UBS Asset Management

Nuclear and the energy transition

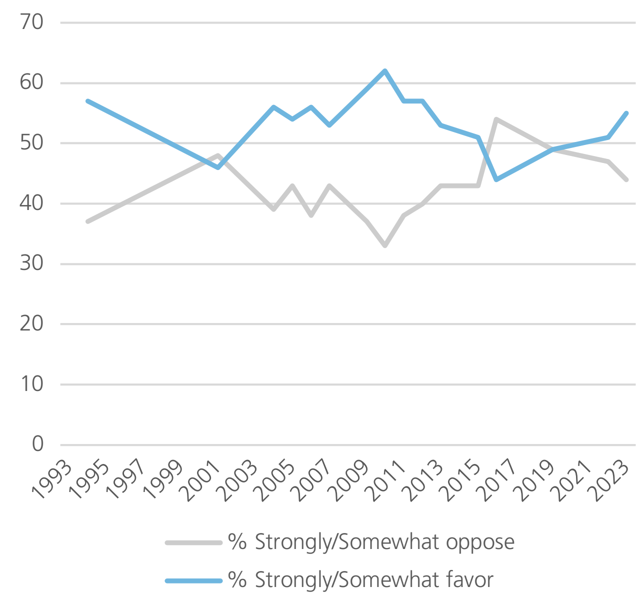
AI, small modular reactors and lessons learned from the lost decades

Nuclear renaissance … again?

Interest in nuclear energy has ebbed and flowed in the past few decades. We have seen several declarations of a "nuclear renaissance" during this period, depending on prevailing public opinion around carbon emissions, energy security and nuclear safety, as well as country-specific issues.

Once again, sentiment for nuclear energy appears to be on the upswing. In the United States, public support for nuclear is at a decade high (see Figure 1). In Europe, the Council of E.U. member states and the European Parliament have officially classified nuclear as a strategic net-zero industry.[1] Even Japan has restarted 12 nuclear reactors since the 2011 Fukushima disaster.[2]

Figure 1: U.S. public opinion on nuclear energy



Source: Gallup Poll, April 2023

The recent hype around generative AI and data centers[3] adds another facet to the nuclear debate. Amazon recently acquired a data center that is 100 percent powered by nuclear,[4] while media reports suggest that all the tech giants are increasingly looking to use nuclear to power their next generation of data centers.[5]

Today, renewable energy from wind, solar and energy storage simply cannot provide the same amount of uninterrupted carbon-free electricity 24/7 as nuclear to businesses such as data centers. Beyond providing electricity to homes and businesses, nuclear is also key to unlocking emerging technologies such as hydrogen production,[6] nuclear desalination and indoor agriculture.

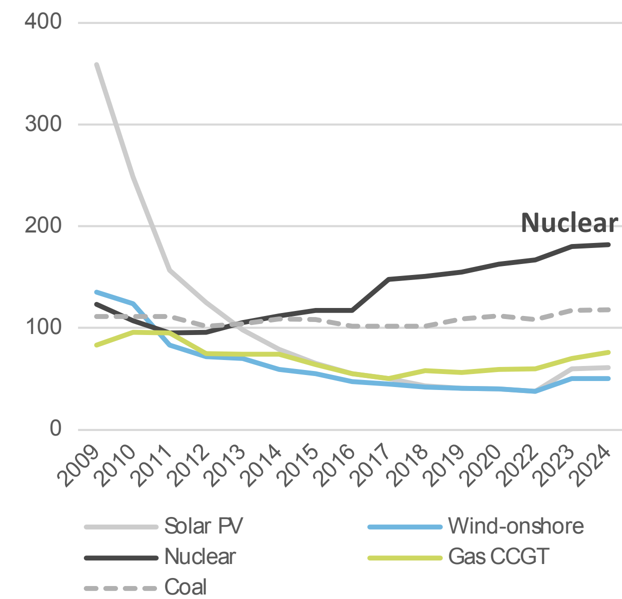
Nuclear has a cost problem

In their long-term forecasts, organizations, such as the International Renewable Energy Agency (IRENA) and the International Energy Agency (IEA),[7] still show nuclear being a part of the 2050 energy mix. But the industry faces one simple but gigantic hurdle – cost.

Currently, a new nuclear power plant is significantly more expensive to build and operate than other energy sources (see Figure 2), as the industry has been plagued by cost overruns.

For example, the recently commissioned Vogtle nuclear project in the United States was $21 billion overbudget and delayed by seven years. The United Kingdom's Hinkley Point project will be £10 billion more than expected and four years behind schedule. Uranium prices have also quadrupled in recent years after the war in Ukraine started, adding to operating costs.

Figure 2: Levelized cost of energy[8] ($/MWh)



Source: Lazard Levelized Cost of Energy 17th Edition, June 2024

How about small modular reactors?

To address the cost issue, small modular nuclear reactors (SMRs) have gained a lot of attention, especially since TerraPower, a company backed by Bill Gates, recently began construction on its 345-megawatt (MW) SMR project in Wyoming.[9]

The premise of a "small" reactor is counterintuitive to how the infrastructure industry has traditionally operated, as larger projects, turbines, boilers or power plants generally meant lower unit costs due to economies of scale.

