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The Economics of Nuclear Energy

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Abstract
Contemporary society has seen Artificial Intelligence (AI) take over the world, becoming inherent to one's life, and it will only continue to grow, similar to the growing concern over carbon emissions. Taken together, nuclear energy cannot be overlooked, despite widespread reluctance rooted from the disasters at Chernobyl and Fukushima. Artificial intelligence and decarbonization commitments are driving global electricity demand higher, engendering novel interest in nuclear energy. Consequently, the world is entering the second major uranium cycle, which, unlike the 2007 peak, is driven by a demand that converges with a supply that fails to sustain the demand for a decade or more. Therefore, uranium demand is expanding across the near-, medium-, and long-term horizons.
Nuclear investment generates substantial output and stabilises both micro and macroeconomic effects, in spite of its cost and regulatory risk, sustaining evidence that nuclear energy has become one of the next pillars of global energy supply.

Key Words: *Nuclear Energy, AI-driven demand, Decarbonization, Uranium Markets, Small Modular Reactors (SMRs)*

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I. Introduction

Electricity consumption rose 4.3% in 2024; the International Energy Agency projects that global electricity demand will nearly double by 2050, though, under its central policy scenario (IEA, 2023). However, it is key to note that a meaningful share of this acceleration is technological, as generative AI's power requirements are expected to grow by roughly 70% annually, and global data centre electricity generation alone is projected to exceed 1,000 TWh by 2030 (Morgan Stanley, 2024; IEA, 2025).

Meanwhile, 25 countries pledged at COP28 to triple global nuclear capacity by 2050 as part of a broader effort to decarbonize electricity generation without sacrificing reliability (UNFCCC, 2023). Together, rising demand, the electrification of computing infrastructure, and climate commitments have pushed governments and utilities to reconsider nuclear energy in its energy matrix.

Nuclear energy history has been shaped by extreme challenges, such as the Three Mile Island accident (1979) and Chernobyl disaster (1986), and the meltdown at Fukushima Daiichi (2011), that triggered waves of public and regulatory backlash. In particular is Germany, who, thereby, shut down its entire nuclear fleet following Fukushima, causing global reactor construction to slow to a fraction of its 1980s peak, and uranium became known for its cyclical, speculation-prone volatility. Then why has Nuclear Energy returned?

Since 2023, uranium prices have climbed again, and, as a consequence, reactors scheduled to close are now being restarted, but, the most notable of all is the AI behemoths entering the market, with Microsoft, Amazon, Meta, and Google signing agreements to secure nuclear power for their data centre operations.

Thus, this paper will examine the economics of nuclear energy across five different views, beginning with the fundamentals of what nuclear energy is and how uranium fuels it, its costs, and its risks. Then, it will thoroughly scrutinise the global supply and demand dynamics of the uranium market, before addressing the macroeconomic and microeconomic consequences of nuclear expansion, ultimately arguing that the current cycle is, in fact, structurally distinct and should be explored by nations, as they could largely benefit from it. Nonetheless, it has its caveats and it is not perfect.

— What is Nuclear Energy?

Before evaluating its economic success, it is key to understand what nuclear energy is. Nuclear energy is extremely complex; unlike fossil fuels, nuclear energy is released from atomic atoms through multifaceted nuclear plants.
This chapter will offer insight on what nuclear energy is and how it functions, discussing its technical foundation.

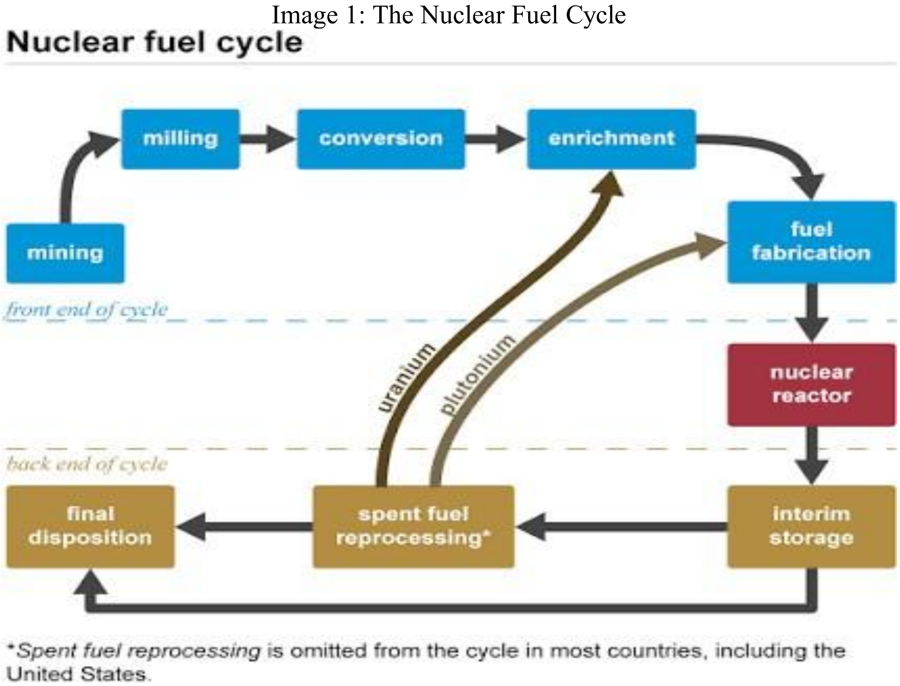
I.1 — How Nuclear Energy Functions

Nuclear energy is a form of energy released from the nucleus of atoms — the center composed of protons and neutrons. This energy can be produced in two ways: fission (when atomic nuclei split into smaller parts) or fusion (when nuclei merge). Currently, the nuclear energy most widely utilized to produce electricity occurs through nuclear fission (IAEA, 2025).

In fission, when struck by a neutron, the nucleus of a uranium-235 atom splits into two smaller nuclei, in particular, a barium nucleus and a krypton nucleus, releasing two or three additional neutrons. These neutrons strike other surrounding uranium-235 atoms (the primary element applied to power this type of energy), which also split and generate more neutrons in a multiplying effect, producing a chain reaction in a fraction of a second. Each time the reaction occurs, energy is released in the form of heat and radiation (IAEA, 2025).

Inside a nuclear plant, reactors and their equipment contain and control these chain reactions — most commonly fueled by uranium-235 — to produce heat through fission. This heat warms the reactor's cooling agent, typically water, to produce steam. The steam is then channeled to drive turbines, activating an electric generator to create low-carbon electricity (IAEA, 2025).

Image 1: The Nuclear Fuel Cycle



***Source**: Pennsylvania State University Radiation Science & Engineering Center (2023)*

The nuclear fuel cycle (Image 1) illustrates the industrial process that transforms raw uranium extracted from the earth into electricity, and as a result determines what happens to the resulting radioactive material. As shown in Image 1, sourced from the Nuclear Regulatory Commission (NRC), the cycle is divided into the front end, which prepares the fuel and the back end, which manages waste after use.

I.2 — Reactor Types

As nuclear energy generation technology has evolved significantly since the first commercial plant in the 1950s, not all nuclear reactors are alike.

The most common type of reactor in the world is the Pressurized Water Reactor (PWR), due to its safety, operational stability, and track record, accounting for the vast majority of the global nuclear fleet in operation (WNA, 2026). In a PWR, the water in the reactor core is kept under high pressure so that it does not boil, even at temperatures above 300°C. This primary circuit transfers its heat to a separate secondary circuit, which, thereafter, generates the steam that drives the turbines. The separation between the two circuits is a central safety feature (WNA). Brazil's Angra 1 and Angra 2 plants, for example, are PWRs (Rossi, 2019).

The second most common type is the Boiling Water Reactor (BWR), which accounts for approximately one-third of reactors in the United States (U.S. Department of Energy, 2025). In a BWR, water is heated directly by the core until it becomes steam; subsequently, it is sent to the turbine without a distinct secondary circuit (NRC). The design is simpler and initial equipment costs are lower, but the steam leaving the core may be slightly radioactive, requiring additional containment systems (S. Bays et al., 2019).

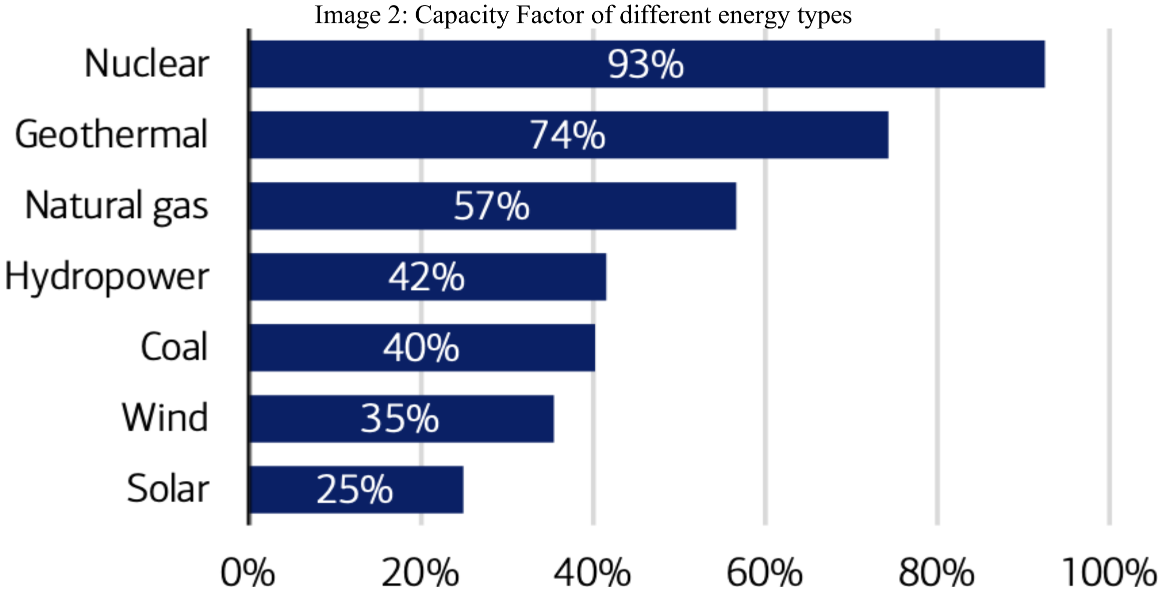
II — Why Nuclear Energy?

This chapter analyzes the main arguments supporting the choice for nuclear energy. This section will, therefore, facilitate the comprehension on why nuclear energy may play a strategic role in the energy transition and in building safer, cleaner, and more resilient electrical systems.

II.1 — Capacity Factor

The capacity factor is the ratio between the actual electrical energy output of a plant over a given period and the maximum theoretical output it could generate if it operated continuously at full capacity (U.S. Department of Energy, 2025).

Image 2: Capacity Factor of different energy types



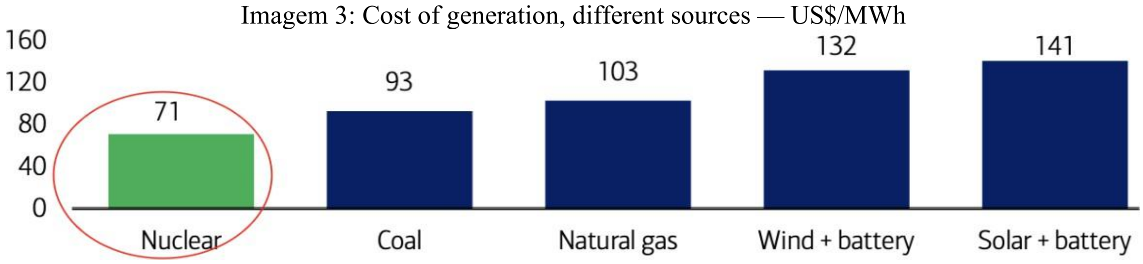
Source: *Bank of America (BofA) Research Committee, Office of Nuclear Energy (2025)*

In particular, to act as a counterpart of nuclear energy, solar energy (25% capacity factor) would require approximately four times more installed solar capacity, in addition to storage to cover nights and cloudy periods. This additional capacity and storage represent a real and significant cost that simple cost-per-unit comparisons, such as the Levelized Cost of Energy (LCOE) — the electricity sector's standard metric for calculating the average cost of generating electricity over the full lifecycle of a plant or generating system (IBM) — often overlook.

II.2 — Cost of Generation

Moreover, as Image 3 illustrates, on a levelized and system-inclusive basis, nuclear energy is cost-competitive at approximately US$71 per Megawatt-hour (MWh), placing it cheaper than coal (US$93), natural gas (US$103), and dramatically cheaper than wind plus batteries (US$132) or solar plus batteries (US$141), once the cost of firming intermittent sources through storage is included.

Imagem 3: Cost of generation, different sources — US$/MWh



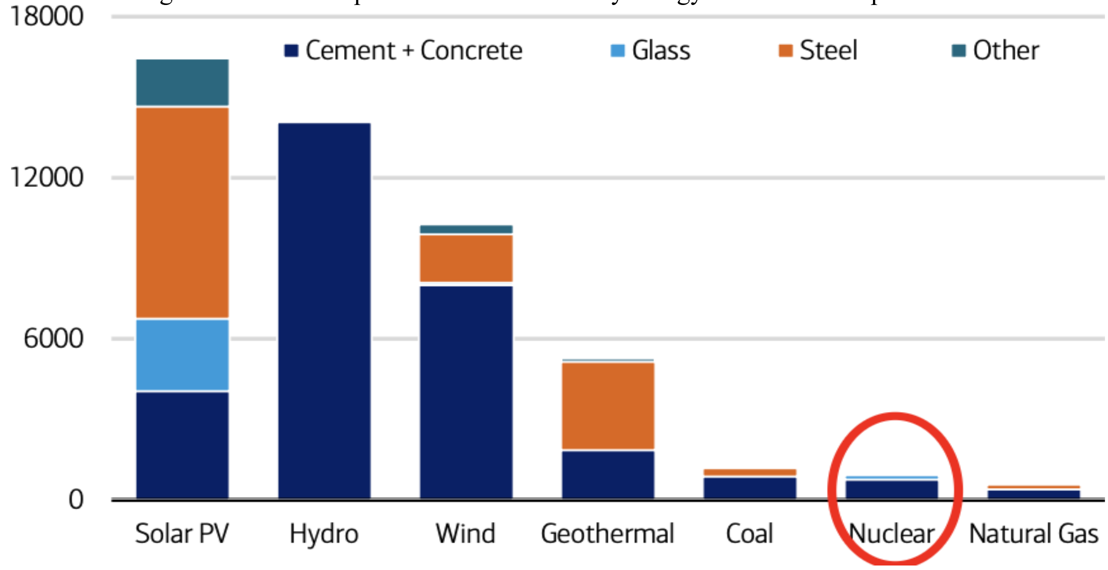
Source: *BofA Research Committee & Lazard (2023)*

Notably, the headline LCOE figures for solar and wind exclude backup costs, and when reliable energy is compared on equivalent terms, the economic ranking favors nuclear power. Many present a misleading LCOE comparison that does not account for the periods when the sun is not shining or the wind is not blowing. During those periods, solar and wind not only fail to generate, but they also require additional costs to maintain reliable supply.

