MUNES'26

STUDY GUIDE

IAEA

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Welcoming Letters

Letter from The Secretariat

Dear Delegates,
As Eskişehir's first and only official MUN, it gives me great pleasure to welcome you to MUNES'26, a historic Model UN Conference. This conference is a special opportunity to promote cooperation, critical thinking, and diplomacy among young people in our city and beyond. In order to ensure that every aspect of this conference reflects excellence, dedication, and a commitment to providing a truly transformative experience, the Academy has brought together the most gifted students from all management teams of local MUNs.
The Eskişehir Municipality and Governorship, along with the prestigious companies that have supported this event, are proud to support MUNES'26. Their contributions and trust demonstrate the importance of MUNES as a catalyst for civic engagement, youth leadership, and the advancement of global awareness in Eskişehir. We really care about setting the rules for talking working together and cooperating with other countries as the only Model United Nations that represents our city. We are the Model United Nations for our city and we want to make sure we do a good job of discussing things and working with other people from different countries. We think it is very important to have discussions, diplomacy and international collaboration as the Model United Nations, for our city.
This conference is an opportunity for you to think like world leaders. You get to discuss problems that affect the whole world and come up with new ideas to solve them.
As a delegate, you are representing the country you were assigned to. You also need to show that you can work well with others respect each other and understand points of view which is what the United Nations is all about.
I want each of you to take part fully in your committees. Listen to what other people have to say even if you do not agree with them.. When things get tough be brave and curious and try to find a way to make it work. The United Nations is, about people working together so let us make that happen at this conference.
I want to wish every delegate the best of luck during their sessions on behalf of the organizing team. I hope your discussions are enlightening, your partnerships fruitful, and your MUNES'26 experiences motivating. Let this conference be a journey of self-improvement, deep connections, and a long-term dedication to changing the world and your communities for the better.
Best regards,
MUNES Secretary General Çağlar Baran Topaç

Letters from The Chairboard

Dear Delegates,
I am Eren Yalçın, The Main Chair of IAEA. I will be the one chairing you throughout the whole experience with my Co-Chair, Zeynep Cemre. Since our committee is a beginner committee, I expect a lot of our delegates to be first or second timers, but don't worry at all. The study guide we have prepared will be more than enough to prepare you for the conference. Do not hesitate to contact me for any help or questions anytime. I hope this experience will be the start of many other MUN journeys for you all. I was once a delegate in beginner committees like yours, and I can only predict your excitement and nervousness for this conference. My best advice to you would be to let it all go and enjoy the conference. Do not be ashamed to speak up, worrying about being embarrassed. Trust me, we have all been there before. I hope we can have a lot of fruitful debates and lots of fun. I am so excited to meet all of you at the conference.

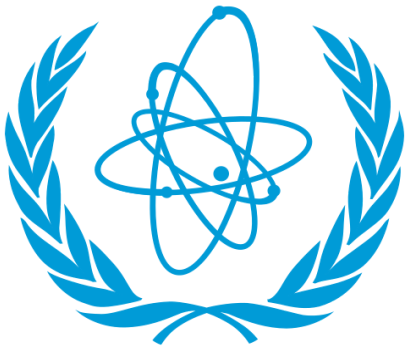
Best Regards,
IAEA Main Chair, Eren Yalçın

Dear delegates,

My name is Zeynep Cemre Divanoğlu, and I will be serving as your Co-Chair in the IAEA Committee. It is a great pleasure for me to be part of this conference and to work alongside our Head Chair, Eren. This will also be my first experience as a member of the chairboard, which makes it even more exciting for me.
In this committee, we will discuss the role of nuclear energy in a sustainable future. As the world searches for reliable and cleaner energy sources, nuclear energy has become an increasingly important topic.
During the sessions, I encourage you to share your ideas freely, respect different perspectives, and work together to find meaningful solutions. I am really looking forward to hearing your speeches and seeing the discussions in our committee.
If you have any questions, please feel free to reach out. I cannot wait to meet you all and spend these days learning and debating together. I'm sure we will have a lot of fun!
Best regards,
Zeynep Cemre Divanoğlu
IAEA Co-Chair

1. Introduction to the Committee IAEA (International Atomic Energy Agency),

Widely known as the world's "Atoms for Peace and Development" organisation within the United Nations family, the IAEA is the international centre for cooperation in the nuclear field. The Agency works with its Member States and multiple partners worldwide to promote the safe, secure, and peaceful use of nuclear technologies.



The IAEA was created in 1957 in response to the deep fears and expectations generated by the discoveries and diverse uses of nuclear technology. The Agency's genesis was U.S. President Eisenhower's "Atoms for Peace" address to the General Assembly of the United Nations on 8 December 1953.

The U.S. Ratification of the Statute by President Eisenhower, 29 July 1957, marks the official birth of the International Atomic Energy Agency. In the press conference following the signing ceremony in the Rose Garden of the White House in Washington, D.C., President Eisenhower evoked his address to the UN General Assembly in December 1953, at which he had proposed to establish the IAEA.

"In fact, we did no more than crystallise a hope that was developing in many minds in many places … the splitting of the atom may lead to the unifying of the entire divided world."

