WORLD NUCLEAR ASSOCIATION

The need for large and small nuclear, today and tomorrow

Cover photos: Oskarshamn 1, Uniper;
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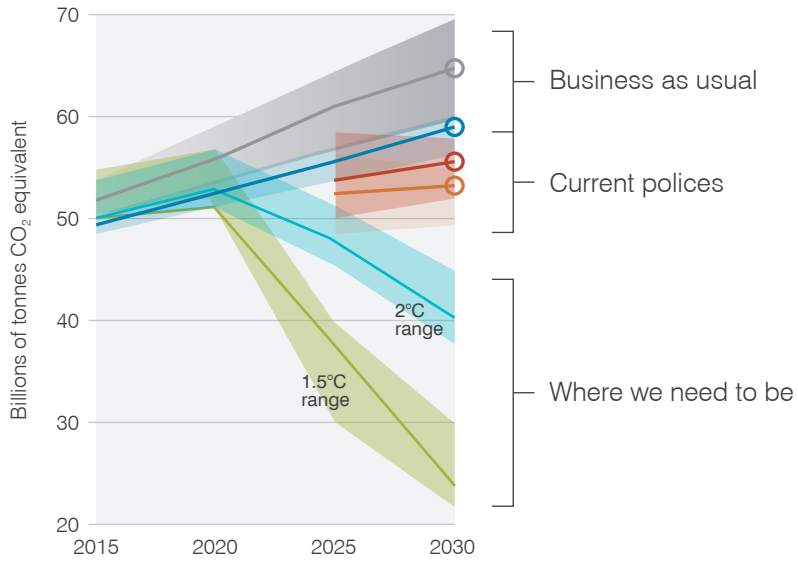
The need for large and small nuclear, today and tomorrow

The world is at a turning point. Despite the considerable efforts to decarbonize the economy and the many billions spent, our world remains highly dependent on fossil fuels. Fossil fuels still supply over 80% of energy worldwide and the trend is clear – instead of reducing our dependence on fossil fuels, we are increasing it. A recent publication from the UN Environment Programme – *The Emissions Gap Report 2019* – highlights the considerable gap between policy commitments made, and the emissions levels that need to be reached (Figure 1). The message is clear – to limit global warming to below 1.5°C, global emissions must decrease rapidly.



A global effort towards establishing a sustainable energy system is underway. The electricity sector is at the heart of that effort, with the need for clean, abundant and affordable electricity widely recognised.

The use of nuclear energy provides an affordable fast track to a high-powered and clean energy system, which delivers a healthier environment whilst strengthening a country's energy security. There is urgent, and immediate, demand for clean energy in developing countries, where electricity demand will more than double – from 15,000 to 30,000 TWh[1]– in the next two decades, and according to the IPCC 1.5°C Middle of the Road scenario, nuclear energy should make a significant contribution in meeting this demand with additional nuclear capacity of 700 GWe by 2040. It is crucial that access to the most efficient and low-carbon solutions – both in terms of technology and financing – is provided to enable sustainable growth.

Nuclear can play a key role in combating poverty and air pollution. In 2019, some 940 million people had no access to electricity[2] - primarily in Sub-Saharan Africa and South Asia. Without access to electricity, these people are denied access to modern life and the opportunity to fulfil their potential. Additionally, 4 out of 10 globally do not have access to clean cooking fuels[3], a key driver behind some 8 million deaths per year due to air pollution[4]. By investing into large and small nuclear reactors, we can bring the modern world to the hundreds of millions who currently live without electricity.

[1] World Energy Outlook, 2018
[2] Our World in Data, 2019: https://ourworldindata.org/energy-access#access-to-electricity
[3] Our World in Data, 2019: https://ourworldindata.org/energy-access#access-to-clean-fuels-for-cooking
[4] World Health Organisation: https://www.who.int/health-topics/air-pollution

Large-scale nuclear reactors are the only proven low carbon technology that can be deployed at the scale and timings required to meet the Paris Agreement goals. These reactors run quietly in the background, delivering immense amounts of power around the clock, regardless of weather or season. At a global level, the nuclear fleet has an excellent operational performance record, with an average capacity factor above 80% – with many reactors achieving above 90%[5].

