

Where Tungsten Closes

Seven Insights from the Tungsten Crisis

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0. The seven insights in brief

1. **The scarcity is a node, not a resource.** The ground holds enough tungsten for more than fifty years. The power sits in one processing step, the conversion of ore into ammonium paratungstate (APT). China's export controls target exactly that step.
2. **The price is geopolitical.** Energy is less than one percent of today's price. The price rose because one gate closed, not because anything became costlier to make.
3. **History repeats.** Western tungsten mines have paid only in wartime, and China has flooded the market before. Large Western mines and refineries carry that risk again.
4. **Small loops beat the long chain.** The routes that bypass the Chinese node are small: keeping carbide as carbide, making carbide straight from ore, and regrinding tools. They are cheaper in energy and they already work.
5. **Europe exports its own loop.** In 2025 the EU shipped 4,911 tonnes of tungsten scrap outside the Union, two thirds to the United States. Brussels funds a mine and leaves the scrap unprotected.
6. **The substitutes are ready; the incumbents do not move.** Ceramic and boron-nitride tools cut certain materials several times faster without tungsten. The tool industry answers the crisis with price rises instead.
7. **Transformation of elements offers no way out.** No route turns another element into tungsten at an acceptable cost.

Each insight rests on numbers that were collected, recomputed and checked against their sources by separate reviewers. Section 9 describes how.

1. The occasion

Four articles in *Het Financieele Dagblad* trace the crisis.

On 11 June 2025, Roland Smid reported that China's export controls were holding up Western weapons programmes. The prefecture of Ganzhou says of itself: as you think of the Middle East with oil, think of Ganzhou with tungsten. A study by Govini found Chinese dominance in the supply chain of 78% of 80,000 American weapon parts. Joris Teer of the EU Institute for Security Studies warned that a refinery must be convinced to stay for thirty years.

On 20 July 2026, the paper reported that the IEA called tungsten the fastest-rising strategic metal. Its price had risen sixfold in twelve months.

On 16 October 2026, Pim Brassier described the crisis as small firms feel it. A metalworking firm in Zoetermeer speaks of "the tungsten crisis". Professional dart sets cost up to 30% more. The old Minas da Borralha in Portugal are being reopened. The Centre for Materials & Resilience (CMR) said that a hundred new mines solve the wrong problem, because China still refines almost all of it.

The question here: what does the crisis really show, and where does it open a way out?

2. The lens

The analysis uses one picture. A chain of production is either a tree or a net.

A tree has one trunk that carries the sum of all its leaves. When the trunk closes, every leaf feels it at once. A net closes in many small meshes. When one mesh breaks, the others hold.

Two further questions follow from the same picture. Where does the chain open and close again: where is a material rewritten, and where is it lost? And can the effect be reached by changing the state of the material being worked, instead of making the tool ever harder?

3. Insight one: the scarcity is a node, not a resource

The ground. World reserves exceed 4.7 million tonnes. At the 2025 mining rate of 85,000 tonnes, that is more than fifty years (USGS 2026).

The mines. China mined 67,000 of those 85,000 tonnes in 2025, which is 78.8%. Vietnam, Kazakhstan, Russia, North Korea, Bolivia and Rwanda follow far behind.

The node. Every tungsten product starts from APT, a white salt made from ore by leaching, solvent extraction and crystallisation. According to S&P Global, about 85% of APT production and capacity is Chinese. The CMR gives 86%. Both are single sources; the figure could not be checked independently.

The controls. China’s Announcement No. 10 of 4 February 2025 places specific tungsten items under export licence:

- APT, tungsten oxides and tungsten carbide powder;
- heavy alloys of tungsten with nickel and iron or copper above 17.5 g/cm³;
- massive tungsten pieces above set dimensions;
- the production technology for these items.

It does not name tungsten concentrate, tungsten metal powder, or finished carbide tools. The controls sit precisely on the node.

What follows. A new mine in Portugal or Spain adds a root. Its concentrate still has to pass through an APT plant. In the EU’s second batch of strategic raw-material projects (9 October 2026), three concern tungsten. According to the company itself, Borralha is the only one that extracts. No tungsten refinery and no tungsten recycling project was identified in that batch.

4. Insight two: the price is geopolitical

Making tungsten carbide from concentrate takes about 10 kWh of electricity per kilogram of tungsten (Furberg et al. 2019). The step from concentrate to APT alone takes about 1.9 kWh.

One trading unit of APT holds 7.93 kg of tungsten. At €0.15 per kWh, the energy share of the price was:

Date	APT price, dollars per unit	Energy share, concentrate to carbide	Energy share, concentrate to APT
Start 2025	331	4.0%	0.73%
End 2025	675	2.0%	0.36%
15 October 2026	2,500–3,100	0.42–0.53%	0.08–0.10%

The energy did not change. The price rose ninefold in less than two years because one export gate closed.

What follows. Any business case for Western tungsten built on today’s price is built on a political decision in Beijing. That decision can be reversed.

