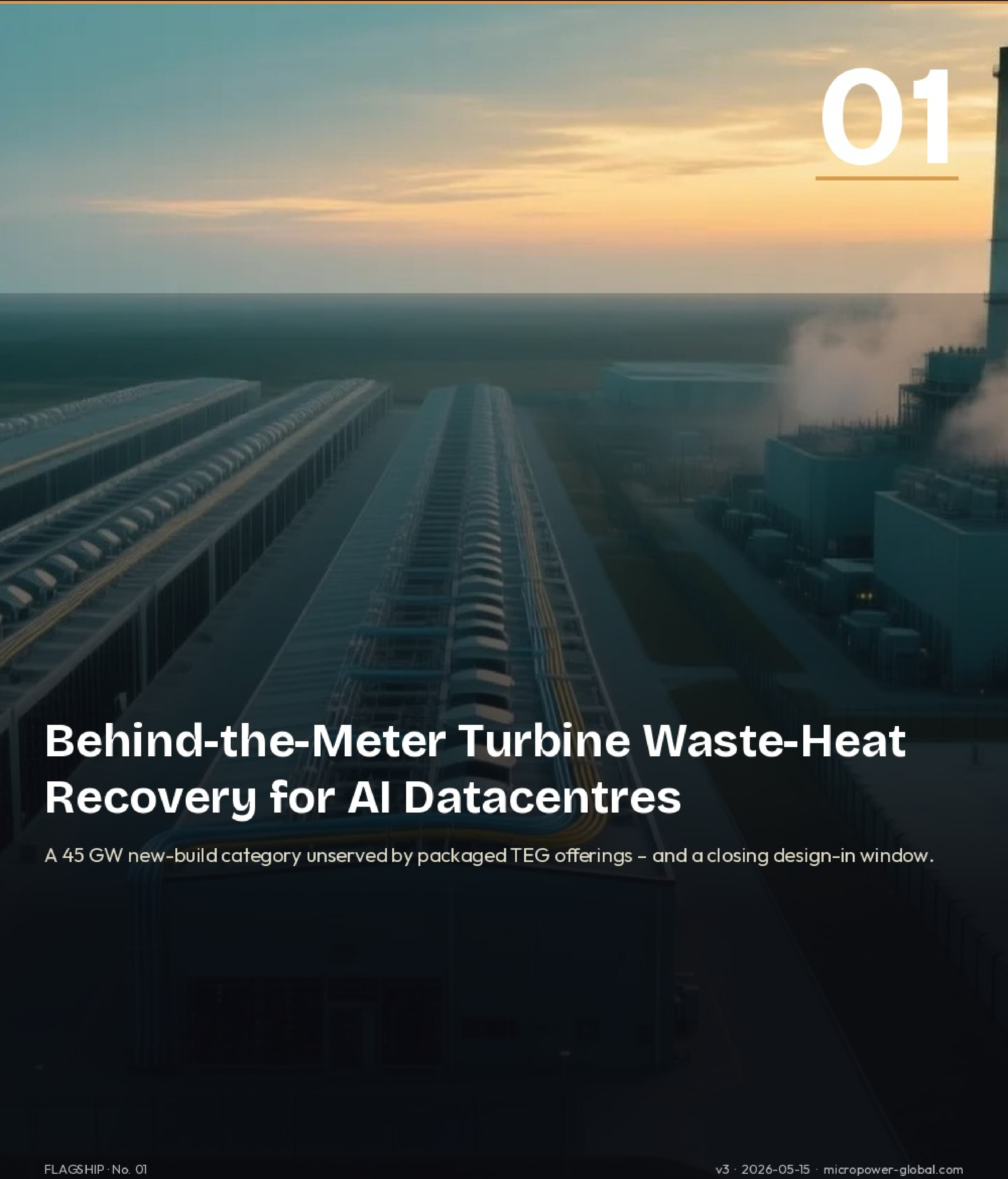

01

Behind-the-Meter Turbine Waste-Heat Recovery for AI Datacentres

A 45 GW new-build category unserved by packaged TEG offerings – and a closing design-in window.

