



sunrise
energy metals



THE MATERIAL FOUNDATIONS OF DATA STORAGE AND USAGE

Sam Riggall

CEO, Sunrise Energy Metals · Australia



The AI build-out is a materials story

Every gigawatt of AI capacity is a claim on physical raw materials

2.3 → 150 GW

Projected growth in AI data-centre capacity, today to 2030 (Structure Research)

~945 TWh

Global data-centre electricity use by 2030 — roughly double today's level (IEA)

~1-2 billion LT

Cooling water used in a 1GW data center, depending on cooling system (could be much lower or higher)

1.1 – 1.8

Power Usage Effectiveness (PUE) = total facility power divided by IT power

Three layers of material demand



Compute

Chips & accelerators: gallium, germanium, indium, arsenic, high-purity silicon, tantalum



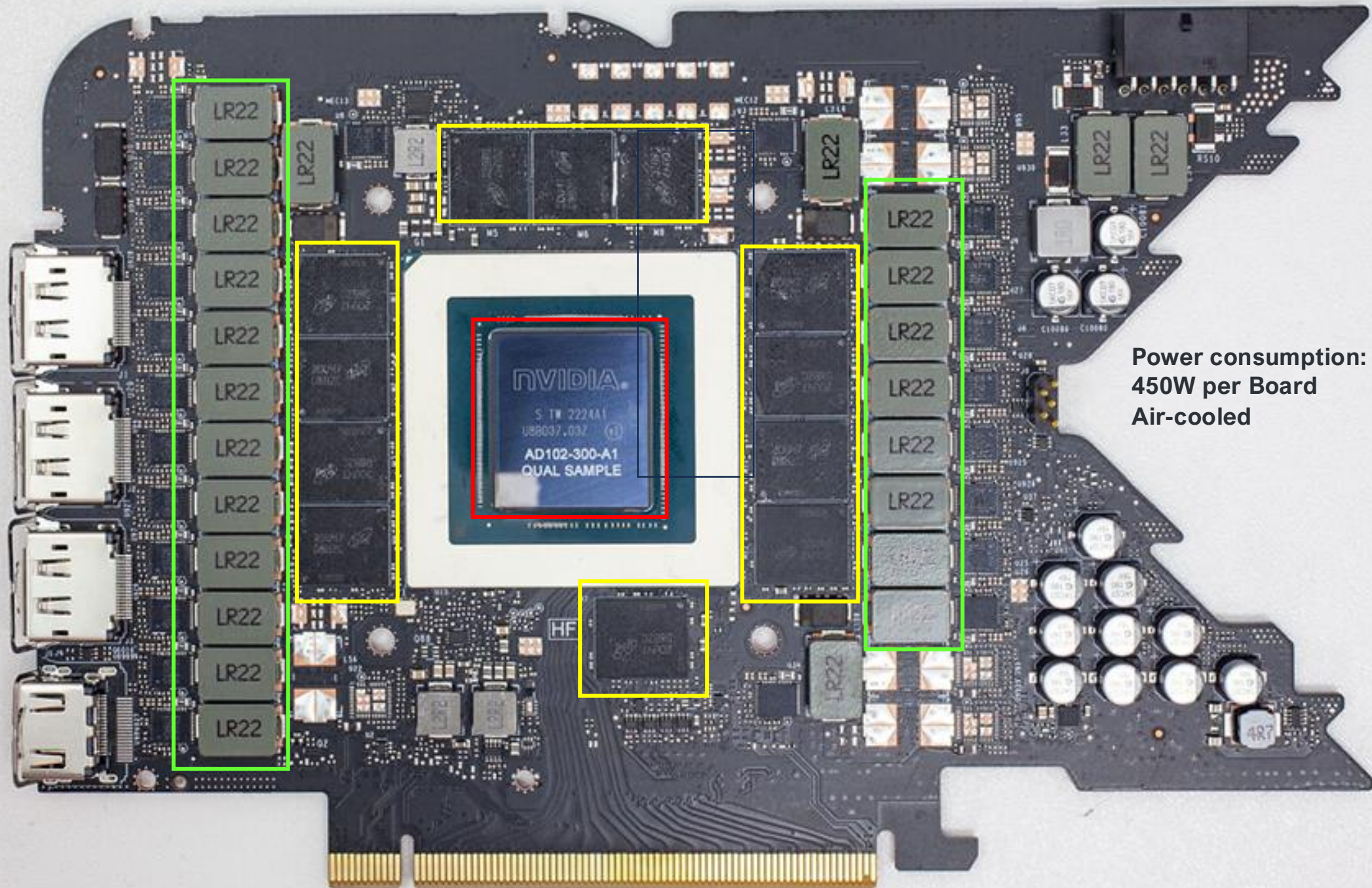
Thermal

Cooling motors, pumps & fans: NdFeB permanent magnets (neodymium, dysprosium, terbium)



