03

Industrial Waste Heat Economics

The TEG recovery case at 300–1,000 °C.

FLAGSHIP · NO. 03

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Industrial process heat above 300 °C is the largest single thermoelectric recovery opportunity and the temperature regime where MicroPower's chip platform delivers efficiency that bismuth-telluride competitors cannot match. Steel, cement, glass, refractory, petrochemical, and primary metals processing collectively release tens of gigawatts of recoverable waste heat globally above 300 °C. Conventional Organic Rankine Cycle (ORC) recovery is uneconomic in this regime – too small, too distributed, too thermally variable. Solid-state thermoelectric recovery is the natural fit, but commercial BiTe TEG modules degrade above 250 °C, leaving the high-temperature opportunity unaddressed.

1 · The platform position

MicroPower's PbTe / TAGS chip platform extends the operating range to 300–1,000 °C at 14% module conversion efficiency at 550 °C, with installed-system efficiency after heat-exchanger losses, thermal interfaces, and cold-side gradient typically 6–10% under realistic field conditions. The chip's high-temperature contact and thermal-interface structures were informed by an early MicroPower collaboration with the U.S. Army Research Laboratory and have been substantially evolved internally since. The 14% figure is extrapolated from the U.S. Army Research Laboratory's evaluation of MicroPower's standard modules. NREL subsequently confirmed independently that production modules met datasheet specification.

MicroPower's separately patented MBE-grown energy-sorting barrier-layer architecture multiplies chip-level power density 1.5–1.8× on top of the baseline platform, measured on the prototype barrier layer in MicroPower's own laboratory. It is not a feature of production-spec modules today; the post-funding production roadmap reintroduces it. Production-spec modules deliver the 14% baseline.

2 · The economics, by application class

Steel mill EAF ducts (CS-A Gerdau Manitoba). 420–460 °C continuous duct-wall temperatures, 2,500+ hours of validated runtime. Per-PowerBlock recovery in the 100–200 W range. Payback is set by the customer's electricity tariff and by capex per installed kW; MicroPower's competitive position is best where the customer pays merchant-market or peak-tariff rates.

Cement and glass kiln walls. 250–400 °C continuous radiant rejection over very large surface areas. PowerBlock array geometry. The economic case here is dominated by surface area × capex per m^2, not by per-module efficiency.

Genset / CHP exhaust (CS-C BrasilGTW). 350–500 °C exhaust pipe surface, PowerRing pipe-wrap geometry. Per-PowerRing recovery 10–50 W; system-level deployment aggregates multiple rings on a

single exhaust run. The case is strongest where the genset already runs continuously for non-recovery reasons (baseload power, prime-mover reliability).

3 · Where TEG recovery does not fit

- Below ~250 °C. BiTe is the correct material below the PbTe/TAGS commercial floor; MicroPower's platform covers BiTe internally as well as PbTe/TAGS, but for pure low-temperature waste heat the BiTe case is where MicroPower meets established competitors on common ground rather than where the platform's high-temperature advantage compounds.
- Above ~1,000 °C continuous. Materials reliability of any thermoelectric approach is a serious engineering question; MicroPower's 1,000 °C+ envelope is a chip rating, not a long-duration module rating.
- Where the heat is needed elsewhere (process pre-heating, district heating, etc.), recovering it as electricity is not automatically the right move. TEG remains viable when integrated into the required heat exchanger — the heat-transfer surface that delivers heat to the next process can carry TEG modules and harvest electrical output simultaneously. Pure standalone electrical recovery is the wrong move only when the host process already has a high-value thermal use for that heat and no surface area is available for module integration.

References