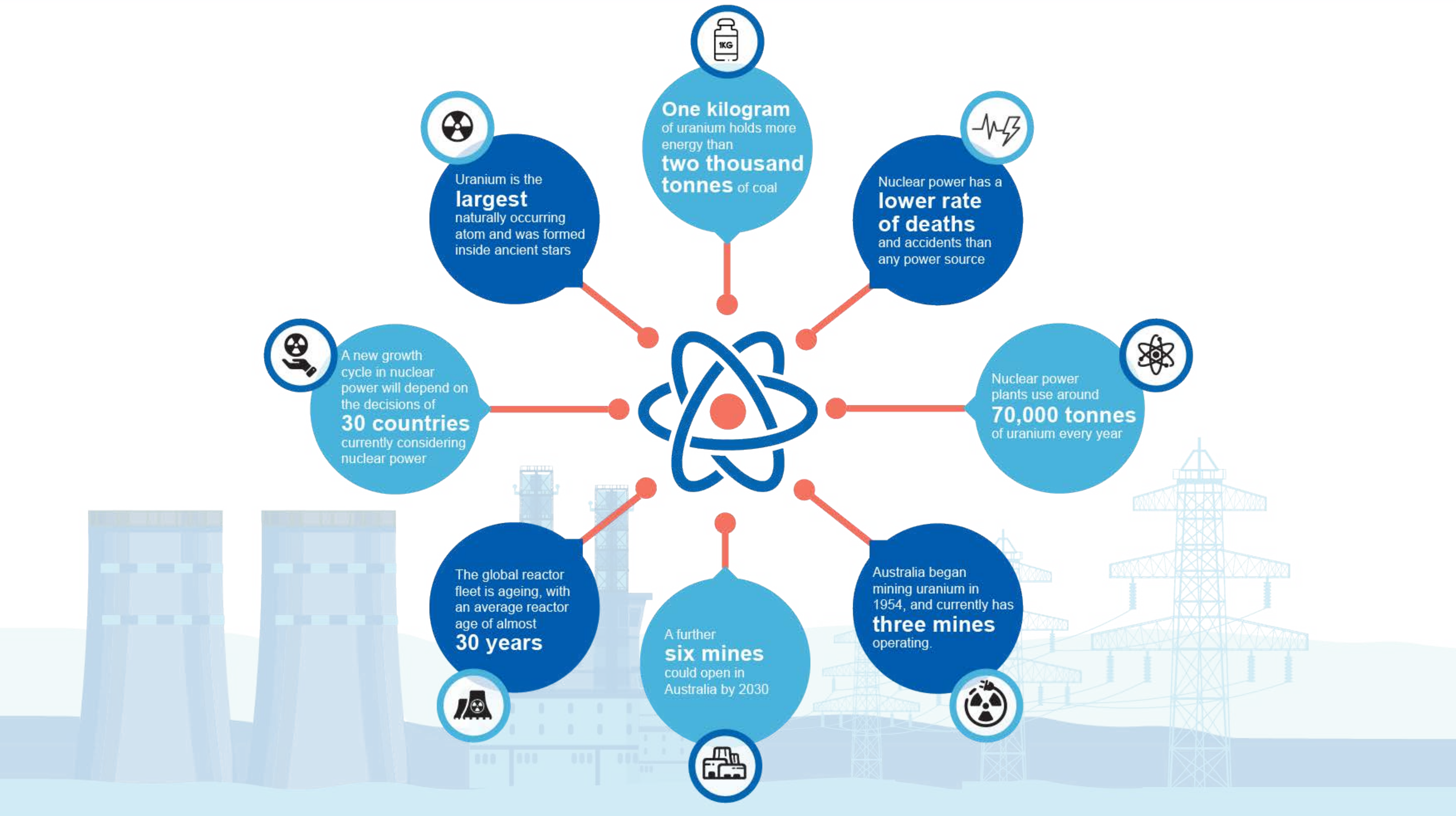
Nuclear power and uranium markets

Resources and Energy Quarterly June 2019



17.1 Summary

- The uranium market is emerging from a sharp downturn after Fukushima, with capital starting to flow towards nuclear power again.
- Long term prospects will depend on a range of factors, including climate change pressures, technological progress, and the decisions of around 30 countries that are considering nuclear energy programs.