5. Insight three: history repeats

The largest tungsten mine outside China, in Australia, was profitable only in wartime. It opened in the First World War, reopened just before 1939, produced for the Korean and Vietnam wars, closed in 1990, and is open again now (Fickling, via FD).

Ten years ago, China sold tungsten below cost. Western mines went under water.

Large projects now under way:

- H.C. Starck, owned since December 2024 by Mitsubishi Materials, invests about €50 million in Goslar. Capacity rises by nearly half, to about 7,000 tonnes a year, by 2028. About 80% of its feed is already recycled material.
- Mitsubishi Materials invests ¥8 billion in Akita, Japan, doubling APT capacity to 2,400 tonnes WO₃ equivalent by April 2029.
- Almonty began processing at Sangdong in Korea in July 2026. Tungsten West began commissioning at Hemerdon in England. Kazakhstan's Boguty began producing in 2025.

These plants make APT outside China. That is valuable. But they are still trunks, with thirty-year payback horizons. They carry the same risk the Australian mine carried: a reopened Chinese tap.

What follows. Large capacity outside China needs a floor under the price: long-term offtake, strategic stock, or public ownership. Without that floor, history will repeat.

6. Insight four: small loops beat the long chain

Four measured routes bypass the node or shorten the chain. They are ordered from simplest to most ambitious.

Regrinding. A worn solid-carbide drill or mill can be reground several times. An independent study finds that more than 60% of the original tool life comes back (Conradie et al. 2017). Vendors claim 85–95%. A regrind costs about 30% of a new tool. Per unit of cutting work, that means 64–73% less new carbide. It needs no new technology.

Keeping carbide as carbide: zinc recycling. Worn carbide is placed in molten zinc. The zinc swells the cobalt binder, the piece falls apart, the zinc is distilled off and reused, and the carbide is milled to powder. The grain itself is never rewritten. It costs about 3.3 kWh per kg of tungsten, a third of the primary route. Recycled powder is not on the Chinese list.

Take-back by the suppliers themselves. Sandvik reports 70% less energy and 64% less CO₂ for recycled carbide and aims to buy back 90% of its insert volume. Its Austrian subsidiary Wolfram Bergbau already makes half its products from recycled material. Ceratizit sells a grade (upGRADE KLC20+) with more than 99% recycled content and a footprint of 8.99 against 20.64 kg CO₂e per kg for its own conventional grade, 56% less.

Making carbide straight from ore. Polini and colleagues (2021) milled tungsten concentrate with carbon black and heated it for six hours at 1,150 °C. After leaching, they had tungsten carbide. The route skips APT, oxide and metal. It uses half the energy (8.7 against 17.3 kWh per kg in their comparison), four reagents instead of fourteen, and less than half the waste. The carbide sintered into hard metal of industrial quality. The Italian firm F.I.L.M.S. holds the related patent (EP3098199B1). Its claims require a small amount of cobalt, nickel or iron as promoter. The route is proven in the laboratory, not yet in industry.

What follows. The routes that work are small. A zinc furnace serves a region. A direct carbide line can stand beside a mine. Neither needs a thirty-year refinery commitment. This is a net of small meshes against one trunk.

Scrap now has a price that makes the loop pay. Carbide scrap fetched under €20 per kg in 2023 (one unattributed source), about €75 in January 2026, a peak of €130–140 in March 2026, and €65–80 on 15 October 2026 (SMM).

7. Insight five: Europe exports its own loop

Eurostat trade data for tungsten waste and scrap (code 810197), re-queried by the

reviewer:

	2024	2025
EU exports outside the EU	4,599 t	4,911 t
of which to the United States	3,236 t (70%)	3,253 t (66%)
EU imports from outside the EU	4,780 t	5,291 t
Netherlands exports	588 t	928 t
Netherlands imports	473 t	625 t

The Netherlands is a net exporter of tungsten scrap, mostly to Germany (73%). The European Cutting Tools Association says that about half the carbide used in Europe already comes from recycling, and that European recycling capacity is “approaching its limits”.

The policy picture:

- The EU’s RESourceEU plan proposes export limits on scrap of magnets, aluminium, possibly copper, and battery black mass. Tungsten is not named.
- Tungsten scrap is on the EU’s “green list” of wastes (B1010). From 21 May 2027 it may go outside the OECD only to listed countries. The flow to the United States is unaffected.
- The Dutch list of critical raw materials (7 July 2026) includes tungsten but contains no measure on scrap.
- Japan’s machine-tool builders already discourage carbide scrap from leaving the country.

What follows. Europe pays for a new mine and lets its richest secondary ore leave. Tungsten scrap holds far more tungsten per tonne than any ore. Keeping it in the European loop, and building the zinc and chemical capacity to process it, is cheaper and faster than any mine.

8. Insight six: the substitutes are ready; the incumbents do not move

For many functions, tungsten has a working alternative.