Whilst large reactors will remain the backbone of many clean energy systems, there are considerable future opportunities for *small modular reactors* (SMRs)[6]. SMRs can complement large reactors by opening new markets and applications for nuclear energy – be it process heat, hydrogen production, or electricity generation for small or remote grids.

The current nuclear landscape

The nuclear power plants operating across the world at present are based on proven technology, which has evolved and matured over the past 40 years. These reactors, available in capacities from about 600MWe to 1700MWe, provide secure and stable electricity supply for their national grids. Moreover, the broad benefits offered from their construction and operation, for example in advancing industrial and urban development, and supporting decarbonisation efforts, are well demonstrated.

There are "shovel-ready" nuclear projects around the world – some 106 planned reactors with approval, funding or commitment in place – which, with the right support, can provide immediate employment and create long-term high-value jobs. Should the decision be taken now, an additional 114 GWe of nuclear energy could be in operation by 2035, extending the provision of affordable, clean, reliable and sustainable electricity to millions of people.

However, a few recent "first-of-a-kind", large reactor projects have suffered delays and cost overruns. These projects show that countries embarking on new nuclear projects after long hiatuses may be impacted from loss of skills and supply chains. Evidence from recent nuclear projects in China, Korea, Russia and UAE highlight nuclear power plants can be built on time and budget, and at lower cost – even in a newcomer country. These countries have demonstrated at various times the value gained from developing their national nuclear capabilities and local supply chain, and a sustained commitment to a reactor programme. They have benefitted from the substantial cost and schedule savings associated with repeat construction of a given design and the development of a strong supply chain[7]. This illustrates that repeat construction and the development of a standardized fleet can result in significant cost savings in nuclear new build.

Small Modular Reactors

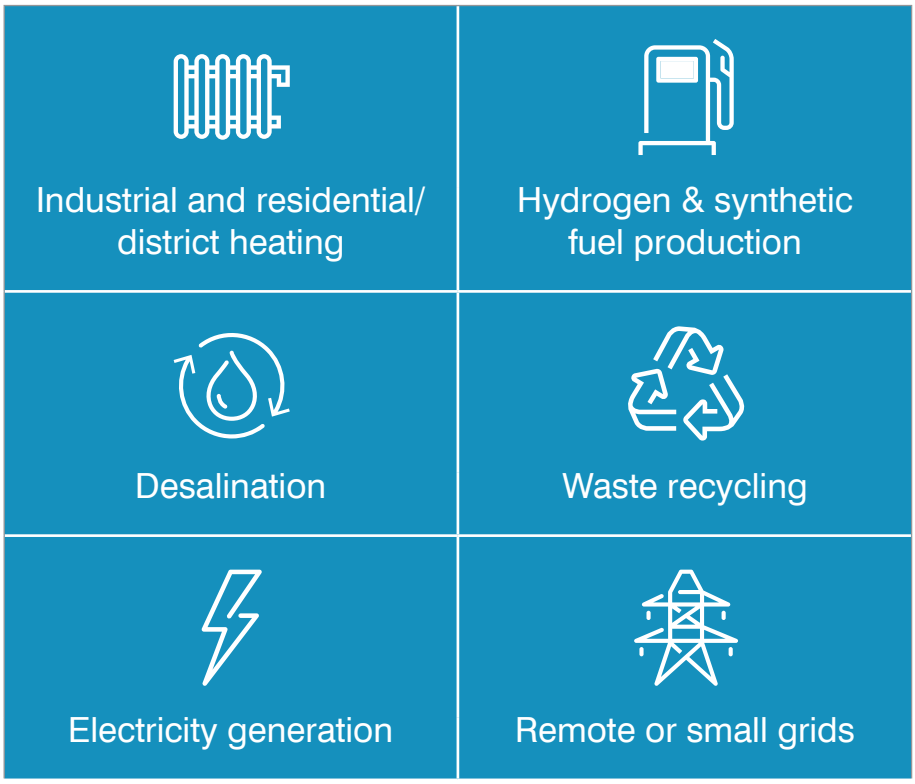
The knowledge, supply chain and experience from large reactors is crucial for the successful deployment of SMRs. Some of the SMRs are derived from existing mature light-water reactor technology with high levels of technological and commercial readiness, whereas other advanced SMRs are of a new design often derived from highly successful research reactor projects. Nevertheless, significant development and investment are required to bring such SMRs to the market as commercial products.

