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Sustainability

The role of nuclear in a net-zero transition

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Key takeaways

- Electricity contributes to c.40% of global greenhouse gas emissions, and the demand for electricity is only increasing. The continued development of new technologies as well as increasing needs from emerging countries could lead to the share of electricity in final energy consumption jumping from 20% in 2023 to at least 30% by 2050.
- Meeting the rising demand solely through renewables may prove difficult and insufficient, requiring alternatives sources of low-carbon energy, and therefore making nuclear part of the solution. However, nuclear as a source of carbon free power remains controversial because of the waste management issue.
- Still, policy initiatives like the Inflation Reduction Act have increased existing incentives for certain nuclear power plants, while enabling new nuclear projects to break ground. In doing so, this enables nuclear to help pave a path towards a net-zero future.

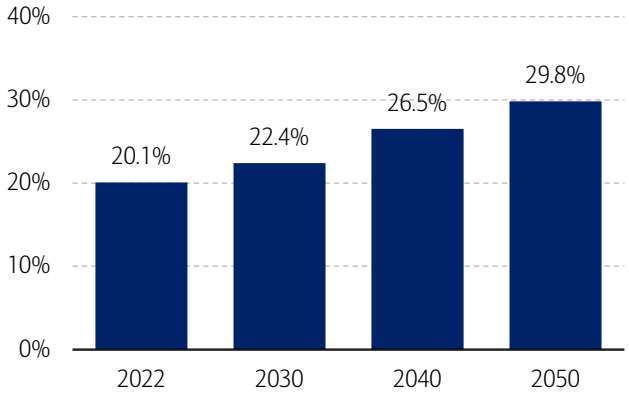
Electricity demand to surge by 2050

Electricity is becoming crucial to a net-zero transition. For one, it contributes to c.40% of the global greenhouse gas (GHG) emissions, according to the World Bank (defined to include fuels consumed for electricity and heat generation). Secondly, the demand for electricity is going to surge over the coming years, per BofA Global Research. Why? Improving economic outlook, the development of technologies (electric vehicles, cloud centers or artificial intelligence (AI) applications amongst others), demography, or increasing needs from emerging countries are all contributors.

The transition to a decarbonized economy also entails a move to electrification for many sectors. For instance, electric vehicles account for 15% of car sales today, and the forecast is for 40% by 2030 according to the Stated Policies Scenario from the International Energy Agency (IEA).

Overall, projections for electricity demand vary, but many conclude that an increase of the share of electricity in final energy consumption may jump from 20% in 2023 to at least 30% by 2050 (Exhibit 1). The International Energy Agency (IEA) looked at three different scenarios in which electricity share of total energy consumption varies from 30% to 50% by 2050.

Exhibit 1: Electricity's share of total energy consumption is projected to go from 20% to 30% by 2050 at minimum
Global final consumption of electricity as part of the total energy consumption (yearly, %)



Source: International Atomic Energy Agency

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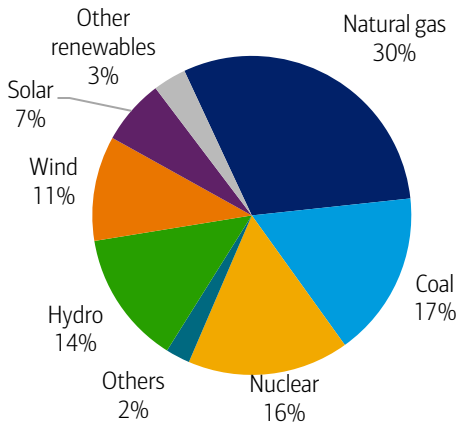
Exhibit 2: Nuclear was 16% of the global electricity production in 2023
Total OECD electricity production (2023, %)



Source: International Atomic Energy Agency

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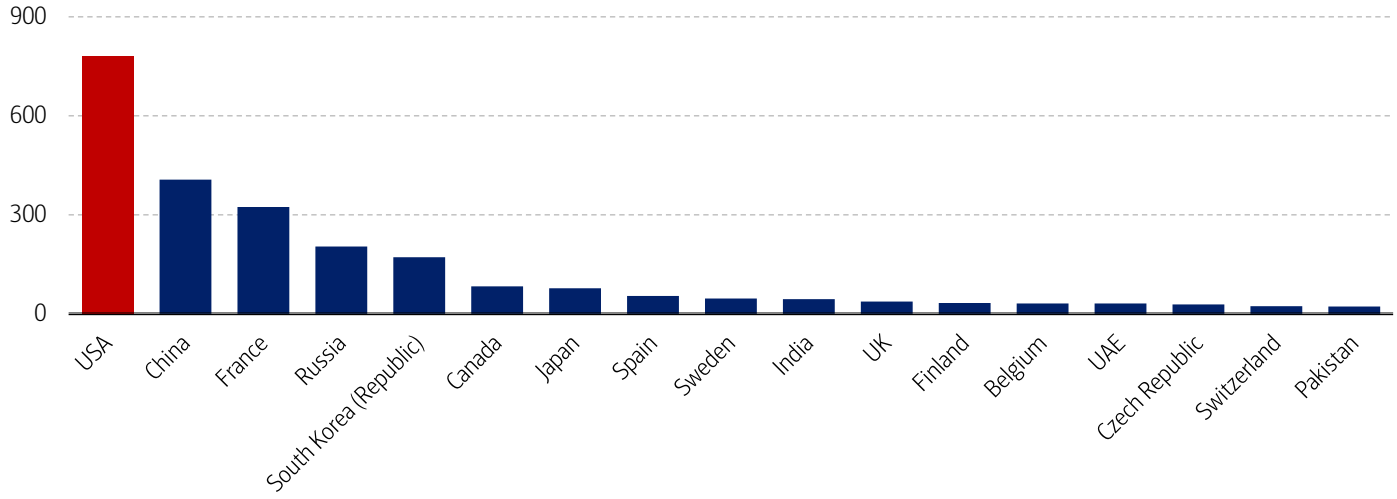
Is nuclear part of the solution?

