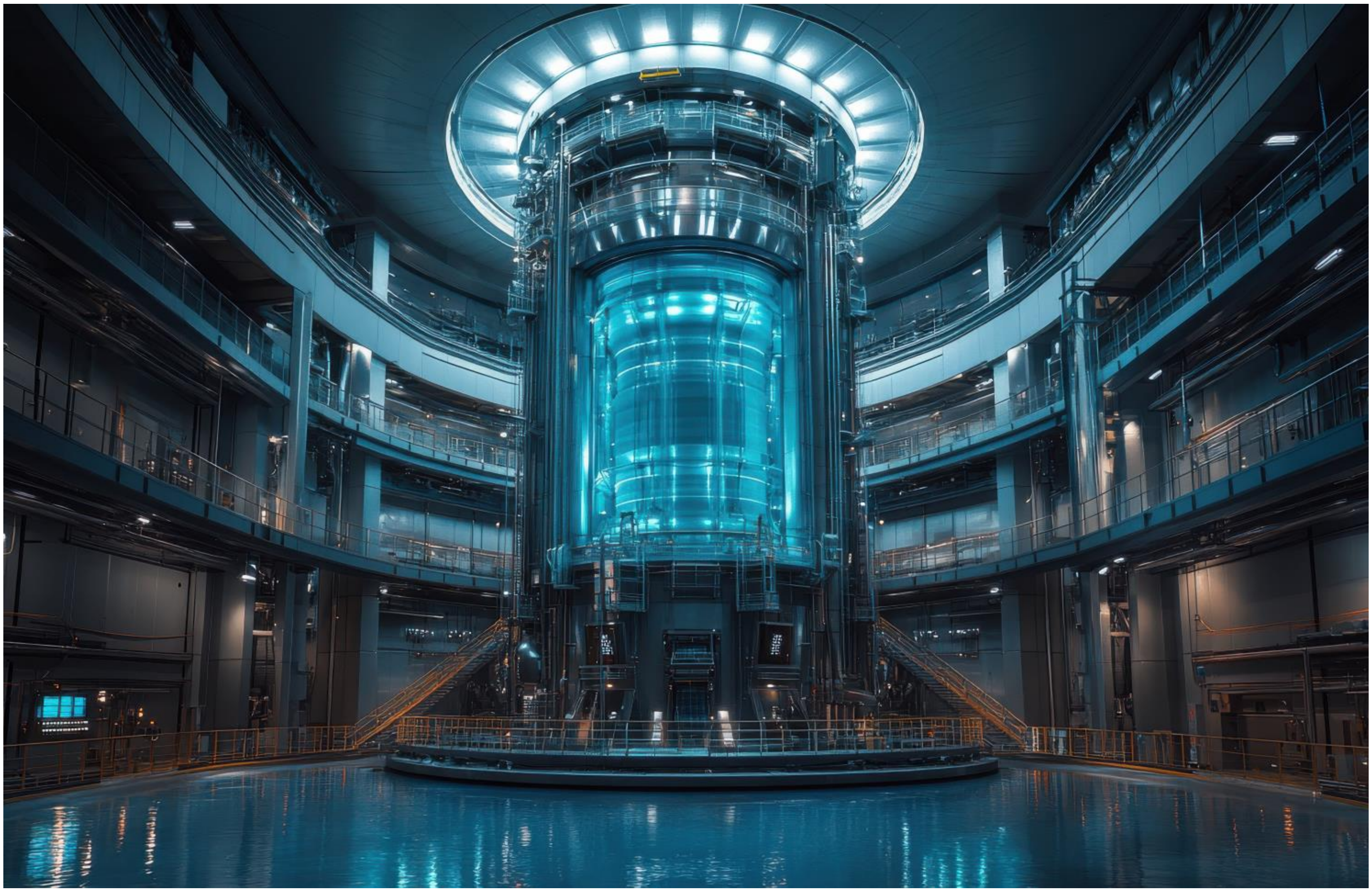
Goldman Sachs Global Institute

# The New Nuclear Age: Why the World Is Rethinking Atomic Power




Goldman Sachs Global Institute

**George Lee,** Co-Head, Goldman Sachs Global Institute
**Dejana Saric**, Associate, Goldman Sachs Global Institute
**Misha Sohan**, Associate, Goldman Sachs Global Institute


September 2025

## Executive Summary

Throughout history, the commercialization of new forms of energy has given rise to fossil fuel conglomerates and renewable energy enterprises, powered energy-intensive technologies, and created new global investment opportunities. As countries now race to secure the massive amounts of energy needed for leadership in artificial intelligence, nuclear energy is newly positioned to meet the moment.

When nuclear power initially rose to prominence during the Cold War, it became a defining feature of the era, symbolizing both existential threat and scientific triumph. In the decades after the Second World War, countries raced to develop civilian nuclear programs, lured by the promise of energy too cheap to meter. But after accidents like Three Mile Island, Chernobyl, and Fukushima, the momentum behind nuclear energy stalled. Public opposition surged, regulatory burdens grew, and innovation slowed. Today, nuclear energy makes up just 9% of the global electricity mix, down from approximately 18% in the late 1990s.

