

# Nuclear Energy - Doomed or Blessed?

## Introduction

Currently, nuclear energy provides about 10% of the world's electricity, producing it in 440 active power reactors as of 2021. The United States has almost 100 nuclear reactors, even though it generates most of its electricity from fossil fuels and hydroelectric power. Unlike in the US, nuclear provides practically all the electricity in countries like Lithuania, Slovakia, and France. Despite the proliferation of nuclear energy, its development and use have long been a contentious issue. For years, its ability to provide lots of “clean” electrical power to cities has been rivalled by claims that nuclear residues imply a great risk to the environment. To counter these claims, significant upgrades to reactor designs have been made to avert disasters similar to Chernobyl or Fukushima. Yet, in the wake of the impending global energy transition, nuclear energy is again gathering increased attention. That is why we decided to analyse the industry and showcase its prospects.

## European Energy Mix

Given its economic significance, the European Union is a big energy consumer, accounting for 15% of the global energy consumption in 2021. Unsurprisingly, petroleum is the most frequently used energy resource throughout the bloc. The aforementioned has a 45% share in the energy mix and is followed by natural gas with a figure standing at 22%. However, only 0.7% of petroleum reserves and 2.2% of natural gas reserves are in the EU. European coal deposits, on the other hand, account for 7.4% of global coal reserves.

Furthermore, the EU has 16% of the world's petroleum refining capacity and 17% of the world's electric energy producing sources. The European Union produced 7% of the globe's petroleum, 10% of its natural gas, and 8% of its coal in 2020. Looking at energy production in the bloc, total primary energy production reached 650 million equivalent oil tons (Mtoe) in 2021, accounting for around 20% of the OECD total. There are four major producers in Europe, making up 78.2% of the total. The United Kingdom is foremost, producing 36.1% of the total in Europe, followed by Germany (17.3%), France (16.5%), and the Netherlands (8.2%).

In general, European energy production is based on gas and petroleum deposits in the North Sea, which are owned by the United Kingdom and the Netherlands. German energy is based on coal deposits, and its long-time rival, France, relies on nuclear power. Other EU countries' production is severely limited, owing to a general scarcity of energy supplies across the continent. Looking at Eastern European countries, Poland stands out because of its output (87 Mtoe), greater than the Dutch figure, while the Czech Republic, with 30.7 Mtoe, is on par with Spain and Italy, and Hungary, with 11.8 Mtoe, is not far below Belgian or Finnish levels. Hence, the EU is compelled to import substantial quantities of petroleum and gas - being especially reliant on Russia. In 2021, 550 Mtoe of crude oil was imported, which is only 1.2% less than 10 years ago. Practically, it implies a significant imbalance between demand and supply. European countries consume 16% of the world's energy while producing only 8% of it.

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As the data reveals, European Union plays a fundamental role in the world's energy mix - especially on the consumer side. Given the considerable imbalance between supply and demand, as well as the looming energy transition, nuclear energy is bound to come into the discussion. With the geopolitical danger of relying on Russian gas, nuclear could be a viable option to replace coal powerplants. Its high reliability and emission-less energy production process place it as an attractive choice. However, some countries like Germany continue to believe that the main focus should be to move away from it and are worried about nuclear waste. However, if the EU wants to lead the energy transition, nuclear will have to play an increasingly important role. Especially considering the lack of scaleable methods of storing wind or sun energy.

### **About Nuclear Power**

The first commercial nuclear power plant started operations back in the 1950s. Today, nuclear energy provides about 10% of the world's electricity and is produced in around 445 reactors worldwide. When the commercial industry began, the boundary between the Eastern and the Western industries was sharp because of the Cold War. However, the nuclear industry is now characterized by international commerce. The United States is the country with the highest number of operable nuclear reactors which, with 93 reactors, generates about 20% of the nation's electricity. Also, France has achieved impressive results as, with its 56 operable reactors, it generates 71% of the country's electricity.

Until recently, nuclear research was mainly driven by the public sector through international government consortiums, but the private sector is starting to raise and control the commercialization of nuclear energy. This is leading to the establishment of new innovative trends that will shape the nuclear energy industry in the future. Small modular reactors are the industry most in vogue technology. In contrast to full-scale nuclear power plants, the SMR hover between 60 MW and 300 MW and have a footprint of just two football pitches. SMRs would be manufactured in a factory in components which are then exported to the site for the final assembly. This would make them much cheaper than traditional large reactors. Furthermore, their compact size allows greater sitting flexibility and safety. They would generate as much power as fossil fuels, without the hassles of fuels or the risks usually associated with nuclear power because of their smaller scale.

Another emerging trend that is attracting many private investors is nuclear fusion. Scientists have attempted to use nuclear fusion instead of fission for decades as it allows to generate almost unlimited green energy from a small amount of mass with no CO<sub>2</sub> created. Although in the past no one has been able to produce more electricity than what the system itself consumes, companies are starting to find realistic solutions to this issue. Nuclear fusion is already substituting nuclear fission in many nuclear power stations projects. For instance, Helion Energy is building what the company refers to as "the first fusion power plant" which is expected to be operating by 2024. Finally, the industry is developing advanced modular reactors whose designs are innovative and versatile. These reactors are designed to use cooling agents and to operate at very high temperatures. The intention is to pair them with renewable generating sources to burn waste as an energy resource, making them less expensive and safer.

