Mitigating AI Infrastructure Risks

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Introduction

The rapid expansion of artificial intelligence (AI) infrastructure is being heralded as the next industrial revolution, with investments expected to surpass $1 trillion over the next decade (Dell'Oro Group, 2025). From data centers and semiconductor fabrication to power grid enhancements and software development, the scale of capital deployment is unprecedented. However, history has shown that large-scale infrastructure investments are not immune to obsolescence. Technological advancements, regulatory shifts, and market miscalculations can turn once-promising investments into stranded assets.

This article examines the risks associated with AI infrastructure investments, focusing on energy consumption, natural resource constraints, and historical parallels from past industrial buildouts. It explores factors that could lead to infrastructure obsolescence, market misalignment, and the ways that investment strategies may evolve in response to AI's future.

Explosive AI Infrastructure Growth May Pose Investment Risks

The rapid expansion of AI infrastructure represents an unprecedented investment surge. However, in Appendix A, *AI "Stranded Assets?"*, we caution that this aggressive buildout may be a risky bet on existing technological frameworks. Rapid advancements in computing efficiency and emerging alternative models could render significant portions of this investment obsolete. Regulatory shifts and mounting energy constraints could further threaten the long-term viability of AI infrastructure.

Much of this investment is concentrated in hardware, with companies such as NVIDIA, Intel, and AMD driving semiconductor advancements tailored for AI workloads. The global expansion of AI-focused data centers is accelerating, led by cloud providers such as Amazon Web Services, Microsoft Azure, and Google Cloud. The International Energy Agency (IEA, 2024) projects that AI-related electricity demand could increase by 50% by 2030, requiring significant power grid upgrades. Additionally, the Semiconductor Industry Association estimates that over $500 billion will be allocated to new semiconductor manufacturing plants to meet AI's growing processing needs (Spiceworks, 2025). While these investments aim to support AI's transformative potential, they carry the risk of premature obsolescence if technological advancements outpace current infrastructure.

Obstacles to AI's Infrastructure Development

AI computing workloads, particularly large-scale model training and inference, require immense amounts of energy. Training large-scale AI models like GPT-4 requires substantial energy, with estimates suggesting that its electricity consumption could be up to 50 times higher than previous-generation models like GPT-3, which itself used approximately as much electricity as 130 U.S. households in a year (WEF, 2024). If demand continues to escalate, AI-related power consumption could place a significant burden on global electricity grids. By 2030, AI is projected to account for nearly 10% of global electricity usage, up from 4% estimated today, which could strain energy networks and increase operational costs for AI firms (EPRI, 2024). The concentration of AI-driven power demand in technology hubs such as Silicon Valley, Singapore, and Ireland exacerbates this issue, as local grids in these regions struggle to keep pace.

Jodie Gunzberg, CFA, Chairperson of the CFA NJ Group and former board member of the CFA Society in New York and co-author of this article, celebrated CFA Society of NY's Veterans Roundtable by ringing the NASDAQ Stock Market Closing Bell in New York City. Gunzberg is a Managing Partner of InFi Strategies and an Editorial Board member of the *CID*.

To mitigate AI's growing energy footprint, companies like Google and Microsoft have committed to transitioning their AI operations to renewable energy. However, reliance on renewables presents challenges, as wind and solar power depend on weather conditions, leading to fluctuations in availability. AI data centers require consistent uptime, and without adequate energy storage solutions, they may still need to rely on fossil fuel backups. The modernization of power grids is another significant hurdle, as existing infrastructure may not be equipped to handle AI's high-intensity, fluctuating energy demands. The cost of upgrading these grids is substantial, and investments may not align with AI's rapid innovation cycles. Additionally, competition for renewable energy resources among AI firms, manufacturers, and electric vehicle companies could create supply constraints, driving up costs and limiting access for new entrants.

Policymakers and energy providers will need to develop strategies to balance demand and ensure equitable access to sustainable power sources.

