MINERALS COUNCIL OF AUSTRALIA

SUBMISSION TO HOUSE OF REPRESENTATIVES STANDING COMMITTEE ON ENVIRONMENT AND ENERGY

INQUIRY INTO THE PREREQUISITES FOR NUCLEAR ENERGY IN AUSTRALIA

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18 SEPTEMBER 2019

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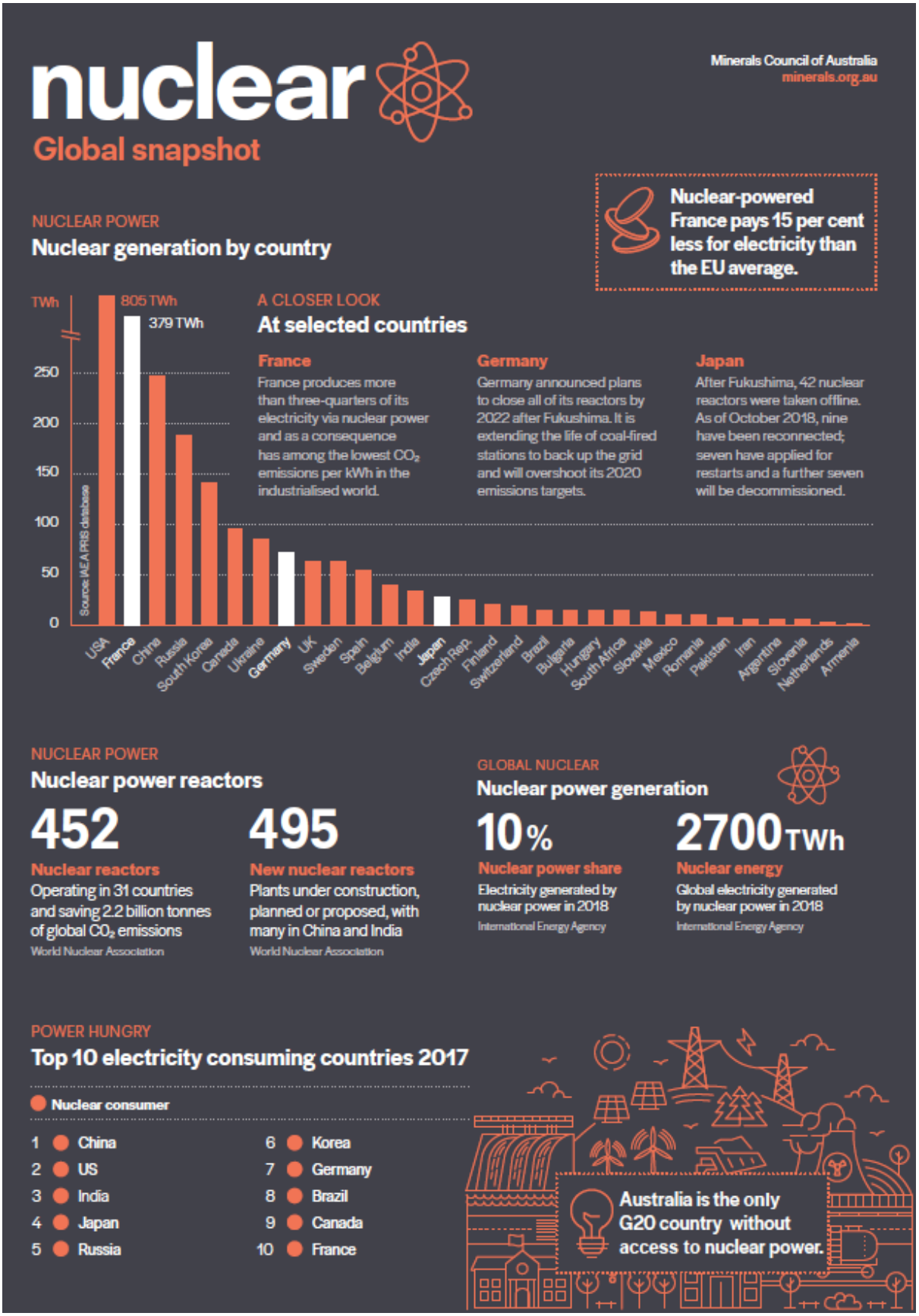

EXECUTIVE SUMMARY

There are four indisputable facts about energy, climate change and nuclear power:

1. Climate change is real and as global energy demand increases, so does the need to decarbonise our power supplies.
2. Nuclear energy provides around 10 per cent of the world's electricity demand with zero emissions power.
3. The power provided by nuclear energy is low cost and can meet the needs of industrial and household consumers 24/7.
4. Billions of citizens in 31 countries benefit from low cost zero emissions nuclear power.

Yet Australia, with the world's largest deposits of uranium, continues to prohibit the use of nuclear power.