Power

Grid, transformers & cabling: copper, aluminium, grain-oriented electrical steel (GOES)



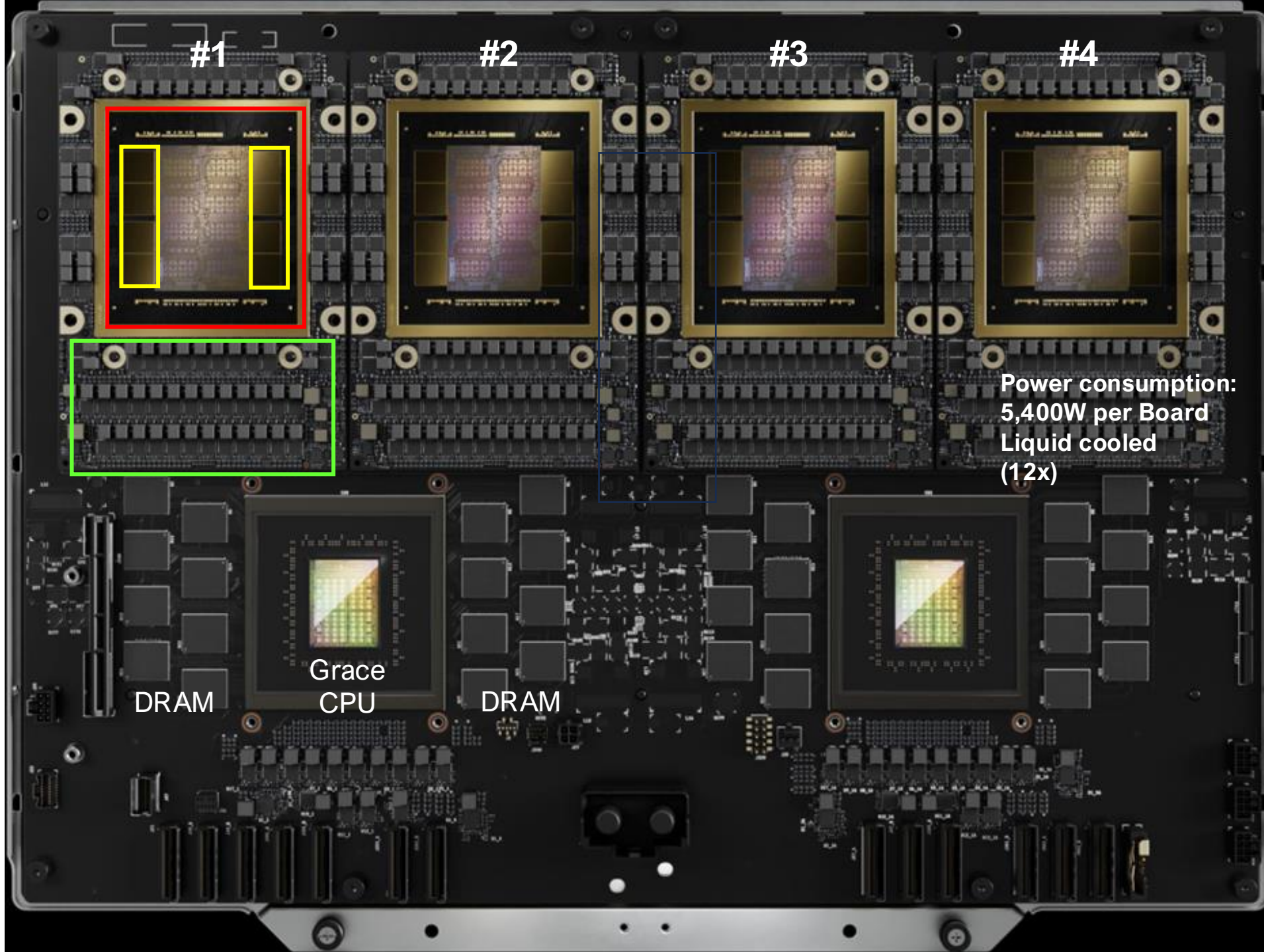
MEMORY
DRAM

GPU

Power consumption:
450W per Board
Air-cooled

POWER
SYSTEMS

NVIDIA's Ada
Lovelace GPU.
The world's first 5
nanometer GPU,
built at TSMC,
with a transistor
count of 76.3
billion and a die
size of 608 mm².
(2022)