17.2 The arc of nuclear power

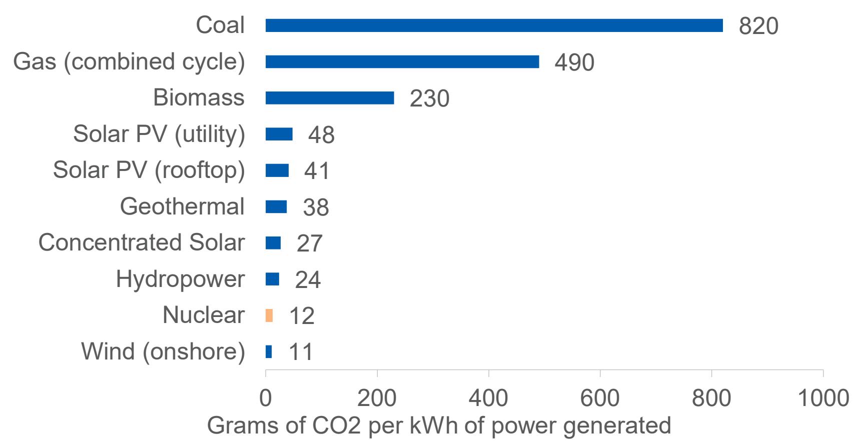
Virtually all uranium is mined for a single purpose — to fuel nuclear power plants. Power is generated in these plants by striking uranium nuclei with neutrons. The resulting reaction splits the uranium nuclei and releases energy. The reaction also releases additional neutrons, which strike further nuclei, creating a chain reaction and a progressive release of power. Uranium is almost unique in its capacity to generate this chain reaction. Outside of the reactors, nuclear plants are similar to coal plants: energy generates steam, which spins a turbine and powers a generator.

Interest in nuclear power is growing at present. This is partly because nuclear power is extremely low-carbon emitting compared with other energy sources (Figure 17.1). Nuclear generation is also reliable and scalable, and requires minimal use of land and materials. As electrification increases power demand, the International Energy Agency has estimated that nuclear generation will need to double its output over the next 30 years in order to hold global temperature warming below 2 degrees.

Nuclear power also has the lowest loss of life and best safety record of any form of power generation (Figure 17.2). While all forms of power generation have been associated with accidents (for example, gas plants to explosions, hydro-electric power to dam failures, coal and oil to spills and pollution), nuclear accidents have been exceedingly rare. Only one accident (Chernobyl) has directly caused loss of life, and no fatal accidents have ever occurred in a modern reactor.

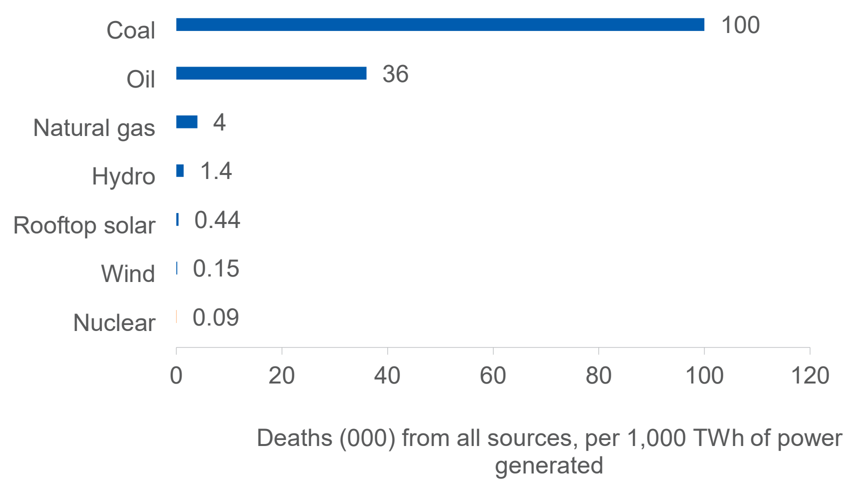
Australia, with three mines in operation and six more in prospect, could play a crucial role as a uranium supplier. However, the prospects for uranium miners are inherently linked to the future of nuclear power.