The House of Representatives Standing Committee on Environment and Energy's Inquiry into the prerequisites for nuclear energy in Australia offers a chance to consider the absurdity of this.

The Minerals Council of Australia strongly supports nuclear power in Australia for the following reasons.

Nuclear energy can provide zero emissions affordable 24/7 power for Australian industry

Apart from existing run-of-water-hydro, nuclear is the only energy source capable of providing affordable zero emissions power 24/7 at industrial scale.

Over the longer term, it must play a key role – along with other zero emissions energy sources like carbon capture and storage (CCS) and renewables – in helping Australia meet its commitments under the Paris Agreement of net zero emissions by the second half of the 21st century.

Australia has lost its comparative advantage in energy. Rising prices and falling reliability are forcing businesses to invest overseas instead of Australia.

Nuclear energy is a mature, proven and safe power generation technology and the foundation of many electricity systems across the globe.

It must be considered as part of the energy mix if Australia is to retain and grow its strong industrial sector with high-paying long-term jobs, particularly in regional and outer suburban areas while also significantly reducing greenhouse gas emissions.

Over the coming decades, older higher-emitting baseload coal plants which have provided cheap and reliable electricity to Australian industry for the past 50 years will close. It is unclear what will replace the output and reliability of those retiring plants.

Only a commitment to restore energy affordability and reliability will reverse this drift, and nuclear power – especially innovative Small Modular Reactors (SMRs) – will go a long way to providing clean, reliable and lower-cost power for Australian homes and businesses.

SMRs could provide the cheapest zero emission 24/7 power in Australia

SMRs are an evolution of a proven mature technology.

Once manufacturing has been established, the Levelised Cost of Electricity (LCOE) from SMRs could be as low as around A$60/MWh. This would likely make SMRs the cheapest zero emissions power source capable of providing 24/7 energy of any technology, including renewables with storage and coal with CCS.

On a system cost basis, SMRs will be even cheaper than comparable zero emission technologies based on intermittent energy sources. This is because SMRs would not require additional storage, could be integrated with existing transmission networks and provide the full range of ancillary services critical for modern electricity grids.

Compared to traditional large reactors deployed at 444 sites in 31 countries, SMRs are smaller and cheaper to build. Sites using SMRs will also be able to add more modular units to increase a site's total generation capacity as and when needed.

These innovative units are currently undergoing regulatory approval in the United States and Canada, along with other countries.

SMRs will be commercially available by late 2020s and could, along with CCS-ready coal plants, replace some retiring coal generators as well as complementing intermittent renewable energy sources.

Nuclear power is the only energy source which deals with its own waste

The waste developed by nuclear energy is dealt with by industry under tough domestic and international regulatory standards. Some 90 per cent of waste is classified as low level, with 7 per cent defined as intermediate and the remaining 3 per cent – primarily spent reactor fuel – high level waste.

Spent reactor fuel can be disposed in deep geological repositories such as that being built in Finland, or reprocessed as occurs in France. Emerging technologies like Generation IV reactors may also use high level waste as a fuel source.

There is no justification for the continued prohibition of nuclear power in Australia

Nuclear power was prohibited in Australia two decades ago based on sentiment from four decades ago, preceding the mainstream understanding of the threat of climate change and potential mitigation solutions.

Repealing the legislated ban on nuclear energy in the *Environment Protection and Biodiversity Conservation Act 1999* (EPBC Act) is critical if Australia is to seriously embrace all technologies so our future energy mix is affordable, reliable and cleaner.

Similarly, removing uranium mining and milling from the definition of nuclear actions in the EPBC Act and lifting the state-based prohibitions on uranium exploration and mining is critical to not just removing discriminations against uranium mining, but also as part of a broader recognition that Australia is joining the International Panel on Climate Change (IPCC) in acknowledging uranium-fuelled nuclear energy as a critical part of global efforts to reduce greenhouse emissions.

Nuclear power's safety record demolishes the argument that nuclear energy should be banned because it is dangerous.

Its public acceptance in communities around the world where it has operated for decades negates the argument that it should be banned because communities do not accept it.

Despite two decades of legal prohibition, nuclear energy commands net positive support in Australia in the most recent polls, shattering the argument that the public is not ready for it to be legal.

Australia is short-changing itself by not allowing nuclear power

Canada is similar to Australia in many ways – apart from its visionary and pragmatic decision to develop a world-class multi-billion dollar nuclear industry which employs 60,000 people in highly skilled, highly paid roles.

From uranium mining, fuel processing to nuclear power generation, Canada is a major exporter of nuclear technologies while also producing 15 per cent of its power needs from zero emissions nuclear power.

While Australia exports enough uranium to provide 246 TWh of zero emissions power – almost Australia's entire power generation – existing state and federal bans on uranium exploration, mining and nuclear power means Australia denies itself the ability to develop a thriving, modern regional industry based on the world's largest uranium resource.

