

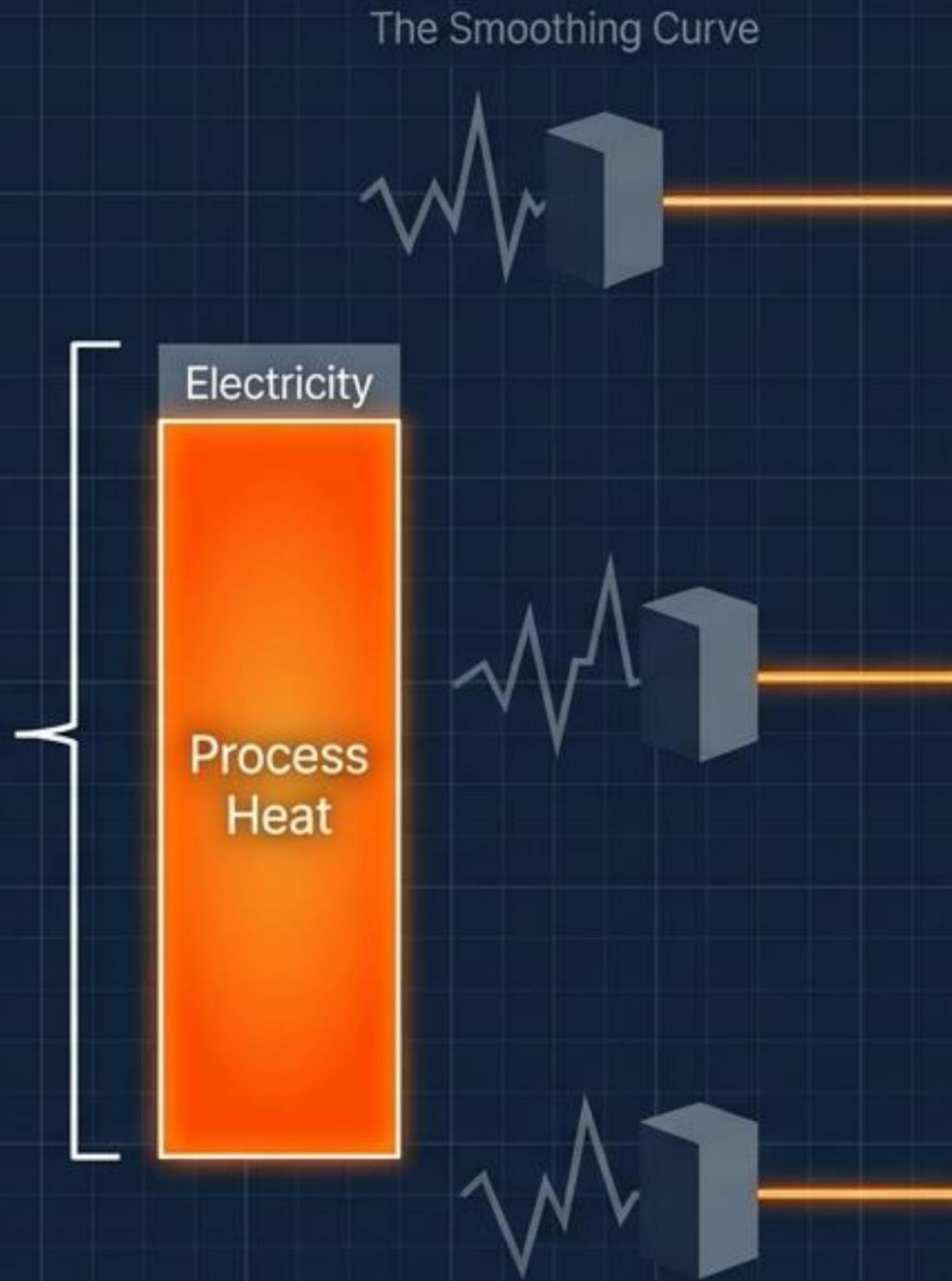
