AUSTRALIAN INSTITUTE OF PHYSICS
victorian branch

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Victorian Branch Chair
Australian Institute of Physics

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The Committee Manager
Standing Committee on Environment and Planning
Parliament House, Spring Street
EAST MELBOURNE VIC 3002

Inquiry into Nuclear Prohibition

Dear Sir/Madam

The Victorian Branch Committee of the Australian Institute of Physics (AIP) extends its support to the Standing Committee in relation to this inquiry. While I do not see it as the AIP's role to advocate either for or against the nuclear technology, I do think that we are in a unique position to analyse and present the evidence to government and the general public. In particular, we recommend the Standing Committee:

- Pursue evidence-based policy, and we offer to act as a liaison to obtain expert advice and information regarding nuclear physics and nuclear technologies from our membership.
- Recommend that the Victorian Government and public service work with tertiary institutes and/or professional scientific bodies such as the AIP to assist in educating the general public on matters relevant to nuclear physics and technology.

In what increasingly appears to becoming a 'post-truth' world, we urge the Victorian parliament to maintain its integrity by listening to and valuing advice from experts in the relevant field.

We offer the comments below in regards to the terms of reference.

1. Exploration and production of uranium and thorium

Uranium is about 2-31 parts per million (ppm) of the Earth's crust and thorium about 6 to 103 ppm. These are not rare minerals, their abundance is similar to tin (2.3 ppm). So, there is abundant uranium and thorium in Victoria, but our understanding is that they are not currently economically viable to mine in most cases. Nevertheless all mining liberates these elements and their radioactive daughters and this goes to waste, e.g. into the atmosphere and

fly ash (burning coal for power). Ignoring other Australian mines, Olympic Dam in South Australia has about 30-40% (Switkowski report, 2006) of the known worldwide uranium reserves and produces 10% (4,000 t) of world supply (74,000 t). The uranium is a byproduct of Cu production.

Uranium is a commodity readily bought and sold within IAEA Safeguards (federally regulated, see Chapter 9, Switkowski Report, 2006). Thorium mining and production is different to that for uranium. Thorium is also safeguarded and currently there is essentially no commercial market. Bi-product thorium (and some uranium) goes to waste in Australian sand mining. There may therefore be an opportunity for Victoria to contribute towards establishing a commercial thorium market. A commercial thorium market would require significant demand which is not currently foreseen.

Thorium is only 'fertile', not fissile with thermal neutrons so it is not directly usable as fuel for nuclear reactors. It requires breeding of from Thorium-232, uranium-233 can be made in a nuclear reactor, uranium-233 can be extracted by reprocessing, it can then be made into fuel, but this takes place in a high radiation environment (due mainly to uranium-232 coproduction) and then used in a reactor designed for uranium-233 operation. This is hard to do, requires essentially a complete nuclear fuel cycle and generates large quantities of uranium-233 which is a suitable weapons material in a high radiation environment.

Additionally, our understanding is that Victoria prohibits uranium exploration and mining but this does not stop its extraction. There may be mineral deposits there could be more profitably exploited if the ban were lifted and less of this material would go into waste streams.

2. Economic, environmental and social benefits (including scientific and medical)

Key drivers for nuclear power are energy security and the low carbon nature of nuclear power production. Our understanding is that energy security is the main driver worldwide. In Australia, coal fuelled power is currently cheaper than every other source neglecting carbon and other emissions.

While there is considerable interest in Small Modular Reactors (SMRs), they are not yet available. Our understanding is that Canada alone is examining 50 different designs for pre-licensing. There is a great potential opportunity for Victorian scientists and engineers to contribute to research in areas such as material science relating to new reactors (see Switkowski Report, 2006; Appendix R).

The lifting of the nuclear prohibition in Victoria would also enable us to potentially build a reactor to produce radio-isotopes in Victoria for the medical sector for vital diagnostic imaging techniques and therapies. This would make us only the second state or territory in Australia to be able to manufacture such valuable isotopes and also provide an export income for Australia. This would also provide redundancy so that supplies of vital radiopharmaceuticals can be assured during downtime of the ANSTO OPAL reactor at Lucas

Heights, NSW. There have been 3 significant periods of short supply in recent years as a result of manufacturing problems at Lucas Heights.