II.3 — Materials, Land, and Longevity

First, as Image 4 shows, a nuclear plant requires approximately 900 tonnes of cement, concrete, and glass per TWh; conversely, solar energy, for example, requires approximately 16,000 tonnes of material for the same energy output.

Image 4: Materials required for construction by energy source — tons per TWh —



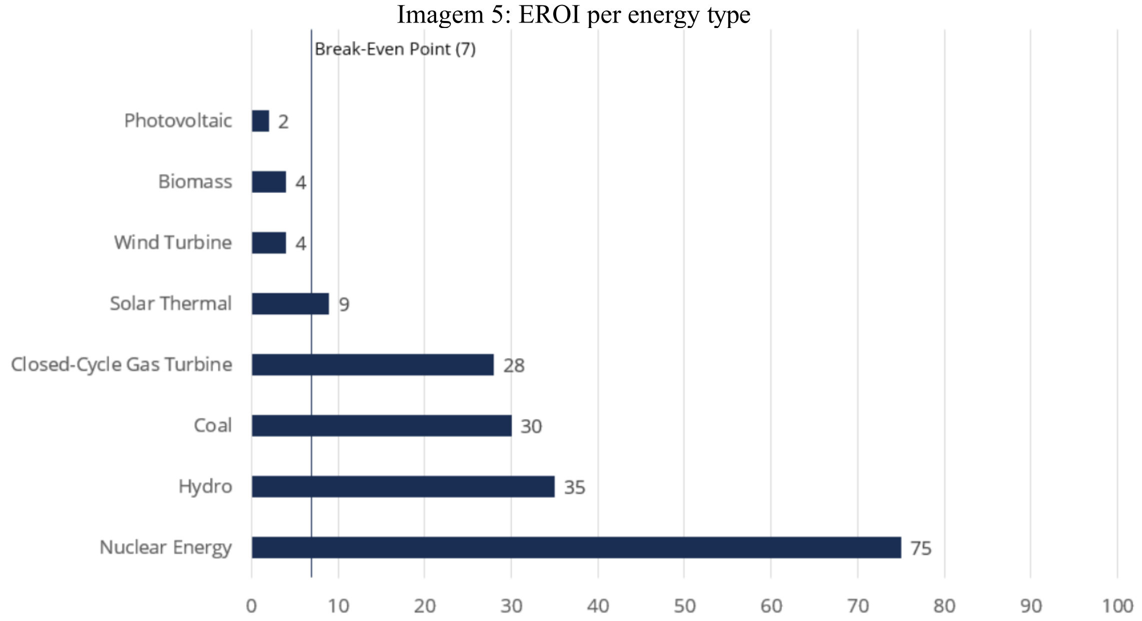
***Source**: BofA Research Committee, Quadrennial Technology Review, Sustainable Review (2025)*

Second, a 1,000 MW nuclear plant requires approximately 1.3 square miles of land — roughly the size of Central Park. The same output from solar would require 45 to 75 square miles; from wind, 260 to 360 square miles — approximately the size of the five boroughs of New York City.

In terms of longevity, nuclear power also outperforms solar and wind: while nuclear plants last 40 to 100 years, solar panels and wind farms must be replaced every 20 to 30 years. A solar farm may be rebuilt up to five times over the lifetime of a single nuclear plant.

Most importantly, the Energy Return on Investment (EROI) — the ratio of total energy produced per unit of energy invested — places nuclear in a category of its own, as demonstrated in Image 5.

Imagem 5: EROI per energy type

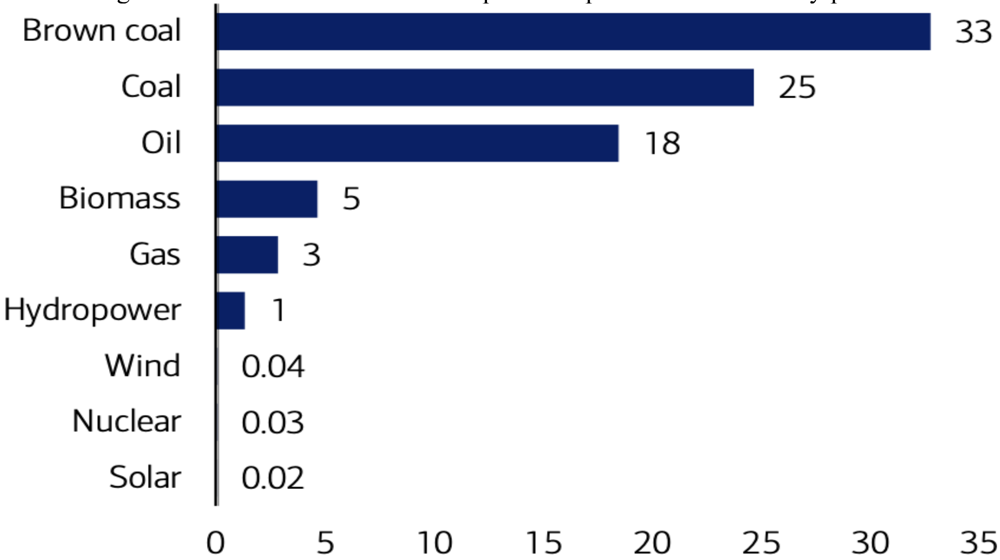


***Source**: Corporate Finance Institute (2020)*

II.4 — Safety

The major accidents at Chernobyl and Fukushima engendered an upheaval in the implementation of nuclear energy, becoming subject to widespread public fear, but seldom disproportionate to the empirical risk it poses: deaths per TWh from accidents and air pollution place nuclear energy among the safest energy sources, being, thus, comparable to wind and solar, and orders of magnitude safer than coal, oil, and gas.

Image 6: Deaths from accidents & air pollution per TWh of electricity produced

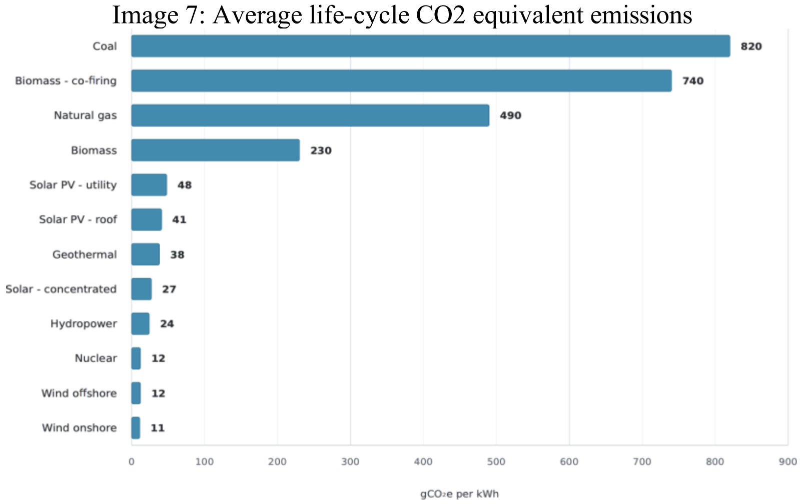


Source*: BofA Research Investment Committee, Our World in Data, Markandya & Wilkinson (2007); Sovacool et al. (2016); UNSCEAR (2008; & 2018)*

Likewise, many condemn nuclear energy for its radiation, but living next to a nuclear plant for a year exposes a person to less radiation than a single dental X-ray. Coal ash, on the other hand, emits approximately 33 times more radiation than a nuclear plant (Canadian Nuclear Safety Commission, 2023). Furthermore, a 1,000 MW plant produces only approximately 3 cubic meters of high-level waste per year. High-level waste represents 3% of the volume but 95% of the radioactivity; it is concentrated and contained, not dispersed (Alwaeli & Mannheim, 2022). A 2023 MIT study concluded that the early closure of reactors, and their replacement with fossil fuel capacity, could cause approximately 5,200 additional deaths per year due to air pollution. Finally, uranium is abundant, and enrichment is a mature technology; consequently, the risk of proliferation exists with or without civilian nuclear energy, and civilian programs are more transparent under IAEA oversight (Bernstein & Gerami, 2012; World Nuclear Association, 2026).

In terms of emission, nuclear has the second lowest emission rate from all types of energy, evident in the subsequent image.

Image 7: Average life-cycle CO2 equivalent emissions



Source*: WNA (2026); IPPC*

As shown by Image 7, on a lifecycle basis, nuclear energy produces approximately 12 gCO_2e per kWh. By comparison, natural gas produces 490 gCO_2e per kWh and coal 820 gCO_2e per kWh, meaning nuclear generates roughly 40 times fewer lifecycle emissions than natural gas and 68 times fewer than coal, reinforcing its position as a structurally indispensable technology in any decarbonization scenario that requires firm, dispatchable generation (WNA, 2026; IPCC).

Image 8: Percent who favor vs. oppose the use of nuclear energy for electricity

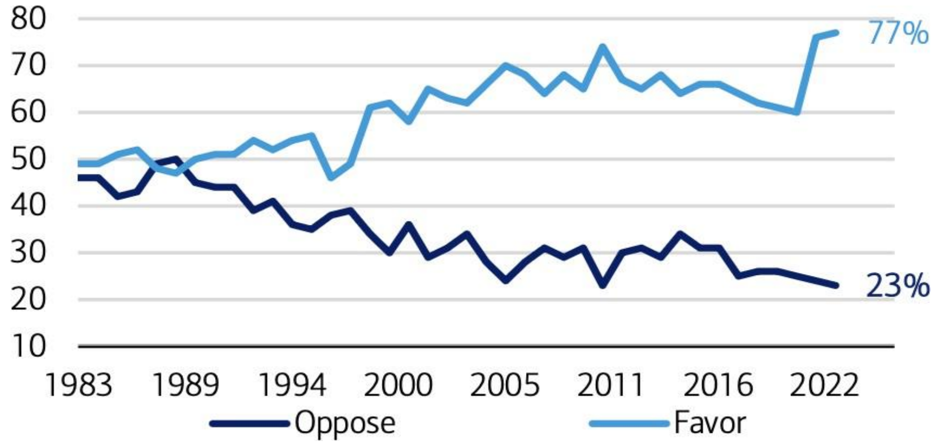
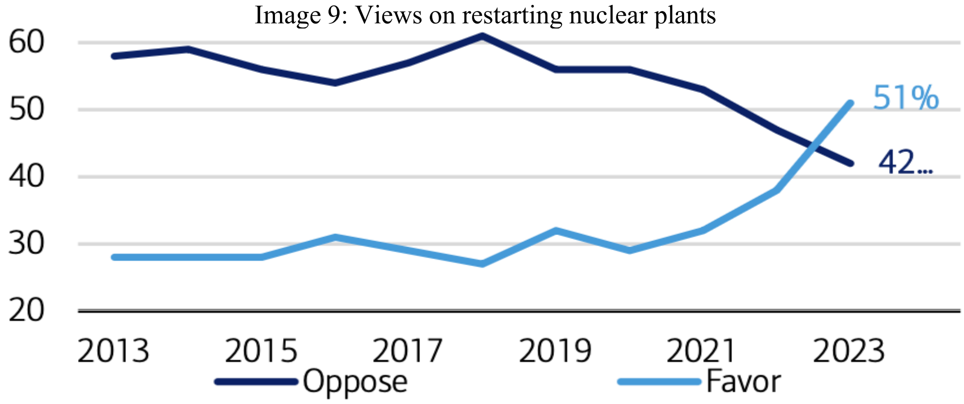


Image 9: Views on restarting nuclear plants



Source: *BofA Research Investment Committee, World Nuclear News (2025)*

Both Images 8 and 9 on public opinion support nuclear energy. As the images emphasize, the historical trend in the United States and Japan, two countries marked, respectively, by the Three Mile Island accident and the Fukushima disaster, showcases a growing reposition in favor of nuclear energy.

II.5 — The Limits of a Fully Nuclear Energy Matrix

That said, then why are governments so reluctant to implement an electricity matrix composed predominantly of nuclear energy?

First, what to do with nuclear energy's toxic, highly radioactive waste remains an unsolved problem (WNA, 2025), and despite the safety of nuclear plants, nuclear accidents have broadly visible and dangerous consequences, which often make governments more reluctant to build new plants — most notably Germany, which shut down all its reactors following the Fukushima disaster and increased its dependence on Russian gas (Earth.org, 2023).

Nations also avoid nuclear energy to prevent geopolitical risks and diplomatic tensions: the same techniques employed to produce enriched uranium for civilian purposes can be adapted to produce weapons-grade uranium. Consequently, nuclear proliferation remains one of the most serious geopolitical risks associated with the global expansion of nuclear energy (Bernstein & Gerami, 2012, NDU).

Additionally, nuclear energy requires large volumes of water for continuous cooling, representing a critical vulnerability in drought-prone regions (Morgan Stanley, 2024).

Private banks rarely lend without government guarantees and insurers charge high premiums, making nuclear projects almost entirely dependent on state support due to the high risk involved, extremely high construction costs, and susceptibility to cost overruns — as exemplified by the Vogtle plant in the United States, whose original budget of US$14 billion reached a final cost of approximately US$35 billion, with a delay of nearly eight years (BofA, 2025). Each year of delay adds billions in financing charges because utilities borrow in advance.

Finally, the workforce shortage in the U.S. nuclear energy market is extremely scarce: bachelor's degree attainment in Nuclear Engineering is declining; there were only 454 graduates (B.S) in nuclear engineering, in spite of approximately 20% of U.S electricity being generated by nuclear energy, This suggests that even in an economy with an established nuclear matrix, the contraction in specialized training makes expansion more challenging — let alone in countries with less developed nuclear education systems, making plant construction and maintenance more costly and complex. Despite growth in nuclear engineering doctorates, it is insufficient to meet rising demand, as bachelor's degrees in nuclear engineering in the U.S. fell approximately 30% between 2015 and 2022, and master's degrees dropped approximately 26%.

Nuclear's contribution to the goal of economies in decarbonization remains constrained by aging infrastructure, unfulfilled development plans, and high costs (Global Energy Tracker, 2025). The Global Nuclear Energy Tracker indicates that 566 gigawatts (GW) of proposed nuclear capacity worldwide, representing nearly 40% of all capacity ever planned, has been cancelled, reinforcing nuclear energy's complexity and unreliability; this amount exceeds both the currently operating nuclear capacity of 401 GW and the retired capacity of 116 GW combined.

