Submission No 56

INQUIRY INTO URANIUM MINING AND NUCLEAR FACILITIES (PROHIBITIONS) REPEAL BILL 2019

Organisation: Medical Association for Prevention of War

Date Received: 18 October 2019

MAPW - Health Professionals Promoting Peace

Legislative Council of New South Wales
Standing Committee on State Development

18th October 2019

Re: An Act to repeal the Uranium Mining and Nuclear Facilities (Prohibitions) Act 1986 and make consequential amendments to other legislation.

Thank you for the opportunity to provide a submission to this inquiry.

The Medical Association for Prevention of War (Australia) works for the elimination of all weapons of mass destruction and the prevention of armed conflict. We promote peace through research, advocacy, peace education and partnerships. Our professional not-for-profit organisation has branches across Australia, and works globally through the International Physicians for the Prevention of Nuclear War.

SUMMARY

MAPW rejects enabling uranium mining and nuclear power in Australia.

Our primary concern is that civil nuclear power generation is associated with the acquisition of a nuclear weapons capability. There are clear historical and current links between the nuclear power industry and nuclear weapons proliferation. Any proposal for Australia to acquire nuclear power is likely to fuel suspicion as to our motives (suspicions that could be well-founded, given recent calls for Australia to keep open the nuclear weapons option), and this could in turn promote regional nuclear weapons proliferation.

However there are many other grave concerns in relation to uranium mining and nuclear power:

- Regulatory capture is already well documented in the nuclear industry in Australia. Uranium mining operations at Olympic Dam in South Australia are a case in point;

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with many regulatory exemptions. By BHP's own assessment, the tailings facilities there are extreme risk for the potential loss of life of at least 100 workers, and means environmental rehabilitation of the site would be impossible.

- There are significant health issues for uranium mine workers.
- Nuclear power plant operations have major health implications for surrounding populations.
- The Chernobyl and Fukushima disasters demonstrated the potential for accidents with far-reaching - but often hidden – consequences.
- Nuclear power plants are vulnerable to terrorist attack or sabotage, which would have disastrous consequences
- Radioactive nuclear waste remains a major unsolved problem internationally. Even proposals to deal with Australia's relatively small amount of nuclear waste are unresolved after nearly two decades. Current proposals are deeply flawed, well below international best practice and are dividing communities.
- Nuclear power is not "carbon-free". It has significant carbon emissions in many phases of its implementation
- Constructing and operating nuclear reactors in Australia would be difficult and slow, with a 15 year time frame being very optimistic, even with small modular reactor construction. This is far too slow to address the urgent imperative for climate action.
- Nuclear energy – including the possibility of small modular reactors - is prohibitively expensive, again raising questions as to why Australia would consider this form of energy when much cheaper options are available.
- Nuclear power requires very large amounts of water; water access will be an even greater problem for Australia in the future than it is already

Many of these problems reinforce the importance of MAPW's primary concern – the nuclear weapons proliferation potential of nuclear power. Why would New South Wales even consider an energy form which has such a long list of unresolved problems, when there are cleaner, faster, cheaper, safer, proven and tested alternatives ready to go?

Discussion of nuclear power is a time-wasting distraction from the urgent need to switch to known, safe and affordable forms of renewable energy.

Deregulating uranium mining is irresponsible. There are significant health issues for mine workers. Moreover, the only end products of uranium mining are intractable highly toxic radioactive waste (with no known disposal solution), nuclear fallout or nuclear weapons.

It is salutary to quote the NSW Uranium Mining and Nuclear Facilities (Prohibitions) Act 1986 No 194.

The objects of this Act are:

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(a) to prohibit mining for uranium, and

(b) to prohibit the construction or operation of nuclear reactors and other facilities in the nuclear fuel cycle,

in order to protect the health, safety and welfare of the people of New South Wales and the environment in which they live.

Protecting the health and well-being of the people is a fundamental task of good government.

MAPW would be happy to appear before the committee to discuss this issue further.

Yours sincerely,

Margaret Beavis
Vice President

Sue Wareham
President

INTRODUCTION

The need to act urgently to reduce anthropogenic global warming and its devastating ecological consequences is virtually undisputed in the scientific community. International governmental deliberations about the importance of addressing climate change by reducing fossil fuel use and thus carbon emissions have been conducted since 1988 and much time has been lost since then.

The health impacts of climate change in Australia are well documented[1]. Recent medical and scientific literature documents the extensive current and potential human health outcomes.[2,3,4] These include increased injuries and deaths from more severe and frequent extreme weather events including bushfires, the impacts of heat waves, population shifts rendering people more vulnerable, changing patterns of infectious diseases, and changes in soil fertility and insect ecology, in turn reducing agricultural output and food security.

Further delay in responding to the climate crisis will aggravate all these trends.

Nuclear power proponents are again advocating nuclear power for Australia as a response to this crisis, while the rest of the world is largely turning away from it. According to the *World Nuclear Agency* (the principal international organization that promotes nuclear energy) globally the share of nuclear in world electricity has shown decline from about 17% to 11% since the mid-1980s…'[5] The number of nuclear reactors under construction in the world has been steadily decreasing for the last five years, and, of the units under construction, a majority are well behind schedule.

The following concerns, which reflect those held globally about the nuclear industry, will now be addressed:

- **Nuclear power and nuclear weapons**
- **Nuclear power and radiation impacts**
- **Nuclear accidents**
- **Nuclear terrorism and deliberate harm**
- **Nuclear waste**
- **Carbon emissions from nuclear power**
- **Climate solutions are needed now**
- **Small modular reactors**
- **Water usage**
- **Regulation**

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[1] McMichael AJ. Climate Change in Australia: Risks to Human Wellbeing and Health, Austral Special Report 09-03S. Melbourne, Australia: The Nautilus Institute, RMIT2009.

[2] Butler C, Harley D. Primary, secondary and tertiary effects of eco-climatic change: the medical response. Postgraduate Medical Journal. 2010;86:230-4.

[3] *Climate Change and Land: an IPCC special report on climate change, desertification, land degradation, sustainable land management, food security, and greenhouse gas fluxes in terrestrial ecosystems* August 2019 https://www.ipcc.ch/report/srccl/

[4] The 2018 report of the *Lancet:* Countdown on health and climate change: shaping the health of nations for centuries to come. *Lancet.* 2018; 392: 2479-2514

[5] https://www.world-nuclear.org/information-library/current-and-future-generation/nuclear-power-in-the-world-today.aspx

1. NUCLEAR POWER AND NUCLEAR WEAPONS

Nuclear fission technology is the same whether it is for civil or military purposes - nuclear fuel is employed to generate a reaction, either controlled in the case of nuclear power or uncontrolled in the case of an explosion.

Nuclear weapons require as fuel either:

- highly-enriched uranium, which can be readily produced by the same process that produces low-enriched uranium for nuclear power, and/or
- plutonium which is produced in nuclear reactors. The quantity of plutonium can be maximised by varying the length of time the fuel rods stay in the reactor. The plutonium can then be extracted from the fuel rods by reprocessing.

Even if a state with nuclear power has not developed nuclear weapons, the infrastructure's dual purpose means that the capacity to do so is there. Acquisition of nuclear weapons fuel – enriched uranium or plutonium - is generally the limiting step if a nation wants to develop nuclear weapons.

