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Monday, 16 January 2023

Committee Secretary
Senate Standing Committees on Environment and Communications
PO Box 6100
Parliament House
Canberra ACT 2600

Dear Secretary,

Re: Inquiry into the Environment and Other Legislation Amendment (Removing Nuclear Energy Prohibitions) Bill 2022

Please find, following, the Australian Citizens Party's submission to your committee's timely inquiry.

Yours sincerely,

Richard Bardon	Robert Barwick
Researcher/Editor	Research Director
Australian Citizens Party	Australian Citizens Party

Citizens taking Responsibility

Summary

The 1998 ban on nuclear power in Australia is irrational, ill advised, and was enacted on the basis not of any sound scientific or economic rationale, but of ideology and party-political horse-trading. It should never have been introduced, and we thank Senators Canavan, Antic *et al.* for introducing this vitally important and long overdue Bill to repeal it.

As advocates of nuclear power since before the ban was introduced, and having conducted extensive research in the course of developing detailed proposals for its deployment in Australia over more than 20 years, the Citizens Party can state unequivocally that nuclear is the safest, cleanest and most reliable source of energy currently available to mankind. Independent research shows that it is also the cheapest over the long term, even under the currently prevailing “market-based” model. It were far better, however, that nuclear power plants and other core infrastructure of an Australian nuclear industry be financed, owned and operated by government, both in principle and for practical reasons.

As much of the world, including Australia, commits to achieving so-called climate neutrality or “net-zero carbon emissions” by 2050, many governments and intelligent conservationists previously opposed to nuclear power have come to realise that it is simply not feasible to run a modern industrial economy on intermittent “renewable” energy sources. Most notably, the European Union in January 2022 reclassified nuclear as “green energy”, and removed regulatory obstacles to its expanded use. Many “developing” countries around the world are embarking upon nuclear energy programs for the same reason. Yet Australia, a supposedly advanced economy and possessor of *one third of the world’s identified uranium deposits*, is the only country to have outlawed its use to produce electricity—albeit we hypocritically allow it to be dug up and sold abroad.

Australia also has some of the world’s largest and most accessible concentrated deposits of thorium, whose addition to the nuclear fuel cycle allows for far greater efficiency, and therefore proportionally less “waste” to store or reprocess. It also greatly reduces the production of so-called “weapons-grade” nuclear materials as by-products in nuclear power reactors, thus mitigating proliferation concerns, the one legitimate objection ever raised to the peaceful use of nuclear power. Combine this with the fact that there now exist reactor types which physically cannot melt down, thus removing what few real safety concerns existed with earlier designs, and there is absolutely no good reason that this Bill not be adopted, and nuclear power immediately thereafter.

Safety

Nuclear power is the safest means of generating power currently available to mankind. Figures published by the Massachusetts Institute of Technology in 2018 show that nuclear has the lowest mortality rate of all power sources, with a mere 90 deaths per trillion kilowatt-hours of electricity generated (i.e., ever).[1] By contrast wind power’s death toll stood at 150 per trillion kW/h; solar, 440; hydro, 1,400; and biofuels and biomass a whopping 24,000.

All 90 nuclear-related deaths resulted from a single incident, namely the meltdown and explosion of one of the four reactors at the Chernobyl Nuclear Power Plant in Ukraine, USSR on 26 April 1986. Media and environmentalist activists have used the spectre of a Chernobyl-style meltdown to sow anti-nuclear hysteria ever since. But as detailed in a 2008 report by the United Nations Committee on the Effects of Atomic Radiation (UNSCEAR), the fact is that of 134 people hospitalised for acute radiation sickness after the accident, “28 died within the first four months, their deaths being directly attributable to the high radiation doses”, and two more from injuries unrelated to radiation exposure; and in the decades since, another 60 had died from cancers and other diseases attributed to radiation exposure. UNSCEAR’s web page on the

[1] Cited in M. Sarram, “Fighting global climate change with renewable energy and nuclear power”, San Diego World Affairs Council, 14 May 2020.