After decades of underinvestment, a convergence of generational technological breakthroughs, intensifying geopolitical competition, and the need for clean, dense, reliable power are positioning nuclear energy for a renaissance.

But the next nuclear age will look different from the last. While nuclear energy is typically associated with nuclear fission on account of its commercialization decades ago, there are actually two distinct forms of nuclear energy that exist, fission and fusion. Innovations in fission like small modular reactors (SMRs) are shaping what the revival of traditional nuclear fission could look like. Separately, the advent of fusion energy represents a technological breakthrough that could revolutionize how energy is generated, with the potential to disrupt global energy markets. Taken together, these innovations in fission and fusion could change not just how nuclear power is produced, but how nations compete, cooperate, and secure their energy futures.

The commercial opportunities are far-reaching: as public and private sector investment flows into nuclear technology companies, investments will likewise be needed in the broader nuclear supply chain. Globally, countries that master advanced nuclear technologies will gain not only energy security but also longstanding commercial relationships, soft power, and the ability to shape global norms. Capturing this opportunity will require increased investment, as well as new regulatory frameworks and forms of government support.

In the United States, President Trump's promise to quadruple nuclear power generation by 2050 may be the starting gun for a race to reassert American leadership in nuclear power. But in doing so, US policymakers and corporate leaders must contend with a domestic industry that has become less competitive compared to that of countries like China and Russia. This paper examines the current landscape of nuclear energy, what comes next, and what it means for countries around the world.

## AI Infrastructure Boosts Nuclear Energy Demand

Before the rise of AI with the launch of ChatGPT in 2022, global electricity demand was already expected to grow significantly due to population growth, the economic growth and urbanization of emerging economies, and the electrification of sectors like transportation. Now, AI is driving an even greater surge in demand. Current estimates forecast global electricity demand to nearly double by 2050.

Data center power demand is projected to rise by as much as 165% by 2030, bringing global data center capacity to about 137 GW—roughly 60% of which will need to be met with new generation capacity, according to Goldman Sachs Research. While hyperscalers are largely turning to natural gas to meet current demand since the infrastructure is already in place, the overarching need to secure firm, dispatchable power has opened the door to creative solutions. The desire to keep carbon emissions in check–a long-term consideration for many large tech companies with net zero pledges–has also underlined the need to develop sustainable power sources, while avoiding the intermittency issues of wind and solar.

Taken together, the result is a renewed interest in nuclear power from both policymakers and business leaders. After years of virtually stagnant growth, global investment in nuclear power generation grew at a CAGR of 14% between 2020-2024. That growth is only set to accelerate. At COP28, 25 countries pledged to triple nuclear energy capacity by 2050. Since then, that number has grown to 31, and large financial institutions and major energy users (including Amazon, Google, and Meta) have joined that pledge.

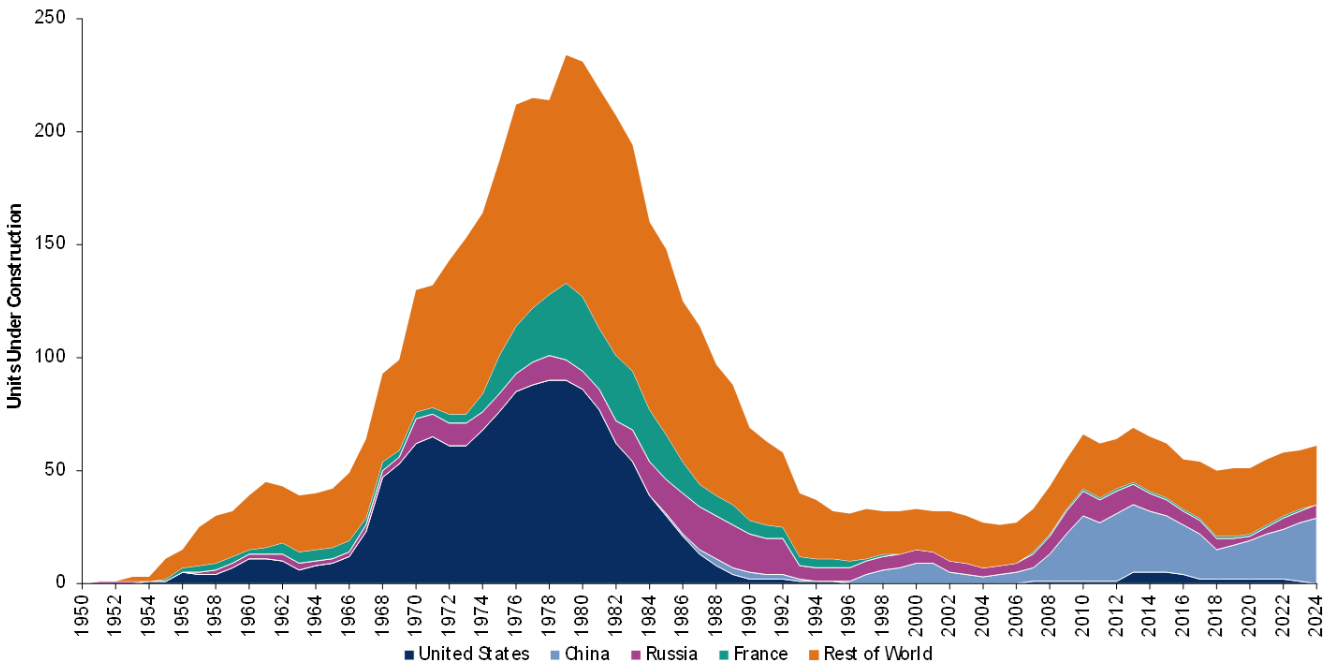
In fact, hyperscalers have been a key driver of renewed investment, particularly in the United States, as demonstrated by Microsoft's 835MW power-purchase agreement (PPA) to restart the Three Mile Island nuclear fission power plant, and Meta's 20-year PPA with the Clinton fission plant in Illinois, both of which were done with Constellation Energy. Amazon has also signed a PPA with Talen Energy Corporation for almost 2GW of nuclear electricity to power its AI and cloud data centers in Pennsylvania. The large-scale nature of nuclear fission plants—most plants are 1GW or greater—makes them a particularly appealing solution for meeting the energy demands of large-load power consumers, like AI data centers.