#1

#2

#3

#4

MEMORY
HBM3E

GPU

POWER
SYSTEMS

Power consumption:
5,400W per Board
Liquid cooled
(12x)

DRAM

Grace
CPU

DRAM

NVIDIA's
Blackwell GPU.
4x GPUs
surrounded by 8x
integrated HBM.
(2025)

It is estimated that c. 60-80% of a data center's IT power draw is driven by memory constraints rather than compute limitations

Memory



DRAM / HBM Wafer - HP silicon, boron, phosphorous, arsenic.
Capacitor – hafnium, zirconium, titanium, tantalum. **Interconnects** – copper, tungsten, cobalt, ruthenium

High-k dielectric materials HfO₂ prevents unwanted quantum tunneling leakage in small transistors – AlScN is emerging as a strong non-volatile memory alternative (highly polarized ferroelectric diodes)

Computation



GPU Power electronics (GaN and GaScN) and optical interconnects (Ga / Ge). **Logic dielectrics** (HfO₂). **Die and packaging** – tantalum, tungsten, cobalt. Many **other** materials.

Integration risks Advances in optics, packaging and interconnects means that the bill of materials continually evolves



Network Edge Computing Expect next-generation models to be hosted outside legacy data centers and much of the inference load to be decentralized. This requires a wireless network capable of operating at high frequencies and at low latency. To date, only CMOS-compatible RF filtering chips containing aluminum-scandium-nitride (AlScN) have demonstrated frequencies at the c. 20GHz range.

The parts of AI infrastructure most people never see — cooling motors and grid transformers — carry two of the tightest supply chokepoints

NdFeB permanent magnets

Where: embedded in the synchronous motors of high-efficiency pumps, fans and compressors to minimize energy waste and heat generation. Enhanced with dysprosium/terbium for high-temperature stability.

Concentration: China controls ~90% of permanent-magnet production and ~85–90% of rare-earth processing.

Control event: since April 2025, China requires export licences for seven heavy rare earths and for NdFeB magnets containing Tb or Dy.

Extraterritorial reach: later measures assert control over goods with only minor Chinese-origin rare-earth content (partly suspended to Nov 2026).



Grain-oriented electrical steel (GOES)

Where: the magnetic core of every transformer connecting a data centre to the grid.

Why it bites: GOES output is limited and transformer lead times have stretched to multiple years — an “enabling material” bottleneck that can delay a whole campus regardless of chip supply.

The pattern repeats: as with by-product metals, the constraint is specialised processing capacity and skilled production, not raw ore. Capacity cannot be rebuilt quickly.



Access to electrical power is the key bottleneck today – off-grid solutions underpin the License to Operate



9-12 months

the order to deployment timeframe for a solid oxide fuel cell stack, cf. 5-7 years for large-scale gas turbines

Near Zero

NO_x, SO_x, noise and water use

50-54%

Average electrical efficiency, cf 37% for a gas turbine (Bloom Energy)

Scandium

is the key material used to stabilize the ceramic electrolyte in the cell

Mapping the solution

The global resource base is adequate for almost every material AI need. The vulnerability lies in the concentration of refining, processing and specialized manufacturing.

1

Map the molecules

Every smelter and refinery should assess the economic extraction cost of its by-products — gallium, germanium, scandium, indium — rather than assigning them zero value.

2

Build centralised, multi-product hubs

Direct industrial strategy to efficient extraction around existing centres of excellence, cheaper power, faster permitting and appropriate waste management.

3

Encourage capital to lean in

Investors are prepared to provide long-term capital if risks around pricing, market access and trade policy are addressed.

4

Price is not value

Weigh the additional cost of a “Western premium” against the defence, national sovereignty and industrial-policy costs embedded in the “China discount.”

Takeaways

1. AI is an energy, materials and infrastructure revolution. Its impacts are localised, not decentralized.
2. Industry scale-up does not hinge on a single point of failure. Bottlenecks will move along the value chain - solving one constraint may simply transfer the problem to the next one.
3. The mismatch between compute (GPU) and storage (DRAM/HBM) is a key contributor to energy intensity – we need new solutions in speed, areal density, hardware lifecycle, etc.
4. Our power systems can be more flexible and better orchestrated - smart grids, distributed generation, storage and software-managed power architectures.
5. For critical minerals we need to map and secure existing supply, centralise processing (where feasible), encourage capital to participate and price local sources of production to reflect its true value. Quantum leaps in performance is a materials science challenge more than an engineering challenge.
6. Design for an integrated system rather than as a collection of independent industries - energy producers, grid operators, component manufacturers, network operators, materials suppliers and AI labs.