The IAEA is strongly linked to nuclear technology and its controversial applications, either as a weapon or as a practical and useful tool. The ideas President Eisenhower expressed in his speech in 1953 helped shape the IAEA's Statute, which 81 nations unanimously approved in October 1956.

The Agency was set up as the world's "Atoms for Peace" organisation within the United Nations family. From the beginning, it was given the mandate to work with its Member States and multiple partners worldwide to promote safe, secure and peaceful nuclear technologies. The objectives of the IAEA's dual mission – to promote and control the Atom – are defined in Article II of the IAEA Statute.

"The Agency shall seek to accelerate and enlarge the contribution of atomic energy to peace, health and prosperity throughout the world. It shall ensure, so far as it is able, that assistance provided by it or at its request or under its supervision or control is not used in such a way as to further any military purpose."

In October 1957, the delegates to the First General Conference decided to establish the IAEA's headquarters in Vienna, Austria. Until the opening of the Vienna International Centre in August 1979, the old Grand Hotel next to the Vienna Opera House served as the Agency's temporary headquarters.

The IAEA has also two regional offices located in Toronto, Canada (since 1979) and Tokyo, Japan (since 1984), as well as two liaison offices in New York City, United

States of America (since 1957) and Geneva, Switzerland (since 1965). The Agency runs laboratories specialized in nuclear technology in Vienna and Seibersdorf, Austria, opened in 1961, and, since 1961, in Monaco.
In 2005, the Norwegian Nobel Committee awarded the Nobel Peace Prize to the International Atomic Energy Agency (IAEA) and to its Director General, Mohamed ElBaradei, for their work for a safer and more peaceful world. The Committee honoured the IAEA and its leader "for their efforts to prevent nuclear energy from being used for military purposes and to ensure that nuclear energy for peaceful purposes is used in the safest possible way."

2. Nuclear Energy and the UN Sustainable Development Goals (SDGs)

The IAEA, in line with its 'Atoms for Peace and Development' mandate, supports countries in their efforts to reach the 17 Sustainable Development Goals (SDGs) set out in the United Nations (UN) 2030 Agenda for Sustainable Development. Many countries use nuclear science and technology to contribute to and meet their development objectives in areas including energy, human health, food production, water management and environmental protection. The use of these techniques contributes directly to nine of the 17 SDGs.
The 2030 Agenda was adopted in 2015. The Agenda's 17 SDGs and their associated 169 targets aim at stimulating action over the next 15 years in areas of critical importance for humanity and the planet. They are integrated and indivisible and balance the three dimensions of sustainable development: the economic, social and environmental.

Nuclear science and technology can help fight hunger and malnutrition and improve food security and food safety. Through the IAEA and its partnerships, including with the Food and Agriculture Organisation of the United Nations (FAO), many countries use nuclear tools to develop sustainable agricultural practices, establish and improve nutrition programmes and ensure stable supplies of quality food. Their work contributes to achieving the United Nations Sustainable Development Goal (SDG) 2 on Zero Hunger and ending all forms of hunger and malnutrition by 2030.

2.1 Sustainable agriculture and food security

Sustainable agricultural practices developed with the help of nuclear and related techniques help farmers conserve soil, water and crop resources, protect plants from damaging insect pests and grow more food using new plant varieties that are disease-resistant, thrive under changing climate conditions such as drought and increased soil salinity. Other methods help farmers protect the health of their livestock and improve animal reproduction and breeding practices while conserving natural resources.

With a ‘farm-to-fork’ approach, the IAEA and FAO help countries use nuclear and related techniques throughout the food production chain. As food products are prepared for consumption, nuclear techniques, such as irradiation, can help protect food quality, increase shelf lives and ensure food safety. These techniques can also be used to check food for contaminants and to ensure its authenticity to prevent food fraud. Such techniques also facilitate export, thus contributing to increasing income for farmers and the national economy at large.

2.2 Fighting hunger and malnutrition

To combat hunger and malnutrition, health professionals and scientists use nuclear and isotopic techniques to study various forms of malnutrition — from undernutrition to obesity. The results of their studies help policymakers and experts develop and maintain effective programmes and policies to address hunger and malnutrition. These include food fortification initiatives that focus on producing food rich in key vitamins and minerals, programmes to limit calorie intake to fight obesity, as well as programmes to help mothers breastfeed their babies and feed their children.
In focus

Benin Introduces Artificial Insemination in Cattle, Improving Animal Breeding and Nutrition

2.3 Good Health and Well-Being

The projection of 35.3 million cancer cases by 2050 and the workforce shortages (need for 84,000 radiation oncologists globally). The use of nuclear technology in medicine, particularly to fight cancer and to diagnose diseases, has become one of the most

widespread uses of nuclear energy. Many countries work with the IAEA to use nuclear technology toward achieving the United Nations Sustainable Development Goal (SDG) 3 on Good Health and Well-being for ensuring healthy lives and promoting well-being for all at all ages.

Nuclear techniques play an important role in diagnosing and treating various health conditions, in particular non-communicable diseases such as cancer and cardiovascular diseases, and also play a role in diagnosing and combating malnutrition. Nuclear and nuclear-derived techniques can also be used for early warning, risk reduction and management of major health hazards, including infectious diseases, such as Ebola, dengue, and Zika.

