

TECHNICAL BRIEF

Direct-Drive Transverse Flux Motors for Next-Generation Data Center Heat Rejection

A technical overview of large-diameter, low-speed TFM fan drives for data center cooling.

Hyperscale data centers are moving toward gigawatt-class campuses, and AI workloads are increasing rack densities. Cooling infrastructure has a direct and lasting effect on operating cost, sustainability performance, and deployment flexibility. The analysis presented in [the white paper](#) concludes that one of the largest remaining opportunities for cooling optimization is the adoption of larger, slower-spinning direct-drive fans enabled by Transverse Flux Motor (TFM) technology.

Larger, slower spinning fans create an important cooling-optimization opportunity. Historically, the high torque required to drive these fans has forced a choice between gearbox-driven systems—with well-known efficiency and reliability penalties—or conventional direct-drive motors that become large, heavy, and costly.

Transverse Flux Motor (TFM) technology delivers high torque at low rotational speeds in a smaller, lighter, and more cost-effective package than conventional direct-drive alternatives.

TFM technology can support a different heat-rejection approach that may improve energy efficiency, reduce water consumption, simplify operations, and support stringent community noise requirements.

Key findings | Representative 1 GW campus

43%	reduction in annual cooling energy costs approximately \$15 million to \$8.6 million
71%	reduction in fan-drive assemblies 600 drives to 175 drives
0 gearboxes	elimination (or reduction) of gearbox-related maintenance and reliability concerns through direct drive
lower acoustic emissions	through reduced fan tip speeds and removal of gearbox-generated tonal noise
low- or zero-water cooling strategies	while maintaining attractive PUE performance
reduced drivetrain cost, material requirements, and overall system weight	compared with conventional direct-drive motors

Source: [Direct-Drive Transverse Flux Motors for Data Center Heat Rejection Systems](#) (ETM white paper)

Strategic implications for hyperscalers

Improving PUE without major architectural changes

AI-cluster energy demand makes heat-rejection power a growing contributor to operating expense and PUE. TFM-enabled fan architectures can reduce cooling power requirements while preserving large fan thermal advantages.

Enabling water-free cooling strategies

Dry cooling eliminates water consumption but often carries an energy penalty. Larger direct-drive fan systems enabled by TFM can offset a substantial portion of that penalty.

Simplifying operations and improving reliability

Reducing component count and eliminating gearboxes can reduce maintenance requirements, minimize potential failure points, and simplify long-term operations.

Supporting permitting and community acceptance

Larger fans at lower speeds can produce lower acoustic output, and direct drive eliminates gearbox-generated tonal noise. This may help with community scrutiny and permitting requirements.

Engineering perspective

The transition to AI-scale infrastructure is placing unprecedented pressure on cooling systems. TFM should be viewed not merely as an alternative motor technology but as an enabling platform for lower total cost of ownership, improved sustainability metrics, and greater cooling-system scalability.

Bottom line

TFM can unlock cooling architectures that simultaneously improve energy efficiency, reduce water consumption, simplify maintenance, and support more sustainable data center growth.

The performance, energy, cost, weight and noise figures presented in this brief, including the 1 GW case study, are illustrative estimates based on modeling and stated assumptions. They are not guarantees of performance. Actual results will vary based on site conditions, system design and operating profile.
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