Figure 17.1: Carbon emissions by power source



Note Lifecycle emissions.
Source: IPCC (2019) Working Group III—Mitigation of Climate Change, Annex III

Figure 17.2: Safety record by power source



Source: Cambridge House (2019), 'The World's Safest Source of Energy Will Surprise You', Desjardins (2019)

Nuclear power hit its stride in the 1970s and 1980s, before tailing off

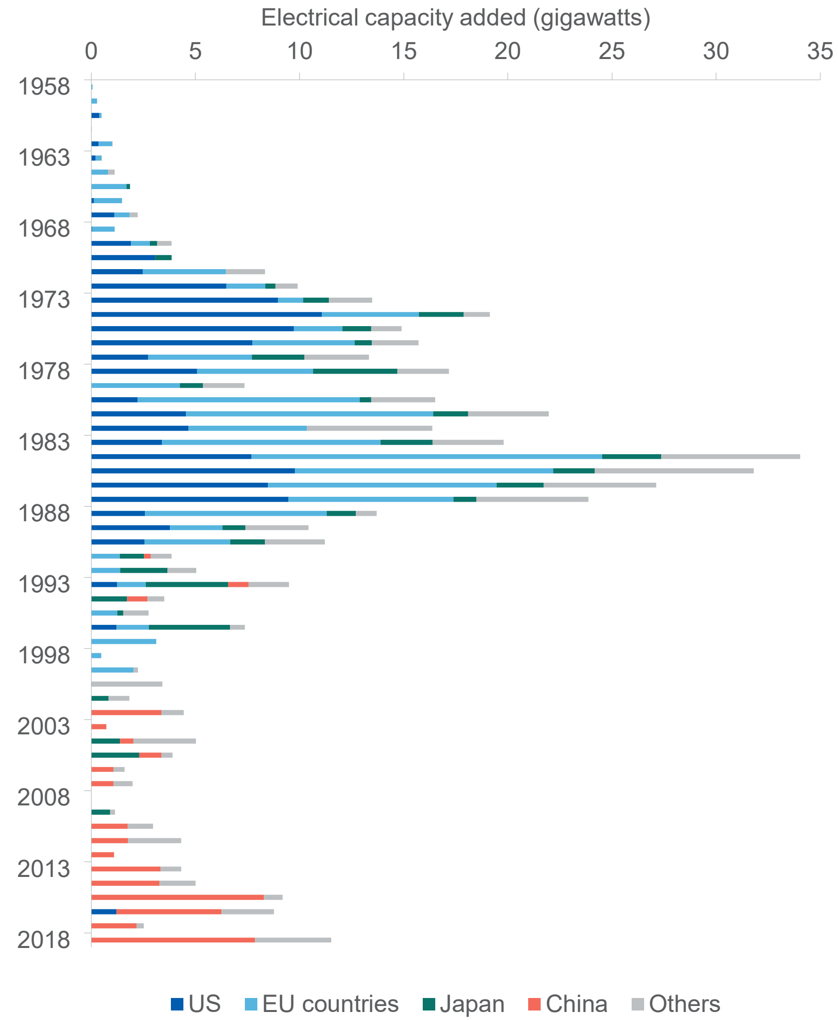
Nuclear research in the modern age was advanced by physicists such as Ernest Rutherford, Albert Einstein, and Niels Bohr, who made crucial discoveries in the 1930s. The first nuclear reactor was built in the US in 1942, and nuclear energy was used to generate electricity for the first time in 1951. The USSR began feeding its power grid with nuclear power in 1954. The first commercial plant was opened in England in 1956, and the US opened its first commercial plant a year later. Rapid growth in nuclear power followed, as Figure 17.3 shows.

By 1960, global nuclear deployment was lifting towards 1 gigawatt (GW). Public opposition to nuclear power was present in many countries from the earliest days of nuclear power generation, and the industry has always faced significant regulatory risks, which have often affected the availability of capital and led to rising costs and construction delays. However, the 1973 oil crisis proved to be a decisive event, with France and Japan leading a wave of investment in nuclear power as countries sought to break their dependency on oil. Investments from the US and Europe led to an average of 20 reactor constructions every year during the 1980s.