Fighting non-communicable diseases, such as cancer

To help achieve the SDG 3 target of reducing deaths from non-communicable diseases by one third, the IAEA assists countries in tackling cancer by helping them to educate and train specialised health professionals, develop comprehensive cancer control programmes, and establish nuclear medicine, radiation therapy and oncology and radiology facilities. This includes providing training and education on safety and radiation protection of patients and health professionals during medical procedures involving the use of radiation.

2.4 Sustainable Development Goal 13: Climate action

Climate change has become one of the biggest environmental challenges worldwide. Experts are working with the help of the IAEA and its partners to use nuclear science and technology to monitor, mitigate and adapt to the effects of climate change and respond to the Paris Agreement on Climate Change and the United Nations Sustainable Development Goal (SDG) 13, which calls for urgent action to combat climate change and its impact.

Nuclear energy currently generates about 10% of the world's electricity, which accounts for roughly 25% of all low-carbon electricity globally.

Nuclear power avoids more than 1 gigatonne of CO_2 emissions every year—the equivalent of taking nearly 250 million cars off the road.

According to the UN and IAEA, at the 2026 Nuclear Energy Summit in Paris, 38 countries reaffirmed their commitment to the goal of tripling global nuclear capacity by 2050 to stay within the 1.5°C warming limit.

2.5 Fighting climate change with nuclear science and technology

Relative to a global nuclear operational capacity of 377 GW(e) at the end of 2024, the low case projects an increase of about 50% to 561 GW(e) by 2050. In the high case, global nuclear operational capacity is projected to increase to 2.6 times the 2024 capacity, reaching 992 GW(e) by 2050. Power uprates were also considered as part of the projections. Small modular reactors (SMRs) are estimated to account for 24% of the 676 GW(e) new capacity added by 2050 in the high case and for 5% of the 320 GW(e) new capacity added in the low case. Worldwide, coal remains the primary energy source for electricity production, accounting for about one-third of the electricity produced in 2024. While coal's share in electricity production has changed little since 1980, that of natural gas — the world's second largest source of electricity — has almost doubled over the same time frame. Hydro is the largest and nuclear is the second largest source of low-carbon electricity. Nuclear contributed about 9% of global electricity production in 2024. In recent years, there has been an increase in the use of wind and solar, with their combined share reaching almost 15% in 2024. By 2050, global final energy consumption is projected to decrease by about 3% and electricity production is projected to double from 2024 levels.

Climate change has made water scarcity, food shortages, biodiversity loss and natural disasters more common worldwide. Researchers use nuclear and isotopic techniques to collect data on and monitor how climate change affects the environment — from the ocean and freshwater to mountains and soil — and identify sources of pollutants and greenhouse gas emissions. This data can help policymakers take science-based decisions for mitigating and adapting to climate change.

As greenhouse gas emissions, such as carbon dioxide, nitrous oxide and methane, accelerate the rate of climate change, countries are working to mitigate these emissions by developing sustainable energy plans, many of which include nuclear power. They are also taking steps to improve the agriculture sector — a major source of greenhouse gas emissions — by using nuclear science and technology to study and develop new methods for growing food that also reduce emissions, such as carbon sequestration, which uses certain types of plants and harvesting methods to encourage soil to take in and hold onto more carbon dioxide from the atmosphere.

To adapt to changes in the environment, scientists are developing sustainable, 'climate-smart' agricultural methods with the help of nuclear science and technology to optimise food production in harsh climate conditions such as drought and high temperatures, while also conserving and preserving natural resources, such as soil and water. They are also researching new methods for protecting energy systems, such as nuclear facilities, from climate-related weather events and disasters.

3. Nuclear Power in Clean Energy Transition

IAEA is committed to supporting the continent's ambition to harness nuclear energy for sustainable growth. With the growing interest in nuclear power in Africa and the recent

decision by the World Bank to re-engage with nuclear energy for development, in partnership with the IAEA, countries now have a critical opportunity to access an expanding pool of global resources and support for their nuclear power ambitions. Realising the full potential of nuclear projects calls for a strong policy framework that fosters collaboration between governments and private sector stakeholders — government support is essential to mobilising the necessary private sector capital and addressing barriers. The IAEA welcomes South Africa's invitation to support its G20 Presidency in 2025, particularly in advancing the agenda of the Energy Transition Working Group. This publication, developed in partnership with the South African Presidency, offers valuable insights into the potential of nuclear energy in enabling a just transition to clean energy while boosting economic development and industrialisation. Drawing on the operating experience of South Africa, as well as several African countries that are actively embarking on new nuclear power programmes, this publication also examines key considerations for integrating nuclear energy into national energy strategies.

According to the International Energy Agency (IEA), a new era for nuclear energy beckons, as demand for clean and secure electricity grows around the world. The number of new projects, policies and investments is increasing, including in technological advances such as small modular reactors (SMRs).

"This news that the world breached 1.5 °C warming in 2024 comes as energy demand is growing. One after another, technology companies looking for reliable low-carbon electricity to power AI and data centres are turning to nuclear energy, both in the form of traditional large reactors and SMRs," said the Director General, Rafael Mariano Grossi, this month in an article in La Revue de l'Énergie.

