Submission to Standing Committee on Environment and Planning

I wish to make a submission to the Inquiry into Nuclear Prohibition. I am not seeking confidentiality for the submission.

As my submission, please accept the submission that I made to the House of Representatives Standing Committee on the Environment and Energy's Inquiry into the Prerequisites for Nuclear Energy in Australia (attached). That submission was structured to address the terms of reference of the Federal inquiry, but the issues raised are directly relevant to the terms of reference of the Victorian inquiry.

A very brief summary of conclusions that can be drawn from the attached submission with respect to each of your inquiry's terms of reference are as follows:

(1) investigate the potential for Victoria to contribute to global low carbon dioxide energy production through enabling exploration and production of uranium and thorium

The notion that nuclear energy is low carbon is superficial. A deeper analysis shows that nuclear energy is an obstacle to realisation of a low carbon economy (refer "c. environmental impacts" in the attached submission). Hence the idea that uranium and thorium exploration and production could make a useful contribution to global low carbon dioxide energy production is mistaken.

(2) identify economic, environmental and social benefits for Victoria, including those related to medicine, scientific research, exploration and mining

Nuclear energy-related facilities tend to create host communities which are economically dependent on these facilities and which are therefore under huge pressure to overlook the safety and environmental risks associated with these facilities (refer "b. health and safety" in the attached submission). The safest approach is not to build these facilities in the first place.
(I assume the phrase "including those related to medicine, scientific research, exploration and mining" is not meant to exclude nuclear power plants and other aspects of the nuclear fuel cycle.)

It is doubtful whether exploration and mining could generate significant economic benefits given that the long-term prospects for nuclear energy are so uncertain. Refer The World Nuclear Industry Status Report 2019: https://www.worldnuclearreport.org/WNISR2019-Assesses-Climate-Change-and-the-Nuclear-Power-Option.html

(3) identify opportunities for Victoria to participate in the nuclear fuel cycle

The attached submission provides many reasons why it would be unwise for Victoria to participate in the nuclear fuel cycle.

(4) identify any barriers to participation, including limitations caused by federal or local laws and regulations.

There are many legitimate barriers to nuclear fuel cycle activities, including safety, environmental protection, non-proliferation concerns and lack of public acceptance, but ultimately the barrier that is most likely to stick is that nuclear energy is not economically viable (refer "d. energy affordability and reliability, and e. economic feasibility" in

the attached submission).

Philip White

Submission to the Inquiry into the Prerequisites for Nuclear Energy in Australia

By Philip White, PhD

I became involved in policy debates about nuclear energy in Japan as the international liaison officer for the Tokyo-based Citizens' Nuclear Information Service (CNIC). I was CNIC's spokesperson to English language media for seven years, including at the time of the 2011 Fukushima Daiichi Nuclear Accident This submission is informed by my experiences at CNIC and my observation of the nuclear energy situation in the post-Fukushima era.

For reasons outlined below, nuclear energy is not and will not in the foreseeable future be a desirable option to supply Australia's energy needs.

The specific terms of reference are addressed below, with particular attention to issues and perspectives that proponents of nuclear energy are inclined to neglect or downplay.

a. waste management, transport and storage

Nuclear waste, in particular spent nuclear fuel (SNF) and high-level radioactive waste (HLW) from reprocessing of SNF, have been accumulating since the first nuclear reactors commenced operation. Various reports, including the UK's Committee on Radioactive Waste Management[1] and the US's Blue Ribbon Commission on America's Nuclear Future[2], have canvassed a number of disposal options for SNF and HLW. Of these, geological disposal in a purpose-built repository is the generally favoured approach. Disposal in deep boreholes is another approach considered worthy of further evaluation. However, so far no SNF or HLW has been permanently and safely disposed of. Nuclear energy programs were approved and implemented without first ensuring that there was a solution to the problem of this extremely hazardous radioactive waste. To the extent that the economic viability of these programs was assessed, it was assessed with totally inadequate consideration of the cost of disposing of this waste, or of the cost of decommissioning in general.