Function	Alternative	Measured gain
Machining cast iron	silicon nitride ceramic	610 against 150–180 m/min cutting speed, 3.3–4 times faster, no tungsten
Finishing hardened steel	hard turning with PCBN instead of grinding	9.6–14.6 times less energy per volume removed; one lathe replaces several grinders
Finishing steel	Ti(C,N) cermets	higher speeds on stable lathes; lower toughness
Nickel alloys	SiAlON ceramics	cutting speed raised from 45 to 180 m/min in one study
Aluminium, composites	diamond (PCD)	tool life four times longer in a vendor test
Memory chips	molybdenum	in volume at Micron and Samsung; SK hynix by end 2026
Shielding, counterweights	lead, steel	lead 4–5% heavier per area for equal shielding, at a fraction of the cost

Ceramics held 8.5% of the cutting-tool market in 2011. The industry’s answer to the 2026 crisis has been price rises, of up to 60% on some tools at DIJET, and carbide with less tungsten. The reviewed sources do not mention a shift to ceramics or cermets.

Two functions have no plentiful alternative: density combined with hardness, as in armour-piercing ammunition, and the wall of a fusion reactor.

Two corrections to common expectations:

- Molybdenum in chips is real, but small. The industry expects molybdenum demand for memory of 25 to 80 tonnes a year between 2027 and 2030. It shows that technology routes around the problem. It does not relieve the tungsten market.
- China mines only 37% of molybdenum, against 79% of tungsten. Its export control on molybdenum covers only fine powder for missile parts.

What follows. The obstacle is not physics. It is habit, installed machines and a supply chain built around one material. Firms that adopt the alternatives now gain independence from the node.

9. Insight seven: transformation of elements offers no way out

Two routes to make tungsten from another element were computed.

The state road. Some stable atoms become unstable when their electrons are removed. This has been measured for dysprosium-163, rhenium-187 and thallium-205. Computed at every charge state, no natural nucleus opens a path to tungsten. The nearest candidate, tantalum-181, stays closed by 138 keV even when stripped bare.

Capture. Tantalum-181 captures a neutron and becomes tungsten. In a strong reactor flux, a thin tantalum foil turns 4–9% into tungsten per year. But every tungsten atom costs one neutron. That puts the energy at least 2.6 million kWh per kg of tungsten, against about 10 kWh for the chemical route. And tantalum is 34 times scarcer than tungsten.

One reverse effect is notable. A fusion reactor's tungsten wall slowly turns into rhenium and osmium: about 0.27 tonnes of rhenium per gigawatt-year, 0.3% of world rhenium output.

10. What it means, for whom

For governments and the EU. Fund the loops and the processing, not only the mines. Keep tungsten scrap in Europe, as is proposed for magnets and aluminium. Build strategic stock where no substitute exists: defence and fusion. Treat clean carbide scrap as a resource, not as waste.

For investors. Mining shares have risen three- to tenfold. Their value rests on a price set by an export gate. History shows what happens when the gate reopens. Processing and recycling capacity outside China, with price floors, is the sounder exposure.

For entrepreneurs. The openings are small and regional: regrind services, scrap pools that reach the 0.5-tonne lots the market requires, zinc recycling near clusters of tool users, and a direct carbide line beside a European mine.

For large manufacturers. Specify by function, not by habit. Ceramic, PCBN and cermet tools already do part of the work without tungsten. Return all carbide to the supplier, and buy recycled grades.

For the people involved. In Borralha, a residents' association has gone to court against the environmental assessment; the consultation drew 653 submissions. In Rwanda, Trinity Metals employs more than 6,500 people, 99% of them Rwandan. At the machine, a loop means separate bins, clean scrap, a spare stock of tools during regrinding, and one person who owns it. Anyone grinding carbide in-house faces the EU's proposed cobalt exposure limit of 0.01 mg/m³.

11. How the numbers were checked

The findings come from three rounds of work over two days, run by Claude Code.

- Round 1 probed nine questions and was too thin.
- Round 2 ran seven parallel lines on material, process and transformation, with 508 pre-registered probes and seven independent reviewers.
- Round 3 ran four lines on innovation: less tungsten per function, other materials,

shorter chains, and local loops. It produced 111 records with sources.

The key round-3 numbers were checked by four separate reviewers who fetched the cited sources. None rested on an invented number. About half needed corrections: a vendor claim labelled as a measurement, a range that had to be narrowed, an attribution to the wrong source. Those corrections are in this version. The Eurostat trade figures were re-queried and matched exactly.

One open point remains. The S&P and CMR figures for China's share of APT could not be checked independently.

Corrections to earlier versions:

- The primary route costs about 10 kWh per kg of tungsten, not 17.
- China mines 37% of molybdenum, not most of it.
- The FD's 1,680 tonnes for EQ Resources is most likely tonnes of WO₃, mostly from Spain.
- AMG's purchase of Aura (€10 million) brought recycled tungsten into AMG's portfolio, as the FD wrote. Aura recycles mainly molybdenum, and also tungsten, vanadium, nickel and cobalt, from spent catalysts, not from carbide tools.

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