Nuclear energy's increasing momentum could be seen at COP28, where the first Global Stocktake under the Paris Agreement called for the acceleration of nuclear and other low-emission technologies to help achieve deep decarbonization. Another key moment at the climate conference in Dubai was when more than 20 countries launched a declaration to triple nuclear energy capacity by 2050. Last year at COP29 in Baku, Azerbaijan, a further six countries joined the call.

With its capacity to deliver low-carbon electricity consistently 24/7, nuclear power has prevented around 70 gigatonnes (Gt) of CO2 emissions over the past five decades and continues to avoid more than 1 Gt CO2 annually, according to the IAEA's "Climate Change and Nuclear Power 2022" report.

3.1 Dispatchable energy

Unlike wind and solar, nuclear power plants and hydropower offer dispatchable energy, meaning they are able to adjust their output to meet electricity demand. Additionally, the expanded use of nuclear power for non-electric applications, including district heating, hydrogen production, desalination and heat for industrial processes, offers further options to reduce emissions.

To support this increasing nuclear energy demand, the IAEA is actively assisting countries by providing technical expertise and capacity building to help them establish or expand nuclear power plants.
Integrated Nuclear Infrastructure Reviews (INIR) are an example where the IAEA assists countries to assess the status of their national infrastructure as they embark on establishing nuclear power plants. INIR missions enable countries to engage in discussions and receive guidance from experts about recommendations and best practices in nuclear power infrastructure development.
These missions ensure that the infrastructure necessary for the safe, secure and sustainable use of nuclear power is developed and implemented in a responsible and orderly manner.
In 2009, the IAEA conducted the first INIR Mission to a country initiating the use of nuclear power. Since then, INIR missions have been hosted by various states including the United Arab Emirates, which has successfully established the Barakah Nuclear Energy Plant. This year, it is expected to supply around 25 per cent of the UAE's electricity, up from its current contribution of 20 per cent, reducing the country's carbon emissions by 22 million tonnes annually.
Similarly, countries like Sweden, France and Finland have utilised nuclear energy combined with hydro and renewables to largely decarbonise their electricity production. France has an extremely low level of CO2 emissions from electricity generation, since over 90 per cent of its electricity is from low-carbon sources, 70 per cent of that from nuclear power. And 94 per cent of Sweden's electricity comes from low-carbon sources, in Sweden with more than a third coming from nuclear, according to the IEA.

3.2 Newcomer countries

The IAEA is also supporting newcomer countries and developing countries in their transition to nuclear energy, with training, technical assistance, and technology transfer of tools and methodologies to help them evaluate the role of different technologies in meeting their future energy needs while reducing greenhouse gas emissions.
"A few years ago, discussions might have been about phasing out nuclear energy. Today, at the World Economic Forum, we're on the road to tripling nuclear capacity. This shows a shift in how nuclear energy is increasingly seen as essential for net-zero and energy transition," said Mr Grossi this week at the first-ever public session on nuclear energy at the World Economic forum Annual Meeting in Davos.
The IAEA's latest projections indicate that world nuclear capacity will increase 2.5 times the current capacity by 2050. At present, 31 countries operate power plants, with 419 reactors in operation, a combined electrical capacity of 378.1 gigawatt GW, producing about 10 per cent of the world's electricity. Additionally, over 62 reactors are currently under construction, highlighting the growing adoption of nuclear energy worldwide.
"I am confident 2025 will see commitments translated into concrete projects. Nuclear energy is still providing the world with a quarter of its low-carbon power and supporting the rollout of intermittent renewables like solar and wind. In future, we will

see even more nuclear deliver the clean, reliable, and secure power the world needs. As always, IAEA will be there to assist countries in making it happen," said Mr Grossi.

4. Innovation and Future Technologies

4.1 Small Modular Reactors (SMRs)

The IAEA supports Member States towards the safe and secure deployment of small modular reactors (SMRs), which can enhance energy security while helping to achieve global climate goals. To this end, the Agency has launched two interconnected mechanisms: the IAEA Platform on SMRs and their Applications (SMR Platform) and the Nuclear Harmonisation and Standardisation Initiative (NHSI).

The SMR Platform serves as the focal point for the IAEA's activities in the field of SMRs and their applications. It provides coordinated support and expertise from across the entire Agency, encompassing all aspects relevant to the development, early deployment, and oversight of SMRs. The SMR Platform is designed to facilitate cooperation and collaboration among Member States and other stakeholders, supporting the safe and secure deployment of SMRs worldwide.

The SMR Platform is a valuable resource for Member States looking to advance their SMR programmes. It offers a range of services, including technical assistance, capacity building, information sharing, and coordination of research and development efforts. Through collaboration and knowledge exchange, the SMR Platform aims to accelerate the development and deployment of SMRs, helping to strengthen energy security while also mitigating climate change.

The NHSI is a complementary initiative that aims to advance the harmonisation and standardisation of SMR design, construction, regulatory and industrial approaches. The initiative is comprised of two separate but complementary tracks: the NHSI Regulatory Track and the NHSI Industry Track.