Beyond energy concerns, AI infrastructure depends on a fragile global supply chain. Advanced AI chips require minerals that are primarily sourced from a few geopolitical hotspots. Over 50% of the world's cobalt reserves are from the Democratic Republic of Congo (DRC), where mining conditions raise serious ethical concerns, including child labor and environmental degradation (USDOL, 2024; USGS, 2024). Similarly, China dominates the supply chain of the neodymium magnets used in AI infrastructure, including cooling systems and power management units, as highlighted by Paterson (2023) and USDOC (2022). Supply chain disruptions, whether caused by political conflict, export restrictions, or resource depletion, could significantly hinder AI hardware production and investment.

The extraction of these materials carries significant environmental costs. Lithium mining, crucial for AI hardware batteries and energy storage systems, consumes vast amounts of water, depleting already scarce resources in regions such as Argentina, Bolivia, and Chile. In South America's "Lithium Triangle," lithium extraction requires nearly 500,000 gallons of water per ton, leading to land degradation and conflicts with local communities over water rights (IER, 2020). Meanwhile, cobalt sourcing's overreliance on the DRC exposes AI chipmakers to supply shocks and regulatory scrutiny. Diversifying sources and investing in synthetic materials could mitigate these risks.

Geopolitical tensions further complicate AI's supply chain vulnerabilities. The ongoing U.S.-China trade war has led to semiconductor export controls and restrictions on critical materials like gallium and germanium (Lv and Munroe, 2024). In response, the U.S. CHIPS Act and the European Union's semiconductor sovereignty initiatives aim to reduce reliance on Asian manufacturers. However, these efforts require years to materialize, leaving the industry exposed to short-term supply disruptions. Another bottleneck is the high cost and long lead time associated with building semiconductor fabrication plants, which costs about $10 billion and takes three to five years and 6,000 construction workers to complete (Intel, 2023). Companies such as TSMC, Intel, and Samsung are expanding chip production, but shifting technological demands could render existing facilities obsolete before they become profitable. Recent global chip shortages, exacerbated by the COVID-19 pandemic, have further highlighted the fragility of AI hardware supply chains. Without investment in alternative semiconductor technologies like 3D chip stacking and nanomaterials, AI infrastructure could face severe limitations.

Ensuring long-term stability in AI infrastructure will require multipronged solutions, including diversified sourcing of rare earth minerals, stronger regulatory oversight for ethical mining practices, and advancements in semiconductor production. Public and private sector collaborations will be critical in building resilient supply chains that can withstand geopolitical and environmental challenges. Sustainable innovation, energy-efficient AI models, and breakthroughs in alternative energy sources will likely be essential to ensuring the long-term viability of infrastructure investments.

Historical Precedents of Stranded Infrastructure

History is filled with examples of large-scale infrastructure investments that became obsolete due to technological advancements, regulatory changes, or shifting market dynamics. These cases offer valuable lessons for AI infrastructure investments, which could face similar risks in the future.

In the 1970s, nuclear power was widely believed to be the future of global energy, prompting significant government and private sector investments in nuclear plants with the expectation of delivering cheap, abundant electricity. However, safety concerns, cost overruns, and increasing regulatory restrictions led to the premature abandonment of many projects. High-profile incidents such as the Three Mile Island disaster in 1979 and the Chernobyl explosion in 1986 heightened public opposition, causing many countries to scale back or phase out nuclear energy altogether, justifiably or not (NRC, 2022; Ahearne, 1987). At the same time, advancements in natural gas extraction, particularly through hydraulic fracturing (fracking), provided a cheaper and more flexible energy alternative, further diminishing the economic viability of nuclear plants until very recently.