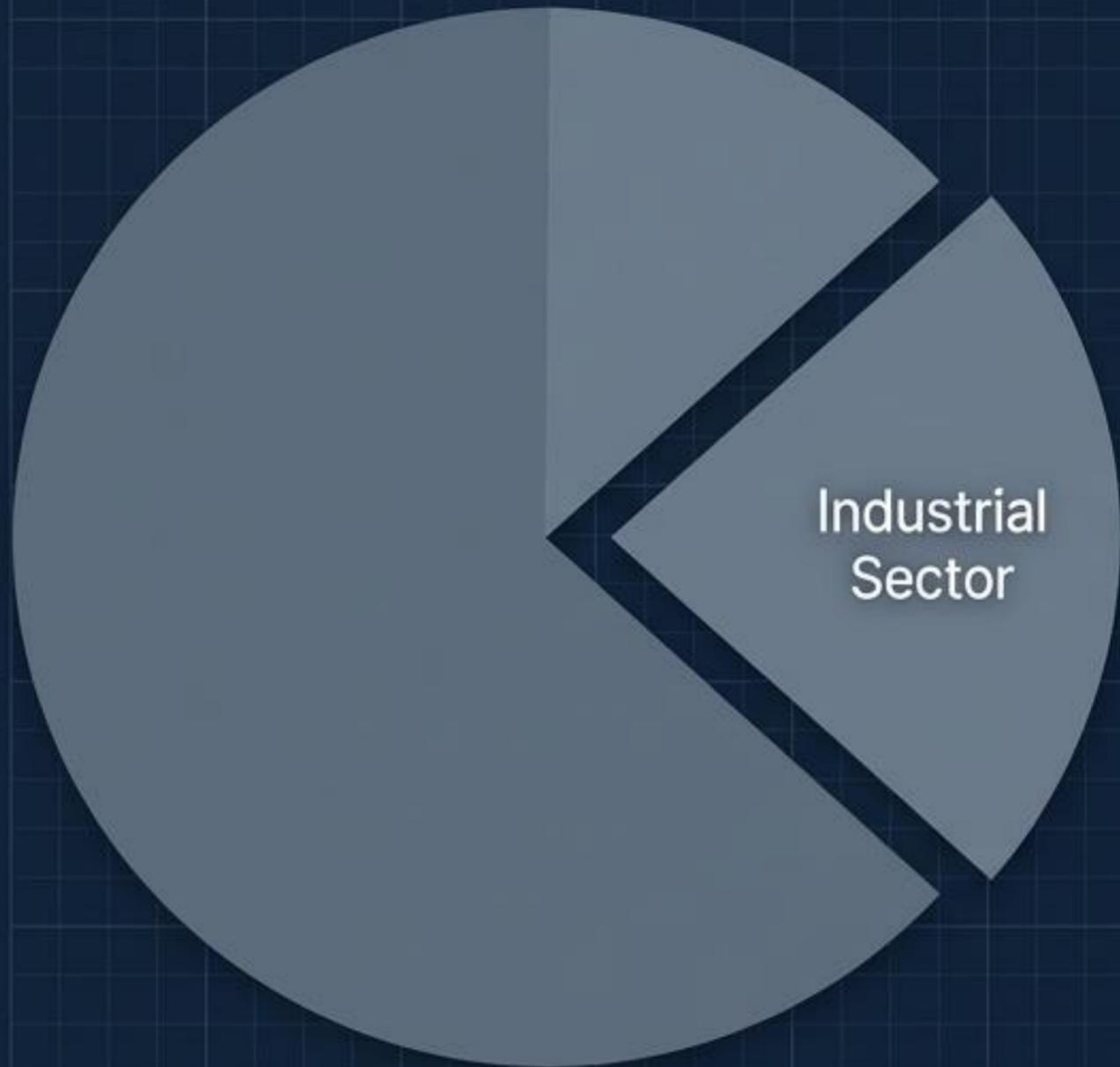