The goal of the NHSI Regulatory Track is to increase regulatory collaboration among Member States, avoid duplication of efforts, increase efficiency, and facilitate the development of common regulatory positions without compromising nuclear safety and national sovereignty. To achieve this goal, the NHSI Regulatory Track has developed ambitious but feasible programs of work that build on previous activities and progressively make important steps toward harmonisation of regulatory approaches.

The NHSI Industry Track, on the other hand, focuses on developing more standardised industrial approaches for SMR development, manufacturing, construction, and operations. By establishing common standards and best practices, the NHSI Industry aims to help reduce licensing timelines, costs and ultimately deployment times for SMRs.

4.2 Next Generation Reactors

The nuclear industry could benefit from a new generation of reactors designed to create inherently safer and more efficient nuclear power plants. These reactors may contribute to the development of more sustainable nuclear energy and may also be used in a variety of industrial applications.

Advanced reactors with unique performance and safety features

The next generation of reactors are made to meet several benchmarks in performance, safety and reliability. Small modular reactors (SMRs), for example, are advanced reactors that can generate up to 300 MW of electricity and whose parts can be transported to installation sites as prefabricated modules.

"Thanks to their prefab construction model and their smaller size, the capital cost is lower for SMRs than for the typical large reactors currently under construction or in operation," said Stefano Monti, Section Head for Nuclear Power Technology Development at the IAEA. "The construction period is also expected to be shorter as the modules are prefabricated and then brought to the installation site for construction. SMRs are also inherently much less prone to severe accidents, as they are designed to have reduced core damage frequency."

With these advanced reactor designs comes the possibility of an expanded role for nuclear energy. So far, nuclear energy has primarily been used for electricity generation, but there is a wide variety of other, non-electric applications for which the new generation of reactors could be well suited.

"The benefits of nuclear energy should not be limited to electricity production, but should also target other applications, such as heat production," said Francois Gauché, Chair of the Gen IV International Forum Policy Group and Nuclear Energy Director at the French Alternative Energies and Atomic Energy Commission. "The concept of small modular reactors is that smaller units, modular construction, simplified design and demonstrated safety are sought in order to add flexibility and make the investment decision easier."

Several countries are in the process of developing and designing the next generation of reactors, and construction has already begun on four SMRs in Argentina, China and Russia.

Innovative reactors for sustainable energy

The most advanced gas-cooled reactor to date, the High Temperature Reactor-Pebble-bed Module (HTR-PM), is currently under construction in China. This modular reactor is designed to optimise energy efficiency and is ideal for adding small incremental capacity to power grids, said Yuliang Sun, Deputy Director and Deputy Chief Engineer at Tsinghua University's Institute of Nuclear and New Energy

Technology. This reactor type is also well suited for the application of power and heat co-generation, in particular for heat application at higher temperature levels.
An integrated pressurised water reactor (PWR), the CAREM, is in the works in Argentina. It is scheduled to come online by the end of 2018. The design of this SMR incorporates safety elements which do not require input from reactor personnel, including the capability to automatically shut down if a problem with the reactor is detected.
A very particular case is KLT-40S, a floating power reactor under construction in Russia. This reactor type has potential applications in heating and electricity and in power supply to isolated consumers in remote areas. The RITM-200, also under construction in Russia, is intended for marine propulsion of an icebreaker ship, but it can also be used as a land-based or barge-mounted SMR for heat and electricity.

Fast reactors for more efficient nuclear energy

Fast reactors are designed to produce as much as 60 to 70 times more energy from uranium than the current generation of thermal reactors. By recycling spent fuel and utilising "fast" neutrons (neutrons produced by fission which are not slowed down by a moderator), these reactors are highly efficient, produce far less nuclear waste, and may have great potential for non-electrical applications of nuclear energy, particularly for industrial processes.
The only fast reactor currently used in commercial operation is the Russian BN-800 reactor. Connected to the grid in December 2015, it runs on mixed oxide fuel and has advanced safety characteristics. The BN-800 is also highly fuel-efficient.
"The BN-800 reactor is another step towards a full commercialisation of fast reactors, which will be able to compete with PWRs on cost," said Vyacheslav Pershukov, Deputy Director General at Rosatom.
The IAEA has been supporting the progress of these innovative technologies, in particular by hosting a series of conferences on new reactor technologies for sustainable development. In June 2017, the IAEA held the third iteration of the International Conference on Fast Reactors and Related Fuel Cycles in Yekaterinburg, Russia. These events bring together a wide range of professionals in this field to discuss how best to apply new reactor designs to provide clean and sustainable energy.

New designs that help overcome challenges

Though SMRs may provide numerous benefits, there are still some challenges associated with their implementation. "As advanced SMRs have yet to be deployed, a regulatory infrastructure for these reactors has yet to be consolidated," Monti said. "Another challenge is to have a single control room for all modules in an SMR facility. This has not been done before, and if successful, could help streamline reactor operations." He added that though licensing of SMRs could take longer initially, this process should be sped up considerably once a regulatory framework is well established.

