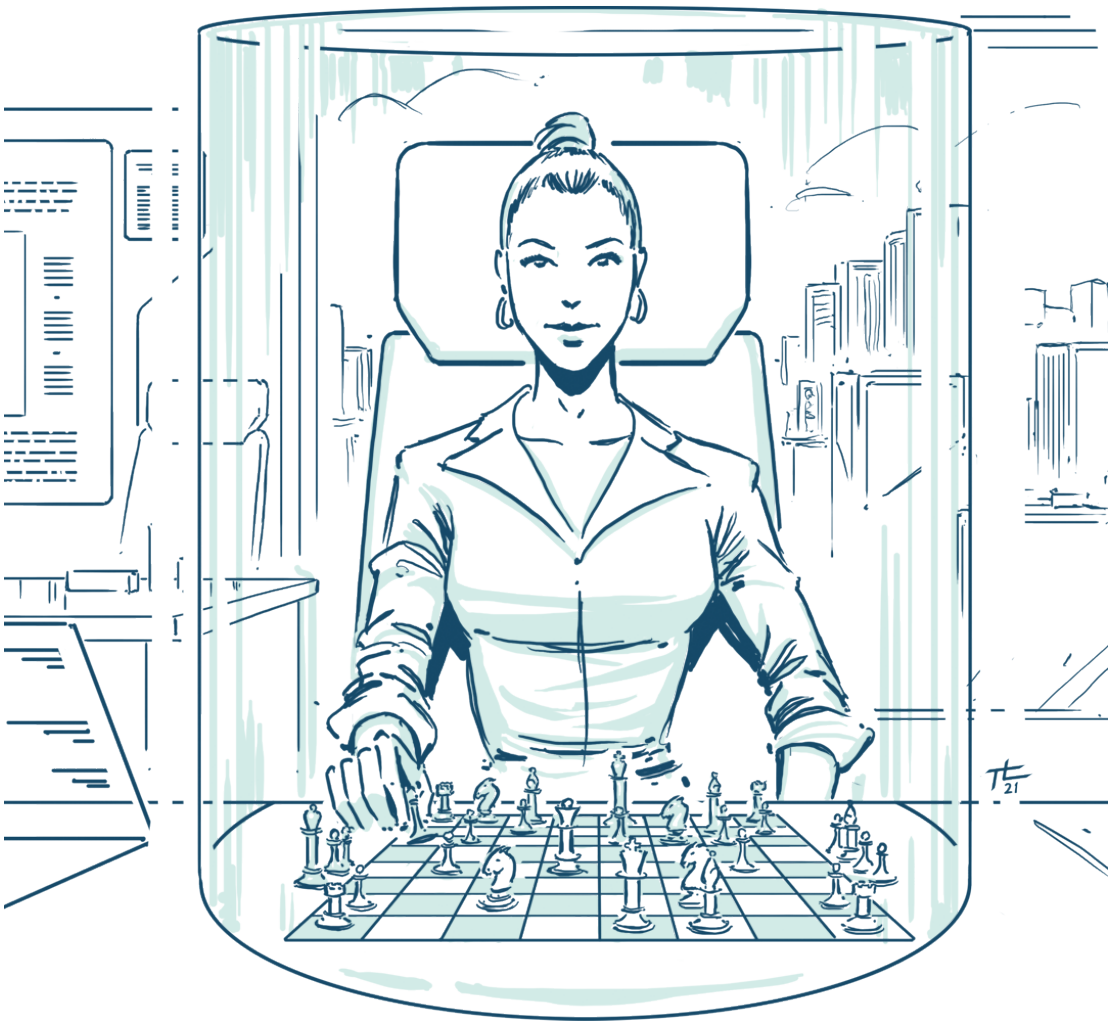
NUCLEAR POWER IN CITIES. SMR OR MMR WINS?