A modern and sensible nuclear policy in Australia would revitalise the nation's nuclear engineering education potential, because nuclear engineers would be required from an early stage. This would encourage universities to develop specialist courses and partner with international universities.

It would also allow Australia to build on its world-class uranium sector, state-of-the-art nuclear facility at Lucas Heights by developing a high-tech nuclear sector which offers a broad range of employment, investment and research opportunities.

Australia can start developing a regulatory framework for SMRs now

The practical timeframe being proposed for the introduction of nuclear power in Australia is 10-15 years, by which time SMRs will be commercially available.

Australia already has a world-class research and medical nuclear reactor at Lucas Heights, and the regulatory framework governing its operation could be the basis for a future approach enabling the successful and safe deployment of SMRs.

Countries like Canada, the U.S. and the United Kingdom have long-established regulatory frameworks which could also serve as a model for Australia.

There is nothing precluding Australia from working with other countries to develop a harmonised regulatory framework for SMRs. This would contribute to lower construction and deployment costs, which in turn would lower the cost of delivered electricity.

ISSUES

Australia has lost its comparative advantage in energy, driving investment and jobs overseas

Over the past decade household and industrial electricity costs in Australia have risen by more than 90 per cent.[1] This is driving jobs and prosperity from Australian shores as businesses seek to make major investments in other countries where energy is affordable and reliable.[2]

In November 2017, the U.S. state of Pennsylvania targeted Australian manufacturing firms with offers of cheaper and more reliable energy.[3]

Reducing energy costs is critical, particularly if Australia is to maintain and increase the number of high-paying jobs in manufacturing where energy is a major input. Many of these jobs are, or would be, located in regional Australia or the outer suburbs of Australia's major cities.

Australia has relied for its development and prosperity on large baseload power generators – mostly coal generators – to provide affordable and reliable energy for industry and households.

These baseload power stations provide power 24/7 and are not dependent on the weather for their operation. They are also the reason Australians enjoy reliable and secure electricity supplies, and until recently affordable power.

However, these coal plants are getting old, with an average age of 34 years, and the cost of maintaining them is increasing. The MCA has estimated that at least 8,000MW of low-cost baseload will close by 2030, if not earlier.[4] This includes Liddell and Vales Point power stations in NSW, Yallourn in Victoria and Gladstone C in Queensland, together representing about 30 per cent of Australia's current baseload generation. Further closures are expected in the early 2030s.

At this stage, it is unclear what will replace these retiring generators and at what cost. Closures of large baseload plants have already led to significant price rises. When Hazelwood Power Station closed in 2017, wholesale prices jumped 80 per cent.[5]

Unless significant new power generation capacity is provided which is capable of meeting the needs of Australian industry for affordable and reliable power available 24/7, Australia will increasingly find itself struggling to compete against countries where energy costs are lower. This will mean fewer jobs for Australian workers, particularly in regional and outer suburban areas.

For the past decade investment in power generation has been dominated by wind and solar PV. This investment, supported by the Renewable Energy Target which mandated a production quota of 33,000 GWh by 2020 and is underpinned by the value of Renewable Energy Certificates, effectively provided a wealth transfer from consumers to renewable energy suppliers.

Supporting only one class of technologies means that Australia's energy policy is not technology-neutral.

The MCA has consistently advocated for energy policy based on genuine technology neutrality. This means that all technologies should be considered, including renewables, nuclear, low emission coal and gas along with carbon capture and storage. This would allow a mix of energy supplies that would provide affordable, reliable low emissions power.

In this context, SMRs can play an important role in restoring Australia's comparative advantage in energy.

[1] Australian Bureau of Statistics, cat. no. 6401, *Consumer Price Index, Australia, Jun 2019*; cat. no. 6427, *Producer Price Index, Australia, Jun 2019*.
[2] For example, Bluescope Steel's 19 August 2019 announcement that it would invest $1 billion in its Ohio's steel works because of cheap energy costs.
[3] The Australian, *US state of Pennsylvania spruiks power to entice Aussie firms*, 28 December 2017.
[4] Minerals Council of Australia, *Submission to the Department of Environment and Energy's Underwriting New Generation Investments consultation paper*, November 2018, p. 3.
[5] Australian Energy Regulator, *Quarterly volume weighted average spot prices*, viewed 13 September 2019.

Nuclear power – critical to helping Australia and the world meet Paris Agreement goals

Reducing greenhouse gas emissions while meeting the needs of an energy-hungry world is the fundamental challenge confronting policy makers.

The MCA supports a measured transition to a low emissions global economy, and particularly Australia's participation in global agreements such as the Paris Agreement with greenhouse gas emission reduction commitments from major emitting nations[6].

Some 10 per cent of the world's power comes from nuclear energy[7]. For 30 years, nuclear has been the biggest low carbon source of electricity for developed countries, providing 18 per cent of all electricity[8].

