MEMO · NOVEMBER 8, 2026

Overbuild, Collapse, Win Anyway

What the railroads, the dynamo and dark fiber say about AI, energy and the price of intelligence

Every general-purpose infrastructure revolution since the canals has followed one script. Financial capital overbuilds the network. The price of what the network produces collapses. Usage explodes anyway. The builders go bankrupt or get consolidated. Productivity arrives a generation late, after the economy is rebuilt around the new input. And the fortunes go to whoever owns what the revolution made scarce, not to whoever sold what it made cheap. AI is following the script. The one new variable is that this cycle's scarce input is electricity, and it is the one input money cannot hurry.

SEVEN PUNCHLINES

1 **Overbuilding is not a bug of technological revolutions. It is how they get financed.**
Britain committed 7 to 8% of GDP to railways at each mania. A quarter of US rail mileage sat in receivership in 1894. 97% of long-haul fiber was dark in 2002. Every one of those networks is still in use.

2 **The product gets absurdly cheap, and we use absurdly more of it. Every time.**
Light fell 325-fold, freight rates by 40%, bandwidth by 90% in four years, GPT-4-class tokens 300-fold in three. Jevons named this in 1865 about coal. Demand for intelligence will not asymptote.

3 **Productivity shows up twenty to forty years late, after the organization is rebuilt around the new input.**
Electric motors were 5% of factory power in 1899 and 50% in 1919. Productivity only jumped in the 1920s, when factories were redesigned rather than retrofitted. Enterprise AI disappointment in 2026 to 2028 is scheduled, not a verdict.

4 **Nobody ever got rich selling the thing that got cheap. They got rich owning what it made scarce.**
Not the railroads but Chicago, Sears and Standard Oil. Not the utilities but the manufacturers. Not WorldCom but Google. Infrastructure is where the capital goes to die and the surplus goes to be reborn.

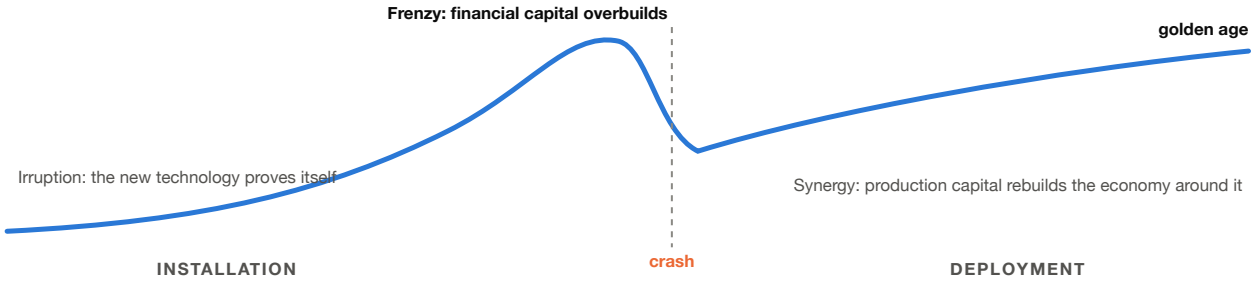
5 **The crash ends in consolidation, not extinction.**
Morgan reorganized the railroads into six systems. Western Union and Bell became monopolies. Three carriers survived fiber. Frontier labs will not vanish. Two or three will survive with pricing power restored.

6 **This cycle's scarce complement is watts, and scarcity is the only thing that has ever protected a builder's margin.**
Power caps how fast the frontier can be trained in the United States. That slows models, pushes training offshore, and, perversely, prevents the classic overbuild at the top of the stack while permitting it everywhere else.

7 **The dark-fiber trade: stranded capacity is the substrate of the next winners.**
Google and Netflix lit fiber for pennies on the dollar. Whoever buys 2029's stranded GPUs and powered shells gets the same trade.

