Nuclear Energy Bulletin 2024 Annual Recap

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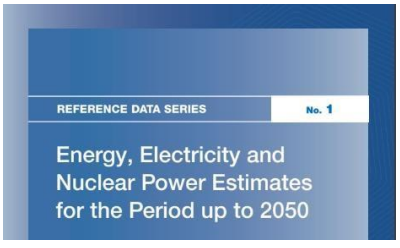
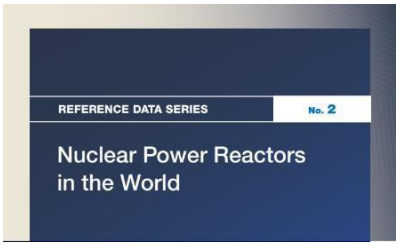
At this year's 68th IAEA General Conference, nearly 3,000 participants from 150 member states gathered to discuss the role of nuclear technology in areas such as energy, health, climate change and food security. The Conference focused on resolutions and decisions that will determine the direction of the IAEA's activities in the coming year. The General Conference hosted important decisions, including the election of 11 new countries to the IAEA Board of Governors for the 2024-2025 term. In addition, the Atoms4Food Scientific Forum featured important discussions on sustainable agriculture and hunger reduction, highlighting the potential of nuclear techniques to address the global food crisis. The conference had a broad global impact, with more than 1,200 news stories through the IAEA's social media accounts and the first-ever conference blog. Throughout the conference, topics such as nuclear security, artificial intelligence and international cooperation were discussed, contributing to safer and more peaceful future nuclear applications.

This report is a guide prepared by the International Atomic Energy Agency (IAEA) entitled "Milestones in the Development of National Infrastructure for Nuclear Power", which provides a roadmap for countries wishing to transition to nuclear energy. The report identifies the infrastructure needed for a country to launch a nuclear energy program and provides guidance on how to build it. It identifies three key milestones, detailing the activities that need to be completed at each stage and the points at which targets need to be achieved. The report covers both "hard" infrastructure (electricity grid, sites) and "soft" infrastructure (nuclear law, regulations, education). It also defines the roles and responsibilities of key organizations such as the government, the nuclear plant owner/operator and the regulator. The report also addresses critical issues such as nuclear safety, legal framework, safeguards and stakeholder engagement. It also includes specific infrastructure considerations for small modular reactors (SMRs). The aim of the report is to assist countries in planning and assessing nuclear energy infrastructure and to provide further guidance, with reference to other IAEA publications in this area.



The two reports provided provide basic information to understand the current state and future potential of the global nuclear power sector. The "Energy, Electricity and Nuclear Power Estimates for the Period up to 2050" report focuses on countries' nuclear power generation data in 2023. It presents key data for each country, such as the number of reactors in operation, total electricity generation capacity (MW(e)) and nuclear power production volumes (TW-h). For example, the US is the largest nuclear power producer with 93 reactors, and China's data includes Taiwan1. This report reveals countries' investments in nuclear power and its share in generation.



The "Nuclear Power Reactors in the World" report provides a more in-depth look at the technical specifications and performance of nuclear power reactors. It provides technical details such as the number of reactors in operation, their types (PWR, BWR, GCR, etc.) and their net electrical power2
. It also includes detailed information on new reactors connected to the grid in 2023, the operating times of reactors, reactors planned and under construction, reactors suspended and shut down, and decommissioning processes3456 By analyzing the performance factors of reactors (EAF, UCF), complete shutdown statistics and reasons9101112..., the report provides important information on the operating dynamics and efficiency of nuclear power plants. It is also mentioned in this report that Turkey has 4 PWR type reactors2. This report stands out as a critical resource for understanding technical advances and operational challenges in the nuclear power sector.

"World Nuclear Performance Report 2024" summarizes global developments and trends in the nuclear power sector in 2023. Electricity generation from nuclear reactors worldwide has increased, but is still below the 2021 level. While generation in Asia increased as new reactors came online, generation in other regions remained largely unchanged. In 2023, five reactors came online and five were shut down, so there was no net change in the number of operational reactors. Capacity factors have remained high since the 2000s, reaching an average of 81.5% in 2023. The report also examines electricity generation by age of reactors, showing that the share of young reactors is increasing as new reactors come online.