5. Safety, Security and Sustainability Challenges

The world wastes a lot of non-renewable energy, according to the IAEA, 20.5% of final energy consumed was electricity, producing 30529 TWh of electricity, when 8.7% of electricity was produced by nuclear energy. Global and regional nuclear power projections are presented as low and high cases, encompassing the uncertainties inherent in projecting trends. The projections are based on three sources: the nuclear data collected by the IAEA's PRIS; the estimate of the nuclear generating capacity established by a group of external experts participating in the IAEA's annual Consultancy Meeting on Nuclear Capacity Projections up to 2050; and national projections supplied by countries for the OECD Nuclear Energy Agency and IAEA publication on uranium resources, production and demand through 2050.

Every day, millions of people throughout the world benefit from the use of nuclear technology. From Africa to Asia and from Europe to the Americas, nuclear technologies are used daily to find and protect sustainable sources of fresh water, produce energy and food, while providing researchers the tools to study the ocean's past and predict its future.

As the world's attention turns to Rio de Janeiro, Brazil, for the United Nations Conference on Sustainable Development (dubbed "Rio+20"), an IAEA brochure highlights ways in which the Agency contributes to the development goals being addressed at this global conference. The brochure entitled IAEA at Rio+20: Nuclear Technology for a Sustainable Future also provides an overview of the many ways in which nuclear technology is contributing to ensuring peace, health and prosperity throughout the world.

"Sustainable development requires international cooperation and the effective use of technology," says IAEA Director General Yukiya Amano. "The IAEA helps its Member States to use nuclear technology for a broad range of applications, from generating electricity to increasing food production, from fighting cancer to managing fresh water resources and protecting the world's seas and oceans."

Through its extensive Technical Cooperation programme, the IAEA also helps to make these benefits available to developing countries. For instance, the IAEA provides assistance in areas such as human health (through the Programme of Action for Cancer Therapy), animal health (the IAEA was an active partner in the successful global campaign to eradicate the deadly cattle disease rinderpest), food, water and the environment.

Nuclear technology is contributing to "building the future we want" in several areas: Population growth, accelerating economic development, and changing lifestyles demand ever more resources. Resource overuse has begun to compromise "natural services" such as biodiversity, clean air, fresh water and arable land; a trend that threatens the sustainability of development. To help Member State governments gain greater adaptability, the IAEA has developed a new methodology for modelling these

complex interactions called CLEWS (Climate, Land-use, Energy and Water Strategies) that allows simultaneous and cohesive analysis of all these areas.

5.1 Access to Sufficient, Safe Water

Increased access to sufficient, safe water is made possible through nuclear techniques that map groundwater resources more affordably and quickly than any other means. Nuclear techniques also improve the efficiency of irrigation systems, which uses 70% of all fresh water resources.

Access to affordable energy directly improves human welfare. Current projections foresee electricity demand growing by 60 to 100% by 2030. As a low-carbon source of energy, nuclear power can minimise greenhouse gas emissions and mitigate the negative impacts of climate change. The IAEA helps countries using or introducing nuclear power to do so safely, securely, economically and sustainably. Its safety standards, assistance and reviews increase safety. The IAEA also verifies that nuclear energy is only used for peaceful purposes, directly contributing to peace and security.

5.2 Access to Sustainable Sources of Food

Access to sustainable sources of food will remain a preeminent challenge in the decades to come. Based on current practice and consumption, agricultural production will have to increase by about 70% by 2050 to meet demand. Nuclear techniques are used in developing countries to increase production sustainably by breeding improved crops, enhancing livestock reproduction and nutrition, as well as controlling animal and plant pests and diseases. Post-harvest losses can be reduced, and safety increased with nuclear technology. Soil can be evaluated with nuclear techniques to conserve and improve soil productivity and water management.

5.3 Understanding and Protecting the Oceans

To better understand and protect oceans, nuclear techniques are used to monitor the ocean's shifting chemical balance caused by ocean acidification, which can stunt and endanger coral and microorganisms' growth. Nuclear techniques are also powerful tools used to acquire an accurate picture of the ocean's distant past.

5.4 Health and Medical Concerns

Health for millions of patients relies upon the safe and effective diagnosis and treatment of disease. Nuclear techniques provide precise diagnostic information that is of vital importance in detecting and curing both infectious and non-communicable diseases, such as cancer. Radiopharmaceuticals are used to treat disease and to enable diagnostic imaging. Radiotherapy also employs focused radiation beams that are essential in curing diseases. In the developing world, infectious and non-communicable diseases, as well as malnutrition, create a socio-economic burden that threatens sustainability. The safe, well-coordinated use of nuclear techniques to detect, diagnose and treat disease and to combat malnutrition contributes to improved health and social stability throughout the world.

"The IAEA contributes to the development of global policies that address the energy, food, water and environmental challenges that the world currently faces," the Director General concluded. "We look forward to making Rio+20 a success."

6. Economics and Financing the Future

Economic analysis is essential to determine the feasibility of any energy project, including one that involves nuclear power plants. Its main objective is to help create and select projects that will contribute to the welfare of society.
The economic aspects of energy are complex, particularly for developing nations. It is not evident how investments in the energy sector will facilitate the achievement of the sustainable development goals, such as health care, education, increasing employment and participating in international markets.
In many cases, the first challenge is to attract and arrange investment for energy infrastructure projects. Few developing nations have the resources required to finance the needed development. Over the past decades, it has become clear that transforming centrally controlled energy systems into liberalised markets can create the right conditions to direct investment and facilitate competition.

