

The Future of Energy: A New Atomic Age?

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Diverse Energy Mix:

2025 dawns on an energy industry in flux. Significant technological innovations, dramatic policy reforms, shifting geopolitical dynamics, and accelerating climate goals are all driving change across an energy complex simultaneously coming to terms with a quantum leap in power demand. The rapid growth of Artificial Intelligence (AI) and its insatiable demand for energy required to power supporting data centers marks an inflection point for the energy industry and underscores the importance of energy reliability and security. Countries and corporations capable of fostering the flexibility to capitalize on a diverse mix of energy sources – embracing innovation while understanding the critical role traditional resources still have to play – will find success in this new paradigm.

Accelerating climate goals and ambitious government targets have been significant catalysts and, of course, quickened the steady march toward renewable energy sources qualified to meet expanding decarbonization initiatives. More than 80 countries are now committed to net-zero goals and an avalanche of capital is funneling to green projects, electrification, and energy efficiency. Wind power generation is expected to grow at a record rate through 2025, as is solar, which is projected to double its global capacity by year-end.¹

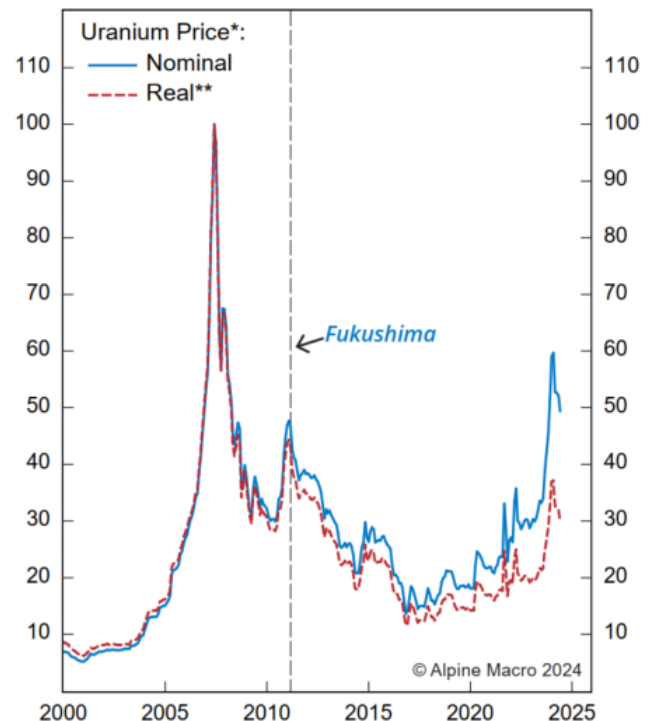
Traditional fossil fuels, however, still account for more than 75% of primary energy consumption today and play commanding roles in fueling the transportation and industrial sectors. Estimations for peak oil consumption continue to be pushed back (according to a new forecast from Vitol – the world’s largest independent energy trader, global demand for oil will not fall until at least 2040),² and fossil fuels are projected to meet the vast majority of global energy demand again in 2025.¹

Interestingly, a desire to achieve the at-times conflicting goals of decarbonization, robust energy security, and broad affordability (given the intermittent generation issues of wind and solar, storage difficulties, and relative expense of some renewable technologies) appears to have created a generational opportunity for nuclear energy after years of negative public perception globally. Following the disaster at the Fukushima Daiichi Nuclear Power Plant on March 11, 2011, Japan almost immediately suspended operations at 46 of the country’s 50 functional power reactors, eventually completing a total nuclear shutdown by 2013.³ To date, just 14 reactors have been restarted. Shortly after the accident, Germany announced plans to phase out nuclear entirely by 2022, Belgium followed suit with a 2025 end date, and dozens of expansion projects across Europe were canceled. Between 2011 and 2020, roughly 48 gigawatts of electric energy (GWe) in nuclear capacity were lost globally as a total of 65 reactors were either shuttered or did not have their operational lifetimes extended.³

But public perception of nuclear power has shifted meaningfully in recent years. The spike in pessimism, even fear, directed at the energy source has since turned to optimism as nuclear has become more broadly recognized as safe, scalable, efficient, carbon-free, and not intermittent – a singular solution for the transition to cleaner energy, the need to meet substantially increasing demand, and the imperative to maintain national security interests.⁴ Global support for nuclear energy is at an all-time high with 1.5x more