Life extension and restart projects of existing nuclear power plants in some countries are also mentioned, t it is emphasized that they are not a substitute for new construction. In addition, attention is drawn to the role of nuclear energy in combating climate change and countries' goals to increase their nuclear energy capacity, such as the signing of a declaration by 25 countries at COP28 with the goal of tripling nuclear energy capacity by 2050. In addition, country-by-country review detail each country's unique nuclear energy situation and projects.

As concerns over the safety and security of Ukraine's nuclear facilities persist, the International Atomic Energy Agency (IAEA) has continued its support to Ukraine during this challenging period. The Agency maintained a continuous presence at the Zaporizhia Nuclear Power Plant (ZNPP) from September 1, 2022, providing site-independent assessments and monitoring. IAEA experts spent more than 8,000 days at the plant, preparing technical reports on nuclear safety, security and safeguards, as well as conducting interviews with plant officials. They found that the seven core principles of the ZNPP had been violated, that implementation of the five core principles remained critical, and that risks at the site were high. While the Agency's efforts have made a critical contribution to preventing a nuclear accident, the situation at ZNPP remains sensitive. The IAEA also continued to assess the nuclear safety and security situation at the Khmelnytskyi, Rivne and South Ukrainian nuclear power plants and the Chernobyl site, and continued to provide assistance and technical support. As part of the IAEA'scomprehensive assistance program for Ukraine, nuclear safety equipment was provided and medical support for personnel was provided. TheAgency also ensured that nuclear material was not used for military purposes.

The International Energy Agency (IEA) 's (IEA) ‘‘Electricity 2024’’ report differs from previous studies by allocating an important place to nuclear energy. According to the report, the increase in renewable energy sources and nuclear power is driving down the emissions of the electricity sector. By 2025, global nuclear power generation is expected to reach a record high. The reasons for this increase include the completion of maintenance work in France, the restart of some nuclear power plants in Japan, and the commercial start-up of new reactors in various markets such as China, India, Korea and Europe. They also emphasize the need to reduce construction risk and improve financing conditions for nuclear power projects.

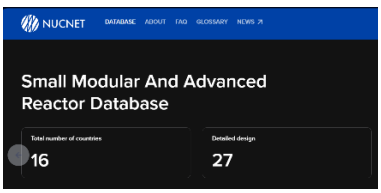
Small Modular Reactors and AI on Nuclear Sector

The European Commission has launched an industrial alliance for the development and deployment of SMRs in the early 2030s. This alliance will develop a strategic action plan on SMR technologies, supply chain, investment barriers, financing and research needs. SMRs will bring significant benefits to Europe, including energy independence, lower carbon emissions, new jobs and economic growth.

56 different SMR designs are being developed worldwide, offering different reactor types, sizes and temperature ranges. In addition to power generation, SMRs offer flexible solutions that can be used in industrial heat, marine and other sectors. Progress is being made in six key areas for the commercial deployment of SMRs: licensing, siting, financing, supply chain, stakeholder engagement and fuel supply. Some SMR designs are already operational in China and Russia, while many others are on track for first commercial use.

SMRs can replace coal-fired power plants, power mining operations, central heating systems and heavy industry. It also has potential applications in areas such as ammonia and fertilizer production, hydrogen production and shipping. The fuels used in SMR projects vary; some use existing commercial fuels, while others require new fuel types such as highly enriched uranium (HALEU).

NEA's SMR Dashboard assesses the commercialization progress of 21 different small modular reactor (SMR) designs, tracking technology readiness as well as progress in licensing, financing, and other critical areas. These assessments are based on publicly available and verifiable data and focus on the potential of SMRs to ensure energy security and reduce carbon emissions.



NucNet's global SMR and AMR database is a subscriber-only platform that provides comprehensive information on SMR and advanced nuclear reactor (AMR) technologies. The database includes data from the International Atomic Energy Agency (IAEA) and the OECD Nuclear Energy Agency (NEA), and enables searches by various characteristics of reactors such as country, type, size, output, fuel type and license stage. In summary, NEA's SMR Dashboard tracks the progress of specific SMR designs, while NucNet's database provides detailed information on a broader range of SMR and AMR technologies. Both resources provide important tools for those interested in assessing the potential of these technologies and keeping abreast of developments in the field.