Nuclear energy's low life cycle emissions profile is widely recognised. As the South Australian Royal Commission found, nuclear energy's greenhouse emissions are comparable to solar PV and wind farms.[9]

Unlike weather-dependent renewable energy sources, nuclear energy can provide zero emissions power 24/7, 365 days a year.

In 2017, nuclear power resulted in about 2.2 billion tonnes of CO_2 not being released into the atmosphere.[10] This is almost four times Australia's total greenhouse emissions. Without nuclear, global electricity sector emissions would have been 6 per cent higher.[11]

The International Panel on Climate Change (IPCC) in its 1.5 degree report from October 2018 indicated nuclear energy would, depending on scenario, have to increase by between 1.5 to 5 times by 2050 (compared to 2010).[12]

SMRs can meet the needs of Australian industry and households

The development of SMRs is one of a number of technological and production innovations in nuclear technologies that will transform how nuclear power is provided.

SMR designs closest to commercial deployment are simply an evolution of a proven mature technology – smaller, cheaper and more flexible than large-scale nuclear reactors. They are currently undergoing regulatory approval in the United States and Canada, along with other countries.

SMRs benefit from inherent design and manufacturing processes which will make them cost competitive with other 24/7 generation sources. Fabrication in factories to a single design provides for economies of scale.

Smaller than traditional nuclear power plants, SMRs will fit better with the emerging energy market in Australia where a higher level of intermittent resources creates a need for smaller load-following generation supplies. In some cases, SMRs would be more highly valued than traditional baseload.

SMRs can also work as baseload generators. For instance, US-based NuScale – which is one of the SMR companies closest to commercial deployment – is designing its SMRs to operate in packs of six or 12 modules totalling 360-720 MW.

SMRs of this size would meet the energy needs of any large industrial user in Australia requiring 24/7 power.

A 360MW SMR would meet the electricity demand of a city the size of Canberra.[13]

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[6] MCA Energy and Climate Change policy position - https://minerals.org.au/energy-and-climate-change. Accessed 10 September 2019.
[7] International Energy Agency, *Nuclear Power in a Clean Energy System*, May 2019, p.3.
[8] ibid, p.2.
[9] *South Australian Nuclear Fuel Cycle Royal Commission – Final Report 2016*, Adelaide, 2016, p. 3
[10] International Atomic Energy Agency, *Climate Change and Nuclear Power 2018*, pp.45-46.
[11] MCA calculation based on total electricity sector emission and saved emissions from nuclear power.
[12] IPCC, 2018: *Summary for Policymakers. In: Global Warming of 1.5°C. An IPCC Special Report on the impacts of global warming of 1.5°C above pre-industrial levels and related global greenhouse gas emission pathways, in the context of strengthening the global response to the threat of climate change, sustainable development, and efforts to eradicate poverty* [Masson-Delmotte, V., P. Zhai, H.-O. Pörtner, D. Roberts, J. Skea, P.R. Shukla, A. Pirani, W. Moufouma-Okia, C. Péan, R. Pidcock, S. Connors, J.B.R. Matthews, Y. Chen, X. Zhou, M.I. Gomis, E. Lonnoy, T. Maycock, M. Tignor, and T. Waterfield (eds.)]. p. 14

SMRs will be cost competitive with other 24/7 technologies in Australia

SMRs represent one of the cheapest new build 24/7 power supplies of any technology. In Australia, this would possibly make SMRs the cheapest zero emission power source capable of providing 24/7 energy.

Table 1 compares the LCOE in 2030 of SMRs operating 90 per cent of the time, with a Combined Cycle Gas Turbine operating at between 40-80 per cent of the time, along with wind and solar combined with 6 hours of pumped hydro storage and coal and gas with CCS.

For wind and solar to have a capacity factor approaching 80-90 per cent, they would need considerably more storage. This would significantly increase the costs.

Table 1: Cost comparison of different electricity sources in 2030

Power generation type	Cost in Australia (A$/MWh)
SMR	$60-$110 [14]
Gas (40-80% load)	$75-$125 [15]
Wind + 6 hrs storage	$75-$110 [16]
Solar + 6 hrs storage	$55-$80 [17]
Coal + CCS (40-80% load)	$145-$230 [18]
Gas + CCS (40-80% load)	$125-$190 [19]

The LCOE allows comparison of different types of electricity generation on a consistent basis by determining the average total cost to build and operate a power-generating asset over its lifetime divided by the total energy output of the asset over that lifetime.

However, its fundamental shortcoming is that it fails to indicate when power is produced. While intermittent technologies often have relatively low LCOEs, the measure fails to account for the system costs of back-up, storage and ancillary services required to ensure grid stability and the reliable provision of power.

This is why 24/7 power produced by nuclear, coal and gas is usually cheaper on a system cost basis because it reduces the need for back-up supplies and storage while also providing the full range of ancillary services.