Much is made of Finland's SNF disposal program. Of all nuclear nations, its program is the furthest advanced for the disposal of SNF from nuclear power plants. Nevertheless, although a licence has been issued for a repository, no spent fuel has been disposed of yet. It is important to realise that obtaining approval for a geological repository does not prove that SNF and HLW can be safely disposed of. It just proves that certain procedural hurdles have been cleared. Given the very long half-lives of some of the radionuclides involved, we will not know whether the project was successful for thousands of years. There are various pathways at each stage of implementation by which radioactive materials could escape into the environment. For example, one long term uncertainty relates to the potential for corrosion of the copper canisters that will contain the SNF.[3] In the shorter term, recent accidents at the

[1] Committee on Radioactive Waste Management, 2006, Managing our Radioactive Waste Safely: CoRWM's recommendations to Government, July

[2] Blue Ribbon Commission on America's Nuclear Future, 2012, *Report to the Secretary of Energy*, January

[3] Ariane Sains, 2018, 'Posiva begins full scale emplacement tests at Finnish repository site', *Nuclear Fuel*, Volume 43, Number 15, July 16

Waste Isolation Pilot Plant (WIPP) in New Mexico illustrate the potential for the unforeseen release of radioactivity at the early stages of a disposal program.[4,5]

Obtaining approval for a repository and social consent from the surrounding population, as Finland has done, does not mean that the potential problems have been solved. Social consent can sometimes be bought with incentives for the present generation, but the costs of getting it wrong will be borne by future generations. The approval in Finland was facilitated by the fact that the repository is to be located near an existing nuclear power plant, so the population is familiar with and accepting of nuclear power in general. In Japan, by contrast, areas which host nuclear power plants and other nuclear facilities have demanded that the SNF and HLW be removed for final disposal elsewhere. In Australia, the history of attempts to gain approval for storage and disposal sites for low and intermediate level radioactive waste has been traumatic and unsuccessful to date, while attempts to persuade the public to accept international SNF and HLW have been a total failure. There is no reason to believe finding a site for disposal of Australian SNF and HLW would be any easier.

b. health and safety

Probably the biggest question that people living near proposed nuclear power plants consider is whether it is safe. They weigh their concerns about safety and environmental damage against their hopes for economic benefits. Nuclear proponents seek to convince the local population and the wider public that nuclear power is safe in general and that the proposed project in particular is safe. Until a few highly publicised nuclear accidents – notably Three Mile Island, Chernobyl and Fukushima – it was possible to convince people that economic benefits outweighed the risks, but since the Fukushima accident it has become extremely difficult to convince the public in western countries to accept new nuclear power plants. The Hinkley Point C nuclear power station is an exception that was approved after the Fukushima Daiichi Nuclear Accident, but there were already two other nuclear power stations (one decommissioned) on the site and planning for the third station began before the Fukushima accident.

There is an inherent conflict between the desire to convince people that a nuclear power project is safe and the requirement to thoroughly and openly investigate all potential flaws and risks. I am most familiar with the Japanese case, although I am sure similarities can be found in the history of nuclear power wherever it has been implemented. The Japanese case illustrates how the public was induced to accept nuclear power plants by unfounded assurances of safety. If the full risks were known, no nuclear power plants would have been built.

In the Japanese case, a myth of nuclear safety was deliberately propagated by nuclear proponents. Indeed, the belief in absolute safety permeated the nuclear industry itself, including the regulators. Anything that challenged this myth was covered up. This included failing to acknowledge or take measures to address known safety risks for fear that to do so would frighten the public and give ammunition to nuclear critics. That is, of course, in addition to the desire to avoid additional expense. This safety myth and this reluctance to

[4] Elaine Hiruo, 2016, *Nucleonics Week*, Volume 57, Issue 33, August 18

[5] U.S. Government Accountability Office, 2016, *Waste Isolation Pilot Plant Recovery Demonstrates Cost and Schedule Requirements Needed for DOE Cleanup Operations*, GAO 16 608: Published: Aug 4, 2016. Publicly Released: Aug 4, 2016, https://www.gao.gov/products/GAO 16 608

address safety problems was one of the root causes of the 2011 Fukushima Daiichi nuclear accident.[6,7] Warnings such as the 1999 accident at the JCO nuclear fuel processing plant did not lead to thorough-going regulatory or cultural change. More fundamental changes were made after the Fukushima accident, but the safety regulations, the culture of the Nuclear Regulation Authority and the law courts still allow nuclear power plants to operate even when safety problems remain.[8,9,10]

The 1986 Chernobyl disaster was dismissed by the nuclear establishment as a problem specific to Soviet type reactors, but the Fukushima Daiichi nuclear accident proved that optimism to be misplaced. Some Australian nuclear advocates have nevertheless sought to trivialise the Fukushima nuclear accident, making claims such as that no one died from exposure to radiation. These claims show a lack of understanding of both the way the Fukushima accident unfolded and how it impacted the surrounding population. The following points should be borne in mind when assessing the impact of the accident.