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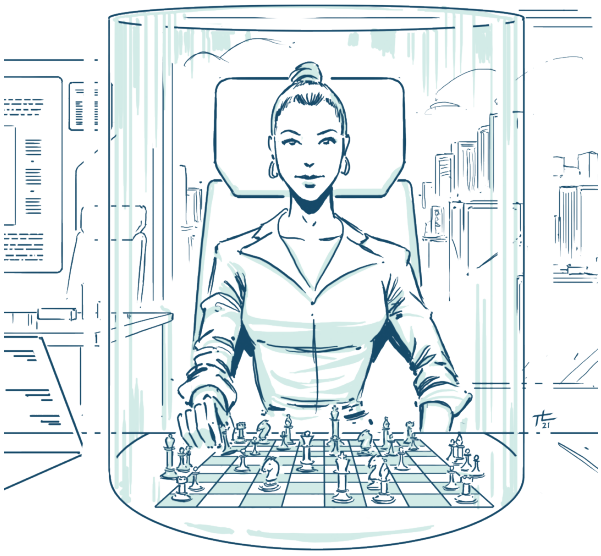
Problems of traditional nuclear power. By 2030, many existing plants will have reached their 40-year lifetime and will have to be decommissioned. The construction of new plants is facing serious delays and huge budget overruns. In addition, new reactors will replace only a small proportion of the reactors being decommissioned. It is difficult for nuclear energy to compete with renewable energy when renewable energy prices are plummeting.

The world will need a much larger supply of energy, especially green electricity. Demand for electricity is growing about twice as fast as total energy consumption and is likely to increase by more than half by 2040.

Some impetus for the industry may come from the European Commission's decision to count certain nuclear-related activities as so-called ‚transitional activities' — that is, activities that cannot yet be replaced by low-carbon alternatives, but which contribute to climate change mitigation.

10 per cent of electricity globally and 18 per cent of electricity in OECD countries is currently provided by around 440 nuclear reactors. According to the International Energy Agency (IEA), global nuclear power generation increased by 3.5 per cent in 2021 compared to 2020 levels, recovering from a nearly four per cent decline caused by the pandemic. Nuclear power is split evenly between Europe, North America and Asia. There are currently around 440 nuclear reactors in operation worldwide generating 367 gigawatts (GW) of power.



Pressurised water reactors (PWRs) and boiling water reactors (BWRs), collectively known as light water reactors (LWRs), provide 88 per cent of today's nuclear power. These include Generation II commercial reactors, built between 1970 and 1990, and Generation III reactors, an evolutionary improvement on Generation II reactors. Advanced reactor designs include light water-cooled small modular reactors (SMRs) and non-water-cooled reactors - Generation IV systems.

Europe is trying to accelerate its efforts to become independent from Russian fossil fuels in the wake of Russia's invasion of Ukraine and global sanctions against Russia. It is to be noted that a significant supplier of enriched uranium is Russia.

Nuclear energy is generating debate and controversy. It is reviving environmental controversy in society.

KEY QUESTIONS

IN THE LIGHT OF THE EUROPEAN SUSTAINABLE DEVELOPMENT GOALS (SDG) AND THE CURRENT GEOPOLITICAL SITUATION, SHOULD WE CONTINUE TO USE AND DEVELOP LOW-CARBON NUCLEAR ENERGY TO ENABLE THE TRANSITION TO A MORE ‚GREEN' ENERGY SYSTEM?

IS NUCLEAR POWER NEEDED TO AVOID THE INCREASING COST OF A NET-ZERO EMISSIONS PATHWAY AND TO REDUCE THE RISK OF NOT MEETING THE TARGET?

IS NUCLEAR POWER NECESSARY TO ENSURE THE FUTURE STABILITY OF THE ENERGY SYSTEM?

PROGRESS

Several countries have already made nuclear power a key part of their future energy landscape. Worldwide, 57 power plants are currently under construction and expected to be operational by 2028. A further 213 power plants are planned.
Many of the future nuclear projects are being built in Asia, where China and India are the main operators. Outside Asia, nuclear power plants are being built with significant delays and budget overruns, including in Finland, the UK, Argentina, Russia and the USA.

Work is also underway on Generation IV small reactors. Governments including the UK, China, Qatar and multimillionaires such as Bill Gates and Warren Buffet are funding projects to build small modular reactors that require less investment and generate less waste. Generation IV small reactors shall be deployed around 2028.

Germany will shut down its entire nuclear power industry in April 2023. In addition to social and environmental phobia, this is also due to uncompetitive cost and long construction time of nuclear power plants, compared to, for example, the construction of wind power plants.

CHALLENGES

Increasing energy demand, due to population growth, the development of energy-intensive technologies and appliances and digitalisation. Particularly ‚green' energy is in demand, due to climate change, sustainability policies and decarbonisation.

Securing baseload, which currently mainly comes from fossil fuel-driven sources (coal, gas, uranium).

Unresolved problems related to waste, decommissioning of power plants and treatment of radioactive substances. This waste poses a serious threat to the environment and human health for many generations.

Loss of expertise needed to design and build new nuclear facilities as the nuclear industry shifts towards Asia and due to potential geopolitical changes.