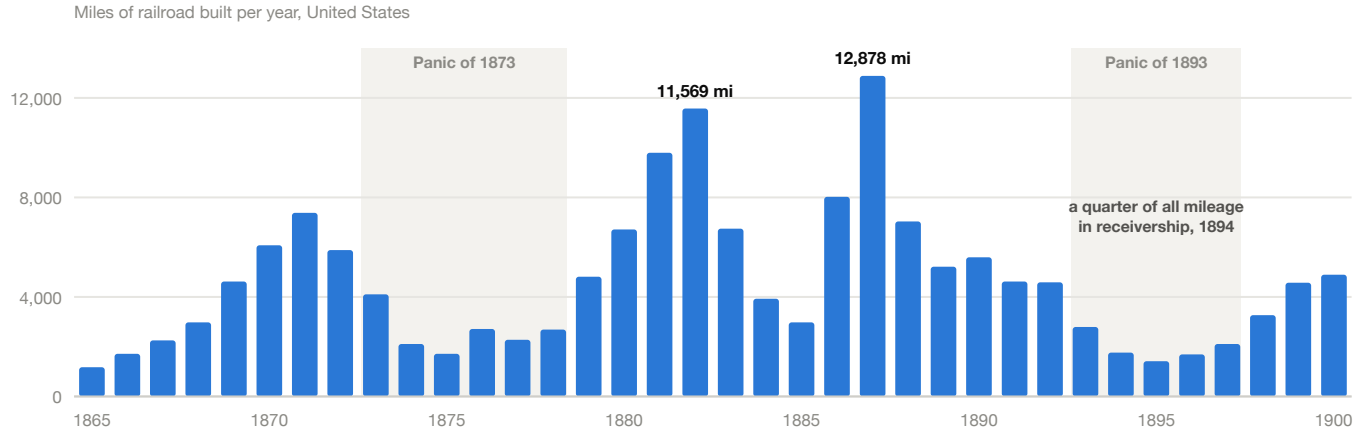
1 Overbuilding is how revolutions get financed

Carlota Perez's reading of five technological surges is the cleanest frame. Each begins with an installation period in which financial capital pours into the new infrastructure, peaks in a frenzy that builds far more than current demand can use, crashes, and then enters a deployment period in which production capital uses the cheap, overbuilt network to rebuild the rest of the economy. The crash is not the end of the revolution. It is the handoff from the people who finance networks to the people who use them.



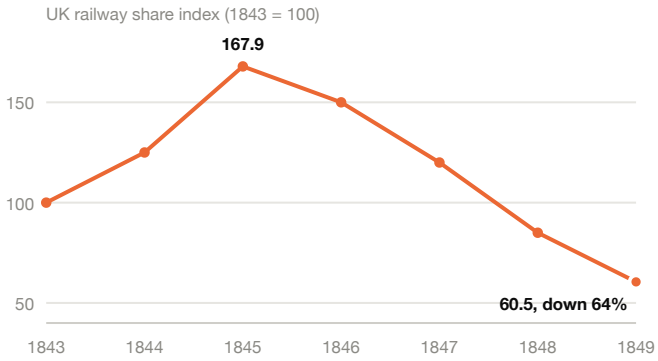
Schematic after Perez, *Technological Revolutions and Financial Capital* (2002). Surges: canals 1771, railways 1829, steel and electricity 1875, oil and autos 1908, microprocessors 1971, frontier AI 2022. The frenzy builds the capacity the deployment period runs on. Without the overbuild there is no golden age; without the crash the assets never get cheap enough to use freely.

American railroads built in two frenzies and broke in two panics



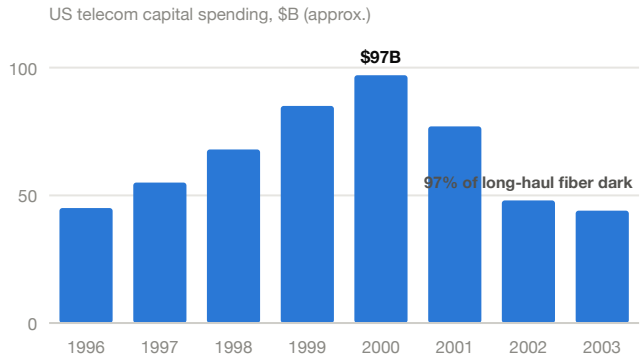
Historical Statistics of the United States, approximate. The country laid 12,878 miles of track in 1887 alone, more than the entire network of 1850. After 1893, 213 railroads covering 56,000 miles, about 30% of the network, passed through receivership. Freight volume never fell for more than a year.

Britain, 1845: the mania that paid off



Odlyzko. Railway shares fell 64% from the 1845 peak to 1849 while mileage tripled. Investors lost; Britain got its rail network at a discount.