1) The surrounding population was exposed to various levels of radiation depending where they were at the time, but the people in the most contaminated areas were evacuated fairly quickly. To the extent that exposure and consequent health impacts were limited, that came at the cost of the upheaval of long-term evacuation and the abandonment of large tracts of previously productive land.

2) Many people died of secondary causes that were nevertheless a direct consequence of the nuclear accident: for example, people in hospitals and aged care facilities who did not survive the evacuation, people who might have been rescued from the tsunami if it were not for the fact that there was a nuclear disaster unfolding that prevented rescuers entering the area, and people who committed suicide due to the stress of having to abandon their homes, livelihoods, livestock and due to the break-up of families.

3) Some people downplay the damage of the Fukushima accident, even suggesting that it was a mistake to evacuate the area. This view not only reveals a misunderstanding of the health effects of radiation (see point 4 below), it also fails to take into account the circumstances in which the evacuation decisions were made. At the time, the

[6] Investigation Committee on the Accident at Fukushima Nuclear Power Stations of Tokyo Electric Power Company, 2012, *Executive Summary of the Final Report*, July 23, https://www.cas.go.jp/jp/seisaku/icanps/eng/

[7] The National Diet of Japan: Fukushima Nuclear Accident Independent Investigation Commission, 2012, *The official report of The Fukushima Nuclear Accident Independent Investigation Commission: Executive Summary*, http://warp.da.ndl.go.jp/info:ndljp/pid/3856371/naiic.go.jp/en/report/

[8] Mainichi Japan, 2016, '3 years after new nuclear rules, work continues to evaluate safety of plants,' July 8, https://mainichi.jp/english/articles/20160708/p2a/00m/0na/013000c

[9] The Asahi Shimbun, 2016, 'EDITORIAL: Nuclear power proponents still scoffing at public safety concerns', March 28, http://ajw.asahi.com/article/views/editorial/AJ201603280014

[10] Citizens' Commission on Nuclear Energy, 2013, *緊急提言 原発再稼働を 3 年間凍結し、原子力災害を二度と起こさない体系的政策を構築せよ [Urgent proposal: Freeze restart of nuclear power plants by 3 years, construct systematic policies to prevent another nuclear disaster from occurring]*, June 19, http://www.ccnejapan.com/?p=1107

government was forced to make decisions in the midst of a rapidly unfolding and quite unpredictable situation. The extent of the accident or the spread of radiation could not be accurately predicted, so a precautionary approach was necessary. As it turned out, the majority of the radioactive fallout was over the sea. If the wind patterns had been different most of that could have fallen on land. In that case the exposure to radiation would have been far more severe over a far larger area. Furthermore, the accident itself could have been much worse. There were explosions at three operating reactors and at one closed for maintenance. Two more reactors at the Fukushima Daiichi Nuclear Power Station and four at the Fukushima Daini Station came perilously close, not to mention the Tokai-2 Station in neighbouring Ibaraki Prefecture which narrowly averted a similar catastrophe.

By a stroke of luck, a meltdown in the spent fuel pool of the Fukushima Daiichi No. 4 plant was averted. A displaced separator gate between the adjoining reactor well and the spent fuel pool allowed 1,000 tons of water to flow back into the spent fuel pool, cooling the spent fuel and preventing it from being exposed and overheating. This water was only available because the No. 4 plant was undergoing maintenance at the time:

> When workers were about to insert a shroud-cutting tool into the reactor core … they discovered that auxiliary equipment to guide that tool into the reactor core was the wrong size. Retooling that equipment caused a delay in the process and, as a result, the reactor well was still filled with water on March 11, the day the Great East Japan Earthquake struck.[11]

Thus, by pure fluke, the accumulated inventory of spent fuel in the reactor 4 spent fuel pool was not released into the environment.[12,13] At the time, Shunsuke Kondo, then Chairman of the Japan Atomic Energy Commission, advised the government that if that happened Tokyo would have to be evacuated.[14] So the Fukushima Daiichi nuclear accident was by no means the worst-case scenario.