There are multiple examples of the dual (civilian and military) uses of the fuel, expertise and technology. For example, Pakistan and North Korea primarily used highly enriched uranium in their nuclear weapons, and India and Israel used plutonium; in all these cases the facilities and fuel were ostensibly for peaceful purposes. France and the UK have used civilian reactors to supply plutonium for their nuclear weapons. Iran's nuclear program, which began in the 1960s with a reactor supplied by the US, illustrates the political difficulties that can arise once the technology is in place, and the technology's potential to raise destabilising suspicions.

The International Panel on Fissile Materials, an authoritative independent international group of experts has observed that:

> *"A phase-out of civilian nuclear energy would provide the most effective and enduring constraint on proliferation risks in a nuclear weapon-free world." (IPFM, 2009)* [6]

This conclusion was underlined by the Board of Sponsors of the Bulletin of the Atomic Scientists - which includes 19 Nobel laureates - in 2010:

> *"…the world is not now safe for a rapid expansion of nuclear energy. Such an expansion carries with it a high risk of misusing uranium enrichment plants and separated plutonium to create bombs."* [7]

The German Institute for Economic Research recently surveyed the 674 nuclear power plants that have ever been built.[8] They found that an examination of economic history confirmed that electricity has primarily been used as a coproduct of nuclear power generation. The driving force was military developments and interests, primarily generating weapons-grade plutonium and, especially in the U.S. in the 1950s, developing pressurized

6 IPFM (International Panel on Fissile Materials) (2010) Global fissile material report 2010. Balancing the books: production and stocks. Available at: http://www.fissilematerials.org.

7 BAS (Board of the Bulletin of the Atomic Scientists) (2010) It is 6 minutes to midnight. Bulletin of the Atomic Scientists, Jan 14. Available at: http://thebulletin.org/content/media-center/announcements/2010/01/14/it-6-minutes-to-midnight.

8 https://www.diw.de/documents/publikationen/73/diw_01.c.670581.de/dwr-19-30-1.pdf

water reactor technology to drive submarines.

The present phase has been shaped by the rhetoric of the “nuclear energy renaissance,” but in reality is characterized by the decline of its commercial use in Western market economies.

Particularly of note in this context are the bankruptcy of major nuclear power plant construction companies Westinghouse (U.S.) and Framatome (formerly Areva, France) and the efforts of energy suppliers to shut down unprofitable nuclear power plants as quickly as possible or shift the financial responsibility to the state.

The market for electricity has become increasingly liberalized since the 1990s, and there is little incentive for private investment in nuclear power plants. They noted that nuclear power harbors the high risk of proliferation.

The importance of the dual nature of nuclear technology cannot be overstated. Nuclear weapons are the most terrifying devices ever created. There are currently approximately 14,000 of them globally. One or more of them will be used again, with catastrophic and almost certainly unprecedented consequences, unless they are eliminated. The hands of the Bulletin of the Atomic Scientists’ Doomsday Clock, indicating our proximity to nuclear catastrophe, stand at 2 minutes to midnight – the closest to midnight that they have ever been. The elimination of these weapons remains the most urgent immediate security challenge that the world faces (climate change being the other existential threat to human survival).

The 2017 UN Treaty on the Prohibition of Nuclear Weapons will be a powerful force towards a nuclear weapons free world when it comes into effect (probably by 2021), but any factors that make the elimination of nuclear weapons more difficult must be categorically rejected. The spread of nuclear power is one of the key factors that hamper the achievement of a nuclear weapons free world.

There is another threat looming over humanity, related to both nuclear weapons and climate, that makes the elimination of nuclear weapons even more critical and urgent – nuclear winter. Recent authoritative research has demonstrated that the detonation of 100 Hiroshima-sized nuclear bombs over cities – less than 1% of the global nuclear arsenal – would generate more than 5 million tons of soot and smoke. This would result in blocking of sunlight, global cooling and decimation of key food crops in many regions for up to a decade. It is estimated that such nuclear-war induced famine would put the lives of over two billion people at risk[9]. This research reinforces the absolute imperative to prevent the spread of the technology that can create such scenarios.

2. NUCLEAR POWER AND HEALTH IMPACTS

Nuclear power relies on processes that produce ionising radiation, which is harmful to human health. Large complex molecular chains, especially of DNA which carries our genetic material and regulates many biological processes, are particularly vulnerable to disruption by

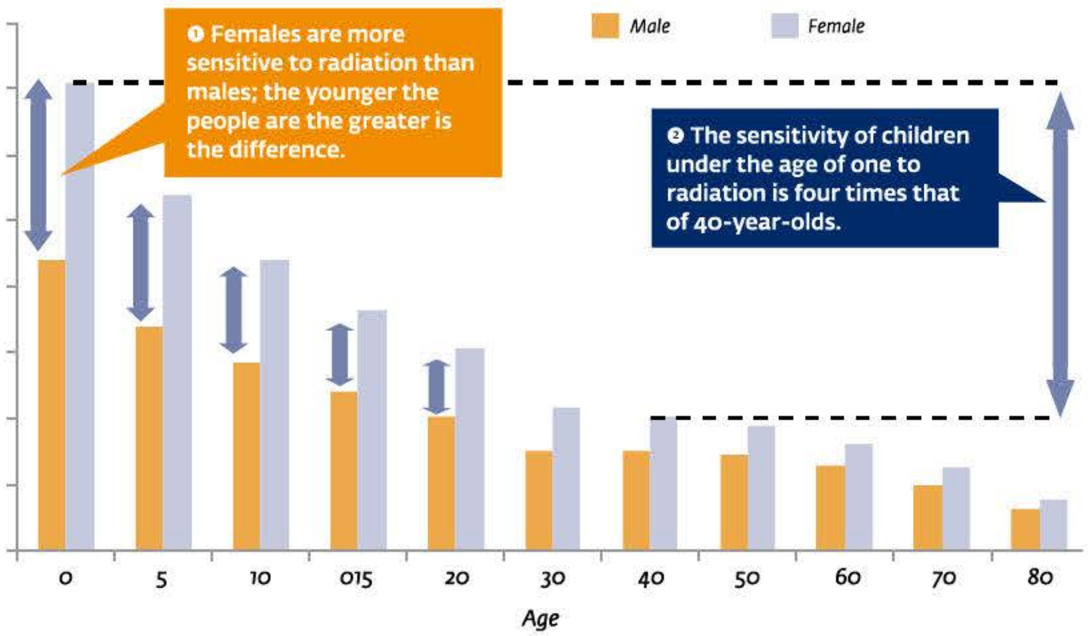
[9] http://www.ippnw.org/pdf/nuclear-famine-two-billion-at-risk-2013.pdf

ionising radiation. Changes in chromosomes, which carry our DNA, have been demonstrated at increased frequencies in New Zealand nuclear test veterans, decades after their radioactive exposure.[10]

Powerful recent epidemiological studies have estimated greater radiation-related health risks than previously thought.[11] Some of these new studies are outlined below.

Children's increased cancer risks

DNA is most susceptible to radiation damage when cells are dividing rapidly. Young children and foetuses are especially sensitive to radiation effects, and their risk of developing a cancer later in life from radiation exposure is disproportionately higher than the increased risk for adults exposed to the same dose of radiation. This is illustrated in the graph below.