However, investment in nuclear power gradually receded towards the end of the decade. This was partly a result of regulatory changes, which increased the commencement period for reactor constructions (the time between initiation and construction) in the US from around 16 months (in the late 1960s) to 54 months by 1980. This, in conjunction with rising litigation and public opposition, added to the cost and financial risks associated with reactor development and construction.

This downturn led in turn to a loss of skills in the nuclear construction sector, which left it increasingly unable to meet the more exacting standards required for reactor constructions. Nuclear reactor construction had entered a downward spiral by the early 2000s, with mining firms exiting the market rapidly. When recovery came, China was the crucial driving factor.

Figure 17.3: Global reactor constructions



Source: International Energy Agency (2019); World Nuclear Association (2019); Department of Industry, Innovation and Science (2019)

Nuclear energy growth is starting to diversify beyond China

China's nuclear power rollout was very rapid, with the country focusing strongly on attaining economies of scale. As Figures 17.3 and 17.4 show, China has come to dominate global nuclear reactor constructions.

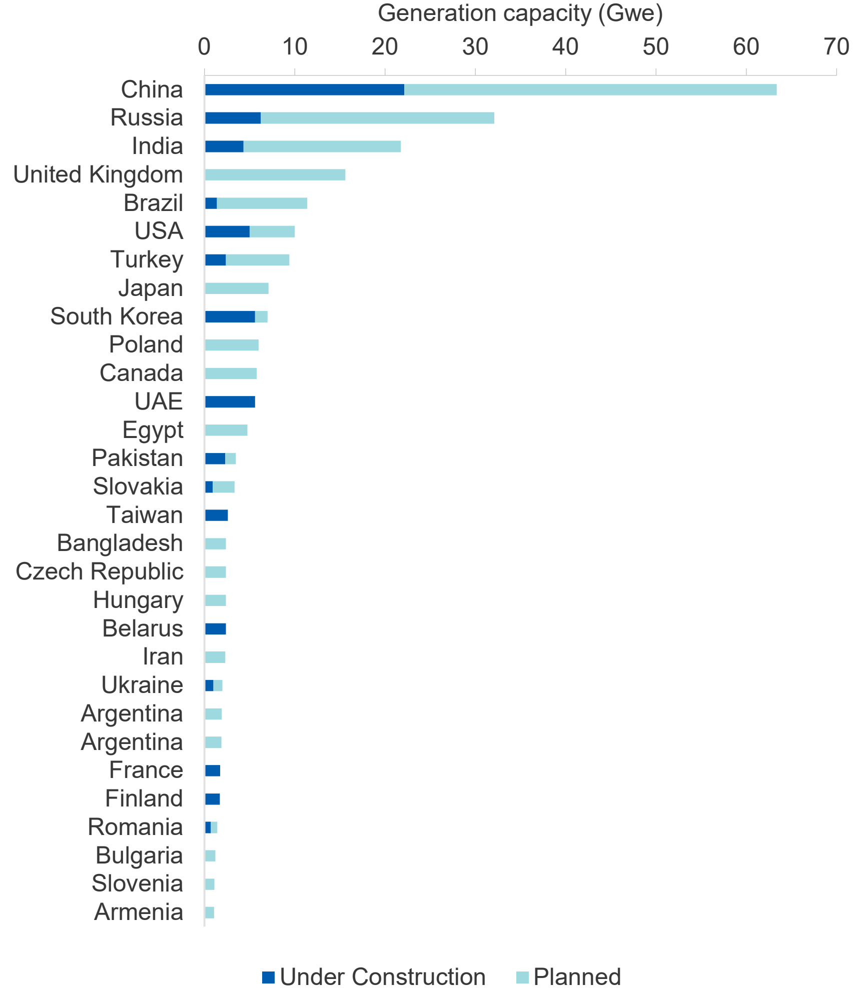
China's construction rate has slowed in recent years, but its large investments have led to improved technology and expertise, enabling take-up of the technology in other countries. A number of these countries have now begun to plan future constructions. The pipeline for reactors in the planning stage is thus far more diverse than that for reactors currently under construction (Figure 17.4). As a result, growth in the uranium market will likely be less China-centred in the future, replicating the more diverse market conditions of the 1970s and 1980s.