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## Industry Overview

As already mentioned, the U.S. is the country with the highest number of nuclear power plants globally. The leading U.S. companies in this sector are Exelon, NextEra Energy, Duke Energy, and Entergy. However, in the past years, we have witnessed the decline of U.S. commercial nuclear exports as China and Russia are becoming the leading exporters of nuclear energy. France is the largest nuclear power generator in Europe, and all its power plants are owned by Électricité de France (EDF). This company is mainly owned by the French government, as about 85% of its shares are in the government hands. Although EDF's struggles regarding debt and reputation for being inefficient, President Macron has announced a €1bn investment into the company for SMRs research aiming at using nuclear power to meet climate goals. With its 51 reactors, China is the third biggest nuclear-producing country in the world. Its capacity is increasing rapidly as 18 nuclear reactors are already under construction, and the other 39 are planned. China has two major nuclear power companies which are both state-owned: China National Nuclear Corporation and China Nuclear Power Group.

In the last decade, the nuclear energy market reached maturity level as there have been no significant changes or new entries in the industry. Nuclear power was not considered appealing either for new investors or consumers and, therefore, the control of the market in every country has been in the hands of only a few companies, the majority of which were at least partially controlled by the governments. Private companies experience high entry barriers to the traditional nuclear fission industry because of the high costs of nuclear power plants. Nuclear energy is a capital-intensive technology. The annual cost of repaying the initial investment is much higher than the yearly operating costs. This is because nuclear reactors are technically complex and must satisfy strict licensing and design requirements. The Levelized cost of electricity (LCOE) is the total cost to build and operate a power plant over its lifetime divided by the total electricity output dispatched from the plant over that period. Reports show that the economics of nuclear plants are heavily influenced by their initial investment, which accounts for at least 60% of their LCOE.

However, recently there has been a change of direction as innovations such as nuclear fusion and SMRs are attracting small private investors to the nuclear power market. Private companies are saying the timeline to make fusion a viable energy source is changing, and by the 2030s, we should see fusion power commercialized. Many of these start-ups entering the market have only appeared in the past years. According to the Fusion Industry Association, about 35 private fusion companies are now operating worldwide, 18 of which have received a total of \$1.8bn in private financing. Reports say that, only in the third quarter of 2021, venture capital poured around \$676mln into the nuclear sector. This number is more than the total amount raised by nuclear energy start-ups in the past five years combined. For example, in the UK, an industry consortium led by Rolls-Royce is planning to invest in the development of a fleet of SMRs. The technology is seen to strengthen Britain's energy security, create jobs, and help deliver Prime Minister Boris Johnson his "green industrial revolution". Also, France is putting the spotlight on nuclear energy again to meet the ambitious European climate objectives. The country has an opportunity to assert its dominance in the field by investing in EDF, which is planning to construct power plants not only in France but also in the UK, Poland, and India.

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The future of the nuclear energy sector is still uncertain, however. There still are many objectors that do not see nuclear power as the solution to environmental issues and electricity shortages because of the technology's downsides. But trends such as nuclear fusion, SMRs, and advanced reactors are growing, and private investors are finding the market more appealing. We should, therefore, expect an increase in nuclear power reactors that will generate energy through cheaper and safer processes.

### ***Nuclear Energy in the EU and Future Prospects***

In the wake of the G20 summit in Rome and the COP26 in Glasgow, the Environment has been back the priority of the global political agenda. Plus, as the ongoing global energy crisis has inspired spikes in gas and electricity prices worldwide, there have been several conversations in the European Union about how to best achieve its goal of carbon neutrality by 2050. Among them, the issue of nuclear power is perhaps the most divisive, splitting the EU's 27 member states along fierce geopolitical lines.

In the transition to carbon-free, sustainable energy sources play an essential role in the environmentally- and climate-friendly economic transformation. Still, as electricity generation from wind, solar and, hydro depend on certain weather conditions, these sources are not consistent and fluctuate periodically, necessitating more stable and complementary resources to plug the supply gap. Hence, nuclear power could be beneficial in achieving the net-zero goal as a "transition" source of energy. As a result, on 11<sup>th</sup> October, ten EU member states led by France expressed their joint support for including nuclear power in the EU's taxonomy on sustainable financing, which would essentially allow the EU to support nuclear projects under its green financing initiative. Despite heavy historical baggage, nuclear power is a clean, zero-emissions energy source that in 2020 generated 25% of the EU's total energy mix. France, for instance, an ardent supporter of nuclear power, drew 70% of its energy from nuclear sources last year.

But the issue of nuclear power pits two of the EU's largest political and economic players against one another: France has long pursued a robust energy policy firmly in support of nuclear power while Germany has cemented for itself a firmly anti-nuclear stance. Earlier this month, President Emmanuel Macron doubled down on France's nuclear strategy, announcing a new €1bn investment in new-generation nuclear reactors. On the other hand, 2022 will witness the shutdown of the last of Germany's nuclear reactors, completing Chancellor Angela Merkel's 2011 plan to phase out the country's 17 nuclear power plants in the wake of the Fukushima disaster.

The moment of shutdown of nuclear reactors in Germany comes to a time when the criticized Nord Stream 2 pipeline is about to start importing gas from Russia to Germany and is expected to double the Russian gas supply. Apart from the fact the pipeline may not be consistent with the European set of climate goals, its geopolitical implications are the project's most controversial aspect. Critics, including several EU Member States, describe Nord Stream 2 as Kremlin's way to export malign Russian influence and gas to Europe. In addition, it looks set to perpetuate Russia's stranglehold on EU energy markets and compromise European strategic autonomy.

While nuclear and renewables account for about 26% and 30% of electricity generation in the EU, 44% is represented by combustible fuel. And most of the latter is also imported. Therefore, nuclear power may be the

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right path to a free carbon emission economy which also guarantees the energy autonomy of Europe. But the opposing views of the EU's two biggest economies and most influential governments highlight how diverging the paths toward net-zero emissions can be.

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