The late 1990s saw a similar miscalculation with the overbuilding of fiber-optic networks during the dot-com boom. Telecom companies, anticipating explosive internet growth, laid thousands of miles of fiber-optic cables, expecting surging demand for broadband connectivity. However, demand failed to materialize at the expected rate, leaving much of the installed infrastructure unused and resulting in a glut of "dark fiber" that took years to become profitable (Hecht, 2016). A comparable risk exists for AI infrastructure today, as data centers and semiconductor fabrication plants are being constructed at an unprecedented pace without clear long-term demand projections.

A parallel can also be drawn to the U.S. railroad boom of the late 19th century, which was driven by government incentives and speculation. Many companies built redundant or poorly planned rail networks, leading to financial collapses when demand failed to meet expectations. The Panic of 1873 and the wave of railroad bankruptcies that followed underscored the dangers of infrastructure overinvestment without proper demand forecasting, as speculative expansion in railroads outpaced economic viability (Fogel, 1964; PBS, 2025). AI infrastructure investments, particularly in data centers and specialized AI chips, could face a similar fate if technological advancements render current approaches obsolete.

More recently, the overinvestment in coal-fired power plants in the early 2000s highlights how rapid technological and regulatory shifts can quickly change the viability of major energy investments. Governments and utilities worldwide invested billions in new coal plants, believing them essential for long-term energy security. However, advancements in renewable energy and tightening regulations on carbon emissions made many coal plants financially unviable. In the U.S., nearly 50% of the coal plants operating in 2010 have since been shut down or converted to natural gas, often well before their intended economic lifespan due to competition from cheaper and cleaner energy sources (EIA, 2019). This serves as a reminder of how quickly market conditions and regulatory policies can shift, rendering once-essential infrastructure obsolete.

These historical examples illustrate the risks of overinvestment in static infrastructure that fails to adapt to evolving technological or regulatory landscapes. With AI infrastructure requiring heavy investment in energy-intensive data centers and specialized semiconductors, flexibility and adaptability must remain central considerations. Policymakers, investors, and industry leaders must ensure that AI infrastructure investments align with shifting market trends and technological innovations to mitigate the risk of stranded assets.

Managing the Risks of AI Infrastructure Investments

AI infrastructure investments designed for adaptability may mitigate risks. One approach is to focus on scalability by developing modular data centers and edge computing architectures that reduce the risk of overinvestment in centralized hubs. Flexible infrastructure allows for incremental scaling rather than large, inflexible capital expenditures. Emerging trends in decentralized computing and federated learning could decrease reliance on large centralized facilities, minimizing the risk of stranded assets. Additionally, hybrid cloud strategies that balance on-premises, edge, and cloud computing resources can optimize cost and efficiency (Sakata, *et al*. 2024; Eriksvik, 2024).

Prioritizing energy efficiency is another key strategy in mitigating risks. AI firms can reduce power consumption by leveraging energy-efficient computing solutions such as photonic chips and neuromorphic processors. Optimizing AI model architectures through techniques like sparsity and low-power processing units can significantly lower energy demand. Governments and industry leaders are also exploring advanced cooling technologies, such as liquid and immersion cooling, to further optimize AI infrastructure. Policy incentives and carbon offset mechanisms could encourage firms to adopt greener computing solutions. Research suggests that improving energy efficiency across the AI model development cycle can substantially reduce carbon impact (Wu *et al*., 2024).

A diversified investment strategy can also help hedge against infrastructure obsolescence. While current AI models rely heavily on classical computing architectures, advancements in quantum computing, optical processing, and next-generation semiconductor technologies could disrupt the industry. Investing in a broader portfolio that includes these emerging technologies can mitigate risks associated with overreliance on current AI infrastructure models. Additionally, investments in complementary sectors such as sustainable energy and advanced materials provide further protection against infrastructure stagnation. Major firms like BlackRock and Microsoft have launched multi-billion-dollar funds focused on AI infrastructure, including data centers and energy projects, signaling a shift toward diversified AI investment strategies (Masters, 2024).