CSIRO/AEMO GenCost 2018 Study nuclear costs are wrong

The CSIRO/AEMO GenCost 2018 study also considered SMRs. However, the capital cost attributed to SMRs of $16,000/KW cannot be validated and appears to be at least 2-3 times that cited elsewhere.

For example, NuScale estimates the capital cost of large-scale fabrication (which leads to lower costs) would be US$3,600/KW or A$5,140/KW.[20] The Canadian SMR Roadmap also provided a range of estimates, with the average just under C$7,200/KW (A$7,500/KW).[21]

[13] Canberra electricity demand in 2018 – 2.8TWh – ACT Government, *ACT Sustainable Energy Policy 2020-2025*, p.9. Calculation based on a 360MW SMR operating at 90 per cent capacity factor.
[14] Economic & Finance Working Group, *SMR Roadmap*, December 2018. Figure 1, p. 19
[15] PW Graham, J Hayward, J Foster, O Story, & L Havas, *GenCost 2018*. Australia, 2018, p29.
[16] ibid
[17] ibid
[18] ibid
[19] ibid
[20] NuScale Energy, Submission to the NSW Standing Committee on State Development – Inquiry the Uranium Mining and Nuclear Facilities (Prohibitions) Repeal Bill 2019, p.17.
[21] Economic & Finance Working Group, *SMR Roadmap*, pp-55-58, op. cit.

Nuclear power is the only energy source which deals with its own waste

Nuclear energy creates radioactive waste. Its management is tightly regulated nationally and globally. Classified as either high, intermediate or low level, it comprises everything from lightly contaminated tools and medical waste through to highly radioactive spent nuclear fuel.

Globally, 90 per cent of all nuclear waste is classified low level, with 7 per cent intermediate and 3 per cent high level.[22]

Radioactivity dissipates over time. After 40-50 years the radioactivity of spent nuclear fuel falls to 1/1000th of the level at its removal from the reactor. After 1,000 years it has the same radioactivity as naturally-occurring uranium ore.[23]

Spent nuclear fuel can be handled and safely stored initially by cooling in water and then being placed into dry-ventilated concrete casks. It can then be disposed in deep geological repositories such as that being built in Finland, or reprocessed as occurs in France.

Emerging technologies such as Generation IV fast reactors could use high level waste as a fuel source.[24]

Australia has a world-class nuclear reactor

The Lucas Heights Open Pool Australian Light Water (OPAL) reactor in suburban Sydney is producing nuclear medicines that are central to the diagnosis, treatment and prevention of many diseases.

The OPAL reactor produces around 10,000 doses per week which are used by 250 medical facilities in Australia and New Zealand.[25]

On average, one in two Australians will need a nuclear medicine scan during their lifetime. These are used to diagnose heart, thyroid, lung, and kidney conditions, along with tumours, fractures and sporting injuries.[26] About one-third of all hospital procedures involve radiation or radioactivity.

The recent completion of the Mo-99 Manufacturing Facility at Lucas Heights will see Australia become a major player in international health care. Molybdenum 99 (Mo-99) is used in 80 per cent of nuclear medicines, particularly the diagnosis of cancers, heart disease, muscular and skeletal conditions. The new facility will meet all of Australia's needs and is capable of supplying 25 per cent of global demand.[27]

Importantly, the OPAL reactor and the regulatory framework supporting it shows Australia can develop capability and safely operate nuclear technology.

The EPBC nuclear ban short-changes Australia

Nuclear power was prohibited in Australia two decades ago based on sentiment from four decades ago, preceding the mainstream understanding of the threat of climate change and potential mitigation solutions.

Repealing the legislated ban on nuclear energy in the EPBC Act is critical if Australia is to seriously embrace all technologies so our future energy mix is affordable, reliable and cleaner.

[22] World Nuclear Association, *What are nuclear wastes and how are they managed* - www.world-nuclear.org/nuclear-basics/what-are-nuclear-wastes.aspx – accessed 10 September 2019.
[23] World Nuclear Association, *Radioactive Waste Management* - www.world-nuclear.org/information-library/nuclear-fuel-cycle/nuclear-wastes/radioactive-waste-management.aspx – accessed 10 September 2019.
[24] World Nuclear Association, *Fast Neutron Reactors* - www.world-nuclear.org/information-library/nuclear-fuel-cycle/nuclear-power-reactors/nuclear-power-reactors.aspx - – accessed 10 September 2019.
[25] ibid
[26] Australian Nuclear Science and Technology Organisation, Benefits of Nuclear Science - https://www.ansto.gov.au/education/nuclear-facts/what-is-nuclear-science#content-the-benefits – accessed 10 September 2019.
[27] Australian Nuclear Science and Technology Organisation, Nuclear Medicine Project - https://www.ansto.gov.au/business/products-and-services/health/services/ansto-nuclear-medicine-project - accessed 10 September 2019.