4) Finally, allow me to deal with the claim that no one died due to radiation exposure. It is first necessary to distinguish between the health effects of acute radiation exposure and exposure to lower levels of radiation. In the case of acute radiation exposure, for example the workers who died as a result of the JCO accident, it is clear that death or injury was caused by the radiation. However, for the lower levels of exposure experienced as a result of the Fukushima nuclear accident, it becomes a matter of probability – so-called 'stochastic effects'. Cancers and some other health problems may arise many years later. No one person's disease can be directly attributed to radiation, but, based on epidemiological studies, people exposed to more radiation are

[11] Toshihiro Okuyama, 2012, 'Fukushima No. 4 reactor saved by upgrade mishap', *The Asahi Shimbun*, March 08, http://ajw.asahi.com/article/0311disaster/fukushima/AJ201203080066

[12] The National Diet of Japan: Fukushima Nuclear Accident Independent Investigation Commission, 2012, *The official report of The Fukushima Nuclear Accident Independent Investigation Commission: Chapter 2, Escalation of the accident*, p. 32, http://warp.da.ndl.go.jp/info:ndljp/pid/3856371/naiic.go.jp/en/report/

[13] Nuclear Emergency Response Headquarters, Government of Japan, 2011, *Additional Report of the Japanese Government to the IAEA The Accident at TEPCO's Fukushima Nuclear Power Stations (Second Report)*, September, Chapter II, pp. II 141 – 143, http://www.meti.go.jp/english/earthquake/nuclear/iaea/iaea_110911.html

[14] Yuri Kageyama, 2012, 'Japan official faults nuke design, defends secrecy', *AP*, Feb, 14, https://www.nrc.gov/docs/ML1209/ML12093A090.pdf

expected to have a higher chance of contracting certain conditions, especially cancer.[15,16,17]

On this basis, the number of fatalities expected to result from the Chernobyl nuclear accident was estimated by the Chernobyl Forum to be around 4,000 among those exposed to the highest levels of radiation (i.e. not including the likely fatalities in areas with lower levels of fallout).[18] Other studies have made considerably higher estimates.[19] Of course, this does not include non-fatal health effects caused by the Chernobyl accident. The notion that only fatalities are worthy of notice is a problem in itself.

Any health effects from exposure to radiation from the Fukushima accident would be of the stochastic variety. Given the levels of exposure involved and the prevalence in the general population of the conditions (in particular cancer) it would be very difficult to distinguish Fukushima health effects from background mortality and morbidity. But that doesn't mean there are no radiation-induced health impacts. It just means they can't be specifically identified.

Studies of children exposed to radiation from the Fukushima nuclear accident have identified a large number of children with thyroid tumours.:

> According to data for the period up to December 2018 released by the Fukushima Health Management Survey Review Committee, 206 children who were 18 or younger at the time of the Fukushima accident were diagnosed with or suspected of having malignant thyroid cancer. Surgery confirmed it in 164 of them.[20]

The panel running this survey claims that these are probably unrelated to the nuclear accident, but this assessment is challenged by independent experts.[21] Considering that the 'National Cancer Center Japan … estimated that there were 2.0 persons with

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[15] Committee to Assess Health Risks from Exposure to Low Levels of Ionizing Radiation, National Research Council, 2006, *Health Risks from Exposure to Low Levels of Ionizing Radiation: BEIR VII – Phase 2 – Executive Summary*, http://www.herbogeminis.com/IMG/pdf/salud y niveles bajos de radiacion.pdf

[16] E Cardis et. al., 2005, 'Risk of cancer after low doses of ionising radiation: retrospective cohort study in 15 countries', *BMJ*, 7 July, https://doi.org/10.1136/bmj.38499.599861.E0

[17] David B Richardson et. al., 2015, 'Risk of cancer from occupational exposure to ionising radiation: retrospective cohort study of workers in France, the United Kingdom, and the United States (INWORKS)', *BMJ*, 20 October, http://www.bmj.com/content/351/bmj.h5359

[18] Chernobyl Forum, 2006, *Chernobyl's Legacy: Health, Environmental and Socio economic Impacts* and *Recommendations to the Governments of Belarus, the Russian Federation and Ukraine*, p. 10

[19] For example, 40,000 fatal cancers predicted by Ian Fairlie in Fairlie, 2016, *TORCH 2016: An independent scientific evaluation of the health related effects of the Chernobyl nuclear disaster*, p. 8, https://www.global2000.at/sites/global/files/GLOBAL_TORCH%202016_rz_WEB_KORR.pdf

