors.

HIGH-VOLTAGE RELIABILITY

NanoPlex HDC's >600 V/µm dielectric strength provides single-material 800–1200 VDC ratings with no electrolytic wear-out mechanism for 15-year AI factory SLAs.

U.S. ENGINEERED, LAB-TESTED

100% U.S.-engineered with allied-sourced materials backed by 20+ Global Patents, ASTM and JIS-certified performance data.

Peak Nano LLC
7700 Hub Parkway, Ste 8
Valley View, OH 44125

sales@peaknano.com
www.peaknano.com
+1 (949) 922-7472

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