To ensure the affordability of services, energy must also be priced appropriately to cover the full cost of supply, yet access to it should not be limited. Pricing adjustments may be necessary to ensure that all consumers can afford to realise the benefits of energy. In the commercial sectors, energy pricing directly influences the competitiveness of goods and services, both locally and internationally.
Economic analysis is a systematic approach to determine the optimal allocation of resources. It involves the comparison of two or more alternatives in achieving a specific objective under a given set of assumptions and constraints. The cost-benefit analysis compares project economic costs with project economic benefits. It should take into account the opportunity costs of the resources employed and attempt to measure, in monetary terms, the private and social costs and benefits of a project to a society or an economy. The analysis should evaluate the economic feasibility of a nuclear power project and compare its economics to other (mutually exclusive) alternatives.
The IAEA helps strengthen Member States' capacities to use energy and nuclear power planning tools to conduct studies for energy systems and electricity supply options. These economic analysis tools can help answer various questions about an energy project’s impact on the entity undertaking the project, on society and on various stakeholders, and about the project’s risks and sustainability.
IAEA’s Planning and Economic Studies Section tools can improve Member States' understanding of nuclear technology's compatibility with national sustainable development objectives and its possible contributions to socioeconomic development, climate protection and energy security. In addition, the Nuclear Economics Support Tool is provided by the IAEA to assist in economic analysis of nuclear energy systems.

6.1 Embracing New Technologies to Improve the Economics of Nuclear

Many high-tech industries have been quick to adopt digital technologies like artificial intelligence and virtual reality, using them to save money, improve their profit margins and thereby their economic competitiveness. Using new digital technologies is likely to be a way to make substantial cost savings and therefore improve the economics of the operations of existing nuclear power plants. However, the nuclear industry has not yet engaged fully with these new technologies and that is something the Global Forum for Nuclear Innovation has set out to change.

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As part of the 2022 Forum events in July, the IAEA held a Technical Meeting at Hinkley Point Nuclear Power Station in the United Kingdom. At the two-day meeting "Fostering Innovation for the Sustainability of the Existing Fleet of Nuclear Power Reactors", participants presented novel technical solutions to better address the needs of aging plants, such as through designing altered reality (AR) and virtual reality (VR) tools to assist in planning and maintenance of nuclear plants. Many organisations are also exploring ways to make the best use of machine learning applications and implement successful programmes to empower and encourage employees to pursue innovative solutions.

"In building operational resilience, it is vital to understand the importance of investing in the skills and competencies of existing and new nuclear professionals, embracing the new ways of learning that modern learners prefer," said Ricky Swanepoel, Chief Technologist at Eskom Holdings. "In a recent skills audit, as many as 26% of staff in technical disciplines indicated their skills are not fully utilised. This presents a significant opportunity to improve business efficiency and productivity."

Several representatives of nuclear power programmes also highlighted using digitally enabled workflows as a successful way to speed up clear and reliable communications between various stakeholders. Digitalisation, they said, significantly improves the speed of information sharing as well as the quality and amount of data collected. Enabling better data collection can support further innovation in the future by providing a clearer picture of the areas that are ripe for change and confidence that data-intensive solutions will have access to the information needed for them to function effectively.

While at Hinkley Point, participants also talked with and learnt from EDF staff how new approaches to building and project management are influencing Hinkley-C's construction. Hinkley C is the first new nuclear power station to be built in the UK for more than 20 years and will provide low-carbon electricity to around 6 million homes.

"These events were an excellent opportunity to engage a diverse gathering of utility, regulatory and Technical Support Organisation (TSO) expertise. Participants developed

actionable recommendations aimed at accelerating the deployment of innovative solutions at operating plants," said Ed Bradley, Team Leader for Nuclear Power Plant Operation and Engineering Support at the IAEA.

The Hinkley Point meeting followed the Global Forum's main event held in London, designed to accelerate innovation. Through a series of immersive workshops, the forum sought to equip the nearly 200 participants with the kinds of skills needed to encourage confidence and innovation. The Forum ran between 17-19 July, it was hosted by EDF and organised by the UK National Nuclear Laboratory (NNL) in cooperation with the United States-based Electric Power Research Institute (EPRI), the IAEA and the Nuclear Energy Agency (NEA) of the Organisation for Economic Cooperation and Development.

6.2 IAEA's Workshop Series on Economics of Emerging and Existing Reactor Technologies

The IAEA has launched a series of virtual workshops on economic aspects associated with different generations of nuclear power reactors as the need for climate change mitigation and sustainable development drives growing global interest in small modular reactors (SMRs) and other emerging reactor technologies.

Many countries are looking at either expanding their nuclear power reactor fleet, replacing part of it or building their first plants for low-carbon, dispatchable energy to meet rising demand for electricity and heat. As technologies such as SMRs and microreactors (MRs) attract interest, the IAEA is helping countries to identify and implement new approaches for building advanced reactors for a sustainable and net-zero emissions future.

The IAEA kicked off the virtual workshop series this month with an event focused on the economics of two types of technologies: advanced or Generation III reactors currently being built and SMRs and MRs, currently mostly in the research and development phase, and aimed at generating electricity as well as producing process heat, hydrogen and other services to provide stability and resilience to evolving electricity grids.