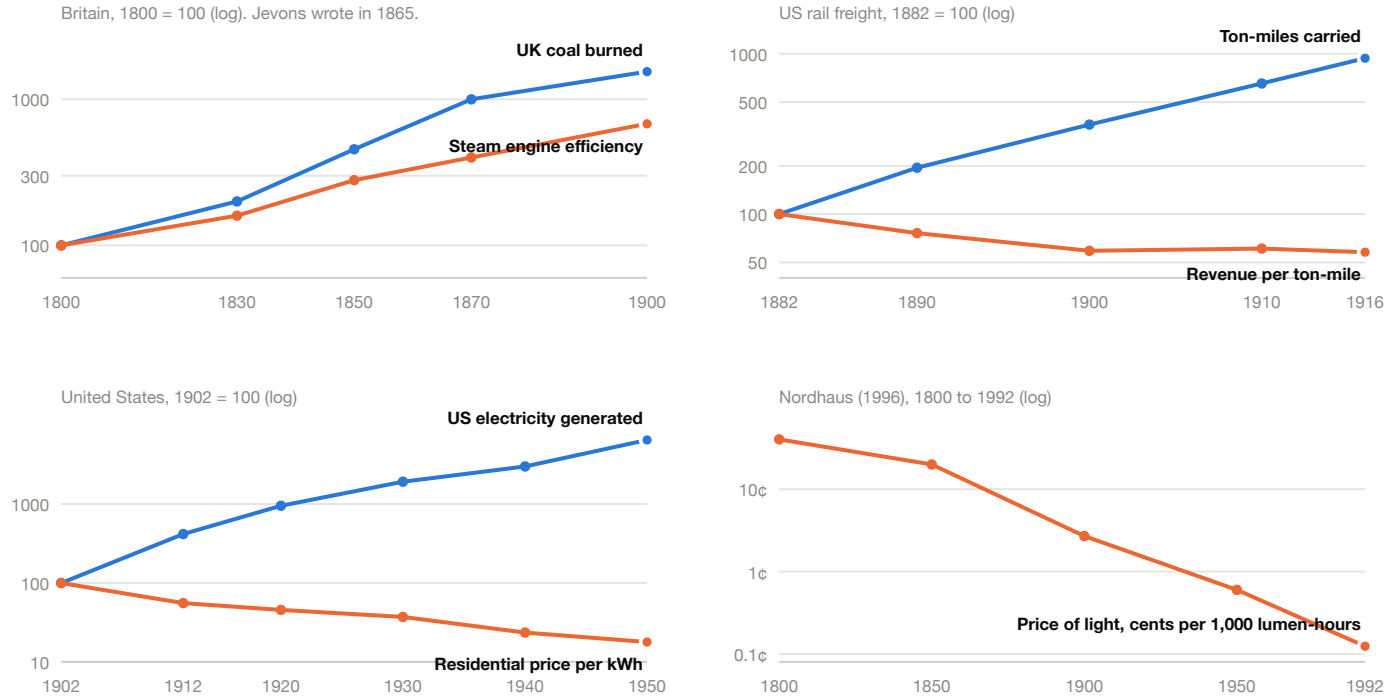
America, 2000: the fiber nobody lit



Approximate. Carriers spent over $500B from 1996 to 2001 while revenue grew 10%. Bandwidth prices fell about 90% by 2004. WorldCom and Global Crossing failed; the glass is still carrying the internet.

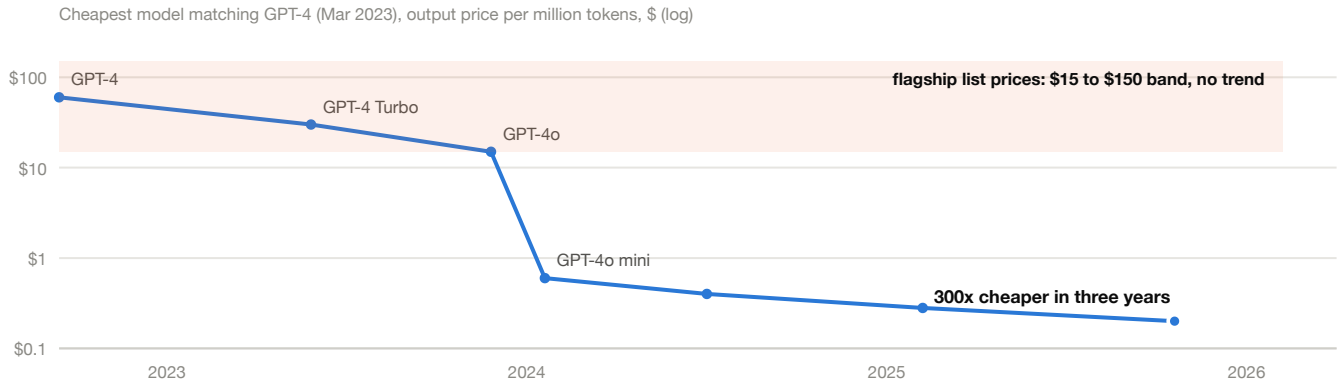
2 The product gets cheap and we use absurdly more of it

William Stanley Jevons watched James Watt's engines cut the coal needed per unit of work by a factor of five and concluded, correctly, that Britain would burn more coal, not less. Cheaper work meant more uses for work. The same curve appears in every revolution: the unit price of the output collapses, and total consumption rises by a larger multiple than the price fell. Four examples, each indexed to its starting year on a log scale so the shapes can be compared.