Reactors are expected to be connected in South Korea, Belarus, Russia, Finland, the United Arab Emirates, India, Slovakia, and Argentina by 2022. Constructions are also progressing in Turkey, Abu Dhabi and Bangladesh, with a further 25 countries considering, planning, or progressing programs. China is building a large export industry, and Russia's Rosatom expects to double its annual export revenue to US$15 billion by 2024.

This growth may come up against uranium supply issues in the near future. The post-Fukushima fall in uranium prices led a number of uranium mines being deferred or placed in care and maintenance. A return to operation for these projects will take time, due to the scale of regulation around uranium supply. This could result in a price and supply crunch by the mid-2020s. However, as uranium prices are a tiny share of power generation costs, the main impact is likely to be a windfall for producers.

Over the longer term, much will depend on whether the large potential volume of reactors in planning stages ultimately come to fruition. Should construction proceed on schedule, nuclear energy would lift from around 10 per cent of total electricity supply to 13 per cent by 2030. However, decisions to extend or shut down existing reactors will also play a role, since most reactors are now more than 30 years into an approximate 60-year lifespan. Further out still, prospects will depend on how many of the 25 countries currently considering the technology end up adopting it.

Figure 17.4: Global reactor construction pipeline



Source: World Nuclear Association (2019); Department of Industry, Innovation and Science (2019)

17.3 The outlook for nuclear power

Success of nuclear power rollouts depends on following best practice

Deployment of nuclear power has met with mixed results. Successes include France, which replaced its entire coal grid with nuclear power in around 15 years (concluding in 1992), and Sweden, which rolled out a large nuclear grid in around 20 years (concluding in 1985). More recently, China has also built 25 reactors over the past 5 years.

Yet, countries such as the US and UK — which have rolled out nuclear reactors successfully in the past — are currently struggling, with nuclear construction in these countries facing long delays and cost overruns.

Performance and cost competitiveness of nuclear power also varies between countries, with regulation playing a crucial role. In both China and South Korea, companies can build reactors at less than one-fifth of the cost to construct in the US. In South Korea and France, nuclear power remains by far the cheapest energy source, easily undercutting gas, renewables, and coal. In contrast, reactors in the US face closure risks due to their lack of competitiveness against gas and renewables.

It is difficult to predict which path countries commencing nuclear power programs follow. However, two factors will likely be pivotal:

- Scale and standardisation — all successful rollouts have involved a small number of reactor designs and a large order book. This allows for economies of scale, repetition, specialisation, and a robust knowledge base to be built. Countries facing cost blow-outs and delays have generally built reactors in low numbers and in a multiplicity of different designs.
- Public support — this has typically lifted sharply in the wake of crises such as the oil price surges of the 1970s, but varies widely between countries. Low public support and political controversy tend to lead to regulatory uncertainty and high risk.

The United Arab Emirates (UAE) is an example of a successful adoption, being on track to construct 6 gigawatt hours of generation in around 10 years, despite having no significant record of nuclear generation in the past. The UAE accelerated its process by hiring experienced offshore companies to build its reactors. Public support for nuclear power in the country is currently above 80 per cent.

In contrast, Vietnam has abandoned its construction plans citing falling demand and rising costs. Other countries remain in the exploratory stage, with potential to go in either direction. But rising electrification, carbon constraints, the need to construct new power grids in Africa and Asia, and the likely need to desalinate large amounts of water, all represent potential upsides for nuclear power generation.

Innovation in nuclear power has sometimes been stymied by regulation, notably in the US, where new reactor models are obliged to follow steps designed for much older builds. Rapid construction, such as that in China, has thus been an important technological driver, with several new reactor models being pioneered in the country. This progress improves the prospects for reactor rollouts in other countries in the future.

Technology under development now includes the so-called ‘Generation IV’ reactors. These reactors can combine liquid fuel with fluoride or salt, creating a mixture which acts as both fuel and coolant. This means reactors cannot melt down due to a loss of coolant, and require much less heat and pressure, allowing them to be small enough to transport on trucks. They can be assembled on production lines, inherently harnessing the benefits of scale and repetition which have been pivotal to successful reactor constructions in the past.