Conclusion

AI infrastructure investment represents a major economic shift, akin to past industrial revolutions. However, history shows the dangers of overinvestment in static technologies. By ensuring AI infrastructure is adaptable, sustainable, and responsive to technological advancements, investors and policymakers can mitigate the risk of stranded assets.

Mitigating AI Infrastructure Risks

The lessons from past industrial and technological transformations highlight the need for cautious optimism. While AI offers immense opportunities, the pace of innovation means that investments made today could become obsolete faster than anticipated. The financial consequences of misaligned investment strategies could be severe, impacting not only corporations but also broader market stability.

Furthermore, the global nature of AI development necessitates a coordinated approach between governments, industry leaders, and investors. Policymakers must strike a balance between fostering AI innovation and implementing regulations that prevent unsustainable energy consumption and environmental degradation. Collaboration between public and private entities will be essential to creating a resilient AI infrastructure that benefits society without leading to unnecessary economic losses.

Ultimately, those investing in AI infrastructure must remain flexible, embracing a forward-looking approach that incorporates the potential for new breakthroughs and shifts in market dynamics. By learning from past infrastructure investment missteps, stakeholders can navigate this new era of AI-driven transformation while minimizing the risks of stranded assets.

Appendix A: AI "Stranded Assets"?

Another Industrial Revolution

The consequences of the latest generation of Artificial Intelligence (AI) algorithms are undoubtedly staggering. We have arguably entered "a new era, just like Gutenberg's press and the invention of the steam engine revolutionized their respective eras," quoting Manthos (2022) on powerful technologies. The software architecture underpinning large language models (LLMs) is astonishingly efficient in effectively storing *all* manner of concepts that are accessible from the corpus of the internet. More technically, LLMs use "optimization algorithms … that iteratively adjust model parameters … in a way that brings the model's predictions closer to the original text [so that] the model 'learns' the linguistic patterns in its training data (and, by extension, the 'knowledge' conveyed in those linguistic patterns)," as explained by Bergmann (2024). These explanations summarize the significance of the current generation of AI models by emphasizing *what they effectively do*. Essentially, we are on the cusp of another Industrial Revolution where this time, instead of a skilled craftsman's work being mechanized, a large fraction of a knowledge worker's tasks will be automated.

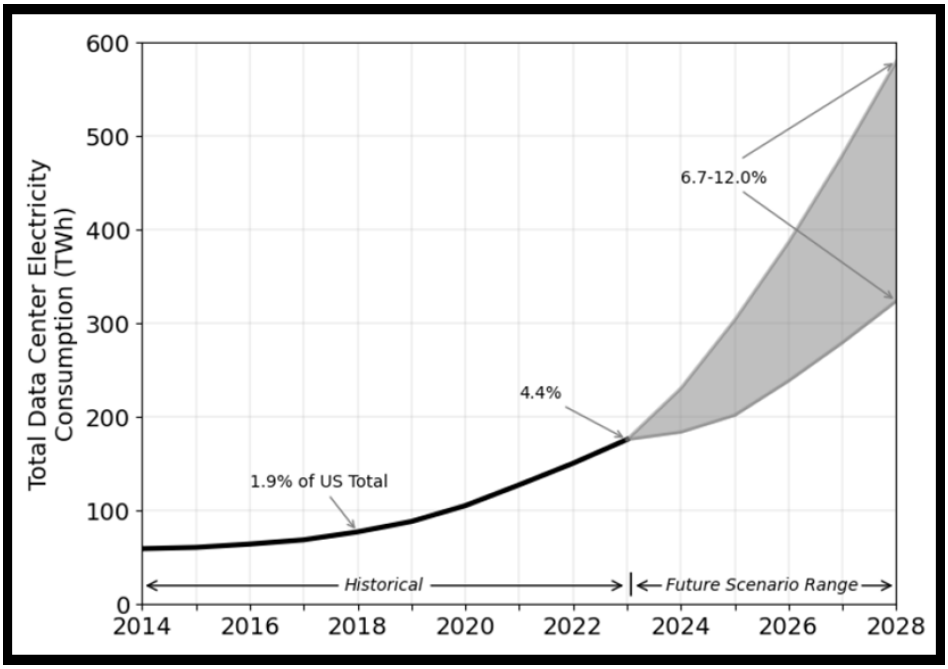
Hilary Till (LHS of photo), co-author of this article, moderated a panel discussion on "AI/ML in Finance – Shaping the Future of Financial Markets" at the London School of Economics (LSE) in an event co-sponsored by the LSE Data Science Institute and the International Association for Quantitative Finance (IAQF). The event took place on June 24, 2025. To Till's right are (L-to-R): Johannes Muhle-Karbe, Ph.D. (Imperial College London), Peter Hafez (RavenPack/BigData.com), Giovanni Beliossi (Axyon AI), and Petter Kolm, Ph.D. (New York University).