But hyperscalers have also helped lead investment in the commercialization of next-generation nuclear power, namely small modular reactors (SMRs) and fusion energy. These technologies, long brushed off as too-far from commercialization, are now drawing significant public and private sector support.

## Rising Power Demand Brings Nuclear Fission Back to the Foreground

Scientists working for the Manhattan Project in the 1940s first harnessed nuclear fission, the process of splitting heavy atomic nuclei to release massive amounts of energy, during World War II. By the 1960s, countries began to invest heavily in nuclear power generation. The general sense of energy insecurity felt throughout the Cold War helped propel investment—in the decade after the 1973 Oil Embargo, construction started on approximately 170GW of nuclear capacity.

Nuclear Reactors Under Construction



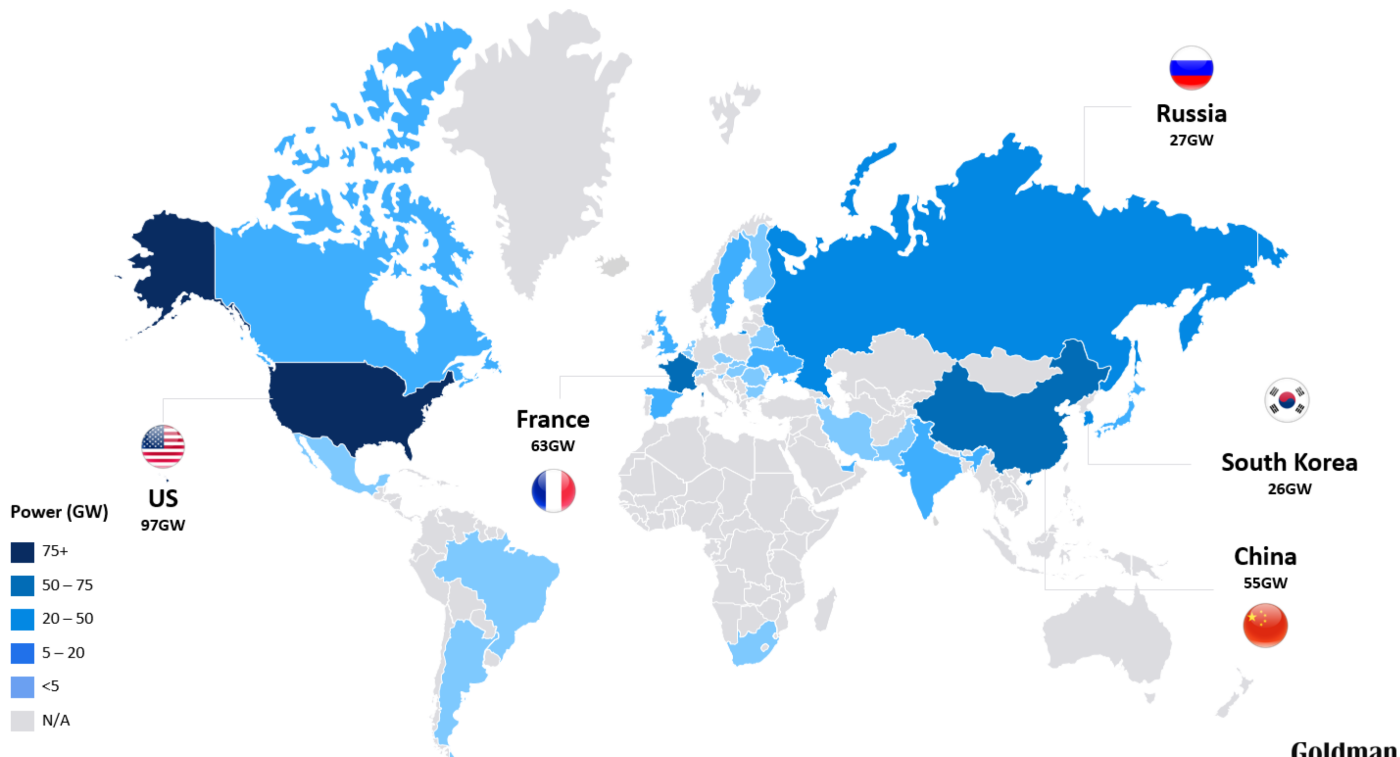

*Source: World Nuclear Industry Status Report as of 2024*

Goldman Sachs

During this period, the United States became the world's greatest generator of nuclear power. In the 40 years between 1957-1997, US nuclear generation capacity grew from roughly 55MW to 100GW (an increase of 1,817x). Other advanced economies likewise invested in building up nuclear capacity during this period. However, successive nuclear incidents, from Chernobyl to Fukushima, changed attitudes towards nuclear energy in many countries, leading to decades of underinvestment.