Increased lifetime cancer risk by age and gender associated with an extra radiation dose of 10 mSv Source: Nuclear Accident Independent Investigation Commission (2012), based on data from Committee to Assess Health Risks from Exposure to Low Levels of Ionizing Radiation.[12]

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[10] Elevated chromosome translocation frequencies in New Zealand nuclear test veterans. https://www.ncbi.nlm.nih.gov/pubmed/18544930

[11] A New Era of Low-Dose Radiation Epidemiology. https://www.ncbi.nlm.nih.gov/pubmed/26231501

[12] Health Risks from Exposure to Low Levels of Ionizing Radiation: BEIR VII Phase 2 (2006) https://www.nap.edu/initiative/committee-to-assess-health-risks-from-exposure-to-low-levels-of-ionizing-radiation

Childhood cancer and CT scans

An examination of the effects of medical radiation exposure from CT scans can provide valuable information on the effects of radiation from other causes. CT scans involve effective whole-body exposures of 1 to 10 or more (up to 20+) mSv. A number of studies have now documented cancer risks following CT scans in children that are much greater than previously estimated. The largest to date is an Australian study of cancer risk after CT scans in 680,000 young people (aged less than 20 years), compared with the 10.3 million young Australians who did not have CT scans, over the same 20-year period.[13]

The study demonstrated a 24 per cent increase in cancer in the decade following one CT scan delivering an average effective dose of only 4.5 mSv, and 16 per cent greater cancer risk for each additional scan. Cancers occurred as early as two years after exposure. The average length of follow-up after the first CT scan was close to a decade, so new cancers will continue to occur through the life of exposed individuals. The findings for leukaemia and brain cancer are quite similar in the Australian study and a smaller British study (which did not include other solid cancers).[14]

The Australian study is now the largest population-based study of low dose radiation ever conducted, in children who are the group most susceptible to radiation, giving its results great importance.

One strong likelihood that emerges is that the dose–response curve for radiation-related cancer risk is not linear as generally assumed, but steeper at low doses, with a greater effect per mSv at low doses than at higher doses, particularly for children.

Childhood cancer and background radiation

A national study was undertaken in Switzerland, where alpine areas are associated with higher levels of background radiation than flatter areas of the country. Census data linked to Swiss Childhood Cancer Registry data identified the risk of cancer 8 to 18 years later; overall cancers increased by 64% and leukemia more than doubled for children living in areas where background external radiation levels were more than 1.8mSv/year, compared with areas where levels were below 0.9 mSv/y.[15]

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[13] Cancer risk in 680 000 people exposed to computed tomography scans in childhood or adolescence: data linkage study of 11 million Australians https://www.bmj.com/content/346/bmj.f2360

[14] Radiation exposure from CT scans in childhood and subsequent risk of leukaemia and brain tumours: a retrospective cohort study. https://www.ncbi.nlm.nih.gov/pubmed/22681860

[15] Background ionizing radiation and the risk of childhood cancer: a census-based nationwide cohort study. https://www.ncbi.nlm.nih.gov/pubmed/25707026

Childhood leukaemia near nuclear power plants

Apparent excesses of leukaemia occurring in children living near nuclear power plants have caused concern and controversy over decades. Perhaps the most prominent was an excess of leukaemia and lymphoma cases around the Sellafield nuclear plant in England in the 1980s, which was the location of the Windscale accident and fire in 1957, and, before the 1986 Chernobyl disaster, the most radioactively polluting nuclear facility in Europe. An investigation recommended by a government commissioned committee unexpectedly found that the risks for leukaemia and lymphoma were higher in children born within 5 km of Sellafield, and in children with fathers employed at the plant, particularly those recording high radiation doses before their child's conception.[16]

A 2007 meta-analysis supported by the US Department of Energy examined all of the reliable data available worldwide, confirming a statistically significant increase in leukaemia for children living near nuclear power plants.[17]

The most definitive findings come from a very large national German study, which examined leukaemia among children living near any of Germany's 16 operating nuclear plants over a 25-year period. It showed that the risk of leukaemia more than doubled for children living within 5 km of a nuclear plant, with elevated risk extending beyond 50 km from a plant.[18] This finding was highly statistically significant. A subsequent but less powerful study in France found a similar increase.

While these findings have been challenged on grounds that they are not explicable on the basis of prevailing estimates of the radiation exposures involved and their predicted effects, this in no way changes the strength of the association, whatever its cause, and no possible cause other than radiation has been identified.

Actual data on real-world outcomes always trumps any theoretical model.

It is likely that either radiation exposures have been underestimated, and/or the effects of radiation exposure are greater than previously estimated.

Cancer risks for nuclear industry workers

Updated results of large long-term studies of hundreds of thousands of nuclear industry workers coordinated by the International Agency for Research on Cancer on risks for leukaemia[19] and solid cancers [20] were reported in 2015. The studies included 308,000

[16] Results of case-control study of leukaemia and lymphoma among young people near Sellafield nuclear plant in West Cumbria. https://www.bmj.com/content/300/6722/423

[17] Meta-analysis of standardized incidence and mortality rates of childhood leukaemia in proximity to nuclear facilities. https://www.ncbi.nlm.nih.gov/pubmed/17587361

[18] Childhood Leukemia in the Vicinity of Nuclear Power Plants in Germany https://www.ncbi.nlm.nih.gov/pmc/articles/PMC2696975/

[19] Ionising radiation and risk of death from leukaemia and lymphoma in radiation-monitored workers (INWORKS): an international cohort study https://www.thelancet.com/journals/lanhae/article/PIIS2352-3026(15)00094-0/fulltext

workers from France, the UK, and the US, followed up to an average age of 58 years. The cumulative doses were well within the current most widely recommended dose limit for nuclear industry workers of an average of no more than 20 mSv per year.
Rates of both leukemia and solid cancers were elevated and were in fact higher than those of the male *hibakusha (*Japanese nuclear bomb survivors), and will continue to rise as the subjects age*.*

These large and powerful studies show risks even at very low-dose rates and total doses well within recommended occupational limits.

Together, the above studies conclusively demonstrate the absence of a threshold for ionising radiation related cancer risk. In other words any exposure can do harm, and the amount of harm is increased with increased exposure.

HEALTH EFFECTS OF URANIUM MINING

It is well established that workers at uranium mines in Australia and other parts of the world have suffered increased incidences of cancers, particularly lung cancer, and other health problems such as heart disease as a result of their workplace exposure. The radioactive gas, radon, was identified as the cause in the 1950s. Studies of underground miners, especially those exposed to high concentrations of radon, have consistently demonstrated the development of lung cancer in both smokers and non-smokers.

On this basis, the International Agency for Research on Cancer (IARC) classified radon as a carcinogen in 1988[21]. In 2009, the ICRP stated that radon gas delivers twice the absorbed dose to humans as originally thought and is in the process of reassessing the permissible levels. At this stage, previous dose estimates to miners need to be approximately doubled to accurately reflect the lung cancer hazard.