Sources: steam efficiency and British coal consumption, standard engineering histories, approximate; rail freight, Historical Statistics of the US, Class I revenue per ton-mile (1.24¢ in 1882, 0.72¢ in 1916) against ton-miles (39bn to 366bn); electricity, Historical Statistics, nominal residential price (16.2¢ to 2.9¢) against generation (6 TWh to 389 TWh); light, Nordhaus (1996), cents per 1,000 lumen-hours, 40.3¢ for a tallow candle in 1800 to 0.12¢ for a compact fluorescent in 1992. Light fell about 325-fold in money and 45,000-fold in labor time.

It is the same chart

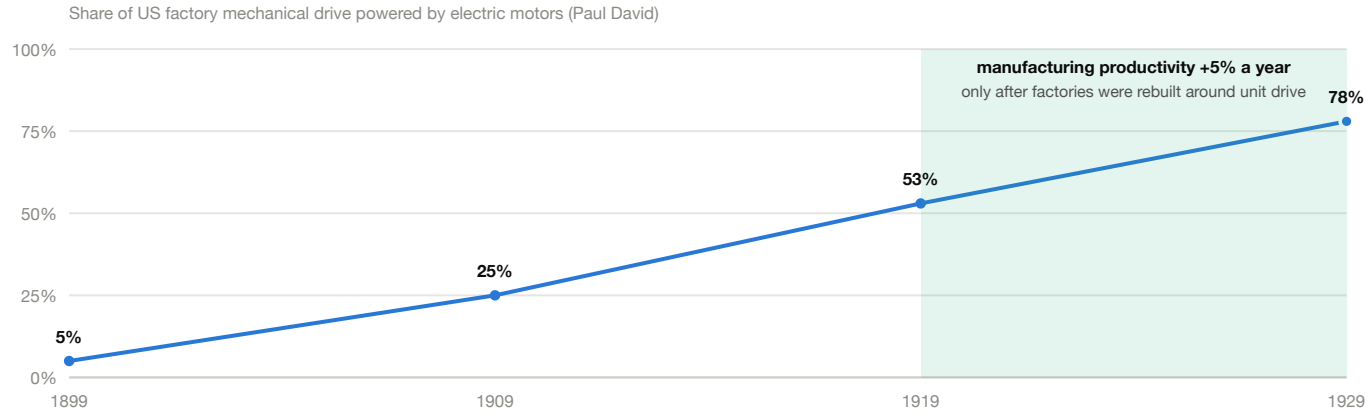


OpenAI list prices and 2026 third-party price trackers, output tokens. The cheapest model matching the original GPT-4 fell from $60 to roughly $0.20 per million tokens in three years, about 300-fold. Flagship list prices over the same period ranged between $15 and $150 with no trend. The two curves in the earlier brief were not a hypothesis. They are the observed record, and they match 1882, 1902 and 2000.

> **The price of light fell 99.7%. We did not use less light, and the lighting industry is not where the fortunes went.**

3 Productivity arrives a generation late

Paul David's 1990 paper on the dynamo is the canonical study. Central-station electricity was commercially available from 1882. By 1899 electric motors drove less than 5% of American factory machinery; by 1919 about half. Measured manufacturing productivity barely moved for those forty years, then rose more than 5% a year through the 1920s. The reason was organizational, not technical. For decades, factories bolted electric motors onto the old line-shaft layout, inheriting all its constraints. The gains came only when engineers put a motor on every machine, laid factories out single-story around the flow of work, and let Henry Ford build the moving assembly line. The technology was cheap in 1900. The redesign took until 1925.



David (1990), Devine (1983). Share of factory mechanical drive supplied by electric motors, with the 1920s productivity surge shaded. Robert Solow restated the puzzle for computers in 1987, "you can see the computer age everywhere but in the productivity statistics," and the statistics answered in 1995, roughly 25 years after the microprocessor.

WHY THE LAG IS STRUCTURAL

- **Retrofitting captures almost nothing.** A motor on a line shaft is a steam engine with a different fuel. A chatbot bolted onto an existing workflow is a faster intern. Value appears when the process is rebuilt around the new input.
- **The complementary skills do not exist yet.** Electrical engineers, plant designers and industrial managers had to be trained. The equivalent today is the people who can redesign a firm around agents, and they are a few years into existing.
- **Capital stock turns over slowly.** Factories built for line shafts ran for decades. Software, org charts and contracts built around humans in the loop will too.
- **Measurement lags reality.** Quality improvements and new goods are undercounted. Output per hour missed most of what electricity did until it could no longer be missed.