Hence, a diversified energy matrix is a more robust policy approach. Nuclear energy is best understood not as a homogeneous replacement for other sources, but as a highly-reliable base load anchor around which intermittent renewables, hydropower, and natural gas can be organized. A matrix structured in this way captures nuclear's unmatched capacity factor and low lifecycle emissions while mitigating its principal vulnerabilities. Excessive dependence on any single source, nuclear included, exposes a nation to compounded economic, geopolitical, and energy security risks.

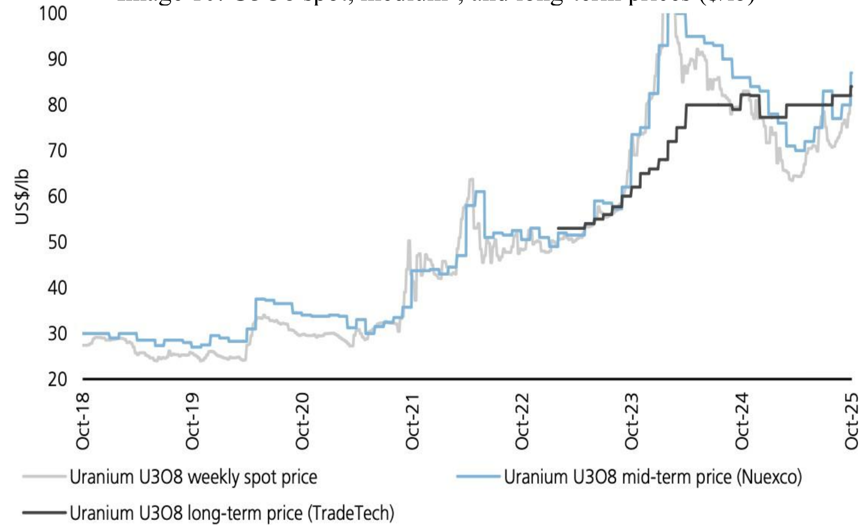
III — Demand

This section analyzes the fundamental framework of nuclear demand; it will highlight how demand for nuclear energy is likely to grow consistently over the coming decades.

Cyclical and volatile prices tend to be intrinsic to all mineral commodity markets due to supply and demand being highly inelastic in the short term. Likewise, demand for nuclear energy tends to be relatively price-inelastic — meaning demand shows low responsiveness to price changes: fuel represents only approximately 5% of a reactor's operating costs, so institutions prioritize security of supply over price, buying almost regardless of cost, as nuclear demand is predominantly state-backed — approximately 73% of major operators are government-controlled. This means uranium demand is driven by national energy security policy, not price sensitivity.

Moreover, essential to understanding nuclear demand is uranium: the primary fuel source for this type of energy; demand for nuclear energy, thus, tends to vary with the uranium price — and vice-versa. The uranium price is oddly complex, being negotiated between its spot, medium and long-term price.

Image 10: U3O8 spot, medium-, and long-term prices ($/lb)



Source: *Trade Tech, Bloomberg, UBS (2025)*

Geographically, uranium demand is currently contained in three principal markets; the US, France, and China together account for more than half of global nuclear generation (at approximately 29%, 13%, and 16%, respectively). This distribution, however, is shifting: divergent national nuclear policies, regulatory frameworks, and fleet expansion strategies are progressively concentrating demand growth in Asia, with China and India emerging as the dominant drivers of medium-term consumption. Combined, their share of global nuclear generation is projected to double from roughly 18% today to approximately 35% by 2035, accounting for nearly three-quarters of all demand growth over the next decade (UBS, 2025).

Lastly, Nuclear power's distinctive cost structure makes uranium demand unusually predictable relative to other mineral commodities. Because of nuclear's high upfront capital costs paired with comparatively low fuel costs, once a reactor is operational, it makes sense (economically) to run it continuously at high capacity, with utilities absorbing fluctuations in electricity load by adjusting fossil fuel generation rather than nuclear output. In other words, when the overall electricity price goes up or down throughout the day, season, or year, utilities don't change how much nuclear power they're producing. In consequence, nuclear keeps running at roughly the same steady output the whole time — it absorbs none of the variability, while fossil fuel, for instance, absorbs all of it. Thereby, uranium demand projections rest primarily on installed and operable reactor capacity, largely insulated from short-term economic cycles, but this relationship is, nonetheless, complicated by policies that grant subsidies to wind and solar generation preferential access to the grid — the network of power lines, substations, and transformers that carries electricity from power plants to homes, businesses, etc (WNA, 2023).

III.1 — Historical Demand

The uranium price functions like any commodity, and is fundamentally driven by the global interaction of supply and demand, amplified by micro and macroeconomic conditions and financial speculation. With that in mind, it is important to analyze demand since the beginning of the 21st century to understand how uranium demand works.

In the early 2000s (2000–2007), the spot price of uranium fell below US$10/lb. However, declining uranium reserves, combined with several supply disruptions — including the McArthur River flood in 2003, the Cigar Lake flood in 2006, and cyclones at Ranger in 2007 — led utilities to increase contracting to cover forward commitments. As a result, prices rose above US$120/lb in 2007 (UBS, 2025).

From 2008 to 2010, the global financial crisis triggered the liquidation of uranium holdings by investment funds and the auctioning of uranium inventories held by the U.S. Department of Energy, estimated at approximately 8 to 10 million pounds of U_3O_8.

Institutions and governments were also reluctant to invest in nuclear energy — which is complex and expensive — during a recession. This pushed prices down toward approximately US$40/lb.

In the years that followed (2011–2016), although more aggressive Chinese buying initially drove prices higher in 2011, the Fukushima accident in March 2011 shifted global nuclear policy from expansion toward slowdown and decommissioning. As a result, prices fell from approximately US$70/lb in 2011 to approximately US$20/lb in 2016.

From 2017 to 2022, supply cuts by major producers — including Kazatomprom's "value over volume" strategy and Cameco's suspension of operations at Rabbit Lake and McArthur River — were followed by COVID-19-driven shutdowns in Canada and Namibia. These events removed approximately 20% of global supply and pushed the market into deficit. Nevertheless, prices remained around US$30–40/lb, partly due to low contracting levels by utilities.

Since 2023, the uranium price increase has been driven by several key factors: falling utility inventories in the U.S. and Europe; stable Chinese inventories alongside high demand; continued discipline from major producers and operational challenges constraining supply; financial and physical trusts removing material from the spot market; geopolitical tensions and sanctions on Russian enrichment capacity leading to "overfeeding" in the fuel cycle; and strong policy support for nuclear energy following COP28 (UBS, 2025).

III.2 — Current Demand (2026–2030)

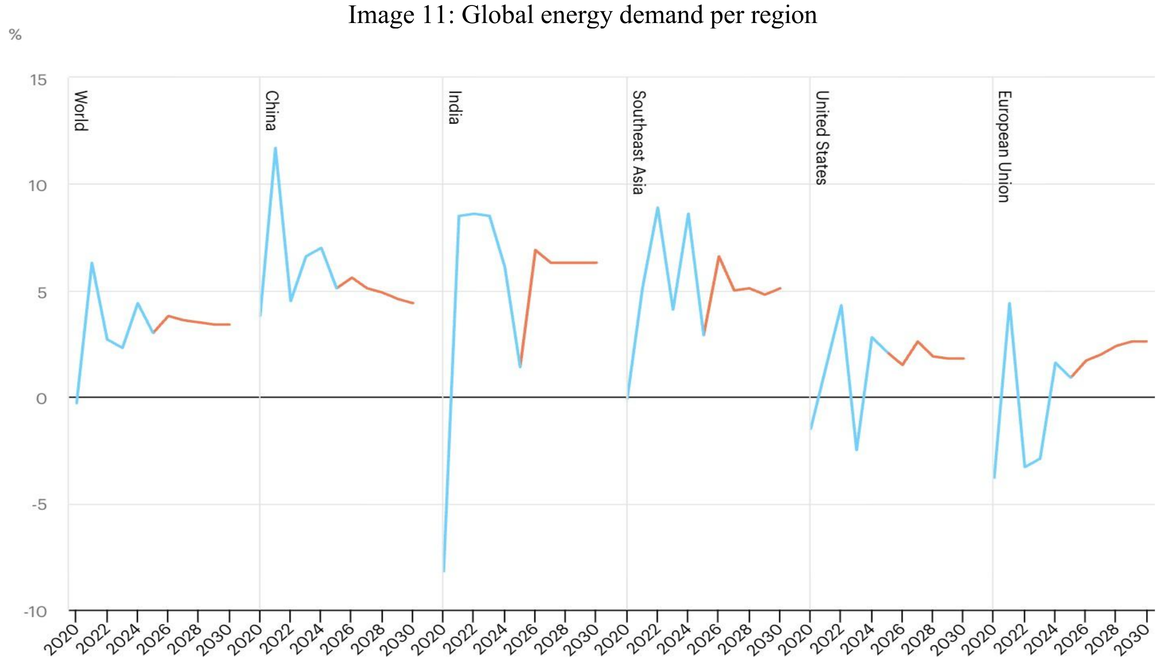
The current global demand environment for nuclear energy is shaped by multiple factors. Driven by the enormous and growing energy consumption of AI and geopolitical conflicts, demand for uranium has been rising as companies and governments turn to nuclear energy as an alternative to oil and gas, in the next five years, according to the IAEA report on *Energy supply for AI,* electricity consumption is expected to grow, on average, 50% faster per year than it did over the preceding decade, propelled by industrial expansion, electric vehicle adoption, rising green energy demands, and the rapid growth of data centres, among other end uses.

Electricity consumption has traditionally been directly correlated with GDP growth closely, with deviations occurring mainly during global financial downturns. Through 2030, however, the IEA projects that electricity demand will outpace economic growth for the first time on a sustained, global basis. This is due to the drivers of demand being shifted from incremental economic expansion to structural, technology-driven consumption growth.

After a stagnation period of 15 years, demand in advanced economies is augmenting. Nonetheless, emerging economies are signaling a sustained growth in the energy sector in terms of demand, remaining the principal engine of global electricity demand growth. This resurgence reflects the structural shift in what drives electricity demand. In earlier decades, energy consumption was tracked solely through population and industrial growth, but consumption is now increasingly interconnected to some of the most dynamic segments of the global economy, consequently causing both total and per capita electricity consumption to reach new record highs across many regions of the world through 2030 (IAE, 2026).

The second uranium cycle is real: demand for electricity via nuclear energy has been growing significantly over the years globally, as evidenced by Image 11, driven by the factors discussed above.

Image 11: Global energy demand per region

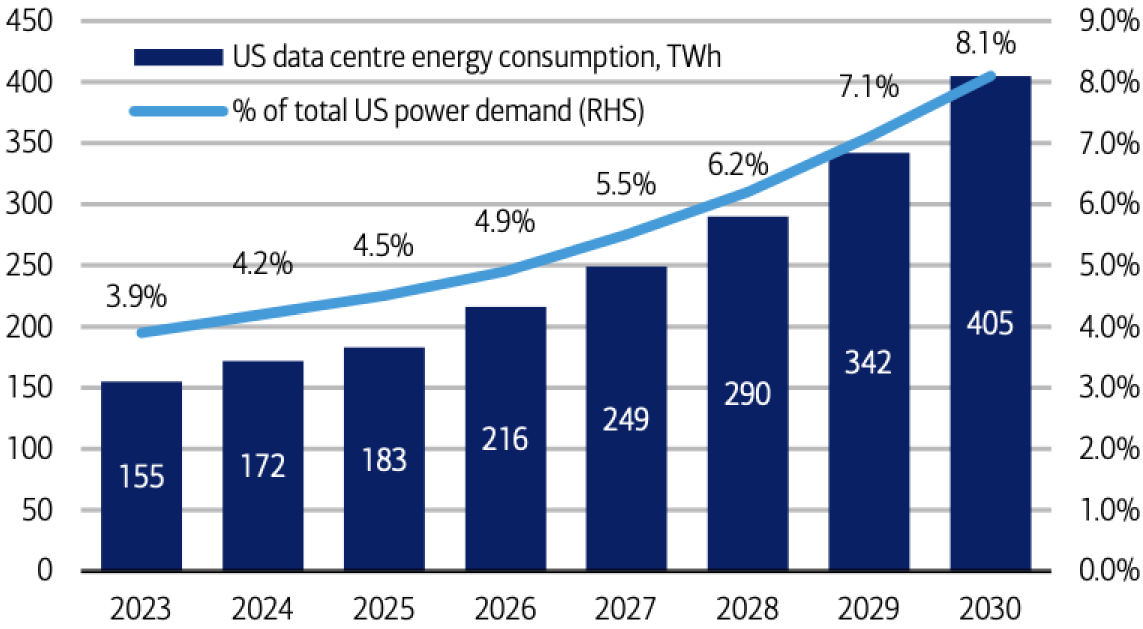


***Source**: IEA Energy Outlook (2026)*

According to IEA's energy demand outlook, energy consumption in the USA is set to rise an more than twice the rate of the past decade: an average of 2% per year, justified by the rapid extension of data centers, while for the European Union, in spite of electricity demand not reaching its 2021 levels before 2028, it is set to grow an average of 2.3% until 2030; that said, the biggest growth is set to be done China, accounting for nearly 50% of the global increase due to its high industrial activities, and as China attempts to mitigate its high levels of pollution, demand for nuclear energy will be largely impacted, as it one of the lowest emissions rate from all energy types. Given that, China's electricity demand will add demand for electricity comparable to that of the European Union's current consumption: annually, China's electricity demand will grow an average of 4.9% per year over the next five years, but down from the 6.5% average from the previous decade. Similarly, nuclear energy demand in India is also set to grow given its carbon-emission goal, while increasing total energy demand to 6.4% annually; Southeast Asia is expected to grow 5.3%. China and the latter are driven by rising electrification and sustained economic growth.