The Biological Effects of Ionising Radiation VI report (1999)[22] reviewed eleven cohort studies of 60,000 underground miners with 2600 deaths from lung cancer, eight of which were uranium miners in Europe, North America, Asia and Australia. These found a progressively increasing frequency of lung cancer directly proportional to the cumulative amount of radon exposure in a linear fashion. Smokers had the highest incidence of lung cancer, as would be expected, but the greatest increase in lung cancer was noted in non-smokers. The highest percentage increase in lung cancer was noted 5-14 years after exposure and in the youngest miners. Other cancers and cardiovascular deaths also occur as a result of increased radiation exposures.

Uranium miners are also exposed to ionizing radiation (IR) directly from gamma radiation and the dose from this is cumulative to that from radon. At the Olympic Dam underground uranium mine, the total dose per miner is approximately 6 mSv, of which 2-4 mSv (allowing

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[20] Risk of cancer from occupational exposure to ionising radiation: retrospective cohort study of workers in France, the United Kingdom, and the United States (INWORKS). https://www.ncbi.nlm.nih.gov/pubmed/26487649

[21] International Agency for Research on Cancer. IARC monographs on the evaluation of carcinogenic risks to humans.

[22] Health effects of exposure to Radon. Committee on Health Risks of Exposure to Radon (BEIR VI), National Research Council. 1999. The National Academies Press

for the new ICRP dose coefficients) are due to radon and the balance due to gamma radiation.

Most modern uranium mines have air extraction systems and monitored ambient measures of radon concentrations to ensure levels remain low. Current levels of radon in underground uranium mines are only a fraction of mines of 100 years ago. Miners are now given personal protective equipment (PPE) including masks to filter out the radioactive particulate matter.

Yet many underground miners find the masks extremely uncomfortable, especially in the hot underground environment they must contend with. It is estimated that up to 50 per cent of underground uranium miners in Australia do not use their masks, and thus drastically increase their risk of lung cancer while underestimating their actual radiation dose where calculations are made assuming PPEs are used.

The Olympic Dam doses mentioned above are typical of modern mine practices. The average miner at Olympic Dam is in his 20s and stays on average five years at the site. A typical calculation using the linear no threshold model and the latest BEIR-VII figures of radiation carcinogenesis risks indicates miners at Olympic Dam therefore have a 1:420 chance of contracting cancer, most likely lung cancer. Note that the research demonstrates that the risk of developing lung cancer is greater for younger workers. These risks are not insubstantial.

Radiation safety and risk principles can be quite complex and it is debatable whether miners have the training to understand the basis, or are even informed of the risks in a comprehensive and accurate manner that they can comprehend and make an informed work decision.

There is also documented evidence that community members living around uranium mines, such as the Navajo Native Americans, have also suffered increased incidences of cancers.[23] There are presently significant concerns that there may be an increased incidence of cancers and stillbirths in the Indigenous populations in the Alligator Rivers Region of the Northern Territory, where there have been several uranium mines over the last 50 years including the Ranger mine and Nabarlek mine.[24]

Upward trends of radiation risks

The science of radiation and health is still evolving. There has been a consistent trend over time that the more we know about radiation effects, the greater those effects appear to be.

Maximum permitted radiation dose limits have never been raised over time (except, arbitrarily and unconscionably, by the Japanese government following contamination by the Fukushima nuclear disaster). Globally recognised "acceptable" levels have always been lowered in accordance with new evidence of increased risks.

[23] Brugge, Doug, Timothy Benally, and Esther Yazzie-Lewis. 2006. The Navajo People and Uranium Mining. Albuquerque: University of New Mexico Press.

[24] Tatz, C et al. 2006. Aborigines and Uranium: Monitoring the Health Hazards: Australian Institute of Aboriginal and Torrest Strait Islander Studies

For example, from 1950 to 1991, the maximum recommended whole-body radiation annual dose limits for radiation industry workers was reduced from approximately 250 to 20 mSv, where it remains. The current recommended dose limit is not a dose below which there is no health risk. Rather, it represents the most recent compromise between safety and optimally protecting people on the one hand, and commercial and other vested interests and cost considerations on the other.

Non-cancer risks and radiation

Ionising radiation also increases the risk of occurrence and death from some non-cancer diseases, including cardiovascular (especially heart attacks and strokes) and respiratory disease. This has been clearly demonstrated at moderate and high doses, and recent evidence has confirmed that non-cancer deaths also increase at low total doses and dose rates, such as occur in nuclear industry workers.[25] The increased risk of death from heart and other circulatory diseases is estimated to be comparable in magnitude to the radiation-related cancer risk, meaning that the total extra risk of dying because of exposure to radiation is likely to be around double the increased risk of death from cancer alone.[26]

Increased vulnerability of young people also applies to the non-cancer health risks of radiation exposure[27].

Health effects of the 1986 Chernobyl nuclear disaster

The effects of the 1986 Chernobyl nuclear disaster have recently been independently reviewed.[28]

Major findings include:

- An estimated 40,000 excess fatal cancers in Europe by 2065;
- 6,000 additional cases of thyroid cancer have already occurred. An additional 10,000 are expected by 2065. Initially these were almost exclusively in children; more recently, cases are also occurring at older ages. Increases in thyroid cancer have also been found in a number of other countries, such as Austria, Slovakia, the Czech Republic, and Poland. It is likely that at least some of this increase is due to Chernobyl;
- Increasing rates of leukaemia among the estimated total 600,000–800,000 clean-up workers, as well as increased risk of cataracts at a lower threshold dose than previously thought

[25] Mortality from Circulatory Diseases and other Non-Cancer Outcomes among Nuclear Workers in France, the United Kingdom and the United States (INWORKS). https://www.ncbi.nlm.nih.gov/pubmed/28692406

[26] Systematic Review and Meta-analysis of Circulatory Disease from Exposure to Low-Level Ionizing Radiation and Estimates of Potential Population Mortality Risks https://www.ncbi.nlm.nih.gov/pmc/articles/PMC3556625/

[27] Systematic Review and Meta-analysis of Circulatory Disease from Exposure to Low-Level Ionizing Radiation and Estimates of Potential Population Mortality Risks https://www.ncbi.nlm.nih.gov/pmc/articles/PMC3556625/

[28] TORCH 2016 www.ianfairlie.org/wp-content/uploads/2016/03/chernobyl-report-version-1.1.pdf

- Increases in nervous system birth defects - such as spina bifida, anencephaly, microcephaly, and small or missing eyes - have been found in the highly contaminated Rivne-Polissia region of Ukraine ;[29]
- Increasing rates of breast cancer in the most contaminated regions of Belarus and Ukraine; and
- The psychological effects of dislocation of lives due to radioactive contamination and long-term worry about radiation risks can also have adverse health consequences. Among clean-up workers, depression and post-traumatic stress disorder rates are elevated even decades later.

Health effects of the 2011 Fukushima Daiichi nuclear disaster

While various Japanese and international agencies stated that no radiation related adverse health consequences were likely to be detected as a result of the Fukushima nuclear disaster, this implausible assessment has already been shown to be in error.
A lack of comprehensive health screening and follow-up for the exposed population and inadequate cancer registries in many of the relevant areas of Japan mean that the capacity to detect and respond to health problems is constrained.

Periodic ultrasound screening of the thyroid glands of children aged less than 18 years at the time of the disaster is taking place in Fukushima prefecture (but not in other fallout-affected areas). Even though such an active search for thyroid abnormalities can be expected to find more cysts and nodules than would come to medical attention in the absence of an active screening program, the findings to date suggest early evidence of an epidemic of thyroid cancer.