WHAT IT MEANS FOR AI IN 2026 TO 2028

- **Enterprise disappointment is scheduled.** Surveys showing most pilots failing to deliver measurable return are the 1905 factory, not a verdict on the technology. Expect two to three years of "where is the ROI" before the redesign wave.
- **It is the most likely trigger for a margin crash.** Not a capability plateau. Buyers pausing spend because the retrofit did not pay, exactly as telecom customers did not need 97% of the fiber in 2002.
- **The winners of the deployment phase are being founded now.** Sears issued its first catalog in 1893, the panic year. Amazon and Google were built on 2002's cheap bandwidth. The firms that design themselves around intelligence from the start, rather than retrofitting it, inherit the overbuild.
- **Agents are the unit drive moment.** Chat was the motor on the line shaft. An agent that owns a process end to end is the motor on the machine. The productivity numbers follow the second, not the first.

> **The technology was cheap in 1900. The redesign took until 1925. Everyone who called electricity overhyped in 1910 was right about the numbers and wrong about the century.**

4 Who gets the rent: the scarce complement and the applications

Each revolution has four layers. The enablers sell the picks and shovels. The infrastructure layer builds and operates the network. The scarce complement is whatever the network makes newly valuable and cannot itself produce. The applications use the cheap output to do something the old economy could not. The capital flows to layer two. The returns flow to layers three and four. Layer one does well until the frenzy ends and then gets cut in half or worse.

REVOLUTION	ENABLERS (PICKS AND SHOVELS)	INFRASTRUCTURE (WHERE THE CAPITAL WENT)	SCARCE COMPLEMENT (WHERE THE RENT WENT)	APPLICATIONS (WHERE THE FORTUNES WENT)
Canals 1790s to 1830s	Navvies, iron founders	Dozens of British canal companies, most obsolete within 20 years of the railway	Port and junction land. New York took the continent's trade on the Erie	Manchester cotton, Wedgwood pottery, Midlands coal to London
Railroads 1830s to 1900	Carnegie (steel rails), Baldwin (locomotives). Carnegie sold out in 1901 at the top	Hundreds of roads; a third through receivership in 1873 and again in 1893; reorganized by Morgan into six systems	Land grants, Chicago real estate, terminals. Standard Oil's rebates extracted the railroads' own margin	Sears Roebuck, Swift and Armour, national brands, the mail-order economy, time zones themselves
Electricity 1880s to 1930	GE, Westinghouse (dynamos, turbines)	Utilities and holding companies. Insull's empire, the largest, collapsed in 1932	Factory redesign and the engineers who could do it; the unit-drive layout	Every manufacturer that rebuilt; Ford's assembly line; appliances; the 1920s consumer economy
Fiber and internet 1995 to 2010	Cisco, Corning, Nortel. Down 80 to 99% from 2000 peaks	WorldCom, Global Crossing, Level 3, 360networks; over $500B deployed; most bankrupt or merged by 2003	Attention and data. Whoever owned the user owned the margin the carriers could not keep	Google, Amazon, Netflix, Facebook. All built on bandwidth bought at pennies on the dollar
Frontier AI 2022 to ?	**Nvidia, TSMC, ASML. The Carnegie layer: extraordinary until the frenzy ends**	**Frontier labs and the clouds. $730B of capex in 2026 alone. The layer the script says gets consolidated**	**Electricity, interconnect and the land that has it. Plus distribution and proprietary data**	**Not yet visible, as Sears was not visible in 1880. Firms designed around agents rather than retrofitted with them**

The pattern is not that infrastructure is a bad business forever. It is that it is a terrible business during the installation period, when capital is abundant and the product is being commoditized, and a decent oligopoly afterward.

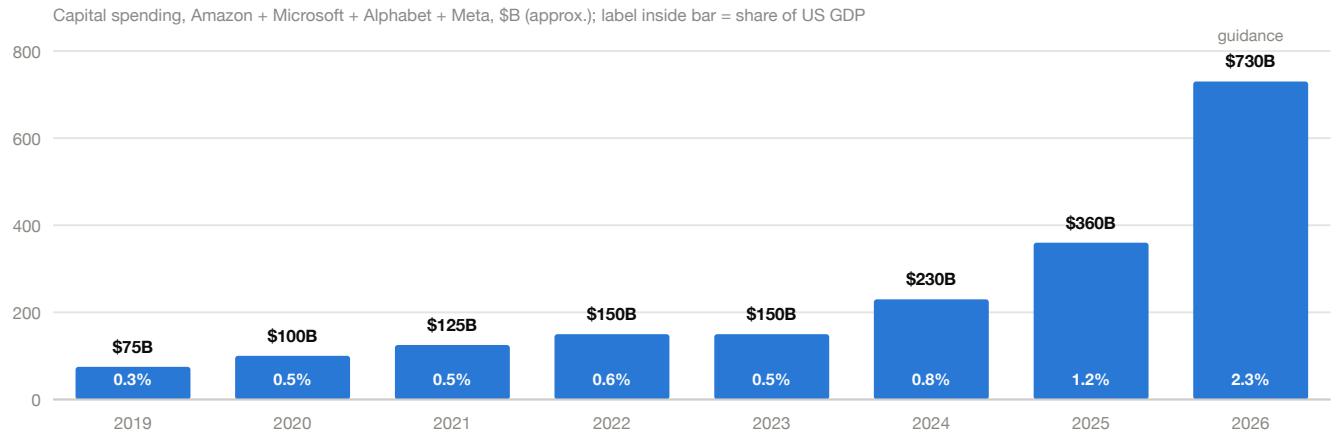
5 The crash ends in consolidation, not extinction