[20] Friends of the Earth Japan, 2019, *Fukushima Today and Japan's Energy Future 2019*, July, http://www.foejapan.org/en/energy/doc/fukushima_2019.pdf

[21] Toshihide Tsuda, Akiko Tokinobu, Eiji Yamamoto, and Etsuji Suzuki, 2016, 'Thyroid Cancer Detection by Ultrasound Among Residents Ages 18 Years and Younger in Fukushima, Japan: 2011 to 2014', *Epidemiology*, Vol. 27, No. 3, May, pp. 316 322, https://journals.lww.com/epidem/Fulltext/2016/05000/Thyroid_Cancer_Detection_by_Ultrasound_Among.3.aspx

thyroid cancer under the age of 18 in Fukushima Prefecture as of 2010',[22] it is unconvincing to dismiss an 80-fold increase as a 'screening effect'.[23]

c. environmental impacts

There is a tendency for nuclear proponents to equate environmental impacts of nuclear power plants with CO_2 emissions during the electricity generation mode and to conclude that nuclear power is good for the environment because it has zero CO_2 emissions. Even without considering other environmental impacts (e.g. impact on the marine environment of warm water releases), there are several fallacies with this line of reasoning and quite a bit of hypocrisy.

To deal with the hypocrisy first, it is ironic that many nuclear energy proponents, notably some pro-nuclear Australian politicians, have a record of climate change denial/scepticism and of obstructing attempts to reduce greenhouse gas emissions. They tend to be strong proponents of coal. This is not a uniquely Australian phenomenon. Both the Trump Administration in the US and the Abe Administration in Japan are promoting measures that will simultaneously benefit nuclear energy and greenhouse gas intensive coal power at the expense of renewable energy. For example, the Trump Administration is considering using an emergency power shortage or a national defense justification to keep operational coal-fired and nuclear power plants that would otherwise be shut down on economic grounds.[24] Meanwhile, (among other measures advantageous to nuclear and coal and disadvantageous to renewables) Japan has introduced a system whereby electricity generated by nuclear power plants is prioritised over renewable energy. A 'priority power supply rule' allows electric power companies to refuse to purchase power from renewable sources when there is a danger that supply will exceed demand.[25] This is the opposite of Germany, where renewables have 'priority dispatch' on the grid.[26]

The Japanese Government's energy policy is explicitly rooted in the notion of 'baseload power'.[27] Australian energy policy is also strongly influenced by this notion, but technological developments are making it increasingly anachronistic. Future environmentally friendly electric power systems will require 'flexible, dispatchable renewable generators, batteries and other forms of storage' that are able to rapidly balance supply and demand, rather than inflexible baseload generators (such as coal and nuclear power plants) that are

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[22] ibid.

[23] For an English language critique of the 'screening effect' argument, see the following: Beyond Nuclear, 2019, '"Oops": Manipulated childhood cancer data hides radiation impact, harms public health protection', July 19, http://www.beyondnuclear.org/radiation health whats new/2019/7/19/oops manipulated childhood cancer data hides radiation impac.html

[24] Jeffrey Ryser and Elaine Hiruo, 2018, 'Government subsidies for coal, nuclear plants may bring court challenge', *Nucleonics Week*, Volume 59, Number 23, June 7

[25] The Asahi Shimbun, 2018, 'EDITORIAL: Commitment to sustainable energy tested like never before', October 17, http://www.asahi.com/ajw/articles/AJ201810170029.html

[26] Craig Morris, 2018, 'German power sector: coal and nuclear down, renewables up in 2017', *Renew Economy*, 16 January, https://reneweconomy.com.au/german power sector coal nuclear renewables 2017/

[27] Agency for Natural Resources and Energy, *Strategic Energy Plan July 2018*, p. 20, https://www.meti.go.jp/english/press/2018/pdf/0703_002c.pdf

slow to ramp up and down.[28] Australia needs to adopt policies to prepare for a time when variable renewables contribute the majority of electricity generation in Australia. These policies will involve 'electricity market design, education and training of professionals and tradespeople, and industry policy'.[29] They will be quite different policies from those required to support a nuclear energy program, which has more in common with a coal-based system.