Today, the average age of reactors in advanced economies is roughly 36 years, and lifetime extensions for old plants now account for approximately 10% of the global fleet. Although the United States still leads the world in terms of installed nuclear capacity, the current operating licenses of most US reactors are due to expire in the 2030s.

Global Nuclear Power Generation Capacity (GW)

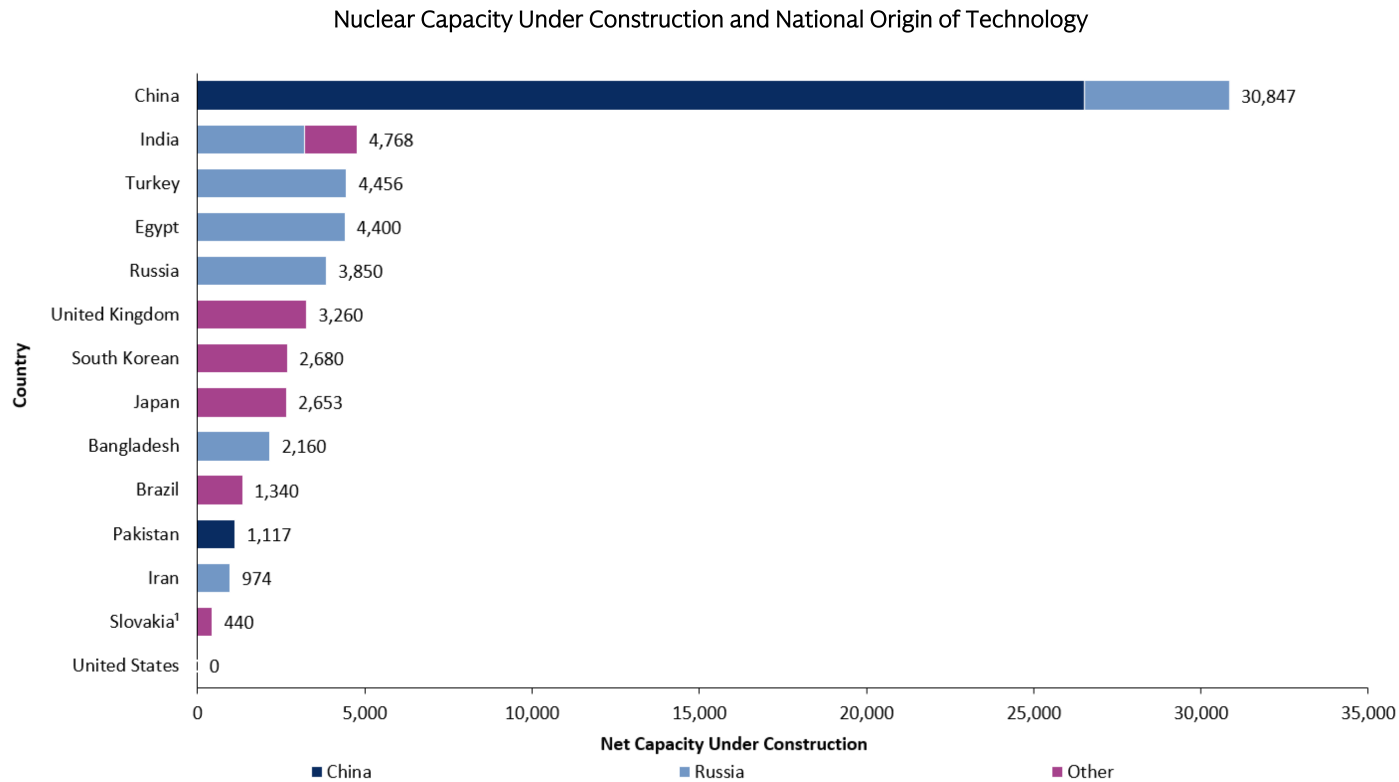



Source: IAEA PRIS database as of July 2025

As the United States and other advanced economies pulled back from investments, China and Russia came to dominate nuclear power. All but four of the nuclear reactors that began construction between 2017 and 2024 are of Russian or Chinese design, and almost half (29 out of 63) of the reactors currently under construction are being built in China. Perhaps most importantly, both countries have leveraged the strength of their domestic industries to export and finance the construction of nuclear fission reactors abroad, cementing decades-long commercial ties with recipient countries.

China, the main competitor to US innovation and development in AI, is now the most prolific investor in nuclear energy in the world. At its current pace, China is on track to leapfrog the United States and become the world's largest nuclear energy generator by 2030, with the ultimate goal of reaching 200GW of nuclear power capacity by 2040.