Similarly, the duplicative approvals process for uranium projects under the EPBC Act and state-based prohibitions on uranium exploration (Victoria) and mining (Victoria, New South Wales) treat uranium different from any other mineral and are not justified.[28]

Removing these prohibitions would send a broader message that Australia – like the IPCC – recognises uranium-fuelled nuclear energy as a critical part of global efforts to reduce greenhouse emissions.

Unless this occurs, Australia will short-change itself by denying consideration of the one source of energy production which can meet industrial demand for affordable 24/7 power with zero emissions.

Importantly, Australia is missing out on the broad range of employment, research and investment opportunities provided by the high-tech nuclear sector.

Canada shows what Australia is missing out on

Canada is similar to Australia in many ways – a large country with a relative small population and impressive mineral resources. Yet Canada's decision to promote and support uranium and nuclear has created a multi-billion dollar industry which Australia mostly lacks.

Canada is a global nuclear leader, exporting uranium and advanced technology to nuclear-powered countries around the world. As the world's second-largest uranium producer, Canada exports 85 per cent of its production, worth C$1.2 billion (A$1.25 billion) per annum.[29]

In 2017 nuclear energy also provided 15 per cent of Canada's electricity with zero emissions.[30] Some 60,000 Canadian jobs are directly and indirectly supported by its nuclear sector, with many in highly paid, highly skilled roles.

With 5000 employed in uranium mining, 25,000 in the nuclear power sector and another 30,000 indirect jobs, the industry generates annual revenues of over C$6 billion (A$6.3 billion). Other beneficiaries are the 200-plus Canadian companies that supply products and services to Canada's nuclear industry.[31]

Australia could imitate this success with great results for regional communities, jobs and our national prosperity.

Australian uranium – providing zero emission, safe, reliable and affordable energy to the world

Australia exports cheap, reliable, clean energy to the rest of the world while denying itself these benefits at home. Australia has one-third of the world's uranium and at 6,517 tonnes in 2017/18, is the third-largest exporter of uranium oxide.[32]

In 2018 Australia exported enough uranium to generate 246 TWh of zero emission electricity – the equivalent of 96 per cent of Australia's total power generation.[33] Because of this, around 20 per cent of Australia's total energy exports is zero emissions.[34]

The Australian uranium sector directly and indirectly employs around 3000 Australians and delivers more than $600 million in export income.[35] Yet as the Canadian example vividly illustrates, Australia could do so much more.

Harmonising international standards for SMRs can be done now with Australia's participation

Internationally-harmonised regulatory frameworks will be critical for the development of SMRs and the Australian Government should immediately start working with other countries on a harmonised approach.

The practical timeframe being proposed for the introduction of nuclear power in Australia is 10-15 years, by which time SMRs will be commercially available.

[28] L Wilkinson, *Mining and the EPBC Act nuclear actions trigger*, MCA Publication, October 2018
[29] Canada Nuclear Association, *The Canadian Nuclear Factbook 2020*, Ontaria, 2019, p.29.
[30] ibid, p. 13
[31] ibid, p. 28
[32] Australian Safeguard and Non-Proliferation Office, *Annual Report 2017/18*, Barton, 2019, p.25.
[33] ibid, p.24.
34 Department of the Environment and Energy, *Australian Energy Update 2018*.
[35] S Davidson & A De Silva, *Realising Australia's Uranium Potential*, Melbourne, 2015, p.6.

Australia's world-class OPAL reactor, and the regulatory framework governing its operation, could be the basis for a future approach enabling the successful and safe deployment of SMRs.

Countries like Canada, the United States and the United Kingdom – which are all currently considering the licensing of SMR designs – have long-established regulatory frameworks which could serve as models for Australia.

There is nothing precluding Australia from working with other countries to develop a harmonised regulatory framework for SMRs. Indeed, Australia's participation in the Generation IV International Forum serves as a precedent.

Harmonising approaches would contribute to SMR design standardisation and lower construction and deployment costs, which in turn would lower the cost of delivered electricity.

APPENDIX: SPECIFIC ANSWERS TO TERMS OF REFERENCE

Waste management, transport and storage

Australia's uranium industry has a long track record of safely producing and transporting uranium products within Australia and overseas through our ports.

The Australian Nuclear Science and Technology Organisation (ANSTO) also has an excellent track record in the safe transportation of radiopharmaceuticals.