Additionally, lifting the present prohibition on nuclear fission would allow benchmarking of all potential solutions to the state of Victoria's present power problems that includes international best practice. The state presently depends heavily on burning brown coal for power production which some sources put at 80% of our present needs. This is a very intense source of carbon dioxide emissions compared to other methods. At present, this is also a disincentive for the widespread introduction of electric cars in Victoria which presently would generate more emissions than petrol cars (see https://environmentvictoria.org.au/our-campaigns/safe-climate/problem-brown-coal/)

Increasingly unreliable and aging power stations have put the security of our supply at risk with consequences for home and industry. The summer just past required securing a "virtual power supply" by asking major power users to shut down on days of high demand. This surely has negative consequences for establishing new industries in Victoria that depend on stable and continuous power supply. It is also not compatible with adopting a large electric car fleet if they could not be guaranteed a reliable source of charge (https://www.abc.net.au/news/2019-12-04/energy-regulator-warns-about-power-outages-this-summer/11762774).

The year 2050 presents a critical milestone in meeting commitments to the Paris accords. A decision making frame work for future power supply strategies should include:

> (1) A target for the power needed by the state of Victoria in 2050 based on best estimates of the likely population, the demands on water supply and air-conditioning from climate forecasts; and
>
> (2) The need to decarbonise the transport fleet likely to need substantial electric power for charging batteries or the production of hydrogen.

Based on these two factors, in proportion to the present maximum power demands of the state of ~10 GW, it is likely a low carbon dioxide power system well in excess of this will be required by 2050. This is a formidable problem. Therefore it is essential to also include:

> (3) An assessment of what sources of power could be built and be operating at this magnitude within the limited timeframe available.
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> (4) An assessment of the likely cost of the electricity generated by these sources given that costs in excess of 20 c per kWh impose significant financial hardship on many households just to meet basic needs (https://www.asbec.asn.au/news-items/acoss-brotherhood-st-laurence-energy-stressed-australia/)

It is also worth noting that to date only one country has succeeded with decarbonising its power system on the 30 year time-scale presently available and that is France. Therefore,

removing a prohibition on nuclear power may also similarly enable the state of Victoria to achieve a similar outcome in a 30 years.

3. Opportunities to participate in the nuclear fuel cycle

Matters related to the Nuclear Fuel Cycle possibilities in Australia were last examined in detail in the Switkowski report, 2006. This report pointed to uranium mining and nuclear power as the most likely fuel cycle activities for Australia.

4. Barriers to participation

Concerns regarding radiation safety appear to continue to be a major concern for the general public. However, reactor accidents at Chernobyl (former USSR) in 1986 and Fukushima (Japan) in 2011 both involved 1st generation reactors (the infancy of the technology). Chernobyl had no containment. Fukushima had a containment and produced a very different health outcome. Both had explosive releases of pressurized steam and the use of water as coolant and moderator was a major underlying root cause of failure. Although current reactors are also water-based, our understanding is that their design is greatly improved and future reactors will have different systems. New reactor types may, for example, avoid water to thermalise neutrons and for heat removal and would therefore be much safer than early designs.

With regard to health and safety effects from previous nuclear accidents, we recommend that the committee carefully consider the distinction between fatalities, acute radiation syndrome and other potential longer-term effects such as social dislocation. In both Japan and the former USSR there was inadequate planning for an accident and indeed a belief that an accident could not happen. Whilst fatalities occurred as a result of the Chernobyl accident, the dominant human detriment was social dislocation, as described by the Chernobyl Forum Report (2005). In Japan, while tens of thousands of people were evacuated and there is a 'theoretical' increased risk of thyroid cancer in the most exposed children, there have been no observed impact on: cancer rates, birth defects or hereditary effects attributable to radiation exposure (UNSCEAR 2013 Report; UNSCEAR white paper, 2017). Therefore, social dislocation was also the overwhelming source of detriment as a result of the Fukushima accident.

Federal Regulation is extensive (see Ch. 9, Switkowski Report, 2006) and follows a range of international commitments. Our understanding is that we cannot proceed to build a nuclear reactor without many changes to Australian law and further international agreements. For example, the *Australian Radiation Protection and Nuclear Safety Act* 1998 (Cth) restricts participation in most parts of the Nuclear Fuel Cycle including Nuclear Power Stations. No steps in uranium or thorium fuel cycles apart from mining uranium and thorium are possible without federal involvement.

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All power sources need to be considered as part of a national energy strategy. Australian states are interconnected both with electricity and gas. Victoria really can't consider energy needs outside the federal context. Both South Australia and Tasmania are dependent on Victorian power and the energy environment regarding investment appears to be largely determined at the federal level. Getting it wrong has huge implications as the recent events in South Australia have shown.

The electricity business is a mixture of private and state providers across the country. Federal involvement is essential to providing an environment in which investment can be made.

Yours truly

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On behalf of the Victorian Branch Committee, Australian Institute of Physics

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