Russia has focused less on domestic buildup and more on international influence. Russia's state-backed Rosatom State Atomic Energy Corporation is currently building 19 reactors around the world, with an international order book of more than $200 billion and export revenues of $18 billion in 2024 (the US order book, in contrast, was zero). Part of what has made Rosatom so effective is the fact that this singular company can offer customers services for the entire lifespan of a nuclear power plant, from the nuclear reactor technology, plant construction, fuel, operational capabilities, maintenance, decommissioning, and fuel cycle management—not to mention generous debt and equity financing from the Russian state. In 2023, Rosatom inaugurated the $20 billion Akkuyu Nuclear plant in Turkey, a project that was largely financed by Russia, built by Russians, and will be operated by Rosatom for decades to come.




*Source: IAEA PRIS database and World Nuclear Industry Status Report*
*1. Delineates Russian reactor design*

Some advanced economies may face greater challenges in scaling up nuclear power in the future. While countries like France and South Korea have built up strong nuclear sectors that have helped them become leaders in nuclear development, others, like the United States, have allowed their domestic nuclear industry and supply chains to erode. The current shortfall in talent presents a key constraint – estimates state that the present US-based nuclear workforce would need to triple to meet 2050 nuclear energy demand. However, the total number of graduates in nuclear engineering in 2022 fell to 929, a 20% drop from peak 2015 levels.

Diminished industry know-how, supply chain disruptions, and regulatory hurdles manifest in longer construction timelines and cost overruns. In the United States, the last two domestic reactors built at Georgia's Plant Vogtle took about 15 years to complete and cost more than $35 billion (more than double initial projections of $14 billion). In comparison, China's average construction time for large reactors is just seven years, while Russia's is estimated at around eight. Building nuclear plants in the United States faster will require not only efforts to streamline regulations but also leaning on technological advantages—as demonstrated by the Nuclear Company's recent $100 million deal with Palantir to develop AI software for the nuclear industry, with the aim of building plants faster, cheaper, and safer. Westinghouse Electric Company also recently announced a collaboration with Google Cloud AI, leveraging their AI tools to accelerate the construction of new Westinghouse nuclear reactors and optimize the performance of existing facilities.

## The Geopolitics of the Nuclear Supply Chain

Changing investment pattens have also led to a more concentrated nuclear fuel supply chain, raising the risks of supply chain disruptions even as interest in nuclear power picks up. This supply chain starts with the mining of uranium, which is then milled into uranium concentrate (commonly referred to as yellowcake), converted into gaseous form, enriched to 3-5% to create Low-Enriched Uranium (LEU) fuel, and finally turned into fuel pellets.

The United States has largely lost the nuclear supply chain expertise that once made it a leader in setting safety and nonproliferation standards. During the Cold War, the United States was amongst the world's leading uranium producers, extracting 20 to 45 million pounds annually. By 2023, this figure had plummeted to just 50,000 pounds. The country has a singular uranium conversion facility remaining. And while the United States used to be the world's greatest producer of enriched uranium, today it has just 8% of global uranium enrichment capacity, from a foreign-owned plant operating in the United States.

Other countries have stepped in to fill the gaps. Today, Kazakhstan is the world's greatest producer of uranium ore (43%) and yellowcake (39%), most of which it sells to its neighbors, Russia and China. Canada, currently the world's second-largest uranium producer—though it produces less than half of Kazakhstan's output—is ramping up domestic production as it aims to overtake Kazakhstan. Downstream the supply chain, Russian and Chinese state-backed or state-owned enterprises control roughly 40% of global uranium conversion capacity and approximately 63% of global uranium enrichment capacity.

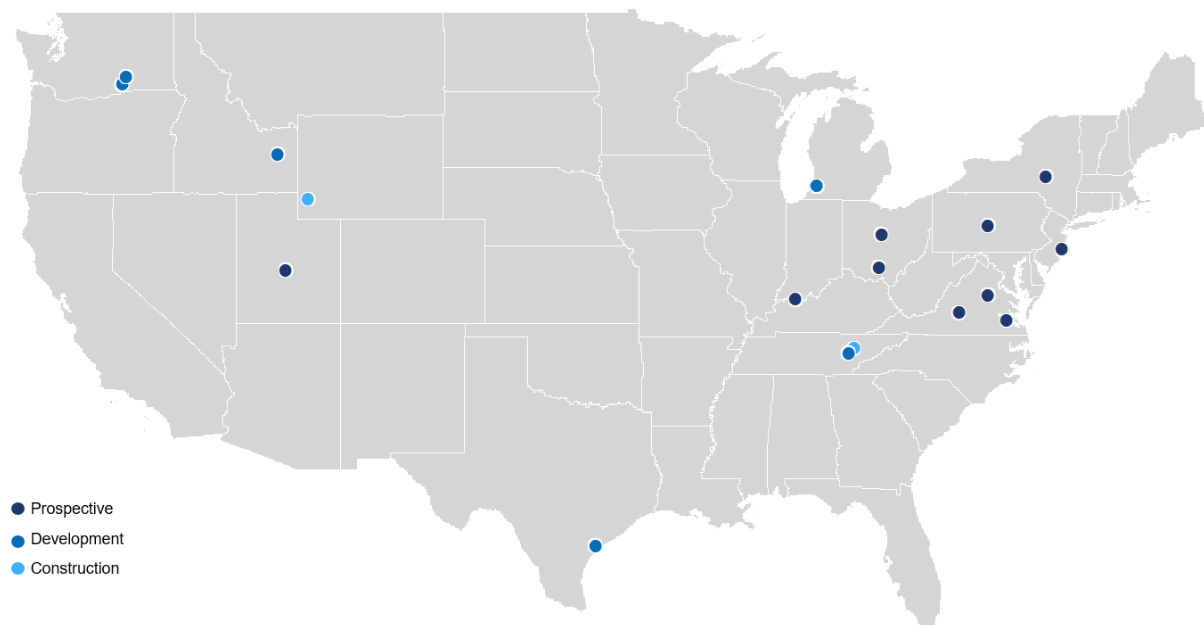
Due to its own lack of capacity, the United States now imports 72% of the enriched uranium it uses. Since Russia's invasion of Ukraine, a combination of US import restrictions, Russian export restrictions, and growing demand have pushed prices for converted and enriched uranium to record highs and raised the prospect of a supply crunch for western utilities in the coming years. Looking to the future, new production from Canada could offer the United States and others a stable source of uranium, shoring up supply chain security.