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Artificial Intelligence (AI) Applications:

The use of AI in the nuclear sector can bring significant advantages in the areas of safety, security and efficiency. AI can be used for big data analysis, risk management, deployment in hazardous areas and rapid learning. The UK, US and Canadian nuclear regulators have published international principles for the use of AI systems in nuclear applications. These principles provide important guidance for AI developers, licensees and regulators.

UK: Efforts to Maintain and Increase Capacity

In the field of nuclear energy, the UK is seeking to both preserve existing plants and increase capacity through new investments. EDF Energy plans to invest £1.3 billion to extend the life of four nuclear power plants and maintain nuclear power generation at current levels until 2026. The plants to be extended include Torness, Heysham A and B, and Hartlepool A, with a total of eight reactors in operation. The company is also considering the possibility of running Sizewell B, the country's only pressurized water reactor, 20 years longer than planned, until 2055.

The government aims to build around 11 new reactors by 2050 in a plan that has been described as the biggest expansion of nuclear power in 70 years. These new reactors will have the capacity to meet a quarter of the country's electricity needs. With these moves, the UK is giving nuclear power an important role in ensuring energy security and reducing energy dependence on Russia.

France wants to consolidate its leadership

France plans to build eight new EPR reactors in addition to the existing six EPR reactors in a bid to increase its nuclear power capacity. The move is part of the country's aim to reduce its dependence on fossil fuels to 40% by 2035. The new reactors are expected to provide a total of 13 GWe of additional capacity. France aims to create 100,000 jobs in the nuclear energy sector and supports the development of small and medium-sized enterprises (SMEs) in this field.

It also aims to invest in nuclear fuel recycling and strengthen international cooperation. Work is underway to merge the nuclear safety agency ASN and its technical arm IRSN to make nuclear safety processes more efficient. France plans to cooperate with countries such as the Czech Republic and India in the field of nuclear energy and to compete in tenders for the construction of new reactors.

India seeks to consolidate energy security with local experience

India is both developing indigenous technologies and encouraging private sector investments to increase its nuclear power capacity. The country plans to redesign its 220 MWe pressurized heavy water reactors (PHWR) under the Bharat SMR name and convert them into small modular reactors (SMR), aiming to produce 40-50 SMRs in 7-8 years. In collaboration with Tata Consulting Engineers, these projects will utilize advanced 3D design platforms. India is also building indigenously designed PHWRs with a capacity of 700 MWe; Kakrapar 3 and 4 units are the first of their kind and will generate around 10.4 billion units of clean electricity per year.

Construction of new 700 MWe PHWRs is also underway in areas such as Rawatbhata, Kaiga, Gorakhpur, Chutka and Mahi Banswara. In addition, the government is encouraging the private sector to invest in nuclear power and is in talks with companies such as Reliance Industries, Tata Power, Adani Power and Vedanta Ltd, expecting investments of around USD 5.30 billion. These investments are aimed at creating 11,000 MWe of new nuclear capacity by 2040.

EU wants to move forward but can't reach a deal

The debate on nuclear energy in Europe is shaped around climate targets and energy security. It is argued that large investments should be made in nuclear energy and nuclear should be included in renewable energy targets. However, some countries reject nuclear energy due to concerns over nuclear waste and safety. This leads to divisions in EU energy policies. While these debates continue, the nuclear power industry aims to return to the construction phase and build new reactors. Small modular reactors (SMR) are seen as an important alternative, with the support of the European Commission. International platforms such as the IEA and COP28 also recognize that nuclear power can play an important role in achieving climate goals. In addition, the leaders of 32 countries together at the nuclear energy summit and made commitments to increase cooperation and financing in this field.