This demand is not unfathomable; rather, is something measurable, evident and embedded in our society, and it has a name: data centers, massive technology companies are driving a new wave of demand by investing in Small Modular Reactors (SMRs) to power highly energy-intensive AI data centers, and Uranium powers approximately 15% of data centers (IEA, 2025)

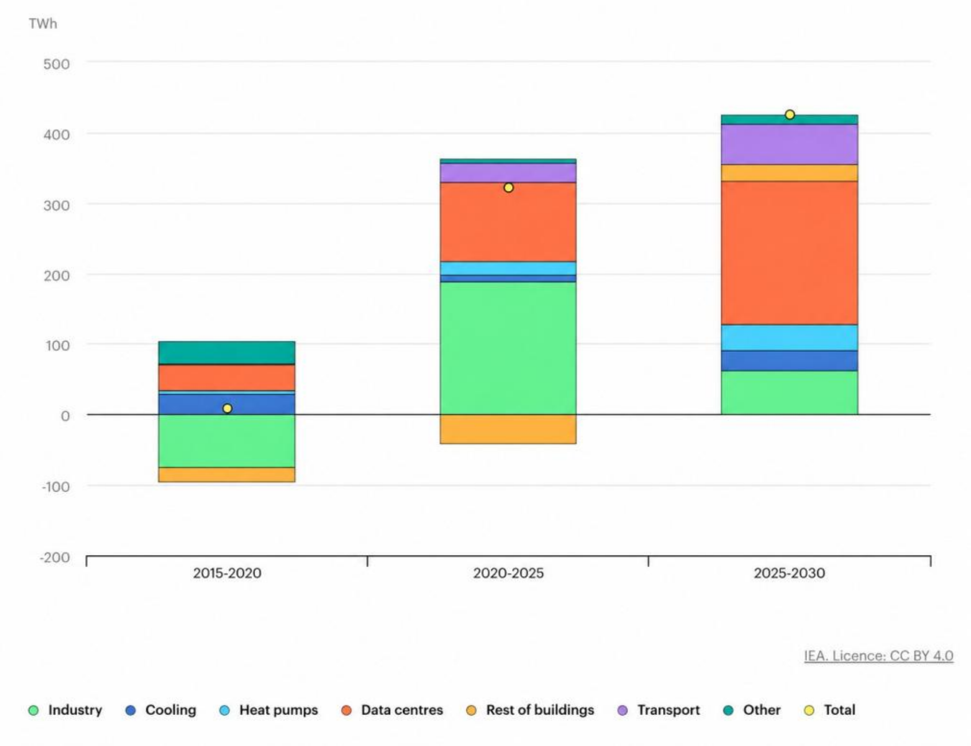
Image 12: US data centre energy consumption (TWh), as % of total US power demand (RHS)



Source: *McKinsey; BofA (2026)*

Image 12 illustrates the total US energy demand (RHS) and data centre energy consumption (TWh), both trends being similar to an exponential curve, and, as nuclear energy composes approximately 18%, demand for nuclear energy will, in consequence, increase as McKinsey's outlook forecasts (Disavino, 2026); currently, nuclear energy composes 20% of energy demand for data centers, and evident in image 13, data centers will continue to expand their energy consumption and become the behemoth of energy consumption, consequently, expanding their share on nuclear energy due to its low price and (IAE, 2026).

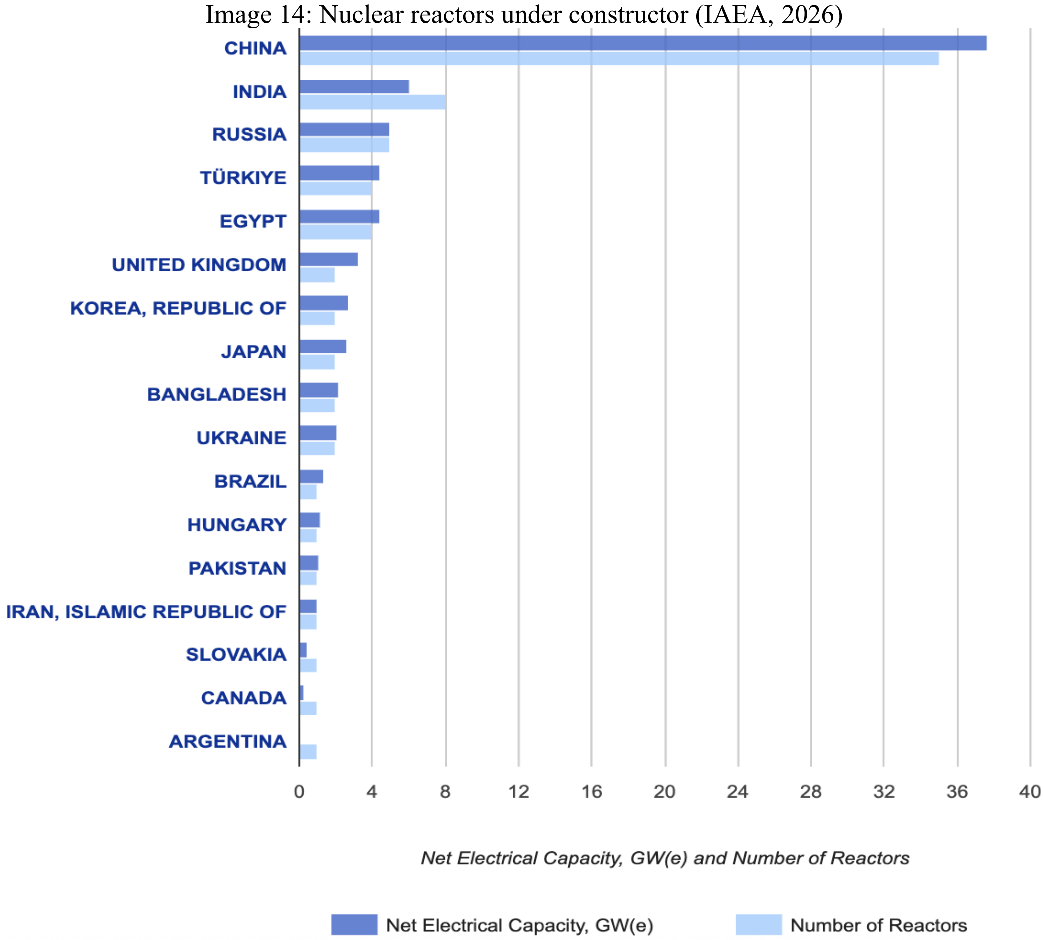
Image 13: Electricity demand growth by sector and end-use in the United States



Source: *IAE (2026)*

In China alone, approximately 35 reactors are under construction (Image 14), according to the IAEA , and these reactors will require fuel within 5 to 7 years — meaning demand begins now. Similarly, Japan has reactivated 14 reactors since 2011 (EIA, 2025); the United States is restarting the Palisades plant, backed by a US$1.52 billion loan from the U.S. Department of Energy (U.S. Department of Energy, 2024). Furthermore, this demand will be sustained for decades: existing reactors are having their operating licenses extended from 40 to 60 and even 80 years. In the United States, many plants are being authorized to operate for up to 80 years (UBS, 2025).

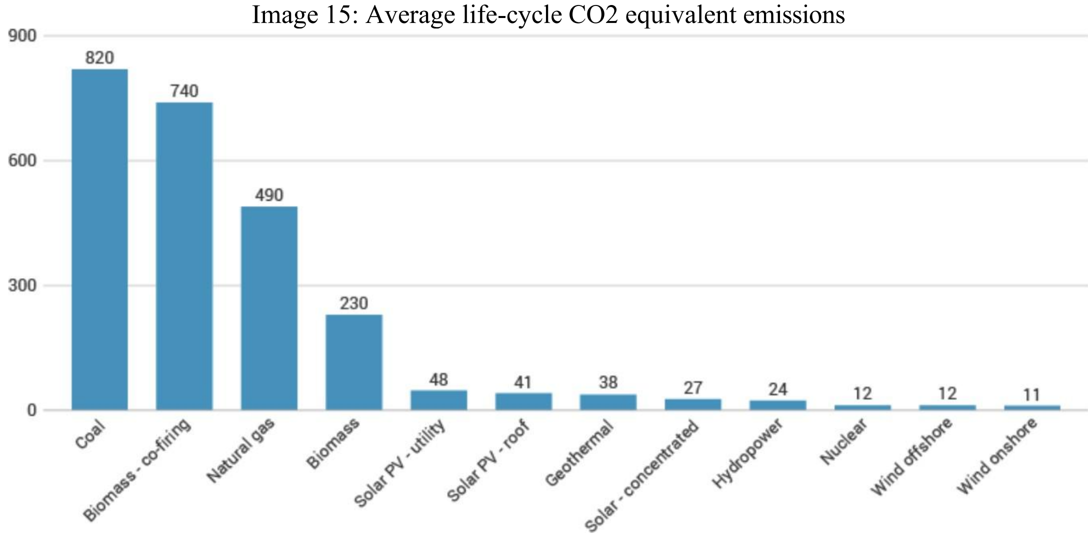
Image 14: Nuclear reactors under constructor (IAEA, 2026)



Source: *IAEA (2026)*

Granted, since approximately 2017, utilities have been accumulating and consuming on accumulated stockpiles, these inventories cannot be consumed indefinitely, forcing utilities to return to the market (UBS, 2025).
Hence, according to IEA's energy demand outlook, energy consumption in the USA is set to rise more than twice the rate of the past decade: an average of 2% per year, justified by the rapid extension of data centers and decarbonization. However, Founder & Publisher at Uranium Insider Justin Huhn cautions that the durable demand driver is reactor growth, not fully AI hype, and that utilities "remain the slowest actors, always", presenting AI as a driver rather than the sole driver. The European Union, in spite of electricity demand not reaching its 2021 levels before 2028, is set to grow an average of 2.3% until 2030, while the biggest growth is set to be done China, accounting for nearly 50% of the global increase due to its high industrial activities, and as China attempts to mitigate its high levels of pollution, demand for nuclear energy will be largely impacted, as it one of the lowest emissions rate from all energy types. Given that, China's electricity demand will add demand for electricity comparable to that of the European Union's current consumption: annually, China's electricity demand will grow an average of 4.9% per year over the next five years, but down from the 6.5% average from the previous decade. Similarly, nuclear energy demand in India is also set to grow given its carbon-emission goal, while increasing total energy demand to 6.4% annually; Southeast Asia is expected to grow 5.3%. China and the latter are driven by rising electrification and sustained economic growth.

Image 15: Average life-cycle CO2 equivalent emissions



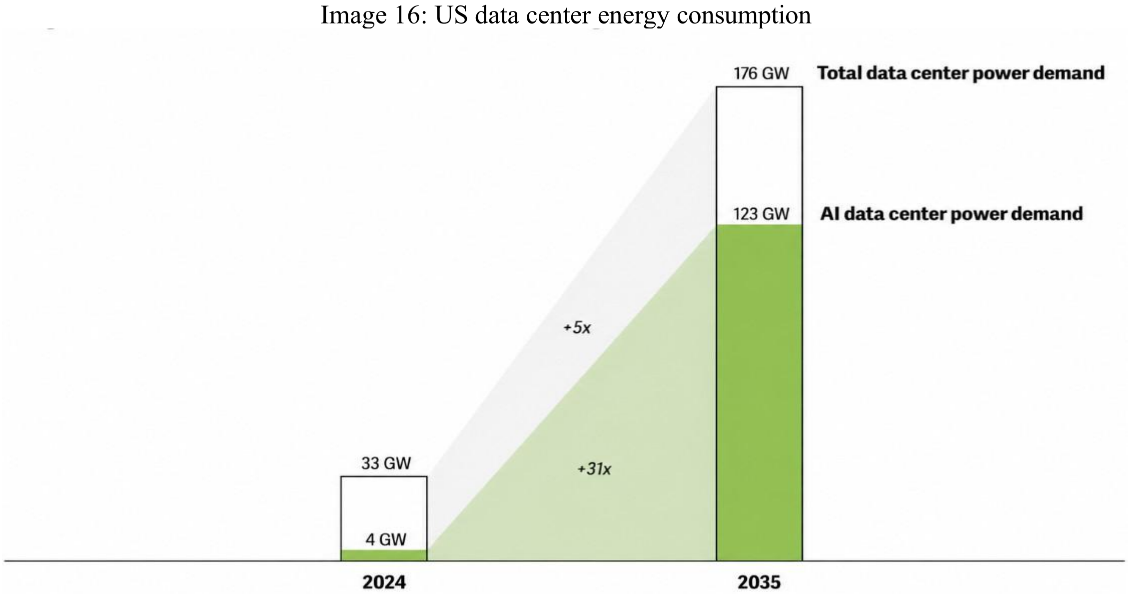
***Source**: World Nuclear Association (2026); IPCC*

III.3 — Medium-Term Demand (2030–2035)

The medium-term demand picture is going to be shaped by a robust and sustained framework of the matters aforementioned. As per World Nuclear Association's report in 2024 on Uranium Markets, the market is expected to grow in a ten year horizon. Notably, China is targeting 110 GW of nuclear capacity by 2030, rising to 200 GW by 2035, while India is scaling toward 22 GW (UBS, 2025; IAEA). Demand will also be supported by "new plants being built and the rate at which older plants are retired." Suggesting considerable room for nuclear capacity expansion in a world increasingly oriented toward decarbonization and energy security, the International Energy Agency's World Energy Outlook 2023 projects uranium demand rising by approximately 51% from 2022 levels by 2040.

A central element of the nuclear renaissance is the rise of Small Modular Reactors (SMRs), which are reshaping the economics and operational flexibility of nuclear deployment, becoming the modular reactor in data centers due to its secure continuous, carbon-free power for highly intensive activity. Relative to conventional large-scale reactors, SMRs require substantially less upfront capital, incorporate passive safety systems that reduce reliance on active intervention, and benefit from standardized, factory-based manufacturing that shortens construction timelines, (U.S. Department of Energy).

Image 16: US data center energy consumption

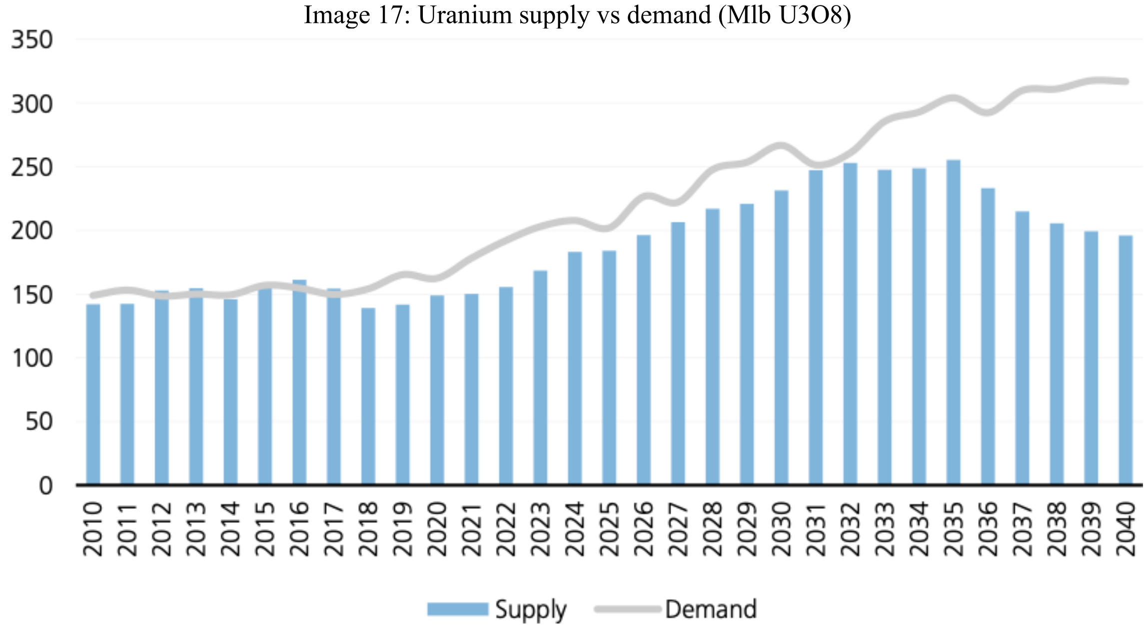


***Source**: Deloitte (2024); analysis of data from DC Byte, Wood Mackenzie, S&P Global, Lawrence Berkeley National Laboratory, Center for Strategic and International Studies, and Wells Fargo)*

In 2024, Microsoft, for example, purchased 835-megawatts of power to purchase its data centers (U.S Securities and Exchange Commission). Data centers are already one of the largest consumers of energy, but it will consume a much larger share of energy than it currently consumes (Image 13). As per a Deloitte analysis, it will expand its consumption by 500%, and AI will increase thirtyfold (1mage 16), and because of its continuous low-cost operation and capacity factors, data centers are actively turning to nuclear energy.
Beyond tech, though, companies, the medium-term uranium market will additionally be molded by decisions over the existing nuclear plants: whether regulators approve lifetime extensions, and if continued operation of older plants remains economically attractive relative to retirement or replacement; this reinforces the demand outlook by IEA, especially because uranium demand is largely associated with installed reactor capacity.