Chernobyl accident[2] elaborates that whilst enhanced screening regimes had detected "more than 6,000 cases of thyroid cancer reported in children and adolescents who were exposed at the time of the accident", there was otherwise "no evidence of a major public health impact attributable to radiation exposure two decades after the accident." Furthermore, UNSCEAR found "no scientific evidence of increases in overall cancer incidence or mortality rates or in rates of non-malignant disorders that could be related to radiation exposure. … Although those most highly exposed individuals are at an *increased risk* of radiation-associated effects, the great majority of the population is not likely to experience serious health consequences as a result of radiation from the Chernobyl accident." (Emphasis added.) Which is to say that whilst a small number of people *may* eventually suffer ill effects, the widespread and persistent health effects initially feared, which anti-nuclear propagandist speak of today as though they were established historical fact, in reality never happened at all. Nor do the world's leading experts expect them to.

The Chernobyl accident was caused by a combination of mechanical failure and human error, ironically during a safety test. The only reason anyone outside the facility itself was affected, however, is because the type of reactors used at Chernobyl, known as RBMKs, were not housed in the steel-and-concrete "containment" structures—so called because they are designed to contain the explosion and any resulting radioactive fallout from such an accident—which are otherwise standard the world over. Pioneering German-American nuclear physicist Hans Albrecht Bethe, a member of the US government's World War II-era "Manhattan Project", wrote 31 August 1991 in the *Chicago Tribune* that "The [RBMK] reactor design would never have been contemplated, let alone licensed, in the West."

The two other incidents often cited to scare people away from nuclear power are the March 2011 meltdown of three reactors at the Fukushima Daiichi plant in Japan; and the partial meltdown of one of two reactors at Three Mile Island, USA in March 1979.

Taking the most recent first, the Fukushima accident resulted from a 15-metre-high tsunami which disabled both the primary and backup power supplies, as well as causing direct physical damage, to the plant's cooling systems. Over 18,000 people were killed by the tsunami, but *no-one died from radiation exposure*. As the World Nuclear Association (WNA) website reports: "Three TEPCO [Tokyo Electric Power Company] employees … were killed directly by the earthquake and tsunami, but there have been no fatalities from the nuclear accident. … UNSCEAR in May 2012 reported that despite skin contamination of several workers, *no clinically observable effects have been reported and there is no evidence of acute radiation injury* in any of the 20,115 workers who participated in TEPCO's efforts to mitigate the accident at the plant."[3] (Emphasis added.) Nor were the public exposed to dangerous levels of radiation, thanks to prompt evacuation of the affected areas.

At Three Mile Island no-one died at all, nor were workers or the public exposed to dangerous radiation. Like Chernobyl, the partial meltdown at TMI was caused by a combination of mechanical failure and human error; but thereafter, containment and emergency management procedures worked as designed, and the crisis was brought under control without further incident. The WNA reports that more than a dozen major independent health studies since the incident have all "found that the radiation releases during the accident were minimal, well below any levels that have been associated with health effects from radiation exposure … [and there is] no evidence of any abnormal number of cancers around TMI years after the accident. The only detectable effect was psychological stress during and shortly after the accident."[4]

Conventional reactors use a fixed array of fuel rods whose replacement requires the complete shutdown, cooling and opening up of the reactor core, a process that becomes more laborious and time-consuming the larger the reactor. The type known as the pebble bed, however, has its fuel encased in tennis ball-sized capsules (the eponymous "pebbles") made of layers of graphite and various ceramics, each containing

[2] http://www.unscear.org/unscear/en/areas-of-work/chernobyl.html
[3] https://world-nuclear.org/information-library/safety-and-security/safety-of-plants/fukushima-daiichi-accident.aspx
[4] https://world-nuclear.org/information-library/safety-and-security/safety-of-plants/three-mile-island-accident.aspx