The Thermal Ledger

Operational Reality, Financial Viability, and the
Race for Industrial Decarbonisation.

2025 Industry Deep Dive

Global Energy Consumption



The Paradigm Shift

For two decades, capital obsessively chased the decarbonisation of electricity. The locus of value creation has now structurally shifted to the missing third: industrial heat.

The Baseline

Historically dominated by natural gas due to high energy density and pipeline infrastructure.

The 2025 Reality

Thermal Energy Storage (TES) has officially crossed the chasm from early-stage venture speculation to a commercial infrastructure asset class ready for deployment.

MACROECONOMIC DRIVERS

Plummeting Marginal Cost

Intermittent renewable electrons from solar and wind.

Systemic Price Volatility

Fossil fuel instability exacerbated by post-2022 geopolitics.

**The \$1.5T
Addressable
CAPEX
Opportunity**

Stringent Mandates

EU Emissions Trading System and the US Inflation Reduction Act.

Key Insight: TES is the only technology positioned at the exact intersection of these three macroeconomic forces.

The Smoothing Curve



Temporal Arbitrage

The core economic advantage of TES lies in decoupling the exact moment of electricity consumption from the moment of heat demand.

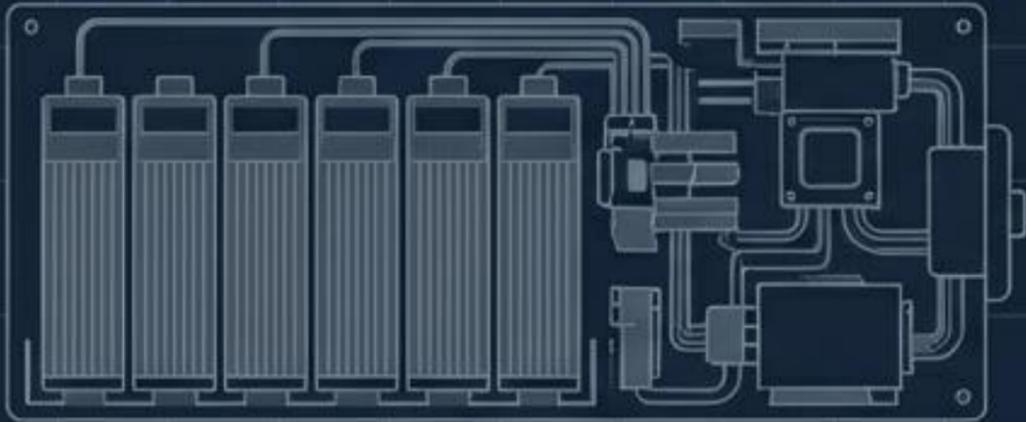
Outcome

Monetising the inherent volatility of the modern power grid to deliver drop-in boiler replacement.

Lithium-ion

Geopolitical Scarcity

~\$250–\$300 / kWh



- Cost floor dictated by critical minerals (Lithium, Cobalt, Nickel).
- Significant OPEX due to degradation and thermal management.

Solid-State TES

Commodity Abundance

\$30–\$50 / MWh_{th}

(Fully installed system costs at \$50–\$150 / kWh_{th})



- Driven by the cheapest, most abundant ancient materials on earth.
- Negligible degradation over a 30-year asset life.

Key Insight: For durations exceeding 4 hours, electrochemical batteries cannot compete. TES cost floors are fundamentally structural.

The Financial Flow of Heat-as-a-Service (HaaS)



The Heat-as-a-Service (HaaS) Engine

Industrial manufacturers operate with tight capital constraints and extreme risk aversion. HaaS completely removes the friction of upfront CAPEX.

Strategic Implication

Because the client refuses balance sheet risk, TES providers must possess massive capital reserves or low-cost project finance to survive.

The Thermal Ledger

The Silicon Valley Playbook

- High-growth, venture-backed strategy.
- Focus on gigafactories and rapid capacity expansion.
- Massive Series B injections (>\$150M).
- Valuations in the \$500M–\$800M range.

Players: Rondo Energy, Antora Energy

The Lean Incumbents

- European and Israeli operational models.
- Project-finance driven, reliant on non-dilutive public grants.
- Strategic industrial partnerships and balance sheet efficiency.
- Distinctly lower valuations despite operational maturity.

Players: Brenmiller Energy, Kraftblock, Polar Night Energy

Key Insight: The market is fundamentally divided not just by technology, but by capitalization strategy.



Rondo Energy (USA)

Status: Private, High-Growth

Technology

Refractory Brick Thermal Battery (>1,000°C capability). Brute force simplicity using century-old steel industry materials.

Financials

>\$195M raised. Backed by Breakthrough Energy, EIP, Aramco. Recent €75M package from EIB. **Est. Valuation:** \$500M–\$600M.

Flagship Asset: Holmes Western Oil Corp (California)

100 MWh unit for Enhanced Oil Recovery. Powered by 20 MW off-grid solar. Est. CAPEX: \$8M–\$12M. Bypasses grid interconnection queues completely.