Chart 1¹¹

Uranium's Price Remains Below Historic Highs



*Average contracted prices of U₃O₈/yellowcake with estimates for latest December and January values
 **Deflated by OECD CPI
 Note: Both series are rebased to June 2007=100; source: IMF, Bloomberg Finance L.P., Alpine Macro

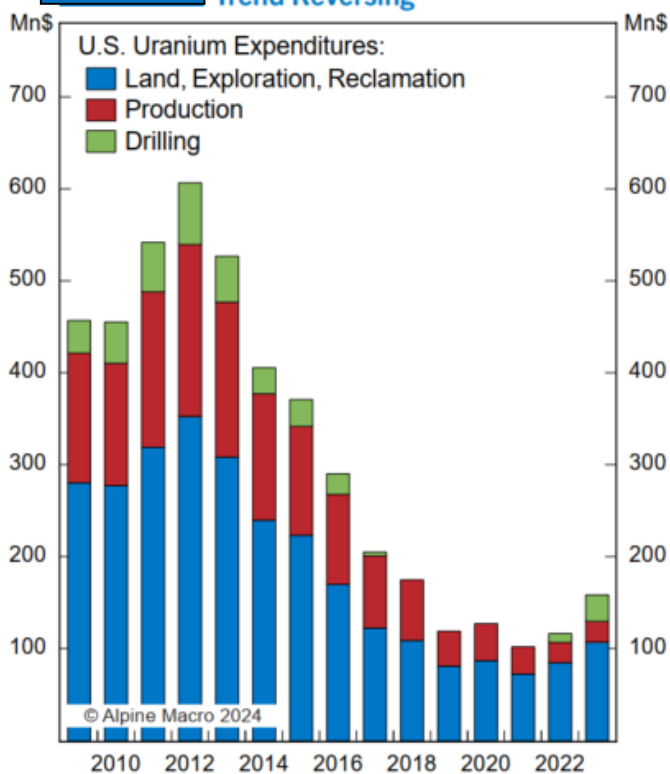
people supporting the use of nuclear energy than opposing it, according to a multinational poll conducted by market research firm Savanta.⁵ In many ways, a global nuclear renaissance is just getting underway with rising investment, new technology advances, and supportive policies in over 40 countries.⁶ A “super-cycle” bull market in uranium prices may lie ahead as demand vastly outstrips supply after a decade of underinvestment and inventory depletion following the Fukushima disaster, and the gulf between the two looks unlikely to narrow anytime soon.

Further discussion will focus on the uranium market and broader nuclear energy industry, but investors are reminded that the global energy stack will remain supported by a diverse mix of energy sources despite the exciting opportunities presented by nuclear at the moment. [It should be noted that the International Energy Agency (IEA) reported that coal-fired power generation reached an all-time high, remained the largest source of electricity globally, and accounted for over 35% of total electricity generation in 2024].⁷

The Nuclear Option:

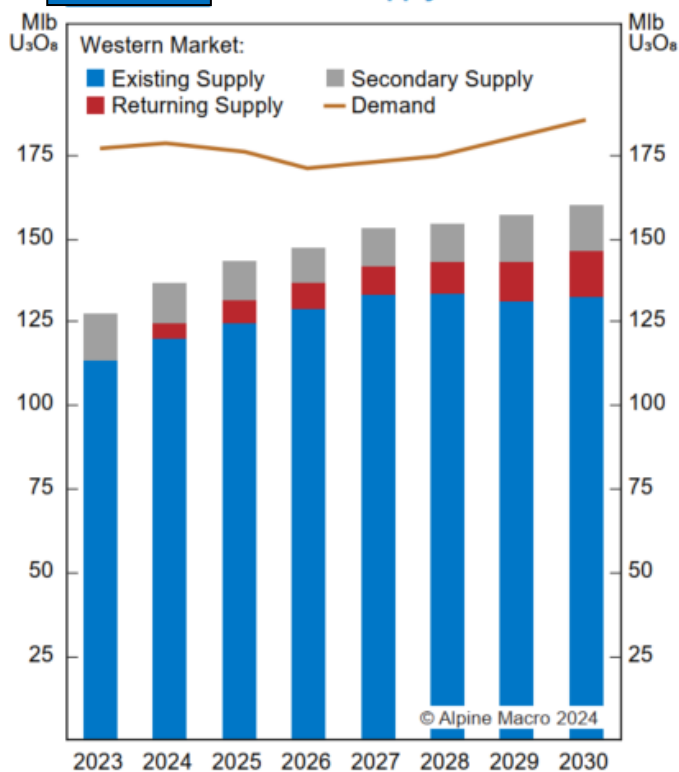
The impact of the Fukushima disaster cannot be understated: the viability of the industry was called into question, a third of all nuclear power reactors were closed, and a flood of supply led to a staggering collapse in the price of uranium of over 70%,⁵ ultimately bottoming at \$19.60/lb – a level at which at least 75% of the world’s production is unprofitable.⁸ However, after roughly a decade as the least-loved and worst-performing commodity in the world, the radioactive metal has emerged from its bear market as both governments and the public have realized its potential to improve energy security, satisfy growing demand, and meet the global urgency to decarbonize. Over the past five years, the price of uranium has increased over 230% - more than triple the gains in gold and copper even after a lackluster 2024.⁸

Chart 2¹¹ Declining Investment Trend Reversing



Note: Drilling, land, exploration and reclamation data withheld for 2018-20 by EIA to avoid disclosure of individual company data; source: EIA

Chart 3¹¹ Structural Supply Deficit



Note: Demand includes reactor requirements and secondary demand; supply does not include new mine developments; Western market excludes Russia Source: TradeTech, Uranium Market Study 2024: Issue 1

Despite the run, uranium’s rally is still in the early stages given a yawning structural supply deficit may persistently fall short of voracious and increasing demand. 22 countries recently pledged to triple nuclear power capacity by 2050 (an increase from 400 GW to 1,200 GW), and the global reactor fleet is rapidly scaling – over 61 reactors are actively under construction and more than 300 are in the planning/proposal phase.⁸ These include several high-profile partnerships and major investments made by tech giants pursuing a proven, scalable, low-carbon, “always on” energy source to power data centers: Microsoft’s partnership with

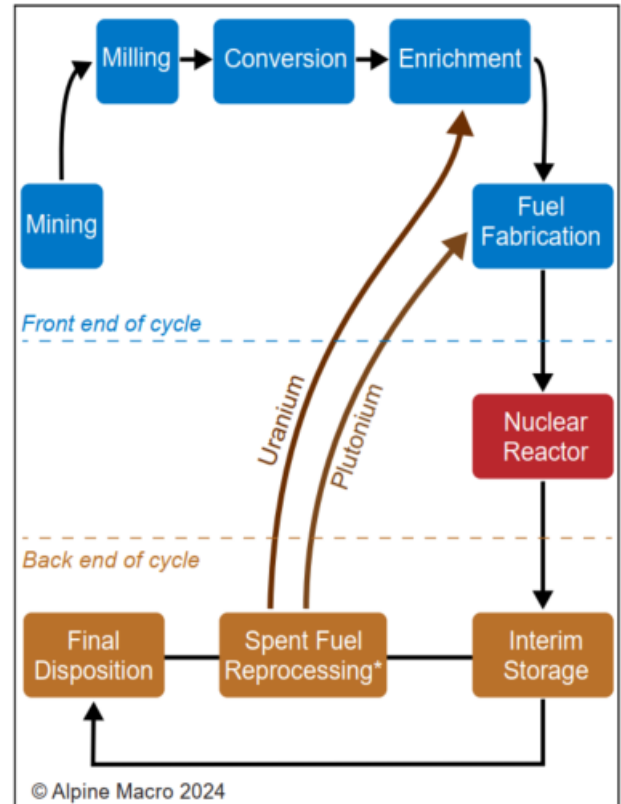
Constellation on carbon-free energy matching and the restart of Three Mile Island, Ubitus – a global leader in AI, cloud solutions plans to restart an existing nuclear reactor to power an AI data center in Japan, and Google, Meta, and Amazon have all made significant investments in small modular reactors (SMRs).⁹ Amazon’s capital investment in nuclear power now exceeds \$500 million across three projects from Virginia to Washington State.¹⁰ SMRs represent a pivotal innovation for nuclear energy, improving efficiency, safety, and waste reduction, and have proven particularly interesting to tech firms and data centers for their compact design and scalability.