## Small Modular Reactors Are the Next Step for Nuclear Fission

The Trump administration has made nuclear energy a key aspect of its energy dominance agenda. In May 2025, President Trump signed four executive orders aimed at easing regulations to speed up the deployment of nuclear energy and strengthening the domestic nuclear industrial base. Some of the administration's most ambitious goals center on nuclear fission, which the President aims to quadruple, with concrete targets including facilitating 5GW of power uprates to existing reactors and commencing construction on at least 10 new large fission reactors by 2030.

But the Trump administration is also championing next-generation advanced reactors, principally Small Modular Reactors (SMRs), as foundational to its pursuit of both energy security and technological leadership in AI. SMRs use the same fission reaction as traditional nuclear plants but utilize different reactor designs for a smaller footprint and better safety features. With only three operational SMRs in the world (in Russia, China, and Japan), SMRs are still several years away from commercializing at scale. However, investor interest has been growing, driven by the conviction that nuclear energy will be crucial to powering ambitions in AI.

SMR Development in the United States




*Source: CSIS Advanced Nuclear Deployment Dashboard, World Nuclear Association, NucNet*
*Exact development locations in New York, Ohio, Utah, and Pennsylvania are not yet determined.*

Goldman Sachs

Some of the Trump administration's policy support is specifically geared at fostering faster commercialization of SMRs. In addition to the incentives that apply to traditional nuclear fission, the administration has ordered the deployment of an SMR at a Department of Energy facility by November 2027 and at a military base by September 2028. In having the government take on the regulatory and technical risks associated with early deployments, the administration can help provide real-world validation of the technology that facilitates further investments. Jumpstarting deployment can also help create demand for parts of the nuclear fuel supply chain that have been underinvested in.

The advantages of SMRs are revealed in their nomenclature. SMRs are significantly smaller than nuclear fission plants, with the largest SMRs around 300MW. They are also modular: unlike giant fission reactors, SMR components can be mass produced in factories and then assembled on site. In theory, this should make SMRs cheaper and faster to build than traditional fission plants, translating to less risk and easier financing. Their smaller size also means siting is more flexible, which could make them easier to deploy for behind-the-meter or off-grid loads, including potentially AI data centers. Most SMRs are also advanced reactors, meaning they use innovative technologies to replace the light-water cooling used in traditional fission reactors. Finally, many (but not all) SMR designs use a different type of nuclear fuel called High-Assay Low-Enriched Uranium (HALEU). HALEU fuel uses uranium that is enriched between 5-20%, higher than the LEU that fission reactors use. Higher enrichment translates to higher efficiency, meaning plants can run for significantly longer before refueling is needed.

As with most new technologies, commercialization is not without its challenges. Goldman Sachs Research estimates that the levelized cost of energy (LCOE) for SMRs is likely to be cheaper than that for gas-powered or coal generation once the technology hits a steady state, but estimating construction costs for nascent technology is inherently difficult. Both Russia and China's operational SMRs experienced cost overruns of 300-400% over initial estimates, and this is likely to be typical until economies of scale develop.

The supply chain for HALEU is another threat to the commercialization of SMRs in the United States. Today, Rosatom's subsidiary Tenex is the only commercial producer of HALEU in the world. Uncertainty over the availability of HALEU has held back some companies from committing to their reactor designs, which in turn impedes investment in domestic HALEU production. US attempts to ramp up domestic supplies began in 2019, when the Department of Energy awarded Centrus Energy Corporation a contract to begin enriching HALEU with government-owned assets. Today, all domestic HALEU production is controlled by the Department of Energy, which can then award part of its stockpiles to advanced nuclear companies. Fostering a fulsome domestic industry will eventually require investments in specialized facilities for commercial production, given the higher risks associated with higher enrichment.