Antora Energy (USA)

Status: Private, High-Growth

Technology

Solid Carbon Blocks (>1,500°C) paired with Thermophotovoltaics (TPV). Unique ability to discharge both high-temperature heat and electricity.

Financials

>\$230M raised. Massive \$150M Series B led by BlackRock/Temasek (Decarbonization Partners). Est. Valuation: \$500M–\$700M. Pre-scale revenue, focusing on San Jose gigafactory.

Flagship Asset: Fresno / Wellhead Electric

5 MWh commercial pilot. Targeting aggressive media CAPEX of <\$10/kWh. Unlocks grid-firming arbitrage alongside industrial heat.



Brenmiller Energy (Israel)

Status: Public (Nasdaq: BNRG)

Technology

bGen™ Crushed Rock matrix. Mature technology with tens of thousands of operating hours.

Financials

Market Cap anomaly of ~\$3M–\$5M. Massive discount relative to private peers. Recent \$25M financing agreement provides critical runway. Claimed pipeline >\$500M.

Flagship Asset: Tempo Beverages (Heineken/PepsiCo)

32 MWh bGen™ ZERO system. Projected \$7.5M energy savings over 15 years.

Analyst Insight

A pure public-private arbitrage opportunity. Significant repricing likely if 2025/2026 commercial backlog is executed, but liquidity burn is a severe near-term risk.

Kraftblock (Germany)



Tech: Synthetic Granules (Upcycled steel slag) up to 800°C.

Advantage: Dual sustainability narrative (circular economy + decarbonisation).

Backing: €20M Series B (Shell Ventures, ArcelorMittal).

Flagship: PepsiCo Netherlands (70-150+ MWh) replacing potato-frying gas boilers via Eneco HaaS model.

Polar Night Energy (Finland)



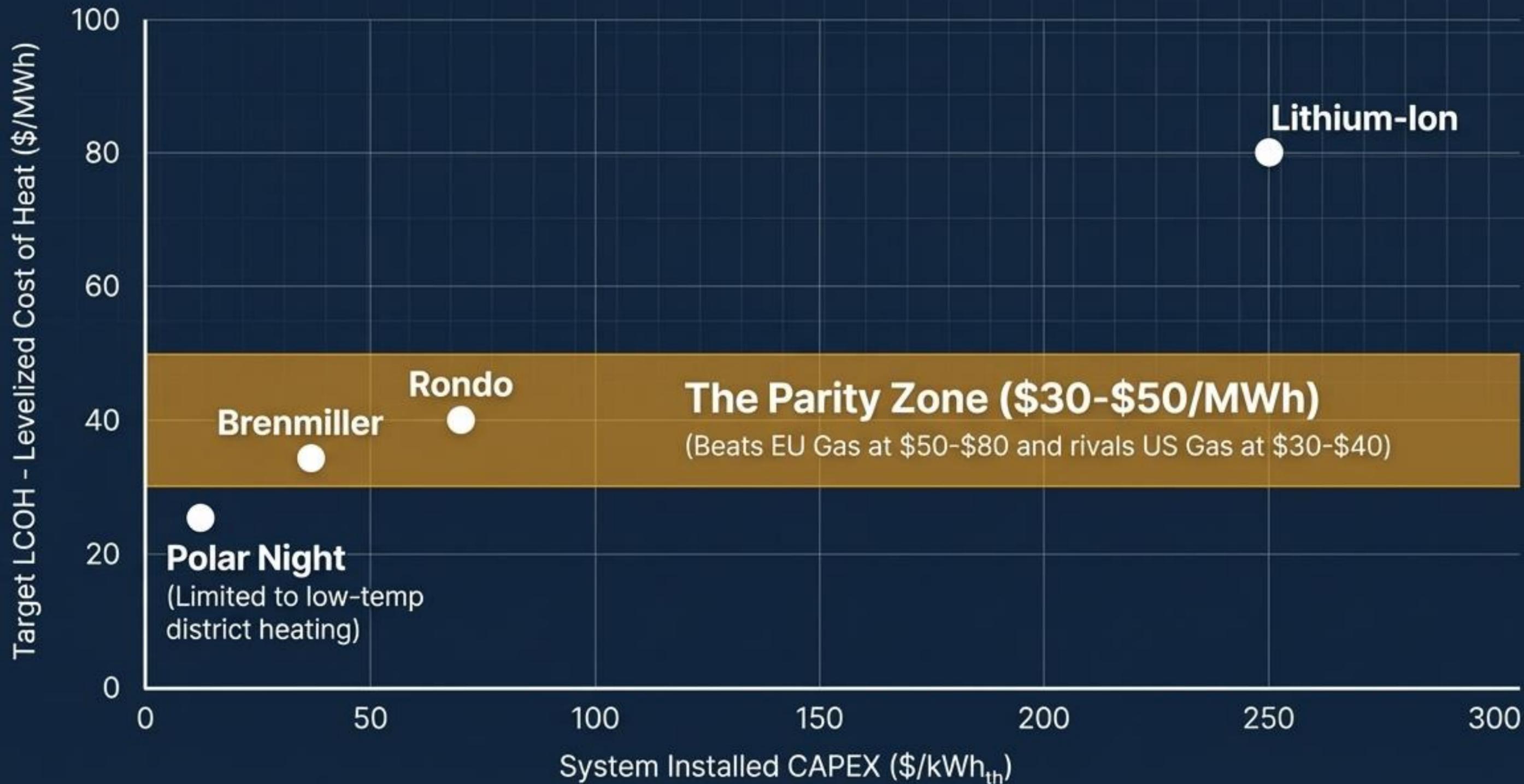
Tech: Low-grade Sand/Soapstone. Ultra-low tech, mechanically simple.