Dozens of potential models for such reactors are under development by an array of start-up companies in the US and other countries. More than 30 advanced reactor development projects have been launched since the 1990s, and more than $2 billion has been committed to their development around the world. The Chinese Government has identified small, molten-salt reactors as a development priority, with plans underway to start up a prototype device within two years. The US Congress recently passed the bipartisan Nuclear Energy Innovation and Modernization Act, which seeks to modernise regulations and foster Generation IV technology.

Nuclear power is expected by most forecasters to continue supplying around 10 per cent of global energy. Under these assumptions, growth in China, India, the UAE, and other Asian countries will offset reactor closures in the US and Germany.

However, most risks to forecasts are now on the upside. Nuclear generation faced a prolonged depression after Fukushima, and further sharp falls at this point in the cycle are unlikely. But there are many potential drivers — economic and technological — which could stimulate a new wave of reactor builds. The competing priorities many countries face — seeking both to constrain carbon emissions and rapidly expand their power output — may lead to a return of the political and economic imperatives of the 1970s, when the oil crisis created a tipping point for widespread growth in nuclear energy. Successful rollouts in countries such as China and the UAE offer a model and a pathway for new entrants.

Re-use and recycling could marginally reduce the need for mined uranium

When uranium nuclei are split, energy is released along with helium and neutron particles. These particles continue to emit from spent fuel even after it has been depleted as a power source. The process by which these particles radiate outward from their source is known as radiation, and the speed and force at which they are emitted means they can cause damage to surrounding material and to living cells.

Spent nuclear fuel represents a tiny volume of waste, and one which can be stored safely in dry casks. Most fission products dissipate in around three hundred years, leaving spent fuel generally no more dangerous than untouched uranium ore of the kind which already exists in substantial quantities underground.

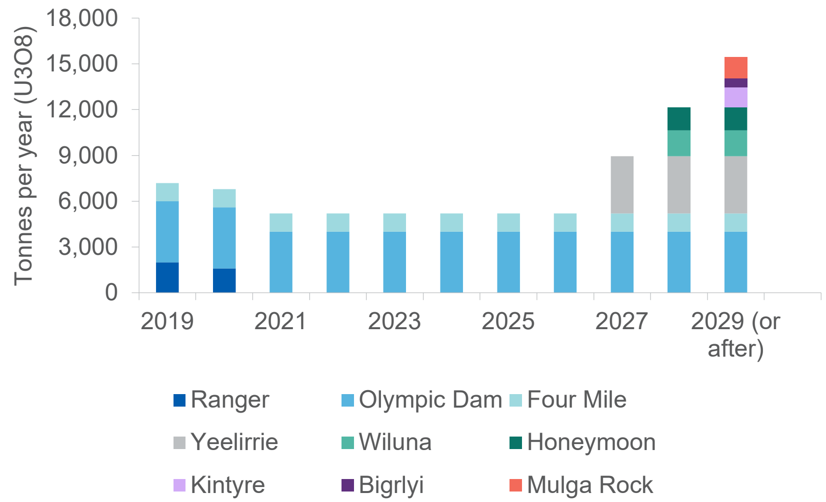
Typically, spent fuel is re-processed to reduce its volume and separate useful material. Breeder reactors — which were first developed in the 1950s — can also re-use spent fuel as a power source. However, it is not likely that recycling and reuse will become widespread enough to wholly displace uranium mining. Mining will thus remain important for electricity generation, medical isotope production and research purposes for the foreseeable future.

Australian supply has potential to grow in scale and importance

Australia currently has three uranium mines: Ranger, in the Northern Territory, Olympic Dam in South Australia, and the Four Mile mine in South Australia. Ranger, which is owned by Energy Resources Australia, is subject to a limited lease, and is required to close in 2020. However, Four Mile has significant deposits remaining and Olympic Dam — one of the world's richest deposits — has enough supply to last for centuries.

Australia also has a further half-dozen mines under development (Figure 17.5), with most located in Western Australia. The post-Fukushima collapse in the uranium price has pushed final decisions on prospective mines further into the future, and it is not clear that all Australian mines under consideration will ultimately commence. However, most of the crucial reviews and permissions have been received, and as the price of uranium edges up, producers are starting to look again at the future of nuclear power around the world.

Figure 17.5: Potential growth in Australian uranium output



Source: Department of Industry, Innovation and Science (2019)