In relation to thyroid cancers in children in Fukushima:

- To September 2016, the number of reported cases was 145[30,31;]
- The rates of thyroid cancer detected initially in Fukushima were between 20 and 50 times higher than the Japanese national average;
- among the cancers diagnosed on a second ultrasound screening, two years after the first, the rate is still 20 to 38 times the national average, likely too great a difference to be explained by active screening alone.

3. NUCLEAR ACCIDENTS

Nuclear power plants carry the potential for large scale radioactive contamination resulting from unplanned releases, caused by deliberate or accidental events. Public awareness of these potential incidents has been raised by the disasters at the Fukushima Daiichi complex

29 Chronic Radiation Exposure in the Rivne-Polissia Region of Ukraine: Implications for Birth Defects
http://scholar.google.com.au/scholar_url?url=http://www.academia.edu/download/43237882/Chronic_radiation_exposure_in_the_Rivne-20160301-25098-14syf7.pdf&hl=en&sa=X&scisig=AAGBfm17vWYv5S5YK474pKOBk5s-8TV6Nw&nossl=1&oi=scholarr

30 Associations Between Childhood Thyroid Cancer and External Radiation Dose After the Fukushima Daiichi Nuclear Power Plant Accident.
https://www.ncbi.nlm.nih.gov/pubmed/30399001/

31 Thyroid Cancer Detection by Ultrasound Among Residents Ages 18 Years and Younger in Fukushima, Japan: 2011 to 2014.
https://www.ncbi.nlm.nih.gov/pubmed/26441345

in Japan in 2011, Chernobyl in the Ukraine in 1986, and Three Mile Island in Pennsylvania in 1979. Apart from these 3 best-known nuclear accidents, there have been partial core meltdowns at:

- NRX (military), Ontario, Canada, in 1952
- EBR-I (military), Idaho, USA, in 1955
- Windscale (military), Sellafield, England, in 1957
- Santa Susana Field Laboratory (military), Simi Hills, California, in 1959
- SL-1, Idaho, USA in 1961. (US military)
- Enrico Fermi Nuclear Generating Station (civil), Newport, Michigan, USA, in 1966
- Chapelcross, Dumfries and Galloway, Scotland, in 1967
- Lucens reactor, Switzerland, in 1969
- A1 plant at Jaslovské Bohunice, Czechoslovakia in 1977

Fukushima

Eight years after the world's most complex nuclear disaster, the damaged Fukushima Daiichi nuclear power plants and spent fuel ponds are still leaking and dangerous, and vast amounts of contaminated water continue to accumulate. Approximately 8000 clean-up workers labour daily and this work will need to continue for many decades, the needs of people exposed to radioactivity are still neglected, no one is in prison for a disaster fundamentally caused by the negligence of the operator and the government, and most of the lessons of Fukushima have yet to heeded.

The former prime minister, Naoto Kan, has revealed that there was a real possibility of requiring the evacuation of 35 million Tokyo residents were the fallout to threaten the capital. It was dumb luck that it didn't, indeed extremely fortunate that the prevailing winds in the first week of the disaster were offshore, dumping most of the fallout in the sea and preventing an unimaginable catastrophe. Recall, nuclear fallout does not respect national boundaries – neighbouring countries might be the biggest victims of a nuclear accident.

The investigation into the Fukushima reactor disaster by the Japanese Diet (parliament) found there was a combination of inadequate safety culture, mismanagement and deception on the part of regulators and operators.

In the decade prior to the tsunami, two separate models predicted the need for better measures to protect the reactor, but these steps were not undertaken.

What Fukushima has done is demolish the nuclear power industry's standing exhortations that they should be trusted with the welfare of millions of citizens because their industry is inherently safe.

TEPCO, the operator of the Fukushima Daiichi nuclear plant, and indeed the whole Japanese nuclear industry, has revealed a long history of poor safety, falsified maintenance and safety records, as well as fraudulently concealed accidents over many decades.

The root cause of the Fukushima nuclear disaster was an insular, politically well-connected nuclear industry which was intertwined with a nuclear regulator that lacked the will and ability to fulfil its role of protecting the public. Many nuclear utilities' engineers and senior management sit on the regulator's safety committee. In essence, the Japanese nuclear regulator became captive to the government and industry's goal of nuclear promotion at any cost, leading to a poor safety culture.

The organisational structure of the industry corrupted the normal checks and balances vital to ensuring safety. The nuclear regulatory agency was an arm of the ministry responsible for nuclear promotion.

In 2002, TEPCO, the operator of the Fukushima nuclear plant, admitted it had falsified repair reports at nuclear plants for more than two decades, It was not alone. The revelation follows the confession by all four companies – TEPCO, Chubu Electric Power, Japan Atomic Power and Tohoku Electric Power – that they concealed flaws in their reactors from government regulators.

Unfortunately, the Japanese nuclear power industry was portrayed during this time as the face of a vibrant, responsible and safe utility by the World Nuclear Association (the industry lobby group) and Japan a role model for all countries to follow.

The IAEA, which is responsible for overseeing the industry, failed in its responsibility to alert the public, instead keeping its assessments closed to the general public. Freshly revealed reports from the IAEA, dating from the 1990s, describe safety precautions at Japanese nuclear reactors as 'dangerously weak'. IAEA inspectors visited four reactors in 1992 and 1995, finding 90 deficiencies in safety procedures.

In a Wikileaks cable an official from the IAEA said in December 2008 that Japanese nuclear safety rules were out of date and strong earthquakes would pose a 'serious problem' for nuclear power stations, which were only rated to withstand a 7.0 earthquake (compared to the recent 9.1 earthquake) and tsunamis of only 5 metres (compared to the 14m recent tsunami). This was seen as a compromise between safety and commercial viability. In other words, it would have significantly eroded the economic viability of the plant if it was rated to a higher standard.

Professor Kiyoshi Kurokawa, who chaired the Nuclear Accident Independent Investigation Commission, Japan's first ever independent parliamentary investigation commission, has written recently that since the Commission submitted its recommendations to the national Diet in 2012, "*little progress of significance can be observed*".[32] He describes the regulatory changes as "*only amounting to cosmetic changes*".

Kurokawa describes the changes prompted by the Commission's report amongst governmental bodies "*have been formalities at the minimum required level*". He writes "*that the structures of regulatory capture are still firmly maintained".*

This textbook case of regulatory capture, with Japanese nuclear regulatory agencies serving the interests of the nuclear power industry instead of protecting the safety of the people, has changed relatively little.

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[32] Kurokawa K, NInomiya AR. Examining regulatory capture: looking back at the Fukushima nuclear power plant disaster, seven years later. *University of Pennsylvania Asian Law Review* 2018;13(2), Article 2. https://scholarship.law.upenn.edu/alr/vol13/iss2/2/

It is the people of Japan who not only suffer the impacts of the disaster, but largely bear the cost, such as through the US$119 billion interest-free loan TEPCO secured from the government, paid by citizens' taxes.