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The AI datacentre power crisis has created a new industrial category. Grid interconnect queues that run 4–7 years have pushed hyperscalers to build behind-the-meter (BTM) gas generation on their own land. Between 2024 and early 2026, xAI, Meta, Microsoft / OpenAI, Oracle, AWS, and Google have announced or permitted more than 45 GW of onsite gas turbine and reciprocating engine capacity. Simple-cycle aeroderivative turbines (GE LM2500, LM6000) run exhaust at 450–510 °C; industrial frame turbines (Siemens SGT-300/400) at 509–630 °C; reciprocating gas engines (Wärtsilä 31SG, Innio Jenbacher) at 450–500 °C. Every one of those figures sits inside MicroPower's PbTe / TAGS operating sweet spot. No commercial TEG or packaged waste-heat-recovery system is currently deployed on a BTM datacentre generator – a structural gap, well-documented in the references.

Why this matters now

- The BTM buildout is 18–24 months old. Most turbines are ordered and permitted, not yet commissioned.
- Design-in with an OEM or deployment partner (Innio, VoltaGrid, GE Vernova, Crusoe) is achievable through late 2026 before the window closes.
- Waste-heat recovery may also serve as a permitting mitigation in NSR applications – an untested angle that, if validated, would accelerate approvals for the same hyperscalers.

1 · The hyperscaler BTM buildout

Grid interconnect queues across ERCOT, PJM, and MISO have stretched past 4 years. Hyperscalers chasing sub-18-month datacentre commissioning windows have concluded they cannot wait. The result is a step-change in onsite generation.

Operator	Site(s)	Capacity	Stage
xAI	Memphis & Southaven	247 MW permitted + 495 MW Colossus 2	Operational + expansion
Meta (Hyperion)	Richland Parish, LA	7 GW+ across 10 plants	Permitted; phased to 2028
OpenAI / Microsoft (Stargate)	Abilene TX + 5 more	986 MW (29× GE LM2500) + 10 GW pipeline	Operational + planned
Oracle via VoltaGrid	Texas multi-site	360 MW Abilene + 2.3 GW fleet	Operational + phased

Operator	Site(s)	Capacity	Stage
AWS	Multi-site (with GE Vernova)	15 GW+ planned	Announced / early planning
Google (Intersect Power)	Hybrid solar + gas backup	5 GW+	Announced / 2025–2026
Announced total	–	~45 GW (2024–2028)	20 GW+ expected by 2030

BloombergNEF (December 2025) forecasts US datacentre power demand reaching 106 GW by 2035, with 33 GW of behind-the-meter generation by 2030. If simple-cycle and reciprocating units are 40–60% of that BTM fleet – the high-exhaust-temperature slice – the addressable thermal resource is 15–20 GW by 2030. The 45 GW headline figure above is a mixed basket: it includes operational, permitted, and announced-but-not-yet-permitted capacity. Treat the ~45 GW as aggregate forward pipeline, not installed base.

2 · Exhaust temperature by engine family

Engine family	Typical unit	Full-load exhaust	TEG fit
Aeroderivative simple-cycle	GE LM2500 / LM2500XPRESS / LM6000	450–510 °C	Good – inside sweet spot
Industrial frame simple-cycle	Siemens SGT-300 / 400 / 500	509–630 °C	Excellent – near-ideal ΔT
Reciprocating gas engine	Wärtsilä 31SG; Innio Jenbacher J6xx	450–500 °C	Very good – modular fleet
Combined-cycle post-HRSG	Large base-load plants	80–120 °C	Poor – retrofit only viable pre-HRSG

Aeroderivatives dominate xAI, OpenAI Stargate, and Oracle BTM deployments because of their rapid cold-start (~5 min) and low-NOx DLE combustors. Reciprocating engines dominate the VoltaGrid / Innio modular fleet. Industrial frame turbines appear where footprint and base-load hours justify the slower ramp – Meta's Louisiana programme is the clearest case. All three families are inside MicroPower's PbTe / TAGS operating range of 300–1,000 °C.

> The physics. At 500–600 °C hot side and 80–120 °C cold side, a PbTe / TAGS PowerRing sees a ΔT of 400–500 °C – the regime where module efficiency is highest. Published prototype work (PMC, ScienceDirect) confirms 2–3% incremental power recovery on gas-turbine exhaust is realistic – e.g. 1 kW on a 40 kW small-turbine prototype. At hyperscaler scale, 1–2% of 15–20 GW is 150–400 MW of recovered electricity.