The use of both large reactors and SMRs can help meet the needs of a wide range of sectors, broadening energy decarbonisation efforts beyond the electricity sector. SMRs will be an important complement to larger reactor designs, rather than in direct competition. They may be better suited for the generation of industrial and residential heat, desalination, waste recycling, or hydrogen and synthetic fuel production. Additionally, SMRs are well-suited for remote or small grids where deployment of their larger counterparts would not be practical.

[5] World Nuclear Performance Report (2020): https://www.world-nuclear.org/getmedia/3418bf4a-5891-4ba1-b6c2-d83d8907264d/performance-report-2020-v1.pdf.aspx

[6] SMRs are reactor smaller than 300 MWe, either of conventional light-water design or advanced (so called Generation IV) concepts, which might be built as a module in a larger plant, or built separately.

[7] https://world-nuclear-news.org/Articles/NEA-study-sets-scene-for-reducing-nuclear-costs



The many applications of nuclear

Small-scale nuclear reactors have actually been operating for many years, with over 27 small and medium power reactors operating globally. SMRs are also powering icebreakers and aircraft carriers. Earlier this year, the world's first floating nuclear power plant (and SMR), the *Akademik Lomonosov*, started operation, providing combined heat and power to remote communities in the Russian Arctic.

The Akademik Lomonosov, the world's first floating nuclear power plant (Image: Rosenergoatom)

A large number of countries, which have extensive nuclear experience, are engaged in developing and considering the deployment of SMR technologies for their own needs and for export. So far notable agreements are in place between SMR vendors and users including Eastern European, Middle Eastern and South Asian nations. Designs are in advanced development stages, with several SMR developers expecting the first power reactors to begin commercial operation in 2028-2030. The substantial deployment of reactors for non-power applications is likely to take place towards the end of the 2030s. Once demonstration reactors have been completed and a fleet of SMRs deployed, there is going to be a good return of experience and cost reduction, further strengthening the commercial viability for specific designs.

Policy recommendations

Large-scale nuclear reactors are the only proven low carbon technology that can be deployed at the scale and timings required to meet the Paris Agreement goals. SMRs will be an important complement to large reactors, and will facilitate nuclear development for new applications and in new markets. They will broaden the applications and scenarios suitable for nuclear energy use- by enabling its greater use in industry, desalination and in support of hydrogen and heat production. As SMR designs reach commercial maturity, their role in decarbonisation is expected to grow rapidly in the 2030s and 2040s.

For many countries, nuclear energy will be the backbone of their future low carbon energy systems. Due consideration should be given in choosing the technologies best suited to each country's plans and needs.

In light of this, the World Nuclear Association calls upon policymakers to:

- *Consider the role of all nuclear power technologies (large-scale reactors and different SMRs) as part of their country's long-term and sustainable energy strategy.*
- *Actively explore the application of nuclear technologies for use in industries such as industrial heat and the production of green hydrogen.*
- *Fast-track the deployment of large-scale reactors, to meet the increasing demand for clean and reliable electricity and fulfil climate change commitments.*
- *Accelerate the development and commercialization of SMRs taking into account the many additional applications they offer. Countries should address key regulatory challenges that may emerge in SMR licensing discussions, and seek to create SMR-specific licensing and promote international harmonisation.*
- *Work closely with multilateral banks in order to find ways to ensure that the growing needs for electricity in developing countries are matched with nuclear solutions rather than fossil ones.*

For further information about the many types of nuclear reactor, visit the World Nuclear Association Information Library: https://world-nuclear.org/information-library/nuclear-fuel-cycle/nuclear-power-reactors.aspx

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