Over 150,000 people were evacuated from the 20km exclusion zone and many may never return to their homes, with the land now uninhabitable. Total economic costs are estimated at $300bn, comparable to that of the earthquake and tsunami that precipitated the nuclear disaster. Heroic (and expensive) plans are afoot to remove contaminated soil from over 2,500km^2 to reclaim as much land as possible in the densely populated country. The total volume of the contaminated soil waste will approximate that of all the high level nuclear waste ever generated in the history of nuclear power (30 million cubic metres).

Risk assessment

The estimated probability of major nuclear accidents, which was considered very small in the past, has increased significantly. Given that, in the history of nuclear energy, hundreds of reactors have operated for a total of 14,400 years (counting each year of operation by one reactor as a reactor-year), a core-damage accident has happened once every 1,309 years of operation with a total of 12 core melts.

With approximately 400 reactors operating worldwide, the rate would yield a core melt an average of once every three calendar years, and an even more disastrous accident with release of radioactivity once every 9 years.

Therefore, we should be very sceptical of the nuclear industry's risk estimates for its Generation III reactors (which have no operational history) of one major accident per reactor every million years, i.e., ten times safer than the current Generation II. Risk estimates for small modular reactors, which have virtually no operational history, should also be viewed with considerable scepticism.

4. NUCLEAR TERRORISM AND DELIBERATE HARM

In the modern era it is necessary for planners and legislators to anticipate and plan for deliberate attacks on infrastructure. To date there have been no major incidents involving terrorism at nuclear facilities but multiple attempts and minor incursions, including involving the research reactor in Sydney. A major coolant loss caused by accident or malice could cause a massive release of radioactive isotopes into the surrounding environment, with profound consequences in terms of morbidity, mortality, social disruption, tourism and agriculture as has been evident in the Fukushima prefecture of Japan.

A successful terrorist attack on the scale of those carried out on September 11, 2001, could lead to a major release of radiation. The US Nuclear Regulatory Commission (NRC) considers the likelihood of this kind of attack as small. The NRC furthermore considers that nuclear power plants are difficult targets due to them being low lying and the reactor core being a small target. However, we should not forget that the probability of the World Trade Centre towers collapsing due to the impact of civilian aircraft was also considered to be small before they fell.

It is equally fallacious for the NRC to claim that the consequence of an aircraft impact is unlikely to lead to a breach of containment. For example, a sudden shutdown of a nuclear reactor ('scram') in the event of a terrorist attack does not necessarily guarantee the reactor core will not continue to increase in temperature and melt, particularly if the impact has disabled the emergency cooling systems. If the containment structure has been breached from an aircraft impact, this could lead to a major release of radioactive contaminants into the atmosphere.

Additionally, the NRC does not consider the consequences of an impact on the spent fuel cooling ponds which hold vast quantities of long-lived radioactivity. The ponds may ignite if there is a loss of cooling water, thereby dispersing radioactivity into the atmosphere. As a result of the World Trade Centre attacks, the Design Basis Threat of US nuclear reactors was upgraded in 2007 to include various terrorist attacks. However, controversially the NRC did not include aircraft attacks, despite internal staff strongly advocating that it do so. It instead insisted ambiguously that only *new* reactors be able to withstand an aircraft attack.

If this had been included in the upgraded DBT all existing reactors would have been required to be retrofitted accordingly, which the NRC insisted was not required. Hence, ironically, all current US reactors are vulnerable to commercial aircraft terrorist attacks and will be for their operational life due to the nuclear regulator's refusal to insist on safety upgrades.[33]

In addition, according to Yukiya Amano, director general of the International Atomic Energy Agency (IAEA), nuclear facilities around the world are facing daily cyberattacks on their systems:

"*Reports of actual or attempted cyberattacks are now virtually a daily occurrence. Last year alone, there were cases of random malware-based attacks at nuclear power plants and of such facilities being specifically targeted … staff responsible for nuclear security should know how to repel cyber-attacks and to limit the damage if systems are actually penetrated. The IAEA is doing what it can to help governments, organizations, and individuals adapt to evolving technology-driven threats from skilled cyber adversaries".*[34]

In addition to the threat of terrorist attack, deliberate sabotage by operating staff or others is also possible. There have been a number of airline mass deaths due to deliberate pilot decisions, presumed to be due to mental illness. The most recent of these was the Germanwings crash in 2015. These types of attack are extremely difficult to prevent.

5. NUCLEAR WASTE

The radioactive waste management experience to date - internationally and nationally - should alert policy makers and legislators to the enormity of the task of dealing with this aspect of the nuclear fuel chain. At this point it is worth observing that there is nothing particularly 'cyclical' about the nuclear fuel industry – it starts with mining uranium, progresses to enrichment and fuel fabrication through reactors and weapons to waste. The idea that there is a 'cycle' comes from proposals to harvest and reprocess the waste stream and thus close the loop; this is barely more than a fantasy after 70 years of the industry and billions of dollars spent on research.

[33] http://www.iaea.org/Publications/Factsheets/English/manradwa.html#note_c
[34] http://www.scmagazine.com/international-conference-on-computer-security-hosted-for-first-time/article/418241/

What we have instead is mountains of radioactive waste all over the planet. Worldwide there is no deep geological repository for HLW currently in operation despite the nuclear power industry having been in existence for over 70 years. Only four countries have anything resembling a program to deal with their waste. The most advanced – Finland - is working on the first of a necessary five deep geological repositories to deal with its own reactor waste alone.

The average nuclear power reactor produces 300 m^3 of low and intermediate level waste per year and some 30 tonnes of *high* level solid packed waste per year.[42] Every year, there is 12,000 tonnes of spent fuel (high level) being produced globally.

In 2019 the IAEA reported that in 2015 there existed approximately 385,000 tonnes of nuclear fuel derived waste around the world.[35] Currently this is being stored on-site in dry casks or pools at most nuclear power plants, or at reprocessing facilities such as La Hague (France), as an interim solution. Greatly complicating this task are the very long half-lives of some of the radionuclides present in this waste (for example plutonium-239 – half-life of 24,000 years, technetium-99 – half-life of 212,000 years, cesium-135 – half-life of 2.3 million years, and iodine-129 – half-life of 15.7 million years). These are highly hazardous to humans and require isolation from the biosphere for hundreds of thousands to a million years.

The aim is to prevent water reacting with the waste since this is the main mechanism by which the waste can re-enter the biosphere. The IAEA states that deep geologic disposal using a system of engineered and natural barriers to isolate the waste is the best method. The principal features of the geological repository concept is to place packaged waste in a stable formation several hundred meters below the surface with engineered barriers around and/or between the waste packages and the surrounding rock.

High level waste (including spent fuel) requires permanent storage in deep geological formations for a few hundred thousand years.[36] Due to the complexity of the problem and the long time periods considered, the ability of a repository to retain radioactivity has a significant degree of uncertainty.

Furthermore, similar assumptions usually based on insufficient or absent data are made to simulate the behaviour of a repository over an arc of time orders of magnitude beyond that of recorded human history. To put this in perspective, the Egyptian pharaohs were in power only five thousand years ago, and homo sapiens are understood to have appeared in East Africa between 100,000 and 200,000 years ago.

Meanwhile, Australia has been trying for decades unsuccessfully to manage its relatively small volume of waste. Regardless of all other problems associated with nuclear power, we should under no circumstances start building a reactor if we have not identified and approved the site for deep geological disposal of the HLW. That alone would add another decade at least to the IAEA framework of safe nuclear power plant development (see below).