More importantly, the IEA acknowledged in its 2023 World Outlook that a net zero energy system could not rely only on solar or wind power. Though they both play a crucial role in decarbonization efforts, they face challenges such as intermittency, land use constraints and resource availability. Meeting the rising demand solely through renewables may prove difficult and insufficient, requiring alternative sources of low-carbon energy, and therefore making nuclear part of the solution.

Nuclear is currently 16% of the global electricity production (2023) with a steady monthly production of 145 GWh (gigawatt hours) on average (Exhibit 2). Currently, 413 nuclear reactors are in operation globally for a total capacity of 372 GW. The US is by far the largest producer of nuclear electricity (Exhibit 3), though it represents only 18% of the country's production, whereas France's nuclear electricity covers 64% of the country's electricity production (Exhibit 4).

The latest COP28 (the annual United Nations Climate Change Conference) was an opportunity for 25 countries to recognize the key role of nuclear energy in achieving global net-zero greenhouse gas emissions by 2050. As a result, these countries collectively committed to triple global nuclear capacity by 2050.

Exhibit 3: The US produces almost twice the nuclear electricity of China, the second highest producer of nuclear energy
Global nuclear electricity production (2023, in terawatt hours)



Source: International Atomic Energy Agency

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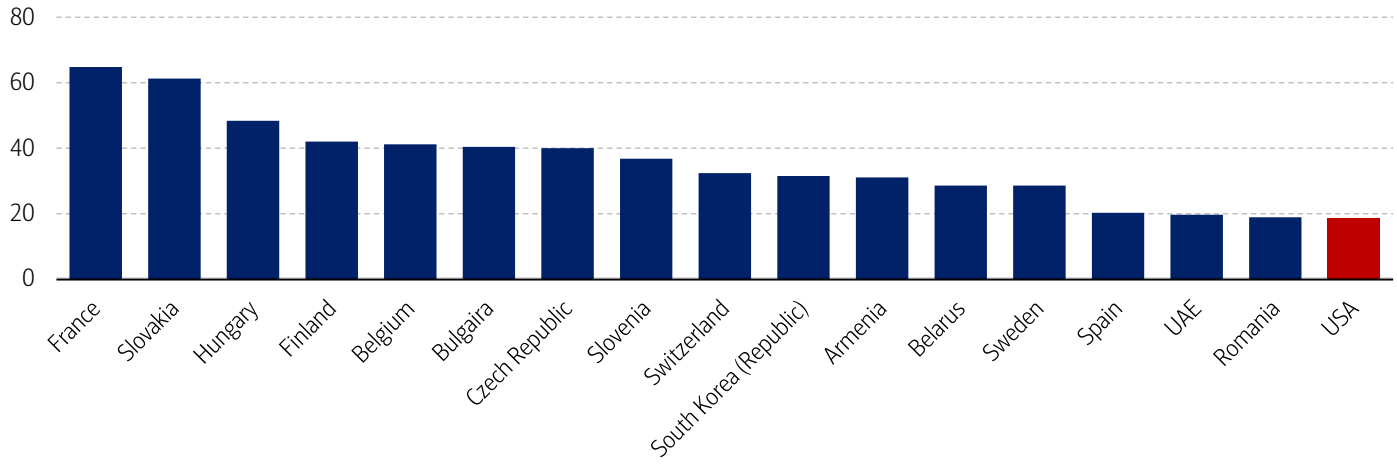
Exhibit 4: France and Slovakia's nuclear share of electricity production share are both above 60%, while the US's share is only 18%
Nuclear share of electricity production (2023, %)



Source: International Atomic Energy Agency

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Zero emissions don't come without costs

Nuclear energy accounts for c.20% of global electricity generation today, but accounts for almost none of the greenhouse gases emitted by the global power industry. This is because nuclear reactors emit no greenhouse gas directly. However, the mining and refining of uranium nuclear fuel does emit small amounts of GHG emissions.

According to BofA Global Research, uranium, and the way it is used in nuclear reactors, is an extremely efficient fuel. In fact, nuclear is approximately 16,667 times as efficient as coal. Additionally, capital efficiency of nuclear will improve, per BofA Global Research. By developing nuclear energy, scale and standardization could prove to be very effective at developing nuclear reactor technology.