3 · Why the segment is unserved – and why that is the opportunity

Three structural reasons explain the white space.

- Timeline mismatch. BTM buildout is 18–24 months old. Heat recovery was not in original designs. The first generation of plants is still being commissioned.

- Retrofit economics. Adding TEG to live generators is complex – thermal integration, vibration isolation, instrumentation, safety case. New-build design-in is materially cheaper.
- OEM inertia. GE Vernova, Siemens Energy, and Innio do not yet offer packaged heat-recovery modules for their BTM datacentre turbines. That is a partnership gap, not a technology gap.

The practical consequence: no packaged TEG offering is currently pitched into datacentre BTM waste-heat recovery. ORC vendors (Turboden, Exergy, Climeon) focus on utility-scale or process-industrial sites, not modular hyperscaler deployments. The segment is unserved by packaged offerings, with a closing design-in window.

4 · TEG and ORC are complementary, not competing

PowerRing is positioned alongside the incumbent waste-heat technology, not against it. ORC at 300–450 °C, at utility scale, achieves 10–15% incremental recovery and is proven. The two technologies stack.

Technology	Best temperature window	Role on a hyperscaler BTM stack
TEG (PowerRing PbTe / TAGS)	450–1,000 °C (hot side)	Solid-state, no moving parts; ideal for first-stage recovery off the turbine outlet
ORC	150–450 °C (after first-stage cooling)	Proven utility-scale power recovery on the cooled stream
HRSG + steam	Base-load combined-cycle only	Not applicable to most simple-cycle BTM installations

On a large simple-cycle site, a rational stack is PowerRing catching the first ΔT off the turbine outlet, then ORC taking the cooled stream into its comfort zone. On reciprocating engine sites at 450–500 °C, PowerRing alone is the right answer – ORC is uneconomic at that scale, the same sub-1 MW-per-unit problem that makes small biogas plants unserved. The pattern repeats.

5 · A worked example – LM2500 fleet recovery

This section models what a design-in looks like on a single engine. All figures are modelled from literature-range values, not site-specific quotes; treat as illustrative. The intent is to show the commercial arithmetic end-to-end – site-specific numbers follow during structured dialogue.

Parameter	Assumption / Source	Value
Engine	GE LM2500XPRESS simple-cycle aeroderivative	~34 MWe
Exhaust mass flow	GE published reference	~70 kg/s
Exhaust temperature	Full-load, GE reference	~510 °C
Recoverable thermal duty	40% of gross waste heat in first-stage band	~25 MW thermal

Parameter	Assumption / Source	Value
PowerRing stage efficiency	Derived from 10–15% module-level efficiency at design conditions × ~50% system derate (heat-exchanger ΔT loss, cold-side parasitic, ducting, contact resistance, packing factor)	5–7.5% system-level
Gross recovered electricity	Thermal duty × stage efficiency	~1.0–1.5 MWe per engine
Parasitic load	Cooling pumps, controls, instrumentation	~10–15% of gross
Net electricity per engine	Modelled	~0.85–1.35 MWe
Typical Stargate cluster	Published Abilene Phase 1	29 × LM2500
Cluster-scale net recovery	Engines × per-engine net, modelled	~25–40 MWe
Indicative uplift at $70/MWh	Modelled revenue proxy	~$15–25M / yr / cluster

Real payback depends on capex per installed kW, installation downtime, parasitic load at site, and the avoided-cost power price the hyperscaler applies. Capex indications from literature for first-of-kind thermoelectric retrofit are $1,500–3,500/kWe; at the cluster scale above, that implies $40–140M capital for $15–25M annual recovery – a payback window of 3–8 years before permitting mitigation value. If the NSR-mitigation framing in §6 is validated, effective payback compresses materially because the value shifts from revenue to schedule.

What is load-bearing in the example, and what is not.
Load-bearing: exhaust temperature, mass flow, MicroPower module performance window.
Assumed: 5–7.5% system-level efficiency (10–15% chip × ~50% system derate), parasitic load range, capex range.
Out of scope: specific hyperscaler avoided-cost rate, site-specific installation constraints, permit-specific NSR mitigation framing – all require structured dialogue with the partner.