Demand for uranium is booming, but the structural supply deficit is significant. Even when factoring in greenfield mine openings, secondary supply, and expected idle mine restarts, the annual shortfall will still range between 20-45 Mlbs in the short term and is slated to expand.⁸ Years of historically low exploration expenditures, persistent production expectation downgrades at key mining assets, long timelines – between eight and fifteen years – to develop new mines, and geopolitical rifts continue to plague miners, muddy supply chains, and limit nuclear power generation.⁸ The U.S. recently passed legislation that blocks imported Russian uranium, and Russia responded by banning enriched uranium exports to the U.S. This tit-for-tat atomic feud could be somewhat problematic given that 27% of the uranium used by U.S. reactors in 2023 was Russian enriched.¹¹ Although optimism abounds from Wall Street to Main Street with the stockpiling of uranium by financial buyers emerging as a new demand driver and 77% of Americans now supporting nuclear energy – a record high – according to the latest National Nuclear Energy Public Opinion Survey, the persistent structural supply deficit for the commodity may limit nuclear power generation for some time.⁸

Conclusion:

The global energy industry remains in the midst of a transformation, and all signs indicate nuclear power will play a monumentally more substantial role going forward, but numerous hurdles still stand in the way of a complete nuclear revival. Aside from the structural supply issues, other sources of energy like renewables continue to challenge for “green supremacy,” and fossil fuels remain the most significant source for primary energy consumption today. Many have suggested that the deregulation intimated by the incoming administration and President Trump’s stated goal of bringing energy prices down will clear some red tape in the permitting process for new mines and reactors, perhaps decreasing the timelines for new production, but only time will tell. Investors should focus on the facts that decarbonization efforts are largely driving policy, technology improvements are catalyzing innovation, and complex geopolitical dynamics are influencing energy markets. The energy stack will remain diverse and fluid, but nuclear offers tremendous upside for the industry, the country, the climate, and the world.

Chart 4⁸ Nuclear Fuel Cycle



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 *Spent fuel reprocessing is omitted from the cycle in most countries, including the U.S.
 Source: Pennsylvania State University Radiation Science and Engineering Center

Economic Definitions:

Risk Free Rate: The risk-free rate of return is the theoretical rate of return that an investor would expect on an investment with zero risk. Any investment with a risk level greater than zero must offer a higher rate of return.

Equity Risk Premium: Equity risk premium is the excess return that investing in the stock market provides over a risk-free rate. This excess return compensates investors for taking on the relatively higher risk of equity investing. The size of the premium varies and depends on the level of risk in a particular portfolio. It also changes over time as market risk fluctuates.

Index Definitions

S&P 500: The S&P 500® is widely regarded as the best single gauge of large-cap U.S. equities and serves as the foundation for a wide range of investment products. The index includes 500 leading companies and captures approximately 80% coverage of available market capitalization.

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¹ [Energy Intelligence 2025 Outlook | Energy Intelligence](#)

² [Vitol sees 2040 global oil demand little changed from current levels | Reuters](#)

³ [Nuclear Power 10 Years After Fukushima: The Long Road Back | IAEA](#)

⁴ https://alpinemacro.com/ags/February07_2024/The_Uranium_Bull_Has_Legs.pdf - Alpine Macro, February 7, 2024.

⁵ [Uranium Another Leg Up.pdf](#) – Alpine Macro, October 9, 2024.

⁶ [The Path to a New Era for Nuclear Energy – Analysis - IEA](#)

⁷ [Coal 2024: Analysis and forecast to 2027](#)

⁸ [Uranium A Nuclear Revival.pdf](#)

⁹ [Executive Summary – The Path to a New Era for Nuclear Energy – Analysis - IEA](#)

¹⁰ [Amazon goes nuclear, plans to invest more than \\$500 million to develop small modular reactors](#)

¹¹ [The Future Of Nuclear Energy And AI.pdf](#)