The Resurgence of Nuclear Energy

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As the global community intensifies efforts to combat climate change and secure sustainable energy sources, nuclear power has re-emerged as a pivotal component in the energy landscape. Its capacity to provide consistent, large-scale, low-carbon electricity positions it as a key player in achieving net-zero emissions by mid-century while supporting global energy security.

The dawn of a new Nuclear era

As of 2024, approximately 440 commercial nuclear reactors operate across about 30 countries, collectively contributing around 400 gigawatts (GWe) of total capacity. This accounts for roughly 10% of the world's electricity production according to the World Nuclear Association.

The International Atomic Energy Agency (IAEA) has observed a consistent upward revision in nuclear power projections over the past four years. In its high-case scenario, the IAEA anticipates a 2.5-fold increase in global nuclear capacity by 2050, with significant contributions expected from small modular reactors (SMRs) and advanced reactor designs.

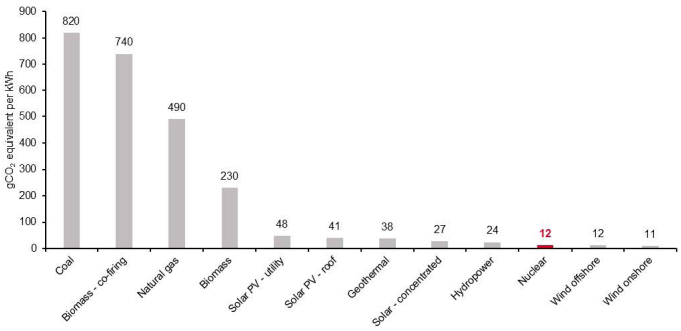
Currently, about 60 reactors are under construction worldwide, with notable projects in countries such as China, India, and Russia. These nations are leading the expansion efforts, reflecting a strong commitment to integrating nuclear energy into their future energy strategies.

Political commitment to nuclear energy is evident on multiple fronts. At COP28 (November 2023), nuclear energy gained renewed support as part of broader decarbonization efforts, while the Nuclear Energy Summit (March 2024) and the COP29 (November 2024) have further emphasized nuclear energy's role in achieving global net-zero goals.

A key role in Global Energy Transition

Nuclear energy's low carbon footprint and reliable generation make it indispensable in the global energy transition. It serves as a stable complement to intermittent renewable sources like wind and solar, ensuring grid stability and energy security. The IEA emphasizes that achieving net-zero goals and transitioning to clean energy systems will require doubling nuclear capacity globally.

Life-cycle emissions of electricity options



Source: IPCC, SG Cross Asset Research/Equity Strategy

Data Centers and AI: new drivers of Nuclear Energy Demand

The rapid expansion of data centers and AI technologies has led to a surge in energy consumption. The International Energy Agency (IEA) highlighted that data centers globally accounted for around 1-1.5% of total electricity consumption, and this share is expected to triple by 2030 due to the AI

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boom. AI-driven servers consume up to four times more power than standard servers, intensifying the energy demand and posing new challenges for grid stability.

To meet this growing demand sustainably, tech giants are turning to nuclear power as a reliable and carbon-free energy source. For instance, Microsoft signed an agreement with Constellation Energy to reopen the Three Mile Island nuclear plant, providing dedicated power for Microsoft's AI data centers. Similarly, companies like Amazon and Google are exploring investments in Small Modular Reactors (SMRs) to ensure energy resilience while meeting their sustainability goals.

Innovation shaping the Future of Nuclear Energy

Innovations in nuclear technology are poised to redefine its role in the global energy mix. Small Modular Reactors (SMRs) offer a compact and flexible alternative to traditional large-scale reactors. SMRs can be deployed in remote locations, require less capital investment (potential economies of scale), and are quicker to construct, making them ideal for powering industries, data centers, and smaller grids.

Fusion energy is also showing some promises. Projects like the International Thermonuclear Experimental Reactor (ITER) are advancing technologies to harness fusion, which replicates the process that powers the sun. Unlike fission, fusion generates minimal radioactive waste and has virtually unlimited fuel potential. Breakthroughs such as achieving net energy gain in fusion experiments signal that commercial fusion could potentially become viable in the coming decades.

Challenges: High Costs and Waste Management

The construction of nuclear power plants demands substantial capital investment, often leading to budget overruns and extended timelines. For instance, the expansion of Plant Vogtle in Georgia, USA, began in 2009 with an initial budget of $14 billion and an expected completion date in 2016. However, the project faced significant delays and cost overruns, with total costs now exceeding $30 billion according to U.S. Energy Information Administration.

Managing nuclear waste remains also a critical concern. The United States has accumulated over 90,000 metric tons of spent nuclear fuel from commercial nuclear power plants, with no permanent disposal solution in place. This amount continues to grow by about 2,000 metric tons annually. Nuclear waste, particularly high-level waste, poses a significant challenge because it remains radioactive and hazardous for thousands of years.

The current global outlook reflects a resurgence in nuclear power, driven by political commitment and technological innovation. As the energy transition accelerates, nuclear energy's role as a stable, low-carbon power source is indispensable. Efforts to streamline construction processes and to develop long-term waste disposal solutions are also key steps toward mitigating costs and enhancing the sustainability of nuclear power.