Even if Australia committed to nuclear energy today, it would take considerably more than a decade before the first nuclear power plant came on line. In the meantime, we would have obstructed the development of a reliable, affordable and low greenhouse gas emissions (GHG) electricity system based on renewable energy. Instead, we would have propped up a high GHG emissions system based on coal. So, even though nuclear power plants don't emit much CO_2 during the electricity generation phase, and even if their life-cycle CO_2 emissions (including construction, fuel production, generation and decommissioning) are arguably comparable with renewable energy sources,[30] the delay in moving to a low GHG emission system makes them a very bad choice from an environmental perspective.

d. energy affordability and reliability, and e. economic feasibility

The only new nuclear power plants being constructed in western countries are years behind schedule and wildly over budget. For example, Finland's Olkiluoto 3 is 'about three times over its original budget and 11 years behind the original schedule, under which it was supposed to be in commercial operation in May 2009',[31] France's Flamanville 3 is already 7 years overdue and has unresolved problems that will delay it further. 'In 2007, the project was expected to take five years to complete and to cost Eur3.3 billion. That cost has last been estimated by EDF at about Eur 11 billion.'[32] On the other side of the Atlantic, the Vogtle plant in Georgia USA 'has experienced a series of first-of-a-kind design, licensing and construction problems that have delayed its operation by five years and nearly doubled its projected cost to around $28 billion',[33] while two new reactors at the Summer Nuclear Generating Station in South Carolina were abandoned when they were about two-thirds built. The Hinkley Point plant in the UK, which recently began construction, is only proceeding because of a guaranteed strike price that is well in excess of prices for alternative electricity generation options (refer submission by Professor John Quiggin). These are large plants which, even though they should benefit from economies of scale, are still not economically superior to renewable alternatives.

The question of whether such large scale nuclear power plants are reliable can be considered from several perspectives. Some nuclear power plants have maintained a high capacity factor

[28] Mark Diesendorf, 2018, 'Renewable electricity policy for Australia', The Australia Institute, November, pp. 10, 25, http://www.tai.org.au/content/renewable electricity policy australia
[29] Ibid, p. 1
[30] Manfred Lenzen, 2015, 'Is nuclear power zero emission? No, but it isn't high emission either', *The Conversation*, 21 May, https://theconversation.com/is nuclear power zero emission no but it isnt high emission either 41615
[31] Ariane Sains, 2019, 'Finland's Olkiluoto 3 edges toward operation, but legacy of delays continues', *Nucleonics Week*, Volume 60, Number 17, April 25
[32] Joel Spaes, 2019, 'French economy minister requests audit of Flamanville 3 EPR project', *Nucleonics Week*, Volume 60, Number 28, July 11
[33] William Freebairn and Mark Watson, 2019, 'Georgia PSC staff sees Vogtle 3 deadline challenges', *Nucleonics Week*, Volume 60, Number 31, August 1

over their operational lifetime, while others have been less reliable. One major problem faced by nuclear power plants is that when a fault is found in one reactor, or there is a serious accident, this is likely to have a profound impact not only on the particular reactor in question, but on all other reactors that could be subject to the same fault or risk. For example, even though the Fukushima nuclear accident occurred eight years ago, only nine of the 54 reactors then in service have restarted. In Japan's case, therefore, nuclear power has been exceptionally unreliable. Japan's dependence on nuclear power is, in fact, a major reason why it has been unable to control its GHG emissions. When its nuclear power plants were taken off line it had to make up the deficit with fossil fuel generators. Its preoccupation with nuclear energy and coal had hindered the contribution of renewable energy to its electric power supply.

In regard to small modular reactors (SMR) and 'Generation IV' (Gen IV) reactors in general, there are no commercially operating examples, even though the basic technology is not new. The hope that these reactors might one day become economical with modularisation and mass production must not form the basis for policy planning in Australia. Australian demand will never be sufficient to promote the formation of the infrastructure base to support mass production, so Australia should not consider being a lead purchaser of these technologies. There is no sense in committing to the installation of such a reactor until the supply chain is in place and prices come down. The history of the nuclear industry warns against believing optimistic predictions without hard evidence. For a detailed critique of SMRs, see Friends of the Earth Australia's submission to this inquiry and the March 7, 2019 edition of Nuclear Monitor.[34]

f. community engagement and i. national consensus

In view of the difficulties encountered over the past couple of decades with attempts to find a site for the storage and disposal of Australia's existing low and medium level radioactive waste, it is reasonable to expect that it would be very difficult to reach either a local or a national consensus in support of a nuclear power plant. Any attempt to enter into some type of community engagement or national consensus building exercise aimed at generating support for nuclear energy would inevitably be divisive. Rather, the government should seek to depoliticise the climate and energy debate. This requires a recognition by the major political parties that climate and energy are too important to allow political point scoring to stand in the way of sound policy. Recent history does not inspire optimism, but if politicians could find it in themselves to prioritise national interest and the interests of humanity, then it should not be impossible to generate a broad consensus on energy policy.