According to UxC, more than 3 billion pounds of utility uranium requirements remain uncovered through to 2045, with roughly two-thirds of future utility requirements still lacking secured supply contracts, while term contract volumes continue to sit around half of their late 2000s and early 2010s peaks, suggesting a significant restocking cycle has yet to materialize and represents a potential upside driver for uranium demand in the medium-term (UBS, 2025).

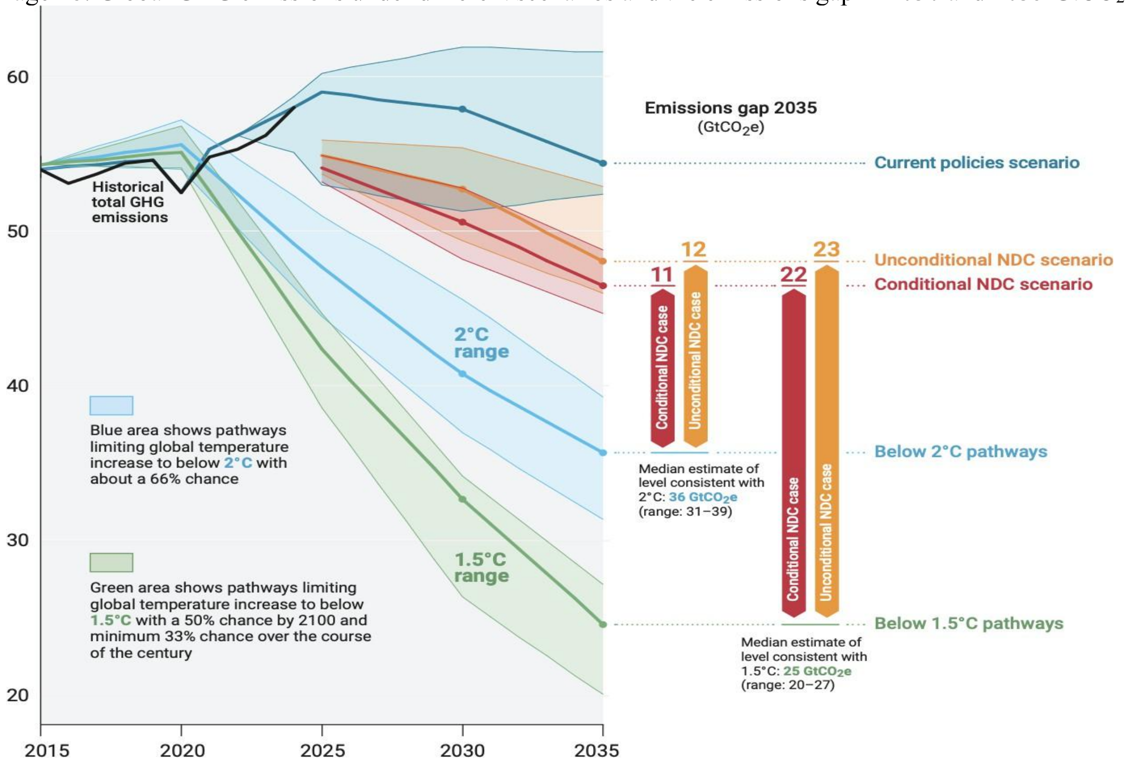
Image 17: Uranium supply vs demand (Mlb U3O8)



***Source**: UBS (2025)*

Image 17 illustrates the structural and widening divergence between global uranium supply and demand from 2010 through 2040. Through the 2010s, supply and demand remained broadly aligned, with sufficient supply to fulfill demand, both converging close to 150 million pounds (Mlb) of U_3O_8 — a period consistent with the post-Fukushima demand contraction and the drawdown of accumulated utility stockpiles discussed previously. From approximately 2023 onward, though, supply and demand begin to visibly diverge: demand accelerates on a steep upward trajectory, reaching approximately 230 Mlb by 2030 and approaching 320 Mlb by 2040, while supply grows at a considerably more modest pace. From 2031 to 2035, demand continues to rise while supply stagnates; because the supply will not be enough to satisfy the needs of society, there will be a steep increase in prices to filter those who are willing and able to buy. This exacerbates when supply starts to decline and demand increases (this will be further discussed in the following section IV.3 — Long-term demand).

Image 18: Global GHG emissions under different scenarios and the emissions gap in 2030 and 2035 $GtCO_2e$



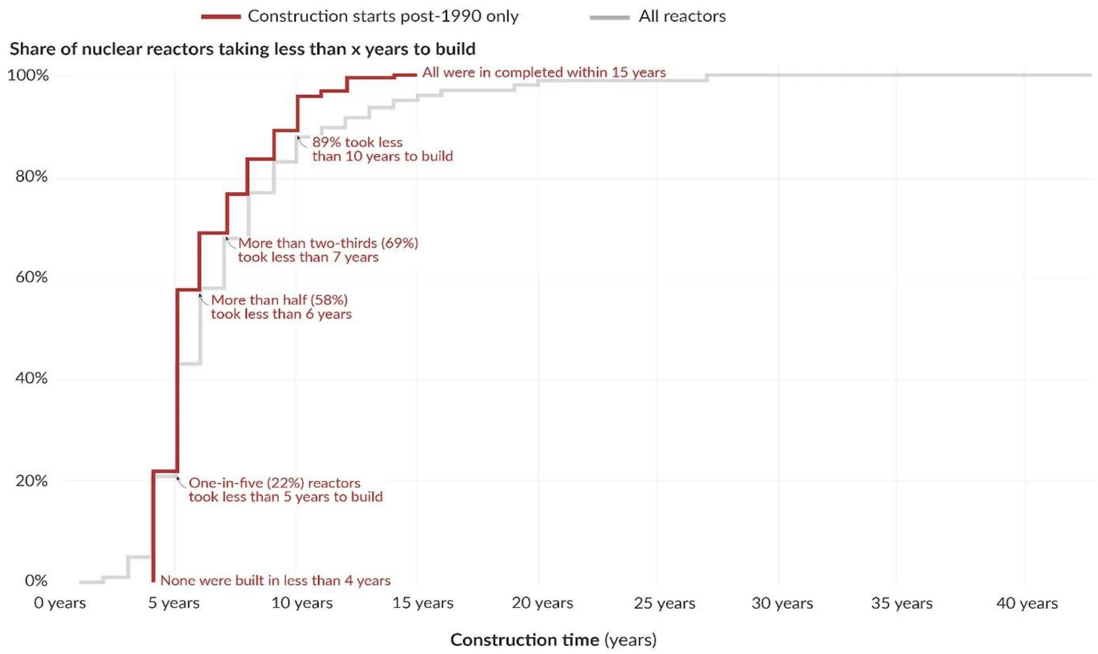
***Source**: United Nations (2025)*

In 2023, the COP28 was held, becoming the Largest United Nations (UN) Climate Change Conference ever held approximately 85,000 participants, including more than 150 Heads of State and Government; the conference concluded the first global stocktake of progress under the Paris Agreement, the verdict was that progress was insufficient across all areas of climate action, and, according to the UN, Global greenhouse gas emissions must be cut by 43% by 2030 relative to 2019 levels to keep the 1.5°C temperature limit within reach (UNFCCC, 2023), targeting to triple global renewable energy capacity by 2030.

Image 18 plots global GHG emissions trajectories from 2015 to 2035 under four scenarios — current policies, unconditional NDCs, conditional NDCs, and the 1.5°C and 2°C compatible pathways — and projects the resulting emissions gap in both 2030 and 2035. Governments subject to binding climate commitments and facing persistent non-compliance will face increasing pressure to deploy every available firm, zero-carbon generation technology. Nuclear energy, as the second lowest emission rates (Image carbon-free source currently available at gigawatt scale, is structurally favored by a widening emissions gap — a dynamic already observable in the policy instruments enacted since COP28, from US executive orders on nuclear capacity to China's 15th Five-Year Plan and the European Commission's inclusion of nuclear in its sustainable finance taxonomy. On account of its positive attributes aforementioned, especially its low emission rate, the emission goal will favor nuclear energy's usage.

Worth noting is its construction time: building nuclear reactors requires a tedious and timely process for the reason that it is shaped by complexity, regulatory licensing, approval, etc. According to Oxford affiliated researcher Hannah Ritchie, in her report *How long does it take to build a nuclear reactor?*, a nuclear reactor takes approximately 6 to 8 years to be built, considering only construction time and ignoring planning and design, but when you add in, planning and licensing (2 to 5 years); design and engineering (3 to 4 years), and, lastly, testing and commissioning (1 to 2 years), this process can be from 10 to 15 years (Petukhov, 2024). There are currently 80 projects under construction, and if no delays occur, all of 80 projects under construction — spanning 15 different countries — are set to finish from 2026-2033, fueling mid-term demand, with an additional "120 power reactors with a total gross capacity of about 110 GWe are planned, and over 300 more are proposed". Those planned are estimated to take 15 years, while the latter has an uncertain timing (WNA, 2026).

Image 19: Time to build a nuclear reactor



***Source**: Hannah Ritchie*

As the current nuclear reactors will finish in a range that will fall within the mid-term demand. Given that, there will be a rising need for supply that is not currently available in the market; meanwhile, demand will increase, causing prices to increase.

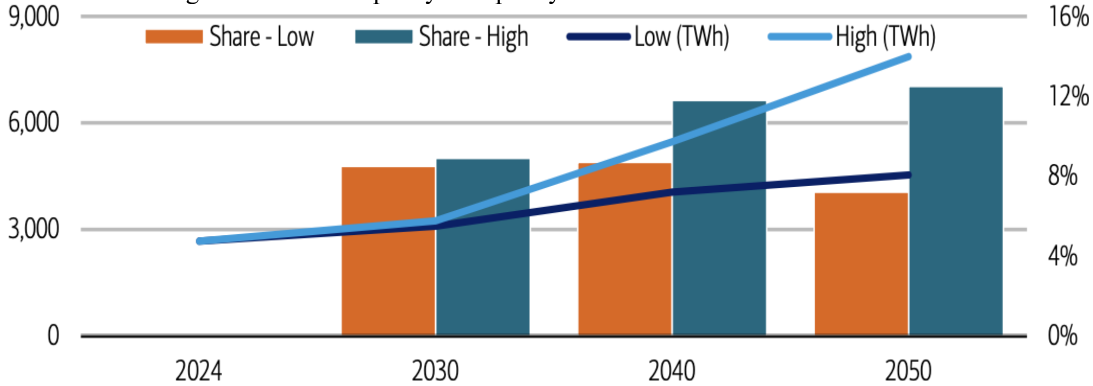
Thus, medium-term demand is underpinned by an expanding global reactor fleet concentrated increasingly in China and India, a wave of SMR deployments beginning to reach commercial scale, lifetime extensions sustaining output from the existing fleet, and a technology-driven surge in electricity consumption from AI and data centres that is structurally biased toward continuous, carbon-free baseload power. Moreover, there is an ongoing demand for uranium that the total supply cannot fulfill (Image 17). As a result, as Image 16 makes evident, is a widening and persistent gap between projected demand and available supply through 2040, with over 3 billion pounds of utility requirements still lacking secured contracts and a restocking cycle yet to fully take place. In sum, the status quo positions the 2030–2035 period as a rising deficit caused by excessive demand, leading to a shortage in the market.

III.4 — Long-Term Demand (2035-2050)

Of course, the long-term demand is, insofar, speculative, but looking at it through the correct lens, a largely discernible path is identifiable. The long-term demand will be underpinned by increased electrification (especially with population levels reaching approximately 9.7 to 9.8 billion by 2050, per the UN); the progressive commercialization of Small Modular Reactors (SMRs) and their integration into AI and data centre infrastructure and demand; the structural price-inelasticity of uranium demand itself, which insulates this demand trajectory from the market corrections that typically interrupt commodity cycles; and — most remarkably — world-wide emission goals established by the COP28, tripling commitment and subsequent national programs.

The COP28 2050 emission goals are much more ambitious than the 43% by 2030: trajectory aims to put the world on track to reach global net-zero emissions by 2050 (European Commission, 2023). With major energy transition commitments from fossil fuels in energy systems (UNFCCC, 2023), 25 nations committed to tripling global nuclear capacity by 2050 relative to 2020 levels — targeting approximately 1,200 GWe, and tripling nuclear capacity implies sustained annual newbuild of approximately 18 GW through 2040.