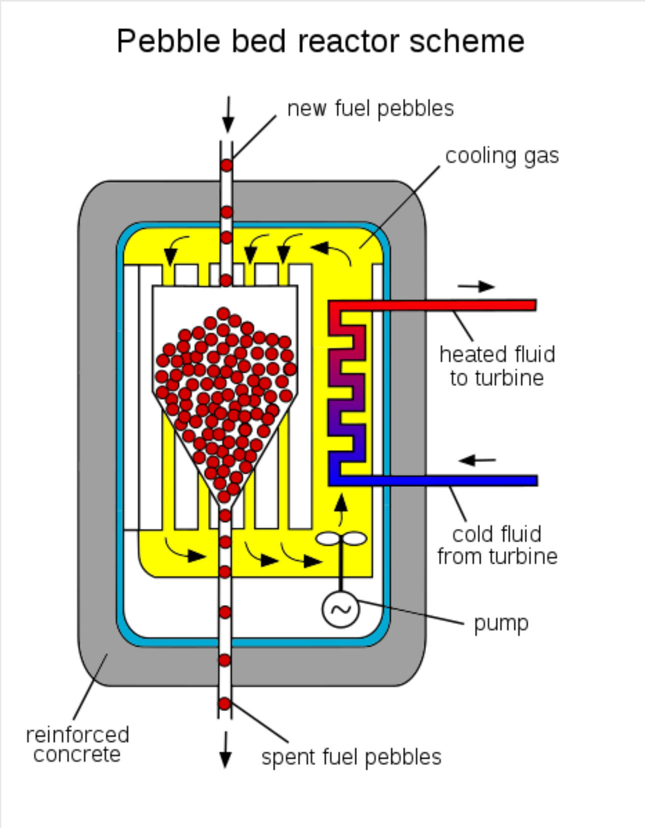
thousands of similarly encased "kernels" of fissionable material a fraction of a millimetre in diameter. The melting point of the fuel capsule material is significantly higher than the reactor can ever reach, even in the event of total coolant loss, making meltdown impossible without any active emergency core cooling system (such as that which failed at Fukushima).[5] This fact was verified experimentally by the AVR (*Arbeitsgemeinschaft Versuchsreaktor*) pebble bed test reactor (in operation 1967-88) at Jülich, Germany. Additionally the self-contained nature of the fuel cells, from which no fission by-products can escape, means that even were the reactor and its containment building somehow breached (by bombing, for example), no radioactive fallout would result. It also makes spent fuel easier to recover and re-process.

Reliability

The reliability of different power sources can be compared via their respective "capacity factor", the ratio (expressed as a percentage) of a generator's actual output, over a given period, to what it would have produced running at full capacity over the same timeframe. The US Department of Energy (DOE) reports that in 2021, the combined capacity factor of the USA's fleet of nuclear power plants was 92.7, compared to 34.6 for wind and an abysmal 24.6 for solar photovoltaic.[6] This means that over the course of a year wind-powered generators produced just over a third of their nominal capacity, and solar less than a quarter. Meanwhile, each of America's nuclear reactors was humming tirelessly along producing, on average, 100 per cent of its capacity all day and night for 335 of the 365 days in that year. The DOE notes that because of this high reliability, while NPPs constituted 8 per cent of the USA's total installed generating capacity in 2021, they "actually produced 19 per cent of the country's electricity due to [nuclear's] high capacity factor".

Nuclear's capacity factor is so high because depending on type and size, most reactors are designed to be able to operate continuously for years or even decades with only brief interruptions for routine maintenance, before eventually requiring a lengthy shutdown for refuelling. Pebble bed reactors, however, have a capacity factor close to 100 per cent because they can be refuelled while operating. As shown in the diagram below, unlike the fuel rods of a conventional reactor, spent "pebbles" can be cycled out and fresh ones added during operation, without stopping, cooling and opening up the reactor vessel. Also, pebble bed reactors are cooled by liquid helium rather than water, making them ideal for use throughout Australia's largely arid inland. This is doubly so because the design lends itself to modularity, and therefore flexibility. Unlike those which employ large conventional reactors, NPPs comprising a complex of small modular reactors (SMRs) can be scaled to suit the needs of individual communities, including through the addition of more modules later on as population and industry expand. Naysayers like to pretend that gas-cooled pebble bed SMRs are a pipe dream, but in fact the are already a reality: the 200 megawatt-electric Unit 1 of Shidao Bay NPP, in northeast China's Shandong province, was connected to the grid in December 2021, and more are under construction.[7] A total of 18 such reactors are planned at Shidao Bay, and larger versions are being developed for use elsewhere.