Advantage: Extreme cost efficiency (<€10/kWh CAPEX).

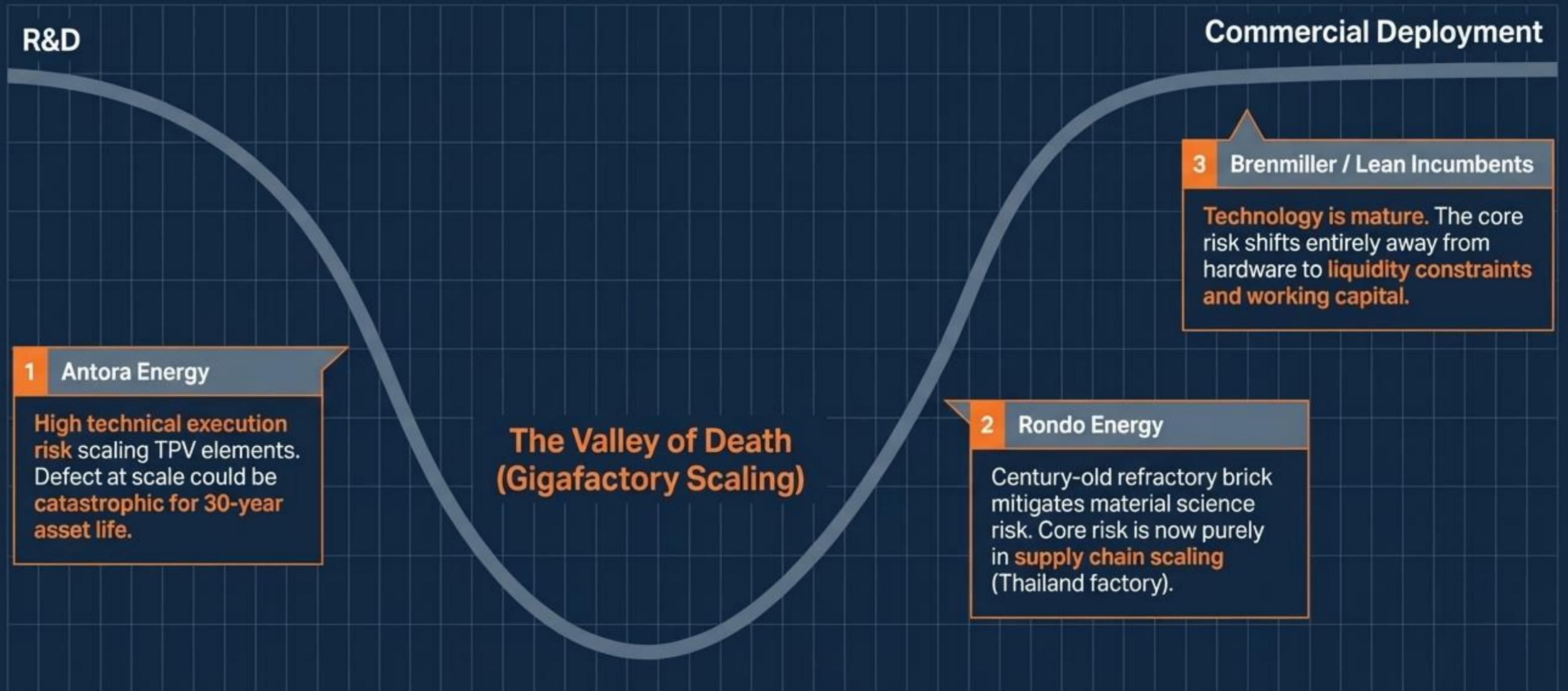
Backing: €7.6M Seed Round.