However, nuclear as a source of carbon-free power remains controversial because of waste management issues. A portion of the waste generated from nuclear, i.e., the radioactive waste, is extremely hazardous.

That said, the dangerous waste from nuclear is relatively easy to manage as quantity remains small. Just three percent of the total volume is actually radioactive and dangerous, per BofA Global Research. Additionally, the World Nuclear Association and the International Atomic Energy Agency (IAEA) estimate that since the first nuclear reactors were operated in the West (e.g., the United Kingdom and the US) in the mid-1950's, a total of 120,000 tons of dangerous waste was generated globally, compared with 120 million tons of coal ash annually, in the US alone. One potential solution to this waste management issue is geological long-term safe storage (half-life of 1,000 years).

Nuclear and risks

In addition to waste management, nuclear as a solution comes with other issues and risks (Exhibit 5). Comparing nuclear power with renewable sources of electricity, the risk is on average higher than for solar photovoltaics (PV) and battery storage, but arguably lower than for wind. The risk for solar PV is due to the availability of minerals and manufacturing the turbines, while the risk for nuclear mostly lies in skilled labor, permitting and cost – three factors that could be significant hurdles for the development of nuclear power.

Exhibit 5: Medium risk for nuclear
Risk associated with electric power technologies (category, low-medium-high)

	Wind	Solar PV	Nuclear	Battery storage
Regulatory and policy risks				
Regulatory frameworks	Medium	Low	Medium	Medium
Policy support	Low	Low	Medium	Low
Permitting and certification	Medium	Medium	High	Low
Supply chain risks				
Critical minerals	High	Medium	Low	Low
Manufacturing	High	Low	Medium	Medium
Skilled labour	Medium	Medium	High	Low
Financial risks				
Costs of financing	High	Medium	High	Medium
Revenue and savings predictability	Medium	Low	Low	Medium
Overall risks	High	Low	Medium	Medium

Source: International Energy Agency

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How does the Inflation Reduction Act support nuclear energy?

The US Inflation Reduction Act (IRA), launched in 2022, recognizes nuclear energy as a potential source of low-carbon electricity. Under an IRA provision, a new Production Tax Credit (PTC) for nuclear power facilities, which do not benefit from the existing Advanced Nuclear PTC, was launched. Generators meeting certain criteria related to wages and revenues are set to receive a credit of up to $15/MWh (megawatt hour).

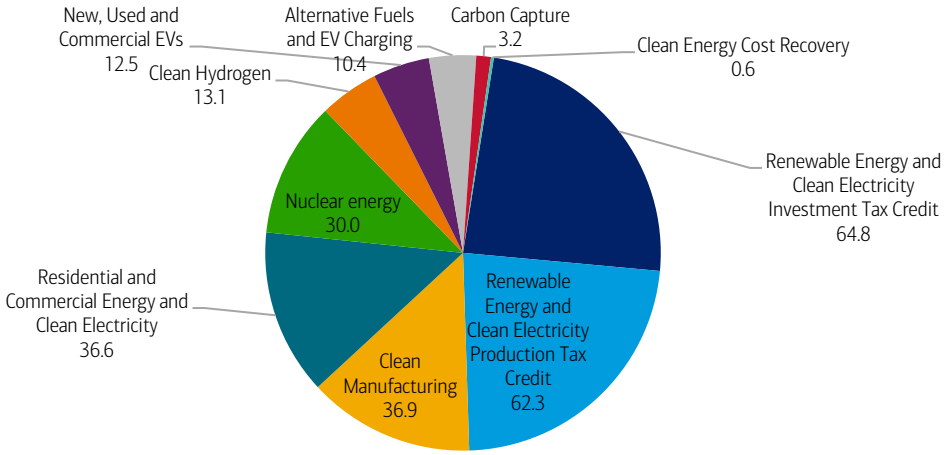
Based upon current natural gas price forecasts, per BofA Global Research, this supports ~$42/MWh 2024 total compensation for unregulated nuclear plants as a support level. The average US nuclear plant cash cost is $29/MWh in 2021, per the US Nuclear Energy Institute (NEI), which implies ~$10/MWh cash margin in 2024 and compares with many nuclear plants being cash flow negative in the late 2020s.

In 2022/2023, nuclear energy already received an estimated $30 billion in production tax credits (Exhibit 6). Overall, the IRA creates equivalency in carbon neutrality between nuclear and renewables.

Critical minerals identified as an issue

As for nuclear, putting the US nuclear portfolio on more solid footing is positive for uranium. Prior to the 2022 spike in natural gas/coal prices and the enactment of the IRA, there was the possibility of some nuclear retirements. Post-IRA, BofA Global Research does not predict any additional retirements through 2032. As such, the IRA will also benefit mining companies and the supply of critical minerals for future technologies in general and nuclear more specifically.

Exhibit 6: Nuclear represents 11% of the green tax credit
Green tax credits in the Inflation Reduction Act by category (2022/2023, $ billions)



Source: Environmental and Energy Study Institute, Congressional Budget Office

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