[5] A.C. Kadak, "A future for nuclear energy: pebble bed reactors", International Journal of Critical Infrastructures vol. 1 no. 4 (2005), pp. 330-345.
[6] https://www.energy.gov/ne/articles/what-generation-capacity
[7] https://www.nuclearasia.com/news/worlds-first-high-temperature-gas-cooled-reactor-connected-to-grid-in-china/4505/



Simplified diagram of a pebble bed reactor vessel. Picture: Wikimedia Commons

Economics

Prime Minister Anthony Albanese and Energy Minister Chris Bowen continue to reject nuclear fission—the cleanest, safest and most efficient means of generating energy currently available to mankind—on spurious economic and environmental grounds, in favour of "renewable" energy sources. For example, speaking to the Investor Group on Climate Change Investment and Finance Summit in June, Mr Bowen declared nuclear the slowest and most expensive form of power generator. He claimed that "Its adoption in Australia would push up power prices and crowd out cheaper and cleaner technologies", and that "Firmed renewables are quicker to build and cheaper to operate." In reality, the only "renewable" energy source of which this is true (indeed the only one worthy of the name at all) is hydroelectricity, which this government is not considering; and which most of Australia lacks the terrain and rainfall to support in any case.

Otherwise, whilst it is true that wind turbines and solar panels incur the lowest up-front cost to install, it is universally acknowledged that the costs and timeframe of the accompanying "firming"—i.e. building the battery or pumped hydro storage to smooth out their intermittent output lest they completely destabilise the grid—will be several times that of the generators themselves. Furthermore, intergovernmental body the International Energy Agency (IEA) cautions that projections of global demand for the minerals required to support a "transition" to firmed renewables "are subject to considerable uncertainty, with different levels of climate ambition and various technology development pathways resulting in a wide range of mineral demand."[8] Among other things, lithium demand in 2040 is projected increase by between 13 and 51 times over today's levels, and cobalt and graphite by 6-30 times, "depending on the direction of battery chemistry evolution". Prices of these and other minerals are already soaring as a result; moreover, there are serious doubts that sufficient reserves of some of them, particularly lithium, even exist. Nuclear, by contrast, has a

[8] https://www.iea.org/reports/the-role-of-critical-minerals-in-clean-energy-transitions/mineral-requirements-for-clean-energy-transitions

relatively high upfront cost; but its lower operating and maintenance costs, exponentially higher efficiency, manifold greater longevity and practically inexhaustible fuel supply make it far cheaper in the long term.

A report published in June 2021 by the University of Queensland (UQ) titled *What would be required for nuclear energy plants to be operating in Australia from the 2030s*,[9] which we encourage the Committee to read in full, shows that through the use of SMRs, nuclear can replace not only all of Australia's current fleet of coal-fired power stations, but its wind turbines and solar panels too, far more cheaply and efficiently than any other current or prospective technology, with effectively zero greenhouse gas emissions beyond those incurred during fabrication and construction. The report shows that the short lifespan of wind and solar generators means their low upfront cost is very much a false economy. "The end-of-life for existing Australian power plants is already in view", it notes. "Not only coal-fired plants, but *all gas plants, wind turbines and all solar PV [photovoltaic] panels on rooftops and in large farms* will have reached the end of their service life by 2050." (Emphasis added.) In contrast, nuclear reactors have a projected service life of 60-80 years.

Further adding to the expense of "renewables" is that they must be built mostly on new ("greenfield") sites in remote areas, necessitating expensive new transmission infrastructure to connect them to the grid. SMR complexes, on the other hand, with their small footprint and greater inherent safety compared to large conventional nuclear plants (of which more below), could take advantage of existing infrastructure. "The potential to re-use old coal plant sites for new SMR plants is one opportunity to make use of what we [already] have", the report says, noting further that around Australia "there are industrial sites, with transmission connections and other tangible infrastructure, close to communities with a skilled workforce interested in jobs where family members may today be employed at ageing coal plants." As the report notes, large conventional reactors "have very large containment structures and are surrounded by large emergency planning zones" (EPZs)—the area likely to be immediately affected in the event of a meltdown, for which emergency evacuation and other contingency plans must be in place)—typically measuring 10 miles (16 km) in radius, making them unsuitable to replace existing coal- and gas-fired plants close to population centres. With SMRs, however, because each module's containment "is integrated with the reactor vessel, the [EPZ] need not extend beyond the site boundary".