6. CARBON EMISSIONS FROM NUCLEAR POWER

[35] **IAEA Worldwide Summary** https://newmdb.iaea.org/dashboard.aspx

37 https://www.stormsmith.nl/reports.html

A critical consideration in relation to nuclear power is the carbon emissions generated by the whole nuclear fuel chain, which are repeatedly overlooked by nuclear proponents. The mining, milling, fuel fabrication, enrichment, reactor construction, decommissioning and waste management all use fossil fuels.

Mark Diesendorf noted in Feb 2014:
"*Unfortunately, the notion that nuclear energy is a low-emission technology doesn't really stack up when the whole nuclear fuel life cycle is considered. In reality, the only CO_2-free link in the chain is the reactor's operation. All of the other steps – mining, milling, fuel fabrication, enrichment, reactor construction, decommissioning and waste management – use fossil fuels and hence emit carbon dioxide."*

Several analyses by researchers who are independent of the nuclear industry have found that total CO_2 emissions depend on the grade of uranium ore mined and milled. The lower the grade, the more fossil fuels are used, and so the higher the resulting emissions.

In one such study, the nuclear physicist (and nuclear energy advocate) Manfred Lenzen found that CO_2 emissions from the nuclear fuel cycle increase from 80 grams per kilowatt-hour (g/kWh) where uranium ore is high-grade, to 131 g/kWh where the ore grade declines to low-grade.

Other experts, such as nuclear energy critics Jan Willem Storm van Leeuwen and Philip Smith, using assumptions less favourable to nuclear energy, have reported an increase in emissions from 117 g/kWh for high-grade ore to 437 g/kWh for low-grade ore.[37]

For comparison, the life-cycle emissions from wind power are 10–20 g/kWh, depending upon location, and from gas-fired power stations 500–600 g/kWh. So depending on your choice of analysis, nuclear power can be viewed as almost as emissions-intensive as gas.

This analysis is reinforced by a report in early 2019 from the Climate Council[38]. They noted "Unlike coal and gas, no greenhouse gas pollution is created in the operation of the nuclear reactor. However, all other steps involved in producing nuclear power (from mining, to construction, decommissioning and waste management) result in greenhouse gas pollution. Greenhouse gas pollution associated with nuclear power could be similar to a gas power station, with estimates ranging from 80 – 437 kg/MWh.

6. CLIMATE SOLUTIONS ARE NEEDED NOW

Nuclear power is too slow

The prospects for a speedy transition to nuclear electricity generation and dramatic carbon-emission abatement of a 'virgin' nuclear power nation like Australia can be framed via the IAEA document 'Establishing the safety infrastructure for a NPP'.

37 https://www.stormsmith.nl/reports.html

38 https://www.climatecouncil org.au/nuclear-power-stations-are-not-appropriate-for-australia-and-probably-never-will-be/

This paper provides a timeline chart which serves as a (typically buoyant) guide to anticipated timing of such a venture.[39] The guidelines propose that between 11 and 20 years are required to establish appropriate safety infrastructure for a nuclear power program, from *initial site survey* to *commissioning* of a reactor.

The chart assumes several optimistic timeframes, given recent experience of reactor-builds in nations such as France, Finland and the United States. Faster processing has been achieved in China, but the existence of a one-party state with very low transparency raises additional safety concerns.

Given the lack of experience, expertise, technology and materials in Australia for a *de novo* program, even the more conservative IAEA time-frames must be greeted with a degree of scepticism.

The IAEA describes phases 1, 2 and 3 in establishing a new reactor.

According to the IAEA, by the end of *Phase 1*, an initial site survey and an environmental impact statement will have been completed over a period of 1 to 3 years and then a nation should be ‘ready to make a decision whether to introduce nuclear power’. Th first step, to complete phase 1 alone articulated here is ‘Site survey’.

Completion of phase 1 would presumably require:

- all major *State* political parties have reached bipartisan agreement on developing a nuclear power program
- attainment of a sufficient State parliamentary majority which can pass enabling legislation
- all major *Commonwealth* political parties have adopted pro-nuclear power policies
- Commonwealth parliamentary majorities have been attained
- Commonwealth legislative changes have been made
- legal challenges have been successfully rebuffed
- community opposition from civil society has been sufficiently suppressed

At present there is no political consensus about nuclear power in Australia, nothing approaching a bipartisan acceptance at the state or federal level and opinion polls repeatedly suggest the electorate is likely to be resistant in the short to medium term at the very least.

The active search to find a location for Australia’s relatively small amount of nuclear waste is still not resolved after nearly two decades. Siting a reactor will be even more contested.

Given the urgent need to transition to low/zero carbon by mid-century, it would also be sensible to measure our prospects against the international experience.

If we experience the same degree of delays in construction as witnessed in other more prepared countries (cost blow-outs, material and expertise and labour bottlenecks, unexpected developments) – then we should estimate more like 10 years to get from

[39] http://www-pub.iaea.org/books/IAEABooks/8636/Establishing-the-Safety-Infrastructure-for-a-Nuclear-Power-Programme-Specific-Safety-Guide

concrete to fission. Even if we assume novice Australian reactor program management can outstrip the French and the Americans, it is hard to see an Australian reactor producing electricity – and thus abating greenhouse gas emissions - much before 2040.

This is way too late.

Rapidly evolving storage technologies are also likely to have major impacts both on centralised grid demand and need for baseload generation.

Experiences with rapid and successful expansion of renewables is well-documented in places including Germany, Spain, Denmark and California and China.

An authoritative study from Stanford University published in May 2015, examined the prospects in the USA for an energy transformation to renewables in the US and concluded:

"The plans contemplate 80–85% of existing energy replaced by 2030 and 100% replaced by 2050….

100% conversions are technically and economically feasible with little downside".[40]

The issue of timeliness is not just academic.

Even with the optimistic timeframes laid out in the IAEA "*Establishing the safety infrastructure for a NPP*" guideline and those proposed by other promoters of nuclear electricity generation, nuclear power (including from small modular reactors) would result in major delays in emissions reduction, resulting in greater climate disruption.

7. SMALL MODULAR REACTORS – HYPE RATHER THAN HOPE?

While the costs of renewable energies have fallen over time, nuclear power has consistently become more expensive. Despite the enthusiastic and optimistic promotion of small modular reactors (SMRs), with new technologies it is well documented that there is even greater likelihood of cost blow outs and delays.

Multiple large reputable agencies have drawn attention to the huge economic challenges facing SMRs. For example, a 2018 report from the **Massachusetts Institute of Technology** noted *"The industry's problem is not that it has overlooked valuable market segments that need smaller reactors. The problem is that even its optimally scaled reactors are too expensive on a per-unit-power basis."*

In studies published in the *Proceedings of the National Academy of Science,* Carnegie Mellon University's Department of Engineering and Public Policy **found** *"Our results reveal that while one light water SMR module would indeed cost much less than a large LWR, it is highly likely that the cost per unit of power will be higher. In other words, light water SMRs do make nuclear power more affordable to set up but not necessarily more economically competitive for power generation."*

[40] http://web.stanford.edu/group/efmh/jacobson/Articles/I/USStatesWWS.pdf

Despite many claims to the contrary, worldwide nuclear plants have required massive government subsidies, uncompetitive pricing and loan guarantees. For example in the UK the Hinkley Point C reactors will require between 4.8 and 17.6 billion pounds subsidy, with electricity price guaranteed at more than twice the current wholesale rate[41]. In the USA, USD $12.5 billion in taxpayer backed loan guarantees have been required to encourage the building of new nuclear power plants[42].