Flagship: Pornainen 100 MWh system. Dominating the Nordic district heating niche, replacing oil and wood chips for a 70% emission reduction.

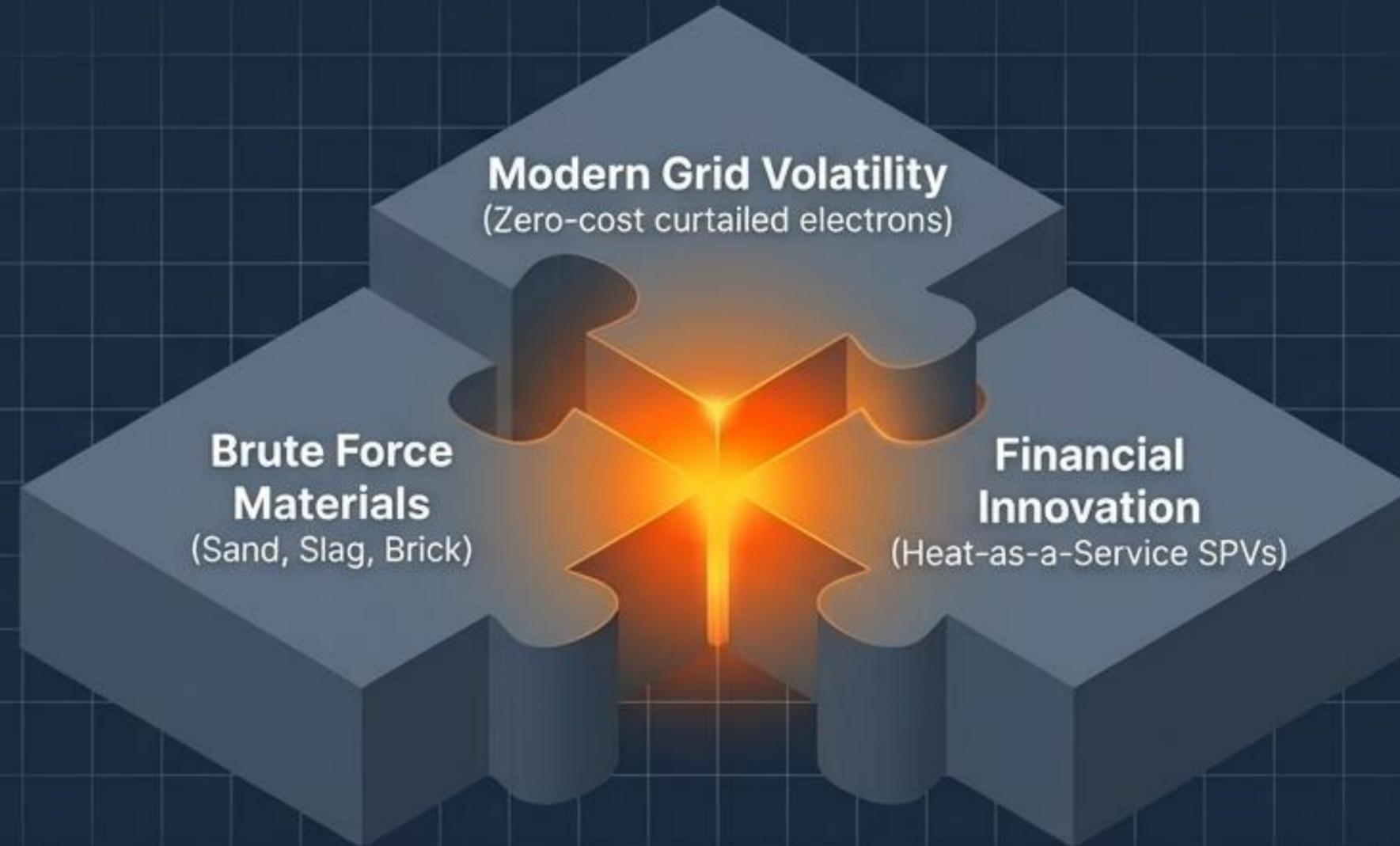
Quantitative Benchmarking: Cost vs. Yield