Image 20: Nuclear capacity to triple by 2050 in the most ambitious scenario

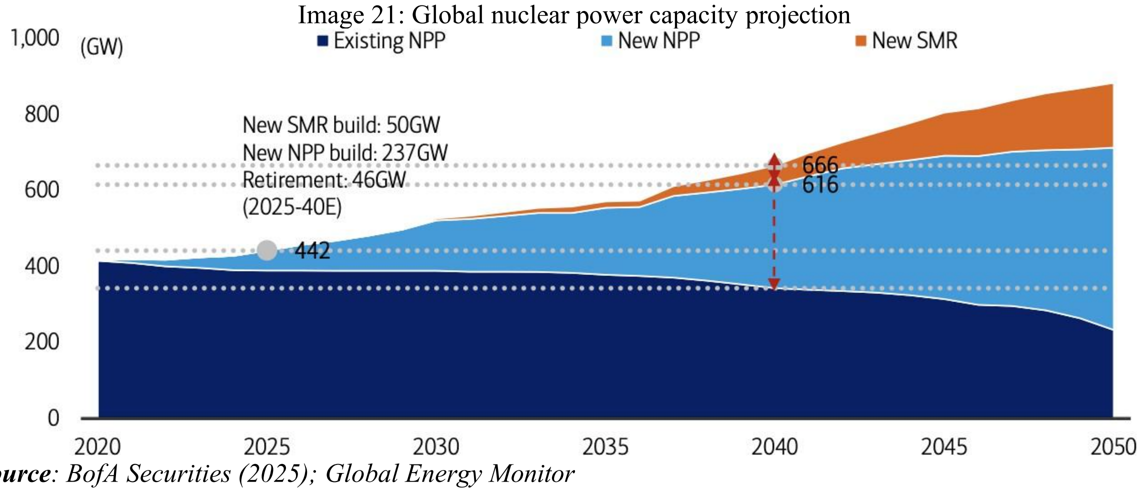


Source: *BofA Securities (2026); IAEA*

Evident in Image 20, IAEA has its high case nuclear generation projection reaching approximately 8,000 TWh by 2050, with nuclear's share of global generation rising to 13%, whereas under the low scenario, generation reaches approximately 4,500 TWh, but nuclear's share of total global generation declines to approximately 7% — reflecting absolute capacity growth alongside even faster expansion of other generation sources (IAEA, apud BofA Securities, 2025). Granted, the disparity between the two scenarios widens materially after 2030, underscoring that nuclear's trajectory on the contribution to the global energy matrix is not yet determined and remains highly sensitive to policy execution, financing conditions, and regulatory environment.

The WNA's *World Nuclear Outlook Report* (2026) finds that total global nuclear capacity could reach 1,446 GWe by 2050 if government targets and project pipelines are delivered, surpassing the 1,200 GWe COP28 tripling target. Five countries alone, China, France, India, Russia, and the United States, would account for nearly 980 GWe of that total. Newcomer nuclear nations add a further 157 GWe of ambition, signaling that nuclear expansion is no longer confined to traditional operators.

Image 21: Global nuclear power capacity projection



Source: *BofA Securities (2025); Global Energy Monitor*

Image 21 accounts for other nuclear technology types, introducing the SMR contribution, which accelerates sharply from approximately 2035 onward, accounting for a growing and eventually substantial share of total capacity additions through 2050. BofA projects approximately 237 GW of new large-scale NPP capacity and 50 GW of new SMR capacity built between 2025 and 2040, against 46 GW of retirements — a net addition of approximately 241 GW over the period, bringing total installed capacity from 442 GW in 2025 to 666 GW by 2040 under the central case, with 616 GW attributable to NPPs alone (BofA securities, 2025). Importantly, achieving this trajectory demands a dramatic and sustained acceleration in construction rates. The WNA projects required annual grid connections scaling from 14.4 GWe per year in 2026–2030, to 22.3 GWe in 2031–2035, to 49.2 GWe in 2036–2040, and ultimately 65.3 GWe per year in 2046–2050 — roughly double the historic peak build rate recorded in the 1980s (WNA, 2026). This escalating requirement underscores that the long-term demand outlook is not merely a function of policy ambition, but of whether the global nuclear industry can develop the manufacturing capacity, supply chains, workforce, and regulatory throughput to match it.

The commercial momentum behind Small Modular Reactors has accelerated markedly over the 2023–2025 period, driven by a convergence of technology readiness, policy support, and a new class of corporate buyer entering the nuclear market directly. BofA's Cleantech team estimates the US SMR market alone could reach approximately US$1 trillion by 2050, with roughly 50 GW of new SMR capacity expected to be built globally between 2025 and 2040 — a volume that, while modest relative to the conventional large-reactor pipeline, represents an entirely new demand tranche with distinct fuel cycle characteristics (BofA Securities, 2025).

The primary driver of this acceleration is the hyperscaler sector: Microsoft, Amazon, Meta, and Google have all signed or committed to nuclear Power Purchase Agreements in pursuit of 24/7 carbon-free baseload power for their AI data centre infrastructure — a requirement that intermittent renewables cannot meet without prohibitively expensive storage solutions (BofA Securities, 2025). The quintessential transaction in this emerging market is Microsoft's investment discussed previously, a deal that signaled to the broader market that investment-grade technology companies were prepared to underwrite nuclear generation at scale and at long tenors, dramatically de-risking the offtake side of future nuclear projects. These companies are not only major investors, deploying billions of dollars in, for instance, the nuclear sector, but they are, in addition, a major influence around the globe, as a consequence, their capital commitments to nuclear energy carry a signaling effect that extends well beyond the individual transactions themselves — when they simultaneously move toward nuclear, these companies effectively validate the technology's commercial viability for an entire ecosystem of institutional investors, project developers, and policymakers who had previously regarded nuclear as a utility-sector asset class unsuitable to private capital markets.

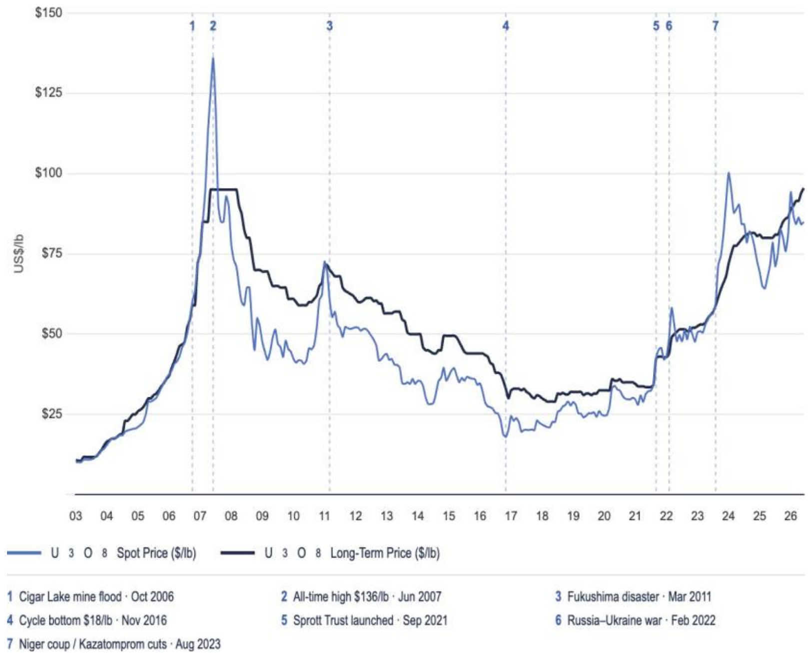
National nuclear capacity goals to 2050 already exceed the global tripling target, reflecting strong alignment between national objectives and global decarbonization needs — yet 542 GWe of that ambition remains without identified projects, and achieving it will require unprecedented construction rates, strategic lifetime extensions, and significant policy and market reforms (WNA, 2026). If nations deliver on their commitments, nuclear power would play a critical role in ensuring secure, affordable, and net-zero-compatible energy for a rapidly expanding and electrified global economy, underpinned by a uranium demand base that is sovereign in character, price-inelastic by structure, and increasingly validated by hyperscaler capital.

IV — Uranium Supply

This section will examine the structural configuration of global uranium supply (its geographic concentration, producer dominance, and inherent inflexibility) alongside the cyclical and deliberate dynamics that have shaped the current supply, and the systemic constraints that prevent supply from responding to demand at the pace the nuclear renaissance requires.

IV.1 The Supply Cycle (2008–2026): Understanding the Second Cycle

Image 22: Uranium price history — key market events



***Source**: Graph elaborated by author utilizing current Cameco data*

Understanding the current supply environment requires a brief account of how it was created. Following the 2007 uranium price rally, driven by speculative buying and optimism over the post-Kyoto conference on nuclear energy, global annual uranium production grew by more than 40% between 2008 and 2016, rising from approximately 44 kt U to 63 kt U at a 5% — compound annual growth (CAGR) — even as post-Fukushima demand stagnated and utility inventories accumulated. The expansion of Kazakhstan's low-cost in-situ recovery (ISR) operations accounted for roughly 80% of this growth, taking Canada's position of largest producer in 2009 (WNA, 2026), with Kazakhstan's share of global supply rising from approximately 19% in 2008 to 39% by 2016 (UBS, 2025).

Peaking in 2016 as prices continued to weaken, annual uranium production peaked in 2016. Major producers shifted their operation dynamics from volume and market share maximization toward margin preservation and long-term market rebalancing: Kazatomprom adopted a formal "value over volume" approach; Cameco placed McArthur River into care and maintenance between 2018 and 2022, while simultaneously purchasing cheap spot material to fulfill contracted deliveries; Rabbit Lake was curtailed in 2016, and US ISR operations were idled in 2017, together removing approximately 20% of 2016 annual supply from the market (UBS, 2025; Decouple Media, 2026).

The supply discipline exercised by the major producers between 2016 and 2022 was a deliberate strategy to exhaust secondary supply buffers, tighten the market, and create the conditions under which utilities would be compelled to negotiate long-term contracts at meaningfully higher price levels. Currently, Kazatomprom still employs such approach, signaling a further approximately 10% production reduction for 2026 against subsoil use agreement capacity, and UBS estimates Cameco's realized output this decade at 26–27 Mlb annually against a licensed capacity of 32 Mlb per year — withholding of approximately 5 Mlb per year from a market where every Mlb of uncovered demand matters (UBS, 2025).

IV.2 Supply Fragility

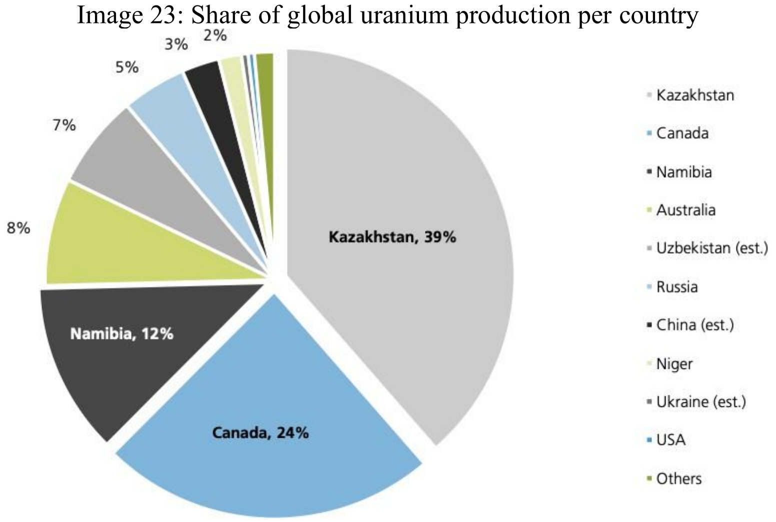
Operational risks well beyond deliberate producer discipline. Operational risks at individual mines have proven material and recurring in uranium mining. In 2026, Cameco's McArthur River was shut down for nearly a month following flooding and the destruction of the Smoothstone River Bridge in Saskatchewanproducing approximately 18 Mlb U_3O_8 annually, or roughly 10% of global supply (WNA, 2026). Furthermore, an increasingly significant systemic risk is the supply chain's dependence on sulphuric acid, the primary

chemical solvent in Kazakhstan's ISR operations, and geopolitical risks: according to the Atlantic Council (2026), nearly half of total sulfur supply transited through the Strait of Hormuz, causing sulphur prices to rise an additional 122%, prior to the Iran war (Chemical & Engineering News, 2026); underinvestment and long development timelines cause supply to be inelastic, unable to adjust to spikes of demand, while underinvestment post- nuclear disasters, of course, cause lower levels of production. The 2011 Fukushima accident, for example, led to years of underinvestment in exploration and new mine development. Bringing new uranium mines online involves complex regulatory reviews and permitting processes that can take a decade

or more (WNA, 2025); in addition, the fuel cycle runs from Kazakhstani mines through conversion, enrichment, and fabrication before reaching a reactor, any disruption at any node (bridge collapse, material shortage, sanctions on Russian enrichment). Lastly, geopolitical constraints and monopolies make supply highly volatile due to major companies and countries dominating global uranium supply, exposing uranium to sudden supply disruption.
Hence, uncertainty in uranium supply drives prices upward and increases market volatility, causing noisy signals that lead to market inefficiency, as firms often misallocate by misinterpreting price fluctuations. Under that uncertainty, firms would rather buy at that spot price than wait, causing prices to rise.

IV.3 — Geographic Concentration and Producer Dominance
Global uranium mine supply is characterized by a degree of geographic and producer concentration that has no close parallel among major industrial commodities. Approximately 75% of global production originates from three countries — Kazakhstan (39%), Canada (24%), and Namibia (12%), evident in image 23 — while the top five producers by equity

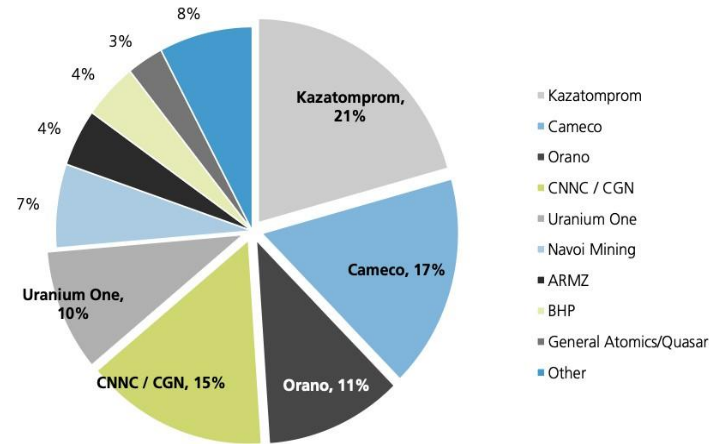
Image 23: Share of global uranium production per country



Source: *WNA, UBS (2025)*

output account for a further 75% of global volume, with Kazatomprom (21%), Cameco (17%), CNNC/CGN (15%), Orano (11%), and Uranium One (10%) together controlling the overwhelming majority of global supply, creating a monopoly and, thus, resulting in higher prices (WNA, apud UBS, 2025). As illustrated in Images 23, the top ten operating mines account for approximately 59% of global supply, with the top ten reserves and resources representing 74% of the world's recoverable uranium base.