## The Next Wave: Fusion Could Revolutionize Nuclear Energy

Beyond fission, the Trump administration has also indicated interest in another advanced form of nuclear energy—fusion. The Department of Energy 's secretarial order designed to "unleash the golden era of American energy dominance," included increasing R&D support for fusion energy. The administration's One Big Beautiful Bill has preserved the Inflation Reduction Act's "technology-neutral" production and investment tax credits for nuclear power (with tighter Foreign Entity of Concern Provisions) and added a nuclear energy bonus tax credit for advanced nuclear facilities.

Though also a form of energy derived from the nuclei of atoms, fusion is drastically different from fission and circumvents the historical concerns that fission faces. While nuclear fission involves *splitting* atomic nuclei, fusion is the reaction in which two light atomic nuclei instead *combine* to form a single heavier one, which releases massive amounts of energy–the same process that occurs in the sun. Fusion produces four times more energy per unit of mass than fission, and *nearly four million* times more energy than oil or coal. Harnessing a fusion reaction on earth requires stabilizing an ionized gas called plasma at extreme pressures and temperatures of over 100 million degrees Celsius. Unlike with nuclear fission, the difficulty of maintaining these conditions means there is no risk of a runaway chain reaction or meltdown risk, because any disruption to these conditions stops the fusion reaction. And unlike the enriched uranium used to power fission, most of the fuels used in fusion are far less radioactive, or not radioactive at all, and cannot be weaponized. These attributes insulate fusion energy from some of the risks associated with fusion. As such, the US Nuclear Regulatory Commission has declared it will regulate fusion energy under the same regulatory regime as particle accelerators, rather than under the stricter regime that covers nuclear fission.

Despite these advantages, fusion technology isn't quite here yet. There are several technological and engineering challenges that need to be overcome before fusion energy is commercialized: maintaining plasma stability at high temperatures; developing materials for the reactor that can withstand the heat and potential radiation of the fusion reaction; reducing fusion's LCOE; and, depending on the fuel type used, managing the fuel cycle. Fusion companies are approaching these challenges in different ways, with growing conviction that the 2030s will be a definitive decade for the commercialization of fusion energy.

## Fusion is Steadily Progressing Towards Commercial Energy Production

There has been a huge acceleration in progress over the last three years. In 2022, US scientists at Lawrence Livermore National Laboratory (LLNL) first achieved "ignition," generating more energy from a fusion reaction than was put in and providing scientific evidence that fusion energy on earth is possible. Scientists are learning how to stabilize plasma for longer: in February of this year, the WEST reactor in France set a plasma duration record of over 22 minutes, smashing the record set by the East reactor in China just a month earlier of over 17 minutes. And researchers are using AI to enhance fusion simulations to better predict plasma behavior and optimize reactor designs, which could further speed up progress.

As the prospect of fusion energy on the grid becomes tangible for the first time, fusion companies are setting their sights on commercialization. Like SMR companies, today fusion companies are laying the groundwork for commercial expansion even as they work towards hitting key milestones. In 2023, Microsoft signed a 50MW PPA with US-based private fusion company Helion, marking the first-ever commercial fusion contract. Helion expects the plant to be online by 2028. In 2025, Google signed a 200MW PPA and Eni signed a 400MW PPA with Commonwealth Fusion Systems (CFS), another US-based private fusion company that expects that their inaugural power plant will generate electricity by the early 2030s.

There are three main approaches being pursued in the race for fusion energy:

- Magnetic confinement, which uses strong magnetic fields created by high-temperature superconducting magnets to confine and stabilize fuel and induce a fusion reaction.
- Inertial confinement, which uses powerful lasers to compress fuel until a fusion reaction occurs.
- Magneto-inertial fusion, which uses magnetic confinement to contain plasma fuel but inertial confinement to compress them together and achieve a fusion reaction.

The approach taken informs the type of fuel that is used and the way electricity is generated. Most approaches harness heat from the reaction to generate steam to power turbines, but some, namely Helion, are attempting the direct capture of electricity.

Beyond these differences in technological approaches, there are macro-level distinctions in how fusion research is being conducted across the globe, opening an additional arena for global competition.

Historically, fusion research has been carried out in labs at the national and multilateral level, with ambitious international projects like ITER. But as the commercialization of this technology nears, countries are now in an intense competition to develop commercial fusion power, with the United States and China at the forefront. In the United States this effort is led by private start-ups, whereas in China the government is building up a state-backed fusion program.

The United States has arguably the world's strongest private fusion sector, boasting 25 of the world's 45 private fusion companies surveyed by the Fusion Industry Association (FIA), and around 80% of the over $6 billion in equity investments into private fusion companies. The United States is also home to three fusion companies widely regarded as the front-runners – Commonwealth Fusion Systems (CFS), Helion Energy, and TAE Technologies – who have some of the most aggressive timelines to commercialization. They also have prominent backers, including Sam Altman for Helion and Bill Gates' Breakthrough Energy Ventures for CFS.

China has consistently used its ability to fund, build, and scale projects quickly to become a global leader in clean energy technologies, from solar panels to electric vehicles. Now, it is applying a similar strategy to fusion, by using enormous amounts of state funding to build up domestic players who will be able to compete for domestic and international market share in the future. Despite joining the game later, China is now spending ~$1.5bn a year on fusion, nearly double US government funding. They also have ten times the number of PhD graduates in fusion as the United States, and are attracting even more talent. China has built multiple fusion facilities, and has more in the works, including a new laser-based facility in Sichuan that has a similar design as the California-based National Ignition Facility but is roughly 1.5 times larger.