China is making significant progress in the field of nuclear energy

China has almost tripled its nuclear capacity in the last 10 years. On August 19, it approved the construction of a total of 11 new nuclear reactors in five different locations across the country, at a total cost of $31 billion. Construction of these new reactors is expected to take about five years. With this move, China aims to reduce coal use and increase energy security. At the same time, the country is increasing the number of nuclear power plants using the indigenous Hualong One technology and continues to build new reactors with this technology. China's rapid growth in nuclear power has made it the world's fastest growing nuclear power producer. China's nuclear power plants are mostly concentrated on the east coast, close to population centers. The country has 55 operating nuclear reactors and 23 reactors under construction

US needs nuclear for AI and data center

In the US, nuclear power is starting to play an important role, especially in meeting the growing energy demand of data centers. Major technology companies are turning to nuclear power to meet the sustainable energy needs of their data centers. Microsoft signed a deal with Constellation Energy to restart a unit of the Three Mile Island nuclear power plant in Pennsylvania, while Google reached an agreement with Kairos Power to purchase power from small modular reactors (SMR). And Amazon Web Services (AWS) acquired Talen Energy's Cumulus data center campus, enabling it to be powered by the Susquehanna nuclear power plant. These deals demonstrate that nuclear power is an important option for meeting the energy needs of data centers. Data centers are expected to consume 8% of total US electricity generation in 2030, with some reports predicting this could rise to 12% by 2028. This further increases the critical role of nuclear power in powering data centers.

Small modular reactors (SMRs) are increasingly gaining traction in meeting the energy needs of data centers. Google's agreement with Kairos Power shows that SMRs are a viable solution in this area. In addition, the US Department of Energy (DOE) is supporting the development and deployment of SMR technologies. This technology can be deployed more quickly and economically than conventional nuclear reactors and offers safer operation. Many energy companies are working on new nuclear power projects to meet growing data center demand. For example, American Electric Power (AEP) has signed letters of intent to provide 15 GW of additional data center power, while Pinnacle West Capital has more than 4,000 MW of data center customers. All these developments show that nuclear power is playing an increasingly important role in meeting data center energy needs in the US, and investments in this area are increasing.

South Korea

The second unit of the Shin Hanul nuclear power plant has started commercial operation. This is South Korea's fourth operating APR1400 type reactor. A total of 26 nuclear power units are in operation in the country and four more APR1400 reactors are under construction.

Japan

A court has allowed five reactors at the Mihama and Takahama nuclear power plants to resume operations. The Takahama nuclear plant has four units that began operating between 1974 and 1985. At the Fukushima nuclear power plant, work to remove molten fuel continues, but there are delays due to camera malfunctions in the robotic device. The plant has about 880 tons of molten fuel.

Kazakhstan and Uzbekistan

Kazakhstan is focusing on its nuclear energy future and will hold a referendum this fall on the construction of a nuclear power plant. Kazakhstan is considering large reactors as well as small modular reactors. Possible technology providers for the nuclear power plant include France, China, South Korea and Russia. Uzbekistan is starting a small nuclear power plant project. Under an agreement with Rosatom, a 330 MWe, six-unit power plant will be built. The plant will use RITM-200N water-cooled reactors based on nuclear icebreaker technology, with the first unit scheduled to start operation in late 2029.

Iran

Iran plans to build four new nuclear power plants over the next 20 years. These projects will involve an investment of $15 billion, with the aim of building four 1,250 MWe reactors in nine years. Iran aims to produce 20,000 megawatts of nuclear energy by 2041. The only nuclear power plant currently operating in Iran is Bushehr-1, with a capacity of 915 MWe. Iran's nuclear program is closely monitored by international nuclear watchdogs.

United Arab Emirates (UAE)

The fourth unit of the Barakah nuclear power plant has been connected to the grid. This is an important step in the UAE's transition to clean energy and is expected to contribute to the country reaching its net zero target by 2050. The construction and grid connection of each reactor at the Barakah plant was faster than the previous unit. The plant will generate 40 TWh of clean electricity per year.

ASEAN

Countries are considering nuclear power to meet climate goals and ensure energy security. But they face challenges such as infrastructure, financing, technical issues and societal concerns. The region is considering around 5.2 GW of nuclear power capacity by 2050. Many ASEAN countries are cooperating with countries such as Russia and China on nuclear energy.