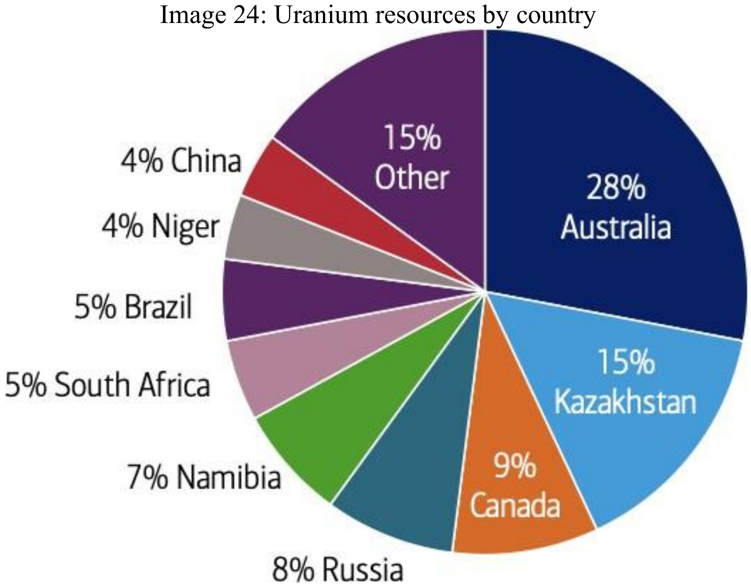
Image 23: Share of global uranium production per company



***Source**: WNA, UBS (2025)*

This concentration reflects the combined effect of geological scarcity of large uranium deposits. As a consequence, global uranium supply is materially more vulnerable to disruptions (operational, political, logistical, or sanctions-related) than a commodity whose production is geographically dispersed, such as agricultural production. For instance, a single disruption in the production dynamics from Kazatomprom, which controls more than a fifth of global supply (image 23), moves the market in ways that no individual producer is able to. Because establishing mines takes years and extracting and enriching uranium takes enormous amounts of effort and energy, its production may span from months to years, thereby, resulting in an inelastic supply, not allowing producers to immediately respond to demand shifts, causing severe price volatility.
Image 24 introduces an additional problem to supply of uranium: that is, uranium production is a highly complex, capital-intensive, and strictly regulated process due to the metal's low natural ore grades, specific chemical reactivity, and strict environmental and international safety standards (WNA, 2017).

Image 24: Uranium resources by country



***Source**: BofA (2025); WNA*

This explains the discrepancy between large holders of uranium that are essentially low producers, compared to the amount they hold of the mineral — such as Brazil and Australia.

IV.4 — Future Supply

The near-term supply will be underpinned by the reactivation of a previously developed industrial site and by the increase of mining by companies. Driven by three principal sources (Kazatomprom's Budenovskoye expansion in Kazakhstan, Cameco's McArthur River and Cigar Lake returning toward nameplate capacity in Canada, and Paladin's Langer-Heinrich and CNNC's Husab restarting in Namibia after extended care-and-maintenance periods), UBS projects mine supply growing by 6% (compounded annual growth) between 2025 and 2030. Nevertheless, these restarts may carry executions risks that the market has repeatedly underestimated; UBS estimates Cameco's realized output this decade at 26–27 Mlb annually against a licensed capacity of 32 Mlb per year, while Kazatomprom has signaled a further approximately 10% production reduction for 2026 against subsoil use agreement capacity, compounded by sulphuric acid availability constraints driven by Strait of Hormuz geopolitical disruption (UBS, 2025; Citi Research, 2026).

Additionally, the IEA further projects global data centre electricity generation exceeding 1,000 TWh by 2030, with nuclear already supplying approximately 20% of US data centre electricity demand and its share set to rise as corporate PPAs translate into active fuel procurement (IEA, 2025).

Thereby, supply will gradually increase, but will not be sufficient to meet the demand until 2031 and 2032 (image 17), causing a shortage in the market. As a consequence, producers will need to increase prices. The market's inability to self-correct through conventional price mechanisms reflects uranium supply's inelastic short-run supply curve. The adjustment therefore falls almost entirely on the supply side, requiring prices to rise not merely to incentive levels but sufficiently above them to compensate producers for the execution risk, regulatory uncertainty, and long capital commitment that greenfield development demands.

The medium and long-term supply outlook across 2030-2040 is defined by a structural deficit, not constituted by insufficient resources, but by an industry incapable of increasing production levels to meet the market's equilibrium demand.

The 2030–2035 period marks the point where existing mines' upheaval from its increasing momentum that characterizes the near-term supply, but supply begins to contract and the market becomes dependent on new mine development for incremental volume after 2032, according to image 17. This transition is structurally more demanding for producers because projects require sustained price incentives at approximately US$100/lb to attract the capital commitments necessary for final investment decisions. These regulatory processes have historically extended well beyond initial timelines, and a specialized technical workforce was deliberately allowed to atrophy during the post-Fukushima rationalization period (UBS, 2025). The projects most likely to contribute in this period are heavily concentrated in Canada's Athabasca Basin; in other words, the geographic diversification of supply that Western buyers require for energy security purposes is not materially advancing even as volumes grow.

In 2035, mine supply peaked at approximately 255 Mlb in the mid-2030s before declining toward 195 Mlb by 2040. Because industry capital expenditure and exploration efforts were kept low during the extended low-price period, the new development projects are now insufficient to replace maturing operations at the pace demand requires, as uranium in those past mining areas are now scarce (UBS, 2025).

Therefore, uranium supply is constrained by the speed at which it can be mobilized, not by its resource capacity. Prices will need to rise, remaining elevated, sufficiently above incentive levels to compensate producers for the execution risk, regulatory uncertainty, and long capital commitments that new mine development demands. That said, predicting future supply in commodity markets is extremely difficult due to supply being supported by external factors, such as geopolitical shocks, supplier capacity, weather, etc, rather than human behavior, whereas demand relies on human behavior that is majorly constant, anticipating how much consumers want, supply forecasting determines if, when, and how a company can actually build and deliver it.

V — Microeconomic Implications of Implementing Nuclear Reactors

This section scrutinizes the microeconomic consequences of nuclear reactor implementation at the level of households, firms, and local communities, discussing the impact on household electricity costs and the cost-recovery mechanisms that determine who bears the capital burden; the local economic effects of plant construction and operation on employment, income, and municipal finances; and the role of risk perception as a microeconomic distortion that shapes willingness to pay, property values, and the political economy of siting decisions.

As of June 2026, the IAE estimates that there are approximately 655 million people still living without electricity, being not only a prerequisite to achieve many of the UN Sustainable Development Goals but a social mobility. Nuclear energy additionally supports economic growth by providing people with well-paid jobs, especially in developing countries, stimulating investment in infrastructure and education and producing strong multiplier effects throughout national economies (WNA, 2021).

V.1 — Household Costs

For nuclear power, at least 60% of its levelized cost is composed of its capital upfront cost (that is, the cost of building the nuclear reactor), while fuel and operations are comparatively trivial (WNA, 2026). The consumer, thus, pays not for electricity generation but for construction execution and financing terms that were constituted by decisions years ago. Furthermore, uranium has a uniquely high energy density, a single fuel pellet roughly the size of an AA battery holds as much energy as a ton of coal. Because the fuel lasts for 1.5 to 2 years before needing a refill, power plants are highly insulated from the fuel shocks and price swings associated with natural gas or coal (U.S Department of Energy, 2021). As a consequence, households are less subject to variations in price of their electricity bill. Stable electricity prices largely impact those from low-income households, as they spend a larger proportion of their income on electricity. A less volatile electricity bill may influence consumer behavior by increasing household spending, as reduced uncertainty about future energy costs can lower precautionary savings and encourage greater consumption of other goods and services. However, because their electricity expenditures are not contingent on rise or fall as much, the reduction in real disposable income is limited, and they have less need to adjust consumption or conserve electricity. Lastly, nuclear energy generates continuous, undisrupted power, withstanding any climate change (regardless of sun, wind, or seasonal changes) whatsoever, benefiting firms whose production processes cannot tolerate interruption, such as those in the semiconductor fabrication industry, hospitals, and now AI data centres, place a high value on guaranteed continuous supply.

In the five leading nuclear power economies (France, US, Canada, China and Russia), nuclear energy consumption exerts a significantly positive effect on the load capacity factor (LFC) — the ratio of biocapacity to ecological footprint, as a supply-side measure of environmental quality (Tang et al., 2024). Taking into account, nuclear energy benefits extend beyond household cost: although nuclear energy is not a positive externality of production, it is a positive externality of consumption, meaning that the total benefit to society from consuming the energy is greater than the private benefit enjoyed by the individual consumer or utility company, impacting society in a positive manner due to its low-carbon emission, whereas fossil fuels, for example, are both a negative externality of consumption and production.

V2 — Local Benefits

The creation of new nuclear energy plants does not only impact households through a more reliable energy source, but generates jobs and engenders economic growth in local regions. Nuclear plants last from 60 to 80 years, creating a long stream of payroll, procurement, property tax revenue, and infrastructure investment for the local community. For instance, the Ginna plant contributes more than USD 350 million annually to the western New York economy and approximately USD 450 million to the broader US economy, while directly employing around 700 permanent staff on an annual payroll of approximately USD 100 million.

Every 18 months, refueling and maintenance cycles generate a further 800 to 1,000 temporary positions, and secondary employment adds another 800 jobs to the local economy (WNA, 2026). Ginna's payroll of USD 100 million across 700 workers implies an average compensation of roughly USD 143,000 per employee, well above the median for the region. Although it may place upward pressure on prices (in particular local markets, especially housing, restaurants and services whose supply cannot expand quickly), this increasing demand supports housing markets, retail, and services at levels that equivalent employment in most other sectors would not, contributing to a tax base concentration that fuels schools, infrastructure, and services at levels far above what comparable towns without plants can afford. The Indian Point, for example, contributed USD 30 million annually in state and local property taxes. Moreover, in the long-term, additional housing construction, business entry, labour-force growth and commuting may moderate these pressures, albeit to an extent that depends on local supply conditions.

VI — Macroeconomic Effects of Implementing Nuclear Energy

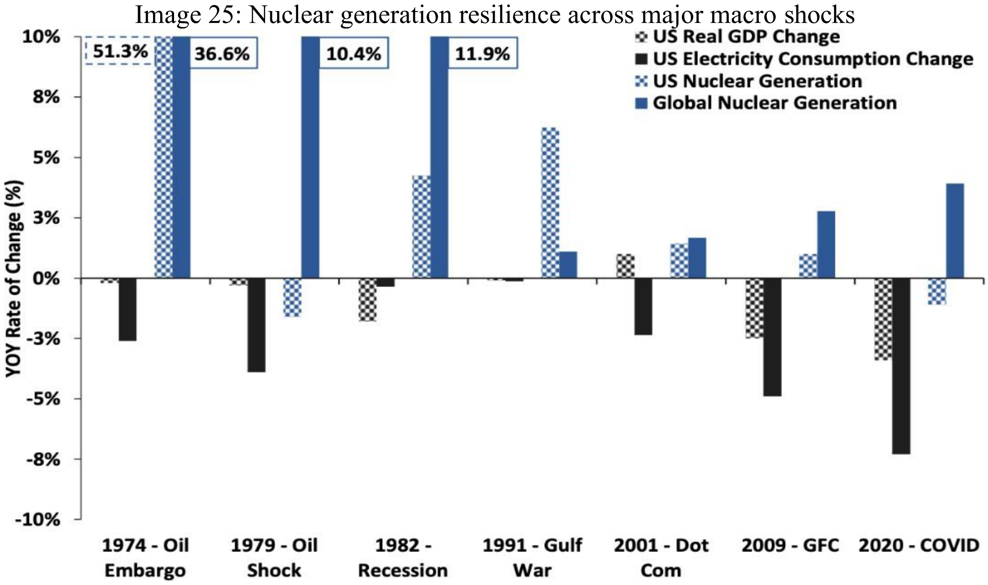
This chapter will analyze how nuclear energy consumption affects nations, politics and states, discussing key macroeconomics effects on an economy that are subject to the implementation of nuclear energy in a country, ranging from its effects on growth and inflation to geopolitical shocks, nevertheless, evaluating both the upside and downside nuclear energy offers and the conditions under which it is realized.

VI.1 — Reliability

Firstly, nuclear energy is resilient to energy shock supplies unlike any other energy. Across every major macroeconomic disruption of the past half-century (the 1974 oil embargo, the 1979 oil shock, the 1982 recession, the 1991 Gulf War, the dot-com bust, the 2009 GFC, and 2020 COVID) US electricity consumption fell in nearly every episode, moving accordingly with GDP; still, nuclear generation did not. Consequently, if a country allocates a robust underpinning in its energy matrix to nuclear energy, the economy of such a nation will be more resilient to supply shocks and will be less dependent on fossil fuels and other types of energy. It is worth noting that the sharp decrease in US Nuclear Generation and Global Nuclear Generation — from 1982 to

1991 — was due to the Chernobyl disaster (1986).

Image 25: Nuclear generation resilience across major macro shocks



Sources: WNA; US Bureau of Economic Analysis; EIA

As the country will remain more resilient to shocks, it will make avoid employment and labor market scarring; continue business investment continuity, as it will maintain its economic policy and the business will not be subject to sudden change, increasing consumer and business confidence; recessions increase government spending on unemployment benefits and social support, lowering unemployment insurance and social safety net strain; lastly, political and social stability, mainly recessions, are strongly associated with political polarization, populist movements, and social unrest. Ceteris parabus, an economy whose energy sector doesn't amplify a downturn, is, by extension, less likely to experience the compounding negative effects aforementioned during an energy-triggered shock.

Reliability also means not being subject to blackouts. Blackouts disrupt economies not only by the seconds it is out: widespread power outages can severely disrupt economic activity and temporarily bring substantial portions of the economy to a halt. Nevertheless, some of the output lost during the blackout may be recovered in subsequent days, particularly in specific sectors. Consequently, accurately assessing the economic consequences of nationwide blackouts requires consideration of both their immediate disruptions and their longer-term effects (University of Chicago, 2026). The 2021 Texas winter storm blackout, for instance, is estimated to have cost the state's economy over US$80 billion to US$130 billion (Federal Reserve Bank of Dallas, 2021). Given that, a grid anchored in a weather-independent nuclear baseload is structurally less exposed to the kind of correlated generation failure that occurs when renewable output and demand move in opposite directions during extreme weather.

VI.2 — Output and income multiplier

In 2021, the IAEA published a study titled *Assessing National Economic Effects of Nuclear Programmes*, with research teams from Indonesia all the way to Russia and South Africa, modelling the construction and the operation of a nuclear power plant against a no-nuclear baseline.

Every national study found that nuclear investment generates output gains exceeding the initial capital outlay. In Malaysia, the investment returned 24% of its initial total input, while in the Russian Federation, the cumulative ratio of gross output increase to total investment reached 3.82 over a 32-year construction-and-operation horizon (IAEA, 2021).

Beyond its direct contribution to electricity supply, nuclear energy generates substantial spillover effects across the broader economy, wherein construction spending flows to domestic suppliers of machinery, electrical equipment, and construction services. Subsequently, the thousands of workers hired for the project spend their wages elsewhere in the economy, generating further demand, creating market feedback through rising wages in a tightening labour market, lifting household income and consumption. In particular, Croatia raised the estimated GDP impact of construction from 0.35–0.40% (direct and indirect effects alone) to 0.75–0.81%, doubling the measured benefit (IAEA), while Indonesia's hypothetical two-unit plant was estimated to generate 840,198 person-years of employment across its ten-year construction period (IAEA)

Nuclear energy is, in fact, extremely expensive, with upfront financing and interest rates being critical variables.