The Chinese state-backed capital being deployed is patient, without needing to respond to near-term demands for returns by investors and shareholders. With patient capital, fusion as a national priority, and more consolidated control of the industry, China is well-positioned to weather the longer development timeline needed to reach commercialization. In addition, stronger government involvement allows China to pursue projects that might face regulatory hurdles elsewhere, such as the world's first hybrid fusion-fission power plant on Yaohu Science Island that aims to produce 100MW of continuous electricity and be connected to the grid by 2030.

In the United States, some worry that China will outpace the US in fusion. Although hyperscalers are showing a willingness to invest in fusion by signing PPAs, most are not taking on development risks. This has led to calls for the US government to up its fusion funding, with industry and expert groups calling for a one-time infusion of $10 billion for fusion commercialization to “ensure American energy dominance.”

### China’s Fusion Supply Chain Advantage

Although the fuel used in fusion reactions is not subject to the same constraints as uranium, the broader supply chain presents additional areas for competition. Some of the most important components of fusion reactors include high-temperature superconducting materials (HTS), especially rare-earth barium copper oxide (REBCO) tape, and high-powered lasers. There are questions about whether the fusion supply chain is capable of meeting current and future commercial demand. A recent report from the Fusion Industry Association stated that fusion supply chain spending increased from $250 million in 2023 to $434 million in 2024. However, 63% of the companies surveyed were uncertain that the supply chain could keep pace with future demand without investments to make the supply chain more robust

Part of the issue is that without firm long-term commitments from fusion companies, suppliers are unwilling to spend the capital needed to scale production. Most fusion companies are currently operating in accordance with a milestone-based roadmap, launching one pilot reactor at a time, making it difficult to commit to large future orders. A weak supply chain could hinder the ability to commercialize at scale when the time comes. Though the US Department of Energy is funding the development next-generation materials for fusion reactors to some extent, China’s dominance in raw materials and advanced manufacturing capabilities, buoyed by strong state support, gives them another leg up in this area of the fusion race. To secure their supply chains and insulate themselves from geopolitical risks, some western fusion companies are investing purposefully on building a supply chain without exposure to China and adapting production lines from other heavy industries.

Whoever is able to commercialize fusion at scale first will be able to shape how this technology advances globally, how supply chains develop, and what norms guide its spread. Commercial partnerships based on exporting fusion technology could be even longer and more durable than those based on nuclear fission. Thus, perhaps the most important differentiator is that China has built a network of development finance and export credit institutions that dwarfs that of the US and gives the country a framework for not only exporting its commercial technology but leveraging development finance for strategic gains. To compete, the US will need a revitalized strategy for strengthening the global reach of its nuclear industry, including innovative capital solutions for first-of-a-kind technologies like fusion energy.

## A Nuclear Energy Transition Will Have Wide-Reaching Geopolitical and Commercial Implications

The mainstream adoption of nuclear energy—whether fission, SMRs, or fusion, or most likely a combination of the three—will have real consequences for geopolitics. Changes to the industry may happen suddenly as new technologies are commercialized, necessitating a framework for scaling up nuclear power, both in the United States and abroad.

For traditionally energy-rich countries like the oil and gas producers of the Arab Gulf, the potential impacts of nuclear energy on global oil demand underlines the importance of economic diversification. Traditional energy exporters may also lose a key source of geopolitical leverage. Countries like Russia, which have sought to weaponize Europe’s dependence on their natural gas supplies for political gain, would see such leverage diminished in a world where nuclear energy is unconstrained by geography.

Conversely, for energy-importing countries, nuclear energy offers a path towards energy self-sufficiency. Nuclear power offers protection from supply disruptions and price volatility, while helping countries meet their net zero goals. Countries that have slowed investments in nuclear energy over the last several decades are now investing once more. Japan has already restarted 14 reactors since Fukushima, and the government has committed to increasing the share of nuclear energy in the country’s electricity mix to 20% by 2040. The UK government announced in July 2025 that it would invest $51 billion in building the country’s first nuclear plant since 1995.

A renaissance in nuclear power will create new competitive dynamics. Control over nuclear supply chains—from uranium enrichment to reactor components, regulatory standards, and export financing—represents an emerging arena of great power competition. Meeting future demand requires building an entirely new ecosystem: stronger supply chains, modernized regulatory bodies, and investors willing to back long-duration, capital intensive projects. Strategic stockpiling of nuclear fuels, workforce development, and international collaboration on safety standards will determine which nations lead—and which lag behind—in this transition.

The nuclear energy renaissance is underway, but success will depend on whether nations can build the infrastructure and partnerships necessary, with the right capital solutions in place, to support a robust nuclear industry.

## About the Author


George Lee

Co-Head, Goldman Sachs Global Institute


## Contributors


Dejana Saric

Associate, Goldman Sachs Global Institute

Misha Sohan

Associate, Goldman Sachs Global Institute