The high cost and length of the investment process casts doubt on nuclear power's ability to help achieve decarbonisation targets by 2035.

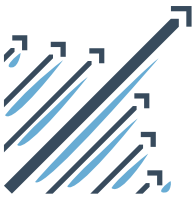
TRENDS

- Dependence on intermittent sources (renewables) is increasing. Governments are looking for solutions to ensure long-term reliability and security of energy supply as well as to maintain grid stability.
- China will soon overtake the US as the world's largest nuclear power producer. Most of China's reactors are fairly new — they were built after 2010. Nuclear power in Germany and Spain is heading for decline, while the UK and France have announced its reactivation.
- A global race for millions to research and develop small, modular reactors which are to provide cheap and stable energy to drive the decarbonisation of major economies. The US, Russia, Argentina, China, Canada, South Korea, France and the UK are all working on their own SMR (small-) and MMR (micro-reactor) models to re-energise nuclear power. There are currently more than 80 different SMR reactor designs at various stages of development.
- Environmental organisations believe that small reactors continue to raise serious questions about their competitiveness and security, and therefore advocate a decarbonisation process based entirely on energy generated from renewable sources, supported by new energy storage systems, under development.
- A number of new models of fast neutron reactors with sodium, lead, gas or molten salt coolants are currently under development. Although fast-neutron reactors have been around since the 1950s, there is now more interest in them because of the accumulation of nuclear waste and the ability of these reactors to destroy by fission the elements in the spent fuel - the waste remains toxic for a hundred rather than tens of thousands of years.
- Cold fusion development is underway, led by ITER and the Southwestern Institute of Physics Chengdu in China, among others, but this research is not expected to be commercialised before 2040, despite strong commitment from companies and start-ups seeking to accelerate the work on cold fusion.

ANTI TRENDS

- Construction of large-scale energy storage facilities. Constantly evolving electricity systems, primarily based on distributed generation and new system services, will stimulate the development of energy storage technologies.
- High levelised cost of electricity (LCOE). Many renewables are more cost-competitive than nuclear power. However, LCOE as a measure does not take into account the fact that nuclear, gas and coal are energy sources available 24 hours a day, unlike RES.
- Climate change is hindering further development of investments. High ambient temperatures can, among other things, reduce the efficiency of power plants or limit access to water.
- Limited access to fossil fuels (oil, gas, coal). The example of France or Germany shows that geopolitical turmoil and the lack of other raw materials can influence the policy of developing nuclear energy.
- Limited access to enriched uranium due to the geopolitical situation. Russia is one of the largest miners and dominates uranium enrichment (43 per cent), which can cause supply chain problems.
- Without improved safety, reduced costs, as well as increased reliability and reduced waste, the continued development of nuclear power plants is in question. According to an MIT study, the cost of building nuclear power plants has increased over the years in most countries. Moreover, delays and cost overruns are common. In contrast, over the past decade, the development of renewable energy has seen significant cost reductions as capacity is increased. In addition, renewable energy sources offer electricity at lower prices.
- Another nuclear power plant accident and contamination, due to war, sabotage or cyber-attack, could lead to an increase in nuclear phobia in society and activate opponents of nuclear power.
- The progress of cold fusion will have a revolutionary impact on the entire energy sector.

CONCLUSIONS



There are indications that neither SMRs nor MMRs will win in Europe, but rather large-scale energy storages that allow grid stabilisation with an increasing share of RES in the energy mix. Renewables seem to be winning out over nuclear power both in terms of construction time and the cost of energy.

Despite this, research work on SMR and MMR is not expected to stop any time soon, if only because of the still strong position of nuclear power in Asia or in selected European countries.

However, if the research and development of SMRs and MMRs progresses fast enough to find a place in the market before the massification of large-scale energy storage, and their costs can be realistically reduced, then both options have a chance of finding an audience because of their use in different conditions: for example, an SMR for a small town and an MMR for a factory. Therefore, traditional nuclear power plants, if they are still part of the energy mix, are likely to be replaced by modern SMRs in the future.

In the case of MMR, however, RES solutions appear to be more efficient and safer at the micro-scale.

ABOUT US

CONTACT US IF YOU ARE INTERESTED IN THE FUTURE OF NUCLEAR ENERGY!

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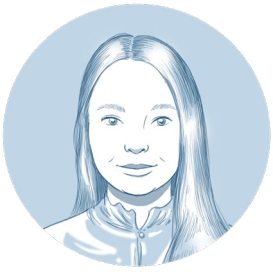

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