Globally, the transportation of used fuel from reactors has also been conducted safely. A 2016 study prepared for the US Department of Energy by the Oak Ridge and Argonne National Laboratories concluded that between 1962 and 2016, up to 44,400 shipments of spent nuclear fuel (SNF) and 130 cask shipments of vitrified high-level nuclear waste (HLW) were undertaken:

> …without any injury or loss of life caused by the radioactive nature of the material transported. In general, there have been few transportation accidents worldwide in the history of transporting SNF, and none have had significant radiological consequences.[36]

The South Australian Nuclear Fuel Cycle Royal Commission fully examined the issues around nuclear safety, and it is worth considering its observations and recommendations. It noted that the transportation of uranium and used fuel is routine and complies with a mature regulatory regime.[37]

The South Australian Royal Commission recommended the state 'pursue the opportunity to establish used nuclear fuel and intermediate level waste storage and disposal facilities in South Australia'.[38] In supporting this, the Royal Commission noted that 'South Australia can safely increase its participation in nuclear activities'.[39] It also highlighted significant economic benefits of around $100 billion over the life of the project.[40]

Health and safety

The safety of workers and the communities in which the minerals sector operates is the industry's number one priority.

Nuclear energy has generated electricity safely since the first commercial reactor began operation in the UK in 1956.[41]

With more than 17,000 cumulative reactor years over the past six decades, nuclear energy generation has resulted in fewer accidents and many fewer deaths and worker injuries than other energy generation sources.[42]

This includes the aftermath of the earthquake and tsunami which hit Fukushima in 2011. Although 16,000 deaths were attributed to these natural disasters, there were no deaths from radiation exposure in the immediate aftermath.[43]

The South Australian Royal Commission considered the issue of safety in detail and found that:

> Data from modern nuclear fuel cycle facilities demonstrates they operate well within the applicable regulatory limits for workers, the public and the environment. Doses of radiation to the local community from any new nuclear facilities in South Australia could be expected to be in the range of those estimated from the international nuclear facilities.[44]

Finally, the uranium industry's radiation protection safety performance is actively monitored by the Australian Radiation Protection and Nuclear Safety Agency (ARPANSA).

[36] US Department of Energy, *A Historical Review of the Safe Transport of Spent Nuclear Fuel*, Washington, 2016, p.v.
[37] South Australian Nuclear Fuel Cycle Royal Commission – Final Report 2016, p. 154. op cit,
[38] ibid. p. 169
[39] ibid, p. xiii.
[40] ibid.
[41] World Nuclear Association, *Pocket Guide 2019-2020*, London, 2019, p. 32
[42] World Nuclear Association, *Safety of nuclear power reactors*, London, 2018
[43] World Health Organisation, *FAQS: Fukushima five years on*, WHO, viewed 10 September 2019, https://www.who.int/ionizing_radiation/a_e/fukushima/faqs-fukushima/en/
[44] South Australian Nuclear Fuel Cycle Royal Commission – Final Report, op cit. p. 135.

The natural level of radiation for all Australian is 1.5 milliSievert (mSv) per year.[45]

In its 2019 Australian National Radiation Dose Register (ANRDR) provides extensive monitoring of the radiation exposure for uranium and other workers. The report confirms the low relative doses of radiation of 1 mSv per year, lower than aircraft crew at 3.5 mSv per year[46] and well short of the maximum dose permitted of 20 mSv per year averaged over five years and not more than 50 mSv in any one year.

Environmental impacts

Australia's uranium mines deliver world-leading environmental performance. An overview of the sector's performance was conducted in 2017 by Dr Ben Heard for the MCA.[47]

Key points from that review include:

- It is the nature and regulation of the mining practice, not the mineral, that determines the environmental outcome[48]
- Australia's modern uranium mining industry is world class, and accordingly delivers world class environmental outcomes.

The OECD Nuclear Energy Agency also closely considered this issue in its 2014 report. It concluded:

> Uranium mining remains controversial principally because of legacy environmental and health issues created during the early phase of the industry. Today, uranium mining is conducted under significantly different circumstances and is now the most regulated and one of the safest forms of mining in the world.[49]

Energy affordability and reliability

Nuclear power delivers safe, affordable and reliable electricity around the globe, and is able to deliver that power to businesses and households 24/7 with zero emissions.

The reliability of the global nuclear fleet has improved every decade. In 1976, 24 per cent of nuclear power stations operated more than 80 per cent of the time. This had increased to 46 per cent in 1996 and 64 per cent in 2016.[50]

Nuclear power stations in the United States are now operating at more than 90 per cent of their rated capacity.[51]

France, with around 75 per cent of electricity supplied by nuclear, has energy costs 40 per cent cheaper than that its neighbour Germany which is phasing out nuclear energy.[52] Average electricity emissions in France are one-tenth of those in Germany – a direct consequence of France's zero emissions nuclear power generation fleet.

Economic feasibility

As noted above, commercially available SMRs are likely to be the cheapest form of zero emission power available 24/7. It is incorrect to claim that SMRs will require a subsidy.

Australia has severely constrained its options by pursuing an energy policy which is not genuinely technology neutral. Providing big subsidies to promote a single group of technologies (wind and solar) has undermined another set of technologies (fossil fuels). This is leading to higher prices and increasing risks of blackouts, and the situation is only going to get worse.