SMRs, with electrical power up to 300 MW per module, have specific design, safety and siting features, with a wide range of applications. MRs, typically with a capacity of up to 20 MW, are factory-built SMRs that could be easily transported — by truck, ship or railcar — to provide reliable heat and power in remote areas and small power grids. In addition, SMRs and MRs can be used to provide stability and resilience to evolving power grids that rely increasingly on variable generation from renewables and a variety of energy storage systems.

Henri Paillere, head of the IAEA's Planning and Economic Studies Section, noted that in its recently released Roadmap to Net Zero, the International Energy Agency sees nuclear electricity generation doubling in 30 years as part of one possible pathway to net zero. Net zero is the point where greenhouse gases (GHG) emitted into the atmosphere are equal to the amount removed from the atmosphere, achieved by

drastically reducing the use of fossil fuels while bolstering low-carbon generation and GHG removal technologies, some of which don't yet exist. But decarbonising electricity will not be enough. "Emission reductions are also necessary in the industrial, transportation and buildings sectors. Nearly half of the reductions in CO2 emissions needed to get to net zero will come from technologies that are not yet deployed commercially, including SMRs and other advanced reactors," Paillere said. "The technological readiness and economic competitiveness of these emerging technologies will be key factors for their deployment, and this is what the workshop series is addressing."

Emerging reactor concepts like SMRs and MRs are among the most promising emerging technologies in nuclear power and have the potential to play a key role in the clean energy transition, particularly in contributing to the decarbonization of hard-to-abate sectors such as industry and heat. The role of MRs was also highlighted in a recent virtual dialogue between IAEA Director General Rafael Mariano Grossi and Ernest Moniz, the former United States Secretary of Energy. Recognising the increasing global interest in SMRs, which are expected to become an option for flexible generation for a wide range of users and applications, including in the developing world, the IAEA recently established a platform to provide integrated support to Member States on all aspects of their development, deployment and oversight.

Saied Dardour, an IAEA energy economist, said the workshop addresses two audiences. "The first is project developers who rely on standard financial appraisals and focus on returns to shareholders," he said. "The second is public sector decision-makers who take a broader view to include benefits and costs to society, accounting for all resources used by the project, and gauge the value the project generates to society at large."

Participants discussed a broad range of topics, including cost drivers, economics of serial production, integration with renewables, and financing. It was noted that while SMRs may be at a cost disadvantage per unit of electricity produced due to size when compared to the electricity production of large reactors, four economic drivers compensate for this in driving costs down: simplified design, modularisation and factory assembly, standardisation, and regulatory harmonisation.

The workshop also included a session on the economics of advanced reactors in future energy systems, followed by a panel discussion on the role emerging reactor concepts can play in evolving electricity grids. Speakers elaborated on the link between advanced reactor designs and their economics, and the challenges related to their integration with renewables, including through the generation of process heat or the production of hydrogen.

Meeting participants, from both nuclear newcomer countries and established nuclear power countries, shared perspectives and provided country-specific examples and case studies. Keynote speakers, with direct experience in designing, planning and implementing nuclear power projects, highlighted their own perspective, challenges and lessons learned.

"We have more work to do to advance these emerging technologies for a successful and sustained deployment, to address global climate change challenges, which will require decarbonising multiple industries, and to meet countries' sustainable development

goals," said Michelle Scott, Senior Advisor at the US Department of Energy's Office of Nuclear Energy.
The workshop took place from 2 to 4 June and was attended by over 150 representatives of nuclear power organisations and economic and financial institutions from countries developing or considering new concepts of nuclear power plants, including SMRs and MRs. The next workshop in the series, scheduled for December 6-8, 2021, will address the economics of currently operating nuclear power plants.

6.3 Assistance to Less Developed Countries With the Production of Nuclear Power

As in all industrial installations requiring large investments, the economics of power production favours large sizes. This is particularly true in the case of nuclear power. In highly industrialized areas, therefore, the first nuclear power plants to be installed will have, for economic reasons, a large power output satisfying the continuous base load demand of an interconnected supply network, and some operating and economic data on such large power reactors is readily obtainable from the large units already in operation. In the case of lesser developed areas, however, the urgent needs for power are often still small and localized, and in some cases ir.ay call for power reactors of small and medium output with which relatively little experience as yet exists.
It became clear that such cost studies would progress rather slowly and would have to be made very carefully in order to avoid misleading generalisations, in particular since the construction of power reactors in less developed areas would be subject to certain conditions widely different from those under which the very few prototype units have been built and are being operated.

Questions to Ponder

1. **What can be done to ensure the provision of clean and sustainable food to people using nuclear energy?**
2. **How can we adapt the use of nuclear energy in medical applications?**
3. **What can be done to prevent climate change with the use of nuclear energy?**
4. **How can nuclear power be used in the Clean Energy Transition?**
5. **How can we use innovative technologies with nuclear energy in order to achieve the SDGs?**
6. **What measures can be taken to address safety, security and sustainability challenges the IAEA faces?**
7. **How can the IAEA help the Less Developed Countries not to fall behind?**
8. **How can the IAEA help life underwater using nuclear energy?**

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