Huge and Costly AI Infrastructure Buildout

The consensus belief on how a company could stay on the cutting edge of AI was summarized in a memo by Karpathy (2018). He noted: "… progress in AI is primarily driven by systems – compute, data, infrastructure. The core algorithms we use today have remained largely unchanged ..." While allowing for

the possibility of improvements, the AI researcher later observed in Karpathy (2024) that since 2017, the current models have "proven remarkably resilient." Hence, the focus (for now) has been on a huge AI infrastructure buildout, which would cost *over $1-trillion* in the next several years alone and which would include spending on chips, data centers, the power grid, and other AI infrastructure, according to Covello (2024) and Nathan (2024). Relatedly, see Figure A-1 on the expected increase in U.S. data center electricity usage through 2028, "owing to the rapid emergence of AI hardware," as discussed in Shehabi *et al.* (2024).

Figure A-1
Total U.S. Data Center Electricity Use from 2014 through 2028



Source: Shehabi *et al.* (2024), Figure ES-1.

A Bet *Against* Innovation

One trillion dollars is a surprisingly large bet on there *not* being sufficient innovation in underlying AI principles, algorithms, and computer chips, and instead relying on enormous infrastructure expenditures. For example, Li (2023) compared current AI models to the field of physics before "Newton … started to write very simple laws in physics." As well, Liebreich (2024) predicted that the computer-chip "sector is moving so fast that there are almost certainly innovations … that could make AI compute dramatically more energy efficient."

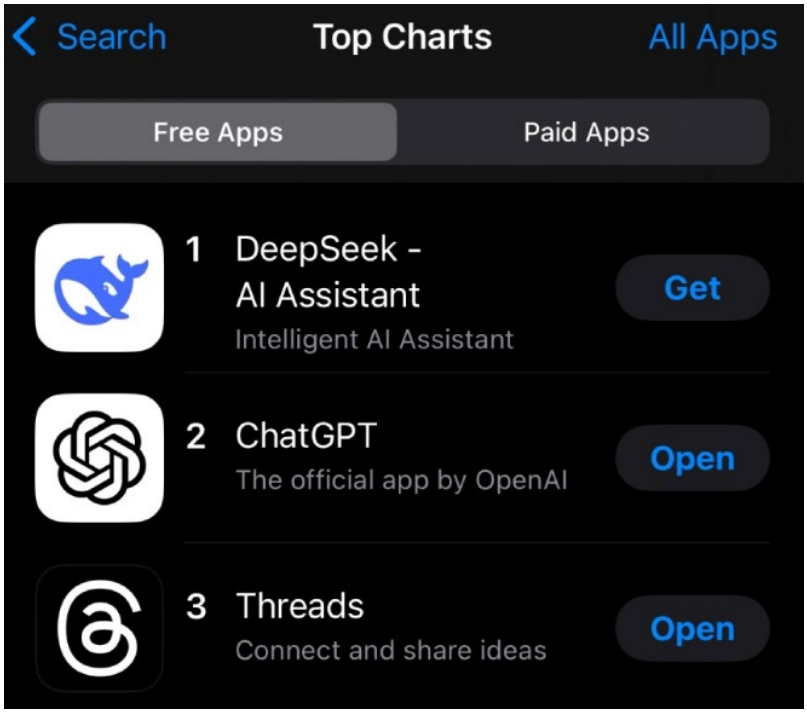
At some point, if there were sufficient breakthroughs, it is questionable whether the huge level of AI infrastructure investment would be needed. Angelo Sabatelle, who manages Moody's project finance team for the Americas, told Shi (2024): "You can't close your eyes to the fact that technology changes