One tool in this (though by no means the only element) could be to foster deliberative forums which enable ordinary citizens to objectively consider Australia's climate and energy options. The process could begin at the local level and build on these local discussions towards state-based and/or national forums. Politicians should listen carefully and respectfully to the considered opinions that emerge and studiously resist the temptation to use them for partisan purposes.

[34] World Information Service on Energy (WISE) and Nuclear Information and Resource Service (NIRS), 2019, *Nuclear Monitor*, March 7, Issue #872 873, https://www.wiseinternational.org/nuclear monitor/872 873/nuclear monitor 872 873 7 march 2019

Nuclear energy could be one of the options that is discussed. Participants need to be given the opportunity to weigh up the merits and demerits of all the alternatives. The concern is not that ordinary citizens would not make sound judgements in a free and open deliberative process. Rather, it is that politicians and bureaucrats would try to rig the process to achieve a pre-determined outcome.

g. workforce capability

Embarking on a nuclear power program would require the development of a new industry for Australia. It would require training and recruiting from overseas a workforce with high level skills in the operation and regulation of nuclear power plants and the management of radioactive waste, including spent nuclear fuel (assuming that uranium enrichment and fuel fabrication services would be imported and that spent fuel would not be reprocessed). Although Australia already operates a test reactor, the workforce issues associated with a nuclear power program would be of a different order of magnitude and level of complexity. Developing these skills would take a considerable amount of time and investment. The United Arab Emirates (UAE), for instance, only managed to certify its first group of senior reactor operators in July this year, after having placed an order for its first nuclear power plants back in 2010. UAE's nuclear power program is currently at least 2 years behind schedule, partly because 'additional training and procedural development was needed'.[35]

The key point here is not that Australia could not develop or buy the workforce capability. Rather, it is the opportunity cost of diverting resources from other energy options that could be implemented faster and cheaper and reduce more GHG emissions in the short to medium term. Inevitably a considerable amount of public funding would be required to develop the workforce and the regulatory system. That money would have been better spent on other energy options.

h. security implications

Two types of security implications are discussed below: some form of attack on a nuclear reactor or other nuclear facility, and nuclear proliferation.

Bombing attacks and cyber attacks are two types of attack that have targeted nuclear facilities in the past and could do so again with potentially devastating consequences. In 1981 Israel bombed Iraq's Osiraq research reactor. Again, in 1991 during the Desert Storm air campaign, nuclear facilities at the same site were bombed.[36]

Regarding cyber attack, Iran has admitted that its nuclear sites were subject to cyber attacks and there are suspicions that its Natanz uranium enrichment plant might have been attacked by the Stuxnet malware.[37] Nuclear facilities in western countries are not immune from cyber attacks. 'Although cyber security systems at most reactor sites worldwide physically isolate critical plant systems from the internet, "they are not failsafe" against cyber-intrusions', according to a report by the Fissile Materials Working Group and the Stimson Center. The

[35] Platts Nuclear News Flashes, 2019, 'UAE nuclear regulator certifies first group of Barakah reactor operators', July 8

[36] Federation of American Scientists, Osiraq / Tammuz I, viewed 11 July 2019, https://fas.org/nuke/guide/iraq/facility/osiraq.htm

[37] David Albright, Paul Brannan, and Christina Walrond, 2010, 'Did Stuxnet Take Out 1,000 Centrifuges at the Natanz Enrichment Plant?', Institute for Science and International Security, December 22

report noted that 'plant cyber security can be compromised by the use of third-party contractors who conduct maintenance activities, as well as contractors who update software and hardware and conduct monitoring…The report said FirstEnergy Nuclear Corp.'s Davis-Besse "is a good example of a facility that, in theory, was air-gapped," but in early 2003 was subject to a cyber-attack by the Slammer Worm.'[38]