6 · The permitting angle

Behind-the-meter deployment above 10 MW triggers New Source Review (NSR) under the Clean Air Act. Permitting has stretched to 6–18 months and is the single largest non-technical constraint on BTM pace. Texas TCEQ issued a new standard air permit for natural-gas EGUs in January 2025 that is speeding approvals, but noise setbacks, 15 ppm NOx targets, and neighbourhood pushback are all live.

Waste-heat recovery as NSR mitigation – an untested but logical position.
No observed NSR permit yet lists TEG waste-heat recovery as a mitigation. That is an absence, not a denial. A PowerRing stack reduces the thermal plume presented to the cooling system and modestly reduces net fuel burn per kWh delivered – both arguments of environmental benefit. If validated by one pilot permit, the framing repositions PowerRing from 'revenue add' to 'schedule enabler' – the far more valuable sell to a hyperscaler under deadline.

7 · Go-to-market priority order

Four channels matter, ranked by proximity to actual metal being installed.

Priority	Channel	Why	Play
1	Innio Jenbacher via VoltaGrid	300-unit Oracle deal; modular engines; design-in window open	Offer a turnkey PowerRing module per engine
2	Crusoe Energy	Developer behind OpenAI Abilene; bundles power with datacentre design	Propose PowerRing inclusion on Phase 2 Abilene sites
3	GE Vernova & Siemens Energy OEM sales	LM2500 / SGT families sold into every major BTM site	Pitch PowerRing as an OEM accessory bundled with new-build
4	Permitting consultants & EPC firms	Burns & McDonnell, Black & Veatch, Foster Wheeler on BTM projects	Co-author a mitigation-framed permit case study

8 · Timeline and strategic bet

The design-in window is roughly through late 2026. After that, most first-wave BTM sites are commissioned and the economics shift firmly toward retrofit. A credible MicroPower path is: design-in with Innio, VoltaGrid or a first OEM by Q4 2026; pilot on a live site in 2027; scale with replication behind the established partner channel.

MicroPower engages selectively with hyperscaler power teams, BTM developers, gas-engine OEMs, and permitting / EPC partners interested in first-deployment TEG integration. Introductions and structured enquiries are welcome via the MicroPower Global contact page.

References

Data Center Dynamics. Elon Musk's xAI Granted Permits for 15 Gas Turbines at Memphis Data Center (Jul 2025).

Global Energy Monitor. Colossus 1 Power Station Profile.

Fortune. Meta's $10 Billion Louisiana Data Centre Build-Out (Aug 2025).

Tom's Hardware. OpenAI Follows Elon Musk's Lead – Gas Turbines to be Deployed at First Stargate Site (2025).

Data Center Frontier. Scaling Stargate: OpenAI's Five New U.S. Data Centers Push Toward 10 GW (2025).

Power Magazine. Oracle Taps VoltaGrid for 2.3 GW Modular Gas Fleet Across Texas (Oct 2025).

Microgrid Knowledge. VoltaGrid Expands Innio Gas-Fired Engine Deal (2025).

Turbomachinery Magazine. Aeroderivative Gas Turbines – Reference.

Power Engineering. Frame versus Aero: Who Wins in Simple Cycle.

Wärtsilä Energy. Wärtsilä 31SG Gas Engine Product Reference.

US Department of Energy. How Gas Turbine Power Plants Work.

BloombergNEF. US Data Center Power Demand to Reach 106 GW by 2035 (Dec 2025).

IEA. Energy and AI – Datacentre Electricity Demand Outlook (2025).

Utility Dive. Behind-the-Meter Generation Reaches 33 GW by 2030: BNEF.

Champier, D. "Thermoelectric generators: a review of applications." Applied Thermal Engineering, 2017.

PMC. Performance Optimisation and Exergy Analysis of Thermoelectric Heat Recovery for Gas Turbine Power Plants (2023).

ScienceDirect. Potential Applications of Thermoelectric Generators in Waste-Heat Recovery Systems (2022).

EPA / Federal Register. Review of New Source Performance Standards for Stationary Combustion Turbines (Dec 2024).

Texas TCEQ. Standard Air Permit for Natural Gas EGUs (Jan 2025).