Nuclear Inquiry Victoria

Submission by Terje Petersen

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"Nuclear power is the safest, cleanest and most reliable way to make electricity"

Terms of Reference for Inquiry

1. investigate the potential for Victoria to contribute to global low carbon dioxide energy production through enabling exploration and production of uranium and thorium;
2. identify economic, environmental and social benefits for Victoria, including those related to medicine, scientific research, exploration and mining;
3. identify opportunities for Victoria to participate in the nuclear fuel cycle; and
4. identify any barriers to participation, including limitations caused by federal or local laws and regulations.

About the Author

Terje Petersen holds a Bachelors Degree in Electrical Engineering and has a long standing personal interest in public policy and in nuclear technology.

Overview of Position

- Australia should end the blanket prohibition on the use of nuclear energy. In deciding if a reactor should be permitted in Australia then science and engineering data should drive our decision making. Not blanket ideology.

- Nuclear energy is not a dragon or a monster as characterised by some commentators. Mythology should play no part in public policy. Nuclear energy is a set of technologies that can be evaluated on their technical merits. There may be a case for prohibiting certain reactor designs (eg the RBMK type of reactor) or certain nuclear facilities, however a blanket prohibition on all reactor designs, both existing and proposed, is indeed an extremist position.

- In looking at the risks associated with nuclear energy it is important to do comparative analysis. Alternate technologies like solar, wind, hydro and coal can at times also cause death, produce toxins, displace wilderness and lead to major accidents. The deadliest power plant accident in history was in fact a failed hydroelectric dam in China. The burning of coal releases radiation. The production of solar panels creates long lived toxic waste. Proper comparative analysis that compares such factors relative to energy produced, and accounts for the full life cycle of plant and fuel, has repeatedly shown nuclear power to be the amongst the cleanest, safest and most reliable ways to make electricity.

- Australian regulations around safe levels of radiation exposure should not be based on the outdated "linear no threshold" view of radiation. Radiation in low doses is not proportionate to high doses in terms of human harm. And in fact, low doses of radiation can have medicinal value.

- Our fear of radiation should be like the attitude Goldilocks took towards the temperature of porridge. If we have too little fear, then we may do ourselves harm. But likewise, if we have too much fear we may also do ourselves harm.

- Some commentators say that nuclear power is old technology. However nuclear power has produced electricity commercially only since the 1950s. Solar panels were commercialised that same decade. Wind, coal and hydro are much older. There has been huge innovation in nuclear power since it's invention such that today it has a track record of being the cleanest, safest and most reliable technology for making electricity. However, there is still huge potential for further innovation. Innovation that can make the technology vastly, cheaper, cleaner and safer. Innovation may also adapt nuclear reactors for use in the industrial heat market to complement their existing role in the electrical and medical sectors. Innovation is not assisted by prohibition or inappropriate regulation.

- Nuclear reactors have sometimes proved expensive to construct. The financial risks associated with building nuclear power plants should reside principally with private investors. The role of the state should be to ensure that risks posed to taxpayers and members of the public are appropriately limited.

Comparative Analysis – Nuclear Energy versus alternatives

Cost

The financial risks associated with the construction of a nuclear power plant should reside principally with private investors. As such comparisons of the cost of nuclear energy to alternatives are best made by investors operating in a marketplace of alternatives. Cost may change based on time, location, design and project management techniques. The argument that a technology should be prohibited merely because it is considered "too expensive" is flawed. We don't ban luxury electric cars or organic food just because of expense. Obviously being expensive is a disadvantage in the marketplace and it may be such a disadvantage that a technology does not advance. However the question of marketplace viability is separate to the issue of legislated prohibition. The cost of building nuclear power plants should be no more than a matter of passing interest in the consideration of whether the technology should be banned.

That said the cost of regulation itself is something that the government should be concerned with. Regulations should not be piled onto any industry in a manner that is disproportionate to the benefit of regulation or with indifference to the cost of the regulation. If regulation stifles innovation it may make the public less safe rather than more safe. Less prosperous rather than more prosperous. There is certainly some indication that the regulation of the nuclear sector in the USA has often caused the technology to be more expensive and hence has at times given market preference to more dangerous or dirty alternatives.

Australia should regulate nuclear energy at the federal level. We have established federal regulatory agencies that can be readily adapted to the task. State and local governments should only be involved with matters relating to where nuclear power plants and nuclear facilities are sited. We should look at nations like Canada, France, Finland and South Korea when considering what regulatory regime to adopt.

Nuclear energy should not be held to a higher standard than other parts of the energy sector.

Accidents

Nuclear accidents such as Three Mile Island, Chernobyl and Fukushima have entered popular culture. Most notably the Chernobyl accident was the subject of a recent TV show. However in doing so the facts surrounding these events have often been distorted.

The worst of these nuclear accidents was Chernobyl. That accident entailed the failure of a RBMK reactor in the Soviet Union. The RBMK type of reactor would never have been licensed in the west. And it should never be built in Australia. The official record is that this accident caused 31 deaths. It seems likely that several

hundred members of the public would have suffered from associated thyroid cancers. In totality it is likely that the total number of deaths from the accident was likely smaller than the lives lost in many commercial airline accidents. Australia has not prohibited commercial airlines from operating in Australia and neither should it prohibit all nuclear power plants.

When it comes to large scale accidents that cause significant damage to property and widespread death the worst technology for making electricity is hydro. The 1975 Banqiao Dam accident in China lead to 26,000 direct deaths and an additional 145,000 deaths occurred due to secondary effects. Hydro accidents with fatalities also occur with much greater frequency than nuclear accidents with fatalities.

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Radiation

Some materials, man made and natural, are radioactive. This means they emit some quantity of high energy particles in one of three forms.