Almost certainly, massive government subsidies would be required for any SMR build in Australia.

When it comes time to sign contracts and pour concrete, it is highly unlikely that any business would opt for a light water SMR, let alone at first-of-a-kind.

SMR's do not have the economies of scale and are therefore even more expensive to operate than large PW reactors.

Development Status And Prospects

Small Modular Reactors (SMRs) have been reported on in 2015 and 2017 in the World Nuclear Industry Report, and the just released 2019 update does not reveal great changes[43].

Argentina. The CAREM-25 project under construction since 2014 is at least three years late.

Canada. A massive lobbying effort is underway to promote SMRs for remote communities and mining operations. Development is in the design stage.

China. A high-temperature reactor under development since the 1970s has been under construction since 2012. It is currently at least three years behind schedule.

India. An Advanced Heavy Water Reactor (AHWR) design has been under development since the 1990s, and its construction start is getting continuously delayed.

Russia. Two "floating reactors" have been built. The first one went critical, with construction starting in 2007, it took at least four times as long as planned.

South Korea. The System-Integrated Modular Advanced Reactor (SMART) has been under development since 1997. In 2012, the design received approval by the Safety Authority, but nobody wants to build it in the country, because it is not cost-competitive.

United Kingdom. Rolls-Royce is the only company interested in participating in the government's SMR competition but has requested significant subsidies that the government is apparently resisting. The Rolls-Royce design is at a very early stage but, at 450 MW, it is not really small.

United States. The Department of Energy (DOE) has generously funded companies promoting SMR development. A single design by NuScale is currently undergoing the design certification process.

41 Trouble ahead for UK's nuclear hopes. Politico.eu 25/6/15 http://www.politico.eu/article/nuclear-uk-hinckley-point-areva-cameron-court-justice-austria-state-aid/

42 Department of Energy **Issues Draft Loan Guarantee Solicitation for Advanced Nuclear Energy Projects** http://energy.gov/articles/department-energy-issues-draft-loan-guarantee-solicitation-advanced-nuclear-energy-projects

43 https://www.worldnuclearreport.org/-World-Nuclear-Industry-Status-Report-2019-.html

Overall, there is no sign of any major breakthroughs for SMRs, either with regard to the technology or with regard to the commercial side.

In addition SMRs face the perennial issues regarding massive water usage, waste disposal, security and nuclear weapons proliferation, as discussed elsewhere in this submission.

8. WATER USAGE

Australia is the world's driest continent. With climate change, it is predicted that the southern part of Australia will get drier. Nuclear power stations require large amounts of water.

Existing nuclear power stations *use* and *consume,* per megawatt, more water than power stations using other fuel sources. Depending on the cooling technology utilised, the water requirements for a nuclear power station can vary between 20 to 83 per cent more than for fossil fuel power stations. Most renewable energy sources, such as wind and PV solar power, do not require water when generating electricity.

9. REGULATION

Any nuclear power industry needs very clear and well enforced regulation to maintain community safety. Like Japan, Australia is likely to under regulate the industry, with a resulting loss of safety culture and increased risk to the community.

To illustrate, one only needs to look at Olympic Dam in South Australia.

Regulatory Capture in Australia

Uranium is a key component of nuclear power generation. Uranium mining in Australia is inadequately regulated.

A clear example of regulatory capture in Australia is the Olympic Dam mining facility at Roxby Downs in South Australia, which is exempt from many important pieces of legislation.

The South Australian Government enacted the Roxby Downs (Indenture Ratification) Act 1982 (Indenture Act) and updated it with the Roxby Expansion Indenture Bill in 2011. The Government has legislated that 1.5 million hectares in central South Australia, including the Roxby Downs mine and surrounding areas, are exempt from some of our most important environmental and indigenous rights legislation. The Indenture Acts provides BHP Billiton the legal authority to override the:

· Aboriginal Heritage Act 1988
· Development Act 1993
· Environmental Protection Act 1993
· Freedom of Information Act 1991
· Mining Act 1971
· Natural Resources Act 2004 (including the Water Resources Act 1997)

An indication of the sweeping nature of the legal privileges is the statement in the Indenture Act that: "The law of the state is so far modified as is necessary to give full effect to the indenture and the provisions of any law of the state shall accordingly be construed subject to the modifications that take effect under this Act."

In other words, the Indenture Act trumps all other SA legislation.

These many exemptions undermine community expectations that corporations should be regulated to limit the potential damage they can cause and to ensure they remain accountable for their actions.

The provision of so many exemptions, overriding confidentiality clauses and the resulting lack of transparency bring into question government's ability to manage the substantial risks that have been historically evident in all phases of the nuclear fuel chain.

It is impossible to know how many incidents of poor practice are not publicly reported. There are significant concerns regarding worker occupational health and safety, with no transparency that monitoring systems are adequately implemented. There is no transparency regarding whether independent "impromptu" site inspections or site audits even occur.

Current corporate reporting of exposures of selected workers and air monitors potentially allows some workers to receive levels of exposure over the current recommended maximum. As noted already, the wearing of respirators in hot and arduous working conditions is not complied with at times and vital communication and verbal instructions are very difficult while wearing a respirator.

One example has come to light due to investor pressure.

In June this year, after pressure from investor stakeholders, BHP released a global assessment of all their tailings facilities.[44] The classification of the tailings facilities is based on the most recent classification of the facilities by the Engineer of Record at each mine.

BHP applied earlier this year to increase its tailings storage facilities at Olympic Dam.

Currently BHP has 67 tailings storage facilities (TSF) internationally. BHP has a record of mine tailings dam failures, most notably at the BHP and Vale joint venture mine at Samarco in Brazil in 2015. This resulted in flooding that destroyed the village of Bento Rodrigues and killed 19 people.

Of these 67 TSF, five TSF are listed as "extreme risk". "Extreme risk" refers to the potential loss of life of at least 100 workers, and means environmental rehabilitation of the site would be impossible after a failure of the TSF. In addition, in such an event infrastructure and economic losses are listed as extreme.

[44] ESG briefing: Tailings dams BHP June 2019 https://www.bhp.com/-/media/documents/media/reports-and-presentations/2019/190607_esgbriefingtailingsdams.pdf?la=en

One of these “extreme risk” sites is in the USA, and that mine has been closed. The four remaining “extreme risk” TSFs are all in Australia, and three out of the four are at Olympic Dam.

Olympic Dam does not comply with state standards, let alone international standards.

Olympic Dam should be subject to legislative and regulatory controls and standards at least as rigorous as those that apply to smaller projects. Existing standards are indefensible.

The current “extreme risk” tailings facilities represent complete abrogation of regulation for both worker and environmental safety, and yet it is likely BHP will gain approval to build more.

This legislative example does little to engender confidence that a either a uranium mining industry or nuclear power industry would be safely regulated.