The value proposition of SMRs is that with standardized and simplified designs, they can be mass-manufactured (like solar panels and batteries), which lowers upfront capex. They will also be easier to operate, which lowers operating costs.

Therefore, the biggest challenge is getting the industry to scale. Governments appear to realize this – the United States and Europe have both established subsidy programs that support SMRs. With widespread political support, could the nuclear renaissance be real this time?

To answer that, we first have to understand why the previous nuclear renaissances fizzled out.[10] For that, we will explore a lesser-known chapter in the history of the nuclear industry – university research reactors.

Case study: Cornell University's nuclear program

In the 1960s, the United States had 64 nuclear reactors at universities that were used for research and educational purposes. One example was Cornell University's Ward Center for Nuclear Science, which housed a 500-kilowatt research reactor.

In 2001, the school decided to shut down the facility, explaining that they had not conducted significant nuclear research since the 1970s, and it disbanded its nuclear engineering program in 1995 due to low enrollment.

It may come as a surprise, but 2,000 students signed a petition opposing the closure.[11] A U.S. senator even wrote a letter urging the school administration to reverse the decision. He pointed out that the Department of Energy could have provided Cornell with $2 million of funding per year,[12] which far exceeded the facility's annual operating cost of $500,000.

It was too little too late, however. Nuclear had fallen out of favor, and for the school, it simply wasn't worth the effort anymore. The same happened at other universities, and today, only 25 research reactors remain in the United States.[13]

Career prospects for aspiring nuclear scientists are also dwindling. At the time of writing this piece, LinkedIn showed only 290 entry-level job listings for nuclear engineers globally, compared with 1,800 for social media managers, 16,000 for lawyers, and 113,000 for programmers.

Similarly, according to smartscholars.com, there are only 26 scholarships available for nuclear engineering majors in the United States, compared with 293 for social studies, 345 for business and 816 for biology.

The lesson learned here is that even positive public opinion, political support and generous subsidies are not enough.

Many issues remain unaddressed. Is there a robust supply chain for maintenance and repairs? Where will the uranium come from? Where will the nuclear waste be processed? And in this example, do students (i.e., customers) and scholarship providers (i.e., financiers) find any value in these nuclear reactors?

A comprehensive upgrade of the nuclear value chain

The closure of these academic research reactors perfectly encapsulates the challenges faced by the nuclear industry.

Stakeholders – including customers, vendors, financiers, citizens and politicians – all have competing interests. Some are short term and economic, while others are long term and strategic – all with different ideologies and emotions.

The mistake of nuclear policies in the past few decades was that they were often sporadic and uncoordinated. For example, one-off subsidies for aging power plants and small grant programs hardly made an impact in the big picture.

For the nuclear renaissance to become a reality, it must be worth the effort for all stakeholders across the entire value chain, not just for the nuclear power plants. This means a new ecosystem will need to be scaled up almost from scratch. It will take time and effort, but we believe that the industry is in a better position now than before.

For example, the U.S. government appears to fully understand the challenge. In the Department of Energy's roadmap for advanced nuclear published in 2023,[14] the agency is looking to provide tailored support to each part of the nuclear supply chain, from upstream fuel to downstream waste, and all the engineering, manufacturing and maintenance in between.

There are already 22GW of SMRs in the pipeline globally,[15] which gives us some optimism about the long-term prospects of the industry. But we must also be patient because most of these plants will not commission until after 2030.

As a final piece to the puzzle, a nuclear renaissance will need a whole new generation of bright-eyed nuclear engineering graduates. Hopefully, their career prospects will be brighter in the future – the success of the industry depends on it.

Notes: [1] *Nuclear power officially labelled as "strategic" for EU's decarbonisation,* Euractiv, February 2024; [2] *Nuclear reactor restarts in Japan have reduced LNG imports,* EIA, February 2024; [3] *Investing in a digital tomorrow,* UBS Asset Management, May 2024; [4] *Amazon buys nuclear-powered data center from Talen,* American Nuclear Society, March 2024; [5] "Tech Industry Wants to Lock Up Nuclear Power for AI," *Wall Street Journal,* July 2024; [6] *Beyond renewables: What's next in greenhouse gas reduction?,* UBS Asset Management, September 2023; [7] *IRENA World Energy Transitions Outlook 2023,* June 2023, and *An updated roadmap to Net Zero Emissions by 2050,* IEA, October 2022; [8] The levelized cost of energy (LCOE) compares the breakeven energy prices for various power generation technologies. [9] "TerraPower begins construction at 345-MW advanced reactor site in Wyoming," Utility Drive, June 2024; [10] The exception is China, which grew nuclear capacity by almost 50GW since 2010. [11] "Students to Trustees: Preserve Ward Lab," *The Cornell Daily Sun,* October 2001; [12] "US Senator Advocates for Ward Funds," *The Cornell Daily Sun,* March 2002;[13] Nuclear Energy University Program, Department of Energy, July 2024; [14] *Advanced Nuclear – Pathways to Commercial Liftoff,* DOE, March 2023; [15] *Global nuclear SMR project pipeline expands to 22 GW,* Wood Mackenzie, March 2024

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