After 1893, J. P. Morgan reorganized the bankrupt roads into a handful of systems, cut capacity, fixed rates through communities of interest, and the surviving railroads earned steady returns for decades. Western Union consolidated dozens of telegraph companies into one by 1866. AT&T absorbed the independents after 1907. Of the long-haul fiber builders, three survived as going concerns and the assets of the rest were bought for cents and operated profitably by their new owners.

For AI the analog is straightforward. If capability plateaus and open models commoditize the base layer, the dozen-plus frontier efforts do not all disappear. Two or three with the deepest capital, distribution and, critically, secured power consolidate the rest and restore pricing power at the top. The bear case for labs is a 2029 shakeout, not an extinction. The bull case for the survivors is 1900's railroads: a regulated-feeling oligopoly earning a fair return on the overbuild someone else paid for.

Where AI is on the script

By the capital measure, AI is in the frenzy. The four largest clouds guided to roughly $730 billion of 2026 capital spending, about 2.3% of US GDP, double 2025 and five times 2022. That is not yet Britain's 7% of GDP in 1847, but railroads were a one-country mania and this one is funded by the most profitable companies in history out of cash flow, which is why it has run longer without a credit event. The product price curve is already in deployment-phase shape: GPT-4-class intelligence costs a three-hundredth of what it did. The organizational redesign is at its 1905. And the scarce complement has made itself visible.



Company reports and 2026 guidance, approximate; share of GDP against US nominal GDP of roughly $31 trillion in 2026. Microsoft trimmed its 2026 figure in October citing delays in third-party data center capacity, which is the energy constraint appearing in a 10-Q.

THE BULL CASE, RESTATED

- **Demand is elastic.** Agents multiply tokens per task 10 to 100x. Jevons has held every year.
- **Efficiency is independent of the grid.** Chips, distillation and sparse models push intelligence per watt up 2 to 3x a year regardless of power plants.
- **Inference escapes the constraint.** Only frontier training needs a gigawatt in one place.
- **The deployment phase is the golden age.** Every prior overbuild funded a boom for the users of the cheap output.
- **Scarcity protects margins.** Whoever owns power, land and interconnect holds a moat financial capital cannot buy quickly.

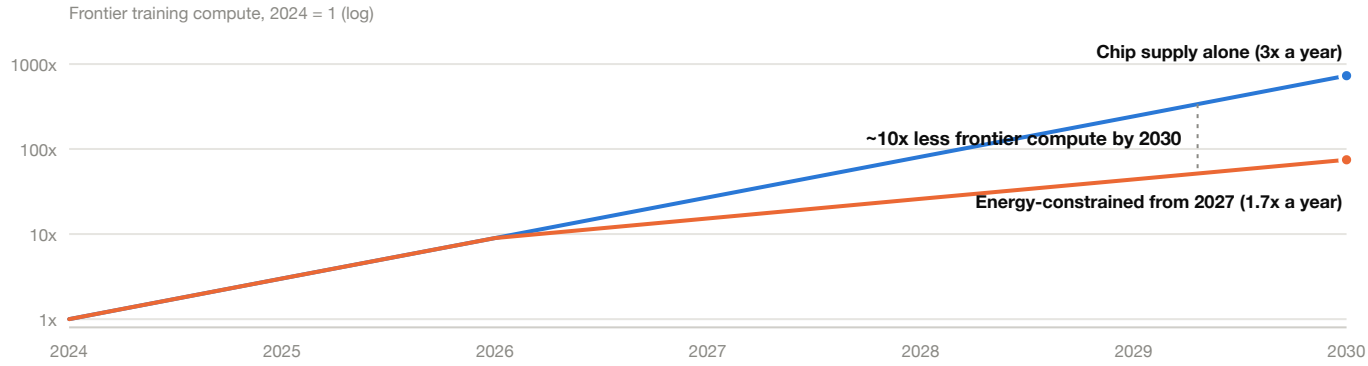
THE BEAR CASE, RESTATED

- **Energy caps US frontier growth.** Interconnect queues, turbine backlogs and permitting kill the gigawatt sites training needs.
- **The frontier moves.** China adds more generation each year than the entire US data center fleet draws.
- **Plateau plus open models strips the premium.** Fiber 2000: usage kept compounding, the builders went bankrupt anyway.
- **ROI disappointment comes first.** Electricity 1905: the retrofit does not pay and buyers pause before the redesign.
- **The enablers get cut in half.** Carnegie sold in 1901. Cisco fell 86%. The picks-and-shovels layer is priced for a frenzy that ends.