Estimates of the total investment needed to replace plants decommissioned by 2050—which, again, includes *all* wind and solar generators now in operation—are "in the order of $150 billion, varying from $75 to $350 billion, regardless of the configuration of the generation-transmission-storage system", the report states. But contrary to Mr Bowen's assertion, "A well-delivered SMR fleet of 20 GW [gigawatts] … would leverage existing physical capital such as sites and network assets, securing the system *at the lower end of the range of total system costs*" (emphasis added).

Cleanliness

As already noted, nuclear produces no greenhouse gas emissions during operation. The inputs that go into its manufacture and construction (concrete, steel, aluminium, copper etc.) are by and large the same as those for other types of generators, for an exponentially greater output of electricity over a far longer service life, and are therefore used exponentially more efficiently when used to construct nuclear generators, in terms of both cost and the mitigation of emissions.

As for the perennial objections regarding so-called nuclear waste, the UQ report notes that Australia has both the world-class waste treatment technology—developed by the Australian Nuclear Science and Technology Organisation (ANSTO), which operates the Lucas Heights research reactor in Sydney—and near-perfect geological conditions for long-term storage of high-level nuclear waste if desired. This should not be necessary, however, since "the 'used fuel' removed from a reactor … still contains approximately 96 per cent of the original fuel that can be recovered to produce new fuel", and/or simply re-used in fast neutron

[9] https://energy.uq.edu.au/files/5963/WhatWouldBeRequired-FINAL.pdf

reactors. Since the UQ report's publication, however, Russian nuclear scientists have developed a "unique zero-waste technology" that recycles spent fuel entirely. As reported 28 September 2022 by the online political magazine *New Eastern Outlook*,[10] "Based on this technology, the Brest-300 reactor has already been developed, a unique, 4th-generation closed-circuit reactor, whose introduction will definitively remove the shortcomings of modern nuclear reactors and all concerns about the possibility of processing waste for military purposes. Thus, if only Russian nuclear waste accumulated over 60 years were processed into fuel for Brest-300 reactors, it would last for several hundred years."

The first Brest-300 reactor is already in operation, at the Beloyarsk NPP near Yekaterinburg in Russia's Ural region. But even with existing "breeder" reactors, which produce more fissile fuel than they consume, it was calculated already 40 years ago this month[11] that "all the world's energy requirements for the remaining 5×10^9 yr [i.e. five billion years] of existence of life on Earth could be provided by breeder reactors without the cost of electricity rising by as much as 1 per cent due to fuel costs. *This is consistent with the definition of a 'renewable' energy source* in the sense in which that term is generally used." (Emphasis added.)

Thorium: the fuel of the future

Of the several SMR variants currently or soon to be available, the UQ report's authors selected that produced by American company NuScale as the mature design—it has been approved by both the IAEA and US regulators—most feasible for Australia for both technical and, presumably, political reasons. A thorium-fuelled SMR such as that now in use in China, however, would be a much better choice, as and when it becomes available (and presuming Australia can get over its lamentable anti-Chinese McCarthyism in the meantime), for a host of reasons. First, thorium is far more plentiful in the Earth's crust than uranium, albeit it tends to quite diffuse. Rankings vary year by year as new reserves are discovered, as well as by who is doing the estimating; but Australia is generally recognised as having either the equal largest concentrated thorium ore (monazite) deposits alongside India, with about 25 per cent of the world's reserves each (according to US government estimates), or to come a close second at 19 per cent (IAEA). Either way, we have more than we could ever use. More importantly, the addition of thorium to the fuel cycle improves the nuclear energy sector in every aspect.