quickly." Further, Covello (2024) warned: "[o]ver-building things the world doesn't have use for … typically ends badly."

Current Developments

Confirming the speed of innovation, the Chinese lab, DeepSeek-AI, has already created an open-source large language model whose "total training costs" were less than $6 million ("excluding the costs associated with prior research" and experimentation), according to DeepSeek-AI (2024). The Chinese lab's model outperforms other models "in accuracy ranging from complex problem-solving to math and coding," wrote Wu and Bosa (2025). In addition, DeepSeek relies on "inference-time computing [which means] they activate only the most relevant portions of their model for each query, and that saves money and computation power," explained Giuseppe Sette, President at AI market research firm Reflexivity, in Picchi (2025). These new developments, concluded Wu and Bosa (2025), have "called into question big tech's massive spend on building AI models and data centers," particularly as the market quickly endorsed DeepSeek-AI's efforts, as shown in Figure A-2. Responding to the launch of DeepSeek's models, the International Energy Agency questioned the power demands of AI, according to Moore *et al.* (2025).

Figure A-2
Top Charts in the Apple App Store for the iPhone on January 28, 2025



Source: Apple App Store.

Stranded Assets

These events remind us of a constant lesson in economic history, dating back to the nineteenth century. For example, we can look to the 1830s and 1840s when investors speculated on the building of a crucial canal that ultimately linked productive Illinois farmland to major population centers. The canal was successfully completed in 1848, by which time it was already on its way to becoming obsolete because of the opening of railways (Till, 2014). In other words, the canal essentially became a *stranded asset* by the time it was built.

Will this historical lesson be repeated?

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Recently, Gunzberg was the Head of Strategic Partnerships at Cboe Global Markets, where she developed strategic partnerships and managed key commercial relationships to drive growth. She crafted policies and strategies for multi-party arrangements, expanded into new business lines, and established global fund issuer services. She was also on the Investment Committee overseeing Cboe's employee benefit plans.

Before Cboe, Jodie Gunzberg was a Managing Director at CoinDesk Indices, directing index product management and strategy, and serving as the company's public spokesperson. She defined digital asset industries, shaped index offerings, and created groundbreaking products for 401(k) plans and financial advisors.

Previously, Gunzberg was the Chief Institutional Investment Strategist at Morgan Stanley, leading the Graystone Investment Office. She developed institutional model portfolios and provided thought leadership for ultra-high-net-worth individuals, pensions, endowments, and foundations, managing assets totaling approximately $400 billion.

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Gunzberg is a CFA charterholder and a member of the CFA Institute's Education Advisory Committee. She previously served on the Boards of CFA NY and CFA Chicago, and founded the CFA New Jersey Group of CFA NY. Currently, she is on the Advisory Board of Hofstra University's Department of Finance. She is also an Editorial Board Member of the *Commodity Insights Digest*, a publication of Bayes Business School, City St George's, University of London, U.K., and she earned her M.B.A. from the University of Chicago Booth School of Business and a B.S. in Mathematics from Emory University.

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Relevant to this article, Till has additionally lectured to members of the Chinese futures industry on the lessons of American economic history, given the early developmental experiences in the city of Chicago and the state of Illinois. She provided these lectures on behalf of the Chicago Institute of Investment.

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