> **The collapse to watch is a margin collapse, not a demand collapse. In every prior cycle the network was built, the price of its output fell, usage compounded, and the builders still lost.**

6 The energy twist: what is different this time

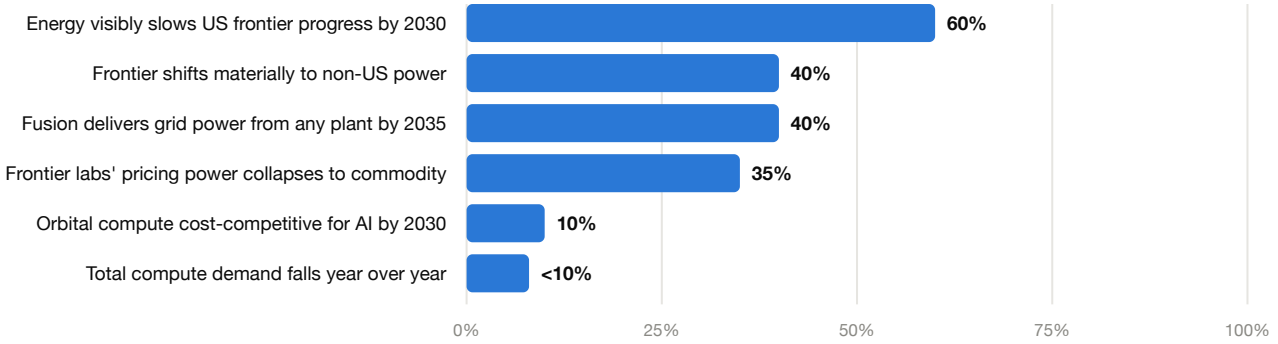
Prior revolutions had scarce complements that money could buy. Land, right of way, spectrum, attention: expensive, but available to whoever bid highest. Electricity at gigawatt scale is different. Interconnection queues run five years. Gas turbines are sold out through 2029. Transmission takes a decade. For the first time, the binding input on the frontier is one that financial capital cannot hurry.



Illustrative compounding. If US power additions cap frontier training growth near 1.7x a year from 2027, the 2030 frontier has roughly a tenth of the compute chip supply alone would allow. The gap is an incentive to train wherever power is unconstrained.

- **Scarcity shows up as rationing, not price.** Labs compete on price and ration by other means: rate limits, usage caps, enterprise-first allocation, shifting compute between training and inference. The symptom of an energy-constrained industry is a late model and tighter limits, not a higher API bill.
- **The constraint prevents the classic overbuild at the top of the stack.** You cannot overbuild what you cannot power. Frontier training capacity in the US stays scarce, which is the only condition under which an infrastructure builder has ever kept its margin. Everywhere the constraint does not bind, in inference, in open models, in chips, commoditization proceeds on schedule.
- **Open models do not free up watts.** An open-weight token costs roughly the same joules as a closed one. Under a power constraint they compete for the same scarce energy. They collapse pricing power at the base layer, not compute demand.
- **Training bears the constraint; inference does not.** Serving goes behind the meter, follows cheap power across time zones, or moves offshore. The gigawatt campus is the bottleneck, and it is the frontier's bottleneck alone.
- **The rent goes to the watts.** Utilities with headroom, turbine makers, land with interconnect, anyone who can bring their own generation. That is why Musk wants to own power end to end and why the space story matters to him even if the cost math is off. He is positioning for the world where watts, not chips or models, are the scarce asset.