However, an abundant share of financing, especially in emerging markets, comes from injections into the economy, with mainly the Barkah Nuclear Plants (UAE) and the Akkuyu Nuclear Plant (Turkey) being notable examples; the UAE accepted US$20 billion from South Korea in 2020 to build four nuclear plants (WNA, 2026), while the latter received US$20 billion from Russia, accounting for almost the entire cost (WNA, 2025).
Similarly, a country's trade balance is better off from such investment in energy because exports grow faster than imports, Poland's dynamic computable general equilibrium model found that from the year nuclear generation commences. A consequence of nuclear power raising the competitiveness of domestic industry by reducing dependence on imported fossil fuels for electricity generation (IAEA).
Hence, nuclear's energy presumably insurmountable financing question functions as a proxy that converts front-loaded foreign capital into decades of compounding domestic return; across every economy examined, regardless of size or development level, nuclear proved the big misconception about nuclear energy: it is, indeed, profitable and, ultimately, beneficial to any economy that instals it.

VII.3 — Inflation and the AI-Era Competition for Reliable Power

Notable is the implications of inflation beyond the household costs (addressed in chapter V.1 — Household Costs), which are driven by AI infrastructure, industrial electrification, and cooling demand, precisely as central banks remain constrained in their capacity to respond to price shocks without reigniting the growth-versus-inflation trade-off that has underpinned monetary policy since 2022; global demand for nuclear energy, as mentioned before, is increasing unprecedentedly. More than ever, volatile fossil fuels prices directly impact an economy's inflation, forcing a policy response, whereas an economy with fossil fuels will significantly mild such shock, gaining more economic stability. With interest rates already elevated and central banks wary of the credibility costs of policy reversals, the ability to absorb an energy demand surge without a corresponding inflation surge will allow economies to grow without major setbacks.
With the future of technology being mainly bolstered and composed of AI, the countries able to supply reliable, continuous baseload power are emerging as the decisive beneficiaries of a global data centre buildout, wherein there are estimates that investments will reach approximately US$5 trillion over the next five years (InfoMoney, 2026); Wells Fargo Securities notes that US Investment in information processing equipment surged more than 21% year-over-year in Q2 2025, fastest growth since 1984, with tech capital expenditure as a share of GDP already approaching the peaks recorded during the 1990s internet boom (Wells Fargo Securities, 2025).
In Brazil, in particular, Fundação Getulio Vargas (FGV) estimates a single 100 MW data centre adds R$ 1.5 billion to national GDP and R$ 590 million in labour income distributed across companies and labour, merely within 18 to 36 months (Info money; FGV, 2026). However, according to the Federal Reserve (Fed), data centers heat up the economy, causing major inflation in the short-run, augment real estate land prices and certain commodities: modelling the electricity component of personal consumption expenditures (PCE), in 2026, Dallas Fed researcher Owen Kay finds that if all currently proposed data centers were connected to the grid and fully utilized, the resulting surge in demand could add approximately 1.02% to annual PCE inflation by 2030, though under the bearish scenario it could range between 0.04 to 0.13 percentage points. Therefore, central banks should be cautious about mass spending in data centers. This highlights the importance of nuclear energy in the new era of technology. AI companies deeply rely on nuclear energy and will increasingly augment their share of nuclear energy consumption, but, as data center demand pushes total consumption higher, grid operators progressively make their prices more expensive; if economies do not invest in such energy, countries face a high chance of encountering an energy crisis in the upcoming years.
The price pressure has pervaded into housing markets, as data centers occupy large amounts of land. In Northern Virginia (the world's largest data center hub), data center companies offer ludicrous, enormous amounts of money for acres in order to assemble residential land for new facilities, with offerings of U$ 4.4 million per acre being recorded, compared to a median county value of U$ 125,000 per acre (National Association of Home Builders, 2026).
Taken together, there are clear inflationary risks associated with the AI-driven electricity demand surge. Although there is little empirical evidence, one can, nonetheless, attribute this inflationary pressure to data centers, as it largely consumes electricity, commodities, land, and even a large share of the job market. Nuclear energy does not solve the problem entirely, though; however, it mitigates the inevitable upcoming state of affairs—the rise of data centers.

VII.4 — Fiscal and Geopolitical Factors

Nuclear energy is exposed to a myriad of problems concerning its constructions. Nuclear projects are seldom delivered in their true cost and schedule, and because of its expensive nature, it now further involves political tensions that nuclear projects engender. American economics and MIT professor Paul Joskow notes that nuclear's cost always exceeds its initial proposed cost (IEEFA, 2024). Ranging from the most recent large-reactor projects built in Europe and North America, final capital costs escalated from original estimates by a

factor of between 1.7 and 3.4, and every one of these projects caused significant financial distress for the companies involved (IEEFA, 2024).
Furthermore, among the world's twenty-five largest nuclear utilities, approximately 60% are wholly state-owned and a further 13% are state backed or hybrid entities (Canaccord Genuity, 2026). Hence, nuclear energy is greatly influenced by state orders, with capacity decisions transcending the discretionary and becoming political. Evidently is China, that has utilized concessional state-backed loans to enable construction approval of roughly ten reactors annually since 2022, while Western governments have moved toward functionally similar tools (Canaccord Genuity, 2026). Consequently, as mentioned previously, countries may be subject to diplomatic tensions with nuclear projects, which could imply a nuclear bomb project merely disguised.
Given that these costs are funded by governments, they are, in turn, utilized through public finances, increasing government expenditure. For example, the French state fully nationalized its utility in 2022, absorbing its accumulated corporate debt onto the sovereign balance sheet, meanwhile subsidizing household electricity prices at a cost projected at $45 billion only in 2023 (WNA, 2026; IEEFA, 2024).

However, state ownership relocates fiscal risk; in a liberalized, merchant-market structure — such as Australia and parts of the US and UK markets — a cost exceed threatens commercial viability directly, forcing a subsidy decision by the government, whereas in a state owned (or heavily backed structure), the same overrun is absorbed more opaquely through contingent liabilities, stranded-debt write-off or a subsidy embedded in tariffs. Nevertheless, nuclear energy depends mostly on its execution, while, of course, its hold backs are still extremely relevant: with political risk playing a key role in nuclear restraints; fiscal risk, here, shows that its solutions are quite challenging, not being mitigated under its different ownership modifications.

VII — Conclusion

In sum, nuclear energy is not the ultimate solution, but it is a definitely a feasible and prominent one, given the not only the proliferation use of AI but the global surge in energy demand and the global concerns on sustainability, as it offers a sustainable, safe and efficient solution that no other energy is able to offer. What differentiates nuclear energy beyond any other energy type, though, is its economic footprint once installed, stabilizing household bills against the volatility that defines fossil-fuel-dependent grids; it becomes a pillar of local economies for a length of a plant's 60 to 80 year life, creating an enormous multiplier effect through decades. Moreover, nuclear energy stabilizes economies from recessions and energy shocks, functioning as a powerful hedge in the energy sector.

Through the demand side, it is no longer speculative or cyclical in the way it was during the 2007 peak. Rather, it is a contractual, and increasingly guaranteed by key decisions (reactors already under construction, extended licensing, etc), and, notably, the AI hyperscaler, signing multi-decade power purchase agreements that did not exist in the past decades, indicating that uranium is truly entering the second uranium cycle.

The supply side, however, will not be able to keep up with demand, given the geographic and political constraints inherent to uranium supply, and as mine development takes 10 to 15 years from discovery to production, uranium production will fail to respond to fluctuations in demand, causing higher prices. Additionally, supply is concentrated in a small number of jurisdictions, leaving the market acutely exposed to supply disruptions; the latter has restricted development in certain regions and from advancing following disasters and accidents, withholding production and, in most cases, shutting down the mines.

Ultimately, nuclear energy offers what future economies will need the most in the upcoming years. It will help countries diversify their energy matrix into a more sustainable one. Nuclear energy is inseparable from its caveats, though; the benefits of nuclear energy are conditional on execution, from the engineering working on it to the mine that fuels such a plant. Cost exceedance, regulatory delays, underinvestment, and political bottlenecks are embedded in the generation of nuclear energy. On that basis, nuclear energy will reshape the energy industry, and those nations serious with this type of energy will largely benefit from it.

Work Cited

[1]. Bernstein, Paul I., and Nima Gerami. Proliferation Risks of Civilian Nuclear Power Programs. National Defense University, 2012.
[2]. BofA Securities. Thematic Investing: I've Got the Power — Nuclear Energy. BofA Global Research, 16 Sept. 2025.
[3]. BofA Securities. Thematic Investing: Step Inside a Nuclear Fusion Reactor. BofA Global Research, 22 May 2025.
[4]. BofA Securities. Transition Investing: The ABCs of Transition Investing. BofA Global Research, 30 Sept. 2025.
[5]. Cameco Corporation. "Uranium Price." Cameco. Accessed 16 Aug. 2026.
[6]. Canadian Nuclear Safety Commission. "Radiation Doses." CNSC. Accessed 16 Aug. 2026.
[7]. Canaccord Genuity. Uranium & Energy Security: Front Row Centre. Canaccord Genuity Corp., Industry Update, 13 Apr. 2026.

[8]. Chemical & Engineering News. "Sulfuric Acid, Sulfur, Fertilizer, and the Iran War." C&EN, vol. 104, May 2026.
[9]. Constellation Energy Corporation. Form 8-K. U.S. Securities and Exchange Commission, 20 Sept. 2024.
[10]. Corporate Finance Institute. "Energy Return on Investment (EROI)." CFI. Accessed 16 Aug. 2026.
[11]. Federal Reserve Bank of Dallas. "Article Title." Dallas Fed Economics, 15 Apr. 2021.
[12]. Gevorkyan, Arkady, et al. Global Commodities Multi-Asset. Citi Research, Citigroup Global Markets Inc., 2 June 2026.
[13]. Global Energy Monitor. "Nuclear Outpaced Fourteen to One by Wind and Solar in Europe." Global Energy Monitor. Accessed 16 Aug. 2026.
[14]. IBM. "O Que É o Custo Nivelado de Energia (LCOE)?" IBM Think. Accessed 16 Aug. 2026.
[15]. InfoMoney. "Data Centers Podem Trazer US$ 1 Tri Para o Brasil em 5 Anos, Projeta AZ Quest." InfoMoney, 2026.
[16]. Institute for Energy Economics and Financial Analysis. Nuclear in Australia Would Increase Household Power Bills. IEEFA, Sept. 2024.
[17]. International Atomic Energy Agency. Assessing National Economic Effects of Nuclear Programmes: Final Report of a Coordinated Research Project. IAEA-TECDOC-1962, IAEA, 2021.
[18]. International Atomic Energy Agency. "Under Construction Reactors by Country." Power Reactor Information System (PRIS). Accessed 16 Aug. 2026.
[19]. International Atomic Energy Agency. "What Is Nuclear Energy? The Science of Nuclear Power." IAEA. Accessed 16 Aug. 2026.
[20]. International Energy Agency. "655 Million People Still Living without Electricity Underscore Urgent Need to Deliver on Universal Energy Access Target." IEA News. Accessed 16 Aug. 2026.
[21]. International Energy Agency. "Demand." Electricity 2026, IEA, 2026.
[22]. International Energy Agency. "Overview and Key Findings." World Energy Outlook 2023, IEA, 2023.
[23]. Kay, Owen. "Data Center Boom Expected to Raise Electricity Component of PCE Inflation." Federal Reserve Bank of Dallas, 5 Mar. 2026.
[24]. Keefer, Chris. "Part 1: The Structural Bull: Why This Uranium Cycle Is Different." Decouple Media, Substack, 30 Apr. 2026.
[25]. Kwon, Ohsung. The Year Ahead: Hope in 1H, Bubble in 2H. Wells Fargo Securities, LLC, Equity Research, 20 Nov. 2025.
[26]. MIT Climate Portal. "Study: Shutting Down Nuclear Power Could Increase Air Pollution." MIT Climate. Accessed 16 Aug. 2026.
[27]. Morgan Stanley. Nuclear Energy Investment Outlook 2050. Morgan Stanley Research, 2024.
[28]. Morgan Stanley. Powering the AI Revolution: AI Energy Demand and Opportunity. Morgan Stanley Research, 2024.
[29]. National Association of Home Builders. "AI Data Centers Are Outbidding Home Builders for America's Land." NAHB, July 2026.
[30]. Petukhov, Boris. "How Long Does It Take to Build a Nuclear Reactor?" LinkedIn, 2024.
[31]. Ritchie, Hannah. "Nuclear Construction Time." Sustainability by Numbers, Substack. Accessed 16 Aug. 2026.
[32]. UBS AG. Uranium: Commodities. Prepared by Amy Yi Li, Lachlan Shaw, Myles Allsop, George Eadie, Daniel Major, Dim Ariyasinghe, Ethan Hong, Alex Stansbury, and Alisa Dudchak. UBS Global Research, 24 Nov. 2025.
[33]. University of Chicago, Climate Program. "How Do Blackouts Impact the Local Economy?" UChicago Climate. Accessed 16 Aug. 2026.
[34]. U.S. Department of Energy. "Holtec Palisades." Energy.gov. Accessed 16 Aug. 2026.
[35]. U.S. Department of Energy, Office of Nuclear Energy. "Nuclear 101: How Does a Nuclear Reactor Work?" Energy.gov. Accessed 16 Aug. 2026.
[36]. U.S. Energy Information Administration. "The Nuclear Fuel Cycle." Energy Explained. Accessed 16 Aug. 2026.
[37]. U.S. Nuclear Regulatory Commission. Reactor Concepts Manual. NRC. Accessed 16 Aug.
[38]. 2026.
[39]. World Nuclear Association. "Are There Different Types of Reactor?" World Nuclear Association. Accessed 16 Aug. 2026.
[40]. World Nuclear Association. "Carbon Dioxide Emissions from Electricity." World Nuclear Association. Accessed 16 Aug. 2026.
[41]. World Nuclear Association. "Nuclear Fuel Report 2023: Decarbonization Energy's Trump Card." World Nuclear Association. Accessed 16 Aug. 2026.
[42]. World Nuclear Association. "Nuclear Power Reactors." World Nuclear Association. Accessed 16 Aug. 2026.
[43]. World Nuclear Association. "Plans for New Reactors Worldwide." World Nuclear Association. Accessed 16 Aug. 2026.
[44]. World Nuclear Association. "Radioactive Wastes – Myths and Realities." World Nuclear Association. Accessed 16 Aug. 2026.
[45]. World Nuclear Association. "SDG1: No Poverty." Climate Change and Nuclear Energy. Accessed 16 Aug. 2026.
[46]. World Nuclear Association. "Supply of Uranium." World Nuclear Association. Accessed 16 Aug. 2026.