> **Alpha Particles** – an alpha particle is essentially a helium atom that is moving at very high speed. Helium is the gas that we put in party balloons. Alpha particles may be characterised as extremely hot helium.
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> **Beta Particles** – a beta particle is essentially an electron moving at very high speed. Electrons are what flows in our power lines and inside our mobile phones. Beta particles may be characterised as extremely hot electrons.
>
> **Gamma Particles** – a gamma particle is essentially a high energy photon. A photon is what gets emitted by a lamp or by the sun. Gamma radiation is however beyond the visible spectrum and it is very high energy.

Each form of radiation can be blocked by a barrier made of some suitable substance. In essence the emitted particle is cooled down by dissipation of energy. For instance, the beta radiation from tritium (heavy hydrogen) can be blocked by a 6mm barrier of air. Or a few layers of skin. Other radiation will require more significant barriers to keep people safe. Some radioactive substances need to be ingested before they pose any form of threat to human health. And many substances that we routinely eat are radioactive and causes us no harm. For instance, bananas are amongst the more naturally radioactive foods and they are healthy to eat.

If a radioactive material is ingested, then the harm will depend on how long it resides in the body. Many materials will only reside in the body for a matter of days and may not be there long enough to cause harm. The harm will also depend on the quantity consumed. Some materials that may be harmful in a significant dose may be harmless in small doses. Just as salt or even water may be harmful if consumed excessively but harmless or helpful in smaller doses.

Radiation can harm us by damaging our DNA. A human cell in a health environment experiences 10,000 events a day that cause DNA damage. We have evolved to deal with such DNA damage and our bodies have robust repair mechanisms. Obviously any system can be overwhelmed but at low levels our body is accustomed to DNA damage and can repair the damage. Low does of radiation are not harmful. Even whilst high doses are.

The mining associated with solar and wind technology also results in radioactive minerals being released into the environment.

The risks from radiation should not be downplayed excessively. However nor should they be over played as some commentators seek to do. Just as we manage the risks of electricity, by isolating it with insulation and other appropriate techniques, so also can radiation risks be managed.

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Toxic Waste

Nuclear power plants produce toxic transuranic chemicals as well as toxic radioactive fission products. The former being made of atoms heavier than uranium and the latter being made of atoms much smaller than uranium. The quantity of waste produced is very small. If produced by nuclear power an individual's electricity needs, across their entire lifetime, produces toxic waste less than the volume of a Coca Cola can. Even though the quantity produced is tiny some of the waste is highly toxic if ingested. For example the lethal dose of Caesium-137 is extremely tiny. As such this small amount of toxic nuclear waste needs to be isolated from humans for centuries until the more toxic chemicals decay. The longer-lived transuranic chemicals may last for millennium but they are generally not as toxic and they are more closely comparable to the original ore from which the nuclear energy was extracted.

Nuclear power plants emit some small quantities of gases with low levels of radioactivity. This includes tritium. Properly managed these emissions do not pose a risk to human health or the environment. If properly managed they should be considered in the same context as glare from solar panels and noise from wind turbines. Both of which are arguable a more serious problem.

Coal fired power plants are responsible for releasing far more radioactivity into the environment than nuclear power plants. This occurs because the coal that they burn naturally contains radioactive minerals which are released into the atmosphere as part of the burning process.

According to an analysis by Environmental Progress (a policy research organisation based in the USA), solar panels create between 200 and 300 times more toxic waste per unit of electricity generated than nuclear power plants. The toxicity of the solar waste is chemical in nature rather than radiological but that does not change the fact that it is a hazard to be managed. Chemical toxicity can last longer than radiological toxicity. For example lead is toxic, at the right dose, and lead will remain chemically toxic for billions of years.

The toxic waste from the nuclear sector is tiny and well managed. Whilst the toxic waste from alternative sectors is often greater and it is often poorly managed.

Nuclear energy should not be held to a higher standard than other parts of the energy sector.

Overall Safety

Nuclear is the safest way to make electricity. The number of fatalities per unit of energy produces is orders of magnitude lower for nuclear power than for other parts of the electricity sector.

Energy Source	**Mortality Rate (deaths/trillion kWhr)**
Coal	100,000
Oil	36,000
Natural Gas	4,000
Biofuel/biomass	24,000
Solar	440
Wind	150
Hydro	1,400
Nuclear	90
Source: Forbes Article, 10 June 2012. "How Deadly Is Your Kilowatt?" by James Conca	

CO2 Emissions

CO2 emissions from nuclear power plants during construction are on par with wind and solar (normalised by energy output). During operation there are zero CO2 emissions.

Lifecycle Emissions (including albedo effect)	
Technology	**Median Value gCO2eq/kWh**
Wind - onshore	11
Wind - offshore	12
Nuclear	12
Hydropower	24
Concentrated Solar Power	27
Geothermal	38
Solar PV - rooftop	41
Solar PV - utility	48
Biomass - dedicated	230
Gas - Combined Cycle	490
Biomass - cofiring	740
Coal - PC	820
Source: IPCC Climate Change Report 2014. Annex III Table A.III.2 | Emissions of selected electricity supply technologies (gCO2eq/kWh) https://www.ipcc.ch/site/assets/uploads/2018/02/ipcc_wg3_ar5_annex-iii.pdf	

Nuclear Weapons

There is some concern about rogue nations using nuclear power plants as a cover to make nuclear weapons. Australia should only prohibit nuclear power on this basis if Australia believes that Australia is a rogue nation. Which is obviously an absurd proposition.

Conclusion

Australia should not have a blanket ban on nuclear power plants, uranium mining, thorium mining, nuclear processing facilities or nuclear waste repositories. That does not mean Australia should automatically approve every such facility that private investors propose. Regulation rather than prohibition is the answer.