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[45] Australian Radiation Protection and Nuclear Safety Agency, *ANRDR in Review 2019*, ARPANSA https://www.arpansa.gov.au/sites/default/files/anrdr_in_review_2019.pdf. - viewed 10 September 2019,
[46] ibid, p.29.
[47] B Heard, *Environmental impacts of uranium mining in Australia: History, progress and current practice*, policy paper commissioned by the MCA, 2017, viewed 10 September 2019, .https://minerals.org.au/sites/default/files/Environmental%20impacts%20of%20uranium%20mining%20in%20Australia_May%202017_WEB.pdf
[48] ibid, p. 5.
[49] OECD-NEA, *Managing Environmental and Health Impacts of Uranium Mining*, Paris 2014, p. 9.
[50] World Nuclear Association - https://www.world-nuclear.org/information-library/current-and-future-generation/nuclear-power-in-the-world-today.aspx, viewed 10 September 2019.
[51] Nuclear Energy Institute, *US nuclear industry capacity factors*, https://nei.org/resources/statistics/us-nuclear-industry-capacity-factors; viewed 10 September 2019.
[52] Eurostat, *Electricity prices for household consumers – bi-annual data*, last updated 18 June 2019.

The existing market framework, which in 2018 saw $20 billion of investment in intermittent energy sources (solar PV and wind) with little if any investment directed towards to dispatchable power, has created a major problem for Australia that needs to be addressed.[53]

The level of intermittent generation in the system is now threatening to hasten the close of existing baseload plants, without adequate supplies being available to affordably and reliably meet demand.

The MCA has warned for some time that the past – including the significantly higher wholesale power prices and lower reliability that followed Hazelwood's close in 2017 – is a reliable guide to the future.

Community engagement

Community engagement will be critical to both drive and reflect the need for political bipartisanship.

The scare campaigns which have tainted discussions to date about nuclear power based on misleading and inaccurate assertions may have been successful in the past, but Australians are waking up to the facts on nuclear power.

Public sentiment is now changing, with recent polls showing significant and growing support for nuclear, including:

- An SBS poll in October 2016 – 55 per cent in favour[54]
- An ABC poll in March 2019 – 61 per cent support[55]
- A Nine Media poll in September 2019 – 65 per cent support.[56]

Essential Research reported in June 2019 that a survey found 44 per cent of Australians supported nuclear power plants, up four points since the question was last asked in November 2015. Support exceeded opposition by four percentage points.[57]

The question for opponents of nuclear power is: where is 24/7, affordable zero emissions electricity going to come from, if not from nuclear energy?

Those who block a sensible and pragmatic bipartisan approach need to explain why they are opposed to technology with a proven track record of producing large amounts of zero emissions power 24/7 safely and reliably which will also be cost competitive in the Australian context.

Workforce capability

The practical timeframe being proposed for the introduction of nuclear power in Australia is 10-15 years – by which time SMRs will be commercially available.

Based on the significant expertise in nuclear engineering amongst Australian universities and the interest in highly skilled, highly paid jobs amongst Australians, developing a capable workforce will be achievable.

The United Arab Emirates has shown how to develop a world-class nuclear industry relatively quickly. Its 5,600MW Barakah nuclear facility which is due to be completed in 2023 will have been developed from scratch in just under a decade as the first commercial nuclear power station in the Arab world.

Introducing SMRs into an Australian context would be more incremental, allowing for the progressive skilling-up of the workforce.

The South Australian Royal Commission into Nuclear also considered this issue and acknowledged that technical and trade-based personnel would be required during the construction phase.[58]

Nuclear engineers would be required from an early stage, encouraging the university sector to develop specialist courses and partner with international universities.[59]

[53] Clean Energy Council, *Clean Energy Australia Report 2019*, p. 7.
[54] Facebook, The Feed SBS Viceland, *Should Australia lift the ban on nuclear energy?* 16 October 2018
[55] Facebook, ABC Brisbane, *Should Australia consider nuclear power as an energy source?* 12 March 2019
[56] Facebook, 9News, *Should Australia turn to nuclear power to prevent summer blackouts?* 21 August 2019
[57] Katharine Murphy, *Australians' support for nuclear plants rising – but most don't want to live near one*, The Guardian, 18 June 2019
[58] South Australian Nuclear Fuel Cycle Royal Commission – Final Report, op cit., p.62.

National consensus

As noted above in the Community Engagement section, political bipartisanship is required to both reflect and drive community engagement and form the basis for a national consensus.

Project proponents would require political bipartisanship in order to have the long-term confidence to invest. However, political bipartisanship is not required to remove the existing prohibition.

Removing the prohibition is critical to attract proponents to investigate and develop potential opportunities.

It is worth remembering that in South Australia, political bipartisanship only developed subsequent to the establishment of the Olympic Dam Copper and Uranium mine.

[59] ibid.