Risk Assessment: Surviving the Valley

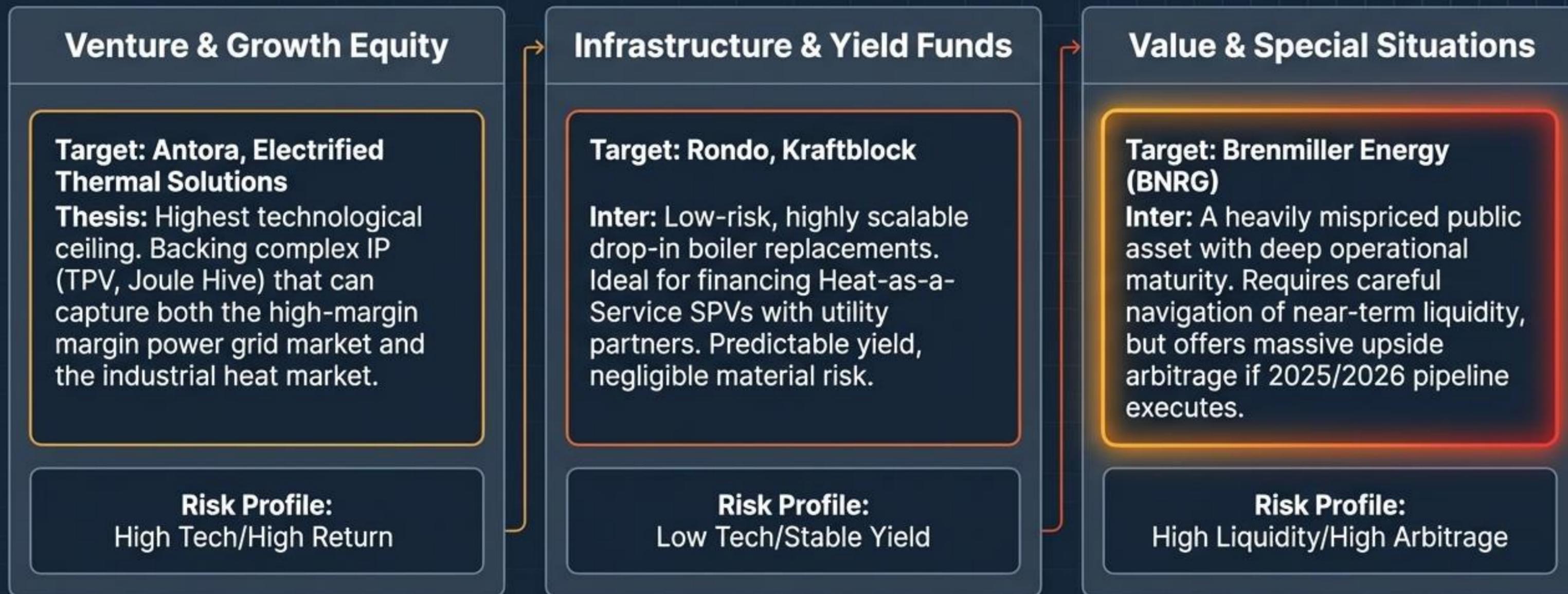


The Thermal Ledger Synthesis: Brute Force Simplicity



The Synthesis Insight: The **winning** strategy in thermal storage is not about exotic chemistry or physics. It is about brute force simplicity. By combining the cheapest, most abundant **ancient materials** with modern financial structures, the sector has successfully shifted the barrier to entry from **technology risk** to **balance sheet and execution risk**.

The Thermal Ledger: Action Matrix



The era of burning fossil fuels simply to boil water is closing. These are the architects of its replacement.