Indian nuclear engineer Ramtanu Maitra elaborated thorium's advantages at length in a November 2005 report for *Executive Intelligence Review* magazine.[12] The advances made since, such as those in China already discussed, serve to bear out his positive assessment. Thorium, he states, has "multiple advantages as a nuclear fuel for future reactors of all types." One of the biggest relates to the non-proliferation of nuclear weapons—always a major concern in Australia, to environmentalists, peace activists and (until recently, at least) governments alike. Combining thorium with standard uranium nuclear fuels, Maitra writes, results in "a significant reduction in the plutonium content of the spent fuel, compared with what comes out of a conventional uranium-fuelled reactor." How much depends upon the fuel mix and reactor type, but experiments in Russia showed that a reduction of up to 80 per cent could be achieved in PWRs, while what little plutonium was produced was extremely high in the unstable isotope Pu-238, causing "correspondingly large heat emission, which would complicate the design of an explosive device…. This barrier, in combination with existing [IAEA] safeguard measures and procedures, is adequate to *unambiguously disassociate civilian nuclear power from military nuclear power*." (Emphasis added.)

Another big advantage of thorium is its efficiency. In addition to its relative abundance, "all of the mined thorium is potentially usable in a reactor, compared with only 0.7 per cent of natural uranium. *In other words, thorium has some 40 times the amount of energy per unit [of] mass* that could be made available" (emphasis

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[10] https://journal-neo.org/2022/09/28/russia-shifts-to-a-zero-waste-nuclear-cycle-in-its-npps/
[11] B.L. Cohen, "Breeder reactors: a renewable energy source", *American Journal of Physics*, Jan. 1983.
[12] https://larouchepub.com/eiw/public/2005/2005_40-49/2005_40-49/2005-46/pdf/64-71_45_sci.pdf

added). Yet because it is a "fertile" fuel, rather than fissile in its own right—meaning it must absorb neutrons either from the fission of another fuel, or from a particle accelerator, before it can undergo fission itself—natural thorium is completely stable. It is also 10-15 per cent more thermally conductive than uranium, making it easier for heat to flow out of the fuel rods (or pebbles); while its melting point is some 500 °C higher, creating a large additional safety margin the event of a temporary coolant loss.

Public finance—and ownership—essential

Australia has all the resources, and the scientific capacity, needed to launch a domestic nuclear power industry. The fact is that as a co-founder and board member of the IAEA, and operator via ANSTO of the Lucas Heights research reactor in Sydney, *Australia is already a nuclear country*. The only obstacles are political.

Besides the irrational legal restrictions that are the subject of this inquiry, the principal obstacle is both major parties' ingrained hostility to the public financing, let alone ownership, of nation-building infrastructure. Yet as the UQ report points out, regardless of whether or to what extent the private sector is involved, "there are some roles only government can play. *This should not be viewed as a special nuclear energy exception*, because it is already the general rule. … [D]irect or indirect government intervention now influences all generation investments and divestments." (Emphasis added.) Governments not only can and do underwrite, lend to or invest directly in energy projects as they see fit, but have established a dedicated government lender, the Clean Energy Finance Corporation, for exactly that purpose. Better yet, the Citizens Party has written legislation for a Commonwealth National Credit Bank, modelled on the original (pre-1959) Commonwealth Bank of Australia, designed to support exactly the kind of science-driven economic renaissance, nationwide and across all sectors, of which a nuclear industry could and should become the cornerstone.

The security aspects of nuclear, especially the necessity for strict proliferation controls around fuel reprocessing, argue for the industry to be operated directly by a Commonwealth agency or statutory company; perhaps by an expanded ANSTO, in much the same way it runs Lucas Heights today. That aside, as a matter pf principle electricity—and all essential infrastructure and services—should be publicly owned and operated as a public good, not for corporate profit. Already in 2017, research by the Grattan Institute[13] showed that the regime of privatisation, deregulation and "competition policy" adopted by State and Commonwealth governments since the 1990s had made electricity vastly more expensive than it would have been under the old vertically integrated State-owned monopolies, costing Australians hundreds of millions of dollars extra a year, for no material or productivity gain. That disastrous error should have been addressed long ago; it should certainly not be repeated with the nation's next generation of electricity assets.

[13] https://grattan.edu.au/wp-content/uploads/2017/03/Price-shock-is-the-retail-market-failing-consumers.pdf