Obviously either a conventional military attack or a cyber attack would result in a direct cost to the nuclear facility due to physical damage and loss of output, but the greater concern is the potential for such an attack to precipitate a catastrophic accident. Recognition of this risk was behind the decision by the Japanese Nuclear Regulation Agency (NRA) to 'order electric power companies to suspend operations of their reactors unless … anti-terror facilities are completed'.[39] The NRA has prevaricated on this decision since post-Fukushima regulatory changes came into force in 2013,[40] while the electric power companies have dragged their feet on implementing the regulatory requirement, but NRA has finally bitten the bullet. The Fukushima Daiichi nuclear accident is proof of what can happen when safety risks are not taken seriously, even if the triggering event is assessed as extremely unlikely.

The second security perspective that I will discuss is nuclear proliferation. Security risks associated with nuclear proliferation relate not only to any ill-advised nuclear weapons ambitions that some Australian politicians or military analysts might entertain, but also to the perceptions of other countries in our region.

The energy used in nuclear power plants to produce heat to drive a turbine to produce electricity is the same energy used in nuclear weapons. In both cases, it is the fissioning of the nuclei of certain isotopes of uranium or plutonium that produces the energy. History shows that some of the countries that acquired nuclear weapons, as well as many others that considered doing so, attempted to conceal their intentions behind a civilian nuclear energy program.[41] The potential to make nuclear weapons increases significantly if a country has access to highly enriched uranium by virtue of having uranium enrichment technology or to plutonium through a spent fuel reprocessing program. Hence, enrichment and reprocessing facilities are subject to especially stringent IAEA safeguards. However, these safeguards are not fool proof. A determined state could run clandestine programs to evade IAEA monitoring and, in any case, there are technical limitations that make it difficult to identify small diversions of fissile material in a timely manner.[42]

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[38] Jim Ostroff, 2019, 'Power reactor cyber security measures "not failsafe," study concludes', *Nucleonics Week*, Volume 60, Number 24, June 13

[39] Yasuyuki Onaya, 2019, 'Sendai reactor to stop due to delay in anti terror upgrade work', *The Asahi Shimbun*, June 14, http://www.asahi.com/ajw/articles/AJ201906140067.html

[40] The Mainichi, 2016, '3 years after new nuclear rules, work continues to evaluate safety of plants', July 8, https://mainichi.jp/english/articles/20160708/p2a/00m/0na/013000c

[41] Jim Green, 2015, 'The myth of the peaceful atom', *Nuclear Monitor*, issue 804, 28 May, https://www.wiseinternational.org/nuclear monitor/804/myth peaceful atom

[42] David Anderson, 'Nuclear Safeguards', Research Paper for Senate Uranium Mining and Milling Committee 1996 7, https://www.aph.gov.au/Parliamentary_Business/Committees/Senate/Former_Committees/uranium/report/c12

If Australia were to choose to embark on a nuclear energy program, this would be a matter of interest to our neighbours. They are aware that in the past Australia seriously contemplated both a civilian nuclear energy program and a nuclear weapons program and they are also aware that there has been discussion in the media recently about whether or not Australia should acquire nuclear weapons.[43] They would also be aware that nuclear energy makes no economic sense for a country like Australia, which is so blessed with renewable energy resources. Inevitably they would question our true motives. A decision by Australia to start a nuclear energy program would re-ignite interest in such countries as Indonesia in pursuing nuclear energy, which in turn would arouse suspicions in Australia. The nuclear non-proliferation regime is already under considerable strain for many well-known reasons.[44] Rather than raising the stakes by committing to a nuclear energy program, Australia would be wiser and safer if it made the most of its renewable energy potential and assisted others in the region to do the same.

j. any other relevant matter

Based on the above analysis, it would be unwise for Australia to embark on a nuclear energy program and it is very sensible to declare this in the clearest possible terms. In this regard, I am encouraged to see in the Terms of Reference for this inquiry the statement that "Australia's bipartisan moratorium on nuclear energy will remain in place."

[43] Joey Watson, 2018, 'Does Australia need a nuclear arsenal? And what would be the cost?', Late Night Live, *ABC News*, 24 October, https://www.abc.net.au/news/2018 10 24/should australia have a nuclear weapons program/10407610

[44] For example, North Korea's nuclear weapons program, Iran's uranium enrichment program, the lapsing of the Intermediate Range Nuclear Forces Treaty, the forthcoming expiry of the New Start Treaty.