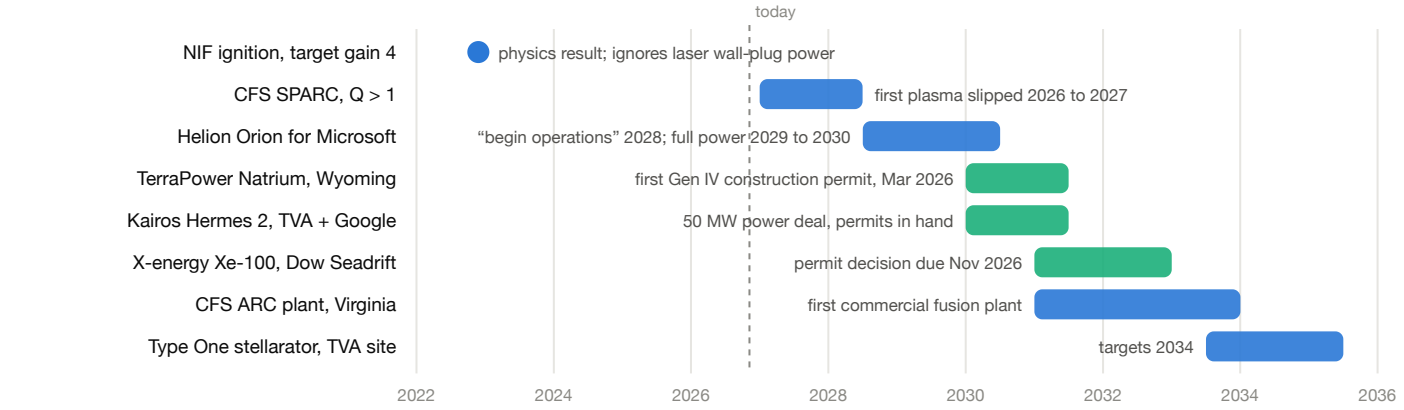
Scenario odds through 2030, with two energy markers



Subjective probabilities. Fusion and orbital compute are the two supply-side stories most often offered as the way out; neither arrives inside the window where the constraint binds.

7 The supply side, and the dark-fiber trade

Fusion is about a year from its first commercially relevant net-energy demonstration and a decade or more from meaningful grid power. Fission is the real near-term breakthrough, moved by permits and hyperscaler money rather than new physics. Solar plus batteries already happened. None of it changes the 2028 to 2030 window.



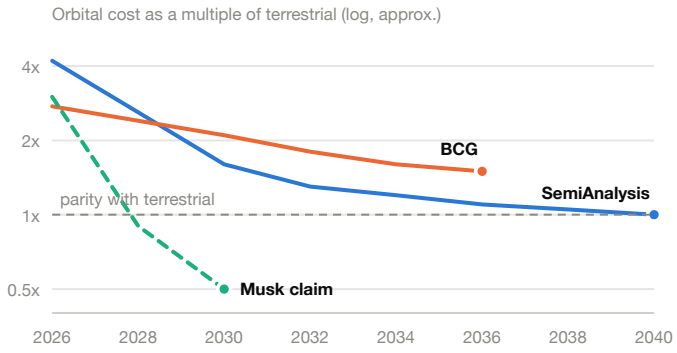
FUSION ODDS

COMPANY	GRID BY ~2035	EVER MATTERS
Commonwealth Fusion Systems	30%	60%
Helion	20%	40%
TAE, Pacific Fusion, Type One	10% each	25 to 30%
Zap, Proxima, General Fusion	≤5% each	10 to 30%

CFS rests on the tokamak physics behind ITER, made small by high-field magnets. Helion has the best economics if it works and has never published a Q value. AI shortens design loops by perhaps 20 to 30% but does not fix magnets, materials or tritium.

MUSK'S SPACE DATA CENTERS

His argument is not that Earth energy fails. It is that terrestrial deployment is capped by grids and politics, orbital solar yields about five times a ground panel, and Starship collapses launch cost. The binding constraint in orbit is cooling, not power, and the economics are a pure launch-cost bet. The story is strongest as a reason a million Starship launches become a necessity, and it was told in an IPO filing.



Approximate readings of published models. SemiAnalysis: more than 4x terrestrial cost in 2026, parity near 2040. BCG: a persistent premium near 1.5x a decade out.

THE DARK-FIBER TRADE

In 2002 Google bought dark fiber for cents on the dollar and built the world's largest private network on other people's bankruptcy. If this cycle follows the script, 2029 produces stranded GPUs at a fraction of cost and, more valuably, powered shells with interconnect that took five years to secure. The second is the asset to want. The chips depreciate in three years. The substation does not.

> **The railroads lost. America won. The question for AI is not whether the network gets built, or whether the output gets cheap, or whether the builders get hurt. History answers all three. The question is who owns the watts and who is designing the Sears catalog.**

Sources. Perez, *Technological Revolutions and Financial Capital* (2002); Historical Statistics of the United States (rail mileage, receiverships, freight rates, electricity); Odlyzko, "The Railway Mania" and "This Time Is Different"; Nordhaus, "Do Real-Output and Real-Wage Measures Capture Reality? The History of Lighting" (1996); David, "The Dynamo and the Computer" (1990); Devine (1983); Jevons, *The Coal Question* (1865); FDIC and TeleGeography on telecom capex and dark fiber; OpenAI list prices and 2026 token price trackers; company 2026 capex guidance; CFS, Axios (Sept 2026) on Helion, FIA 2026 report, LLNL, X-energy filings, SMR Intel; SemiAnalysis and BCG on orbital compute. Historical series are approximate and indexed; probabilities and scenario curves are the author's own.