TRANSCRIPT

LEGISLATIVE COUNCIL ENVIRONMENT AND PLANNING COMMITTEE

Inquiry into Nuclear Energy Prohibition

Melbourne—Friday, 26 June 2020

(via videoconference)

MEMBERS

Mr Cesar Melhem—Chair	Mr David Limbrick
Mr Clifford Hayes—Deputy Chair	Mr Andy Meddick
Mr Matthew Bach	Dr Samantha Ratnam
Ms Melina Bath	Ms Nina Taylor
Mr Jeff Bourman	Ms Sonja Terpstra

PARTICIPATING MEMBERS

Ms Georgie Crozier	Mrs Beverley McArthur
Dr Catherine Cumming	Mr Tim Quilty
Mr David Davis	

WITNESSES

Dr Tilman Ruff, AO, and

Dr Margaret Beavis, MBBS, FRACGP, MPH, Medical Association for Prevention of War (Australia).

The CHAIR: I declare open the Environment and Planning Committee's public hearing for the Inquiry into Nuclear Prohibition. Please ensure that mobile phones are turned to silent and that background noise is minimised.

I would like to welcome Dr Margaret Beavis from the Medical Association for Prevention of War and Dr Tilman Ruff, also from the Medical Association for Prevention of War. Thank you very much for making yourselves available today and providing us with evidence. We look forward to your contribution.

All evidence taken at this hearing is protected by parliamentary privilege, as provided by the *Constitution Act 1975*, and is further subject to the provisions of the Legislative Council's standing orders. Therefore the information you provide during the hearing is protected by law; however, any comments made outside this hearing may not be protected. Any deliberately false evidence or misleading of the committee may be considered a contempt of Parliament. All evidence is being recorded. You will be provided with a proof version of the transcript in the next few days, and the transcript will ultimately be placed on the committee's website.

We have allowed somewhere around 5 to 10 minutes for opening remarks. We do have your submission, and I believe members have read the submission. So opening remarks will be appreciated, but then we will go to questions. So over to you. Who would like to go first?

Dr RUFF: Thanks very much for inviting us and for the opportunity to present to the committee on what for us is an important issue. It will be clear from our submission that we are very firmly of the view that the legislation that was enacted in Victoria in 1983 has served us well and should remain. I was very pleased and proud as a Victorian when that legislation was enacted, and I am still pleased and proud that it is there.

The nuclear industry is uniquely hazardous to humans. I just wanted to try and encapsulate some of the reasons why that is the case and give you a sense of what we are talking about here. Ionising radiation is really unique in the potential for a relatively small amount of energy to cause a great amount of biological harm. Radiation is so injurious to living tissues—not so much because of the amount of energy that it contains but because of the way that it is packaged and delivered to living tissues. It has the properties of being particularly damaging to the long, complex chains of molecules, the DNA, that really define who we are and that are our most precious inheritance from our ancestors and the most precious legacy we leave to the next generations. Damage to those molecules is a risk for the lifetime of the exposed individual and can obviously have transgenerational effects as well. Those effects relate to acute injury if the dose is sufficiently high, but long term also to increases in a large variety of cancers and a range of other chronic diseases, particularly cardiovascular disease, for the lifetime of the exposed individual, even if the exposure ceased decades earlier.

To give you some sense of the particular ability of ionising radiation to cause harm, an example is that the amount of energy in what would be a lethal dose of acute radiation for you or I—that would kill us reliably within a couple of weeks—can be no more than the amount of heat in 3 millilitres of water at 80 degrees. So a sip of coffee, in the heat that it contains, is the amount of energy that is in a lethal dose of radiation. So it is not that it is an extraordinary amount of energy; it is particularly biologically damaging.

The nuclear fuel chain, whether it is involved with weapons or reactors, changes the very nature of materials—that is what a nuclear reaction is. The radioactivity that is present in the waste and the products that come out of those processes is not the same as what went in. So both nuclear weapons explosions and reactors amplify the amount of radiation present in the initial material many millions of times—typically between 1 and 10 million times. So what you get out is very different from what you put in. A nuclear reactor is essentially a large neutron factory that transforms the materials inside and generates a huge range of about 300 different isotopes, with varying behaviour and half-lives and ways of being transmitted in the environment. But all of them have this capacity to harm human tissue. It does not matter the nature or the source; it is basically a matter of the dose that are delivered.

Even in normal operations of nuclear reactors there are substantial amounts of radioactive material that is generated in the process of mining and refining and milling and fabricating fuel. There are large amounts of radioactive materials that are generated inside the reactor, and then of course there are the waste products to deal with afterwards, which are the most toxic materials known to humans that need to be absolutely strictly isolated from the environment for geological periods of time. We are 70-plus years into the nuclear age and no country yet has an established functioning repository, and we can never know that those repositories when they are finally established will persist safely and function for the extraordinary periods of time involved—hundreds of thousands, even millions of years. But even the normal operation of those facilities generates large amounts of radioactive materials, some of which are inevitably released into the environment through gaseous emissions, through liquid emissions into soil, into cooling water. Particularly when the reactors are refuelled is a time when particularly volatile products are released in large amounts.

It is clear now that people who live near nuclear facilities, even normally functioning, properly regulated ones in North America, Europe and Japan, get more radiation than people who live further away, and it is clear that that radiation is harmful. Children who live within 5 kilometres of a normally functioning nuclear power plant—studies in a large number of countries have shown that the risk of childhood leukaemia is more than doubled for children living within 5 kilometres, and this is without accident, and that that risk extends out to 50 kilometres. We now have very clear evidence that even the very small doses of radiation that are part of the normal background that all of us get from the rocks, from space, from other natural sources are a significant factor in the background rates of cancer around the world.

There are now large studies of nuclear industry workers, particularly some studies I commend to the committee that we refer to, organised through the International Agency for Research on Cancer. There are very large cohorts of close to half a million workers that were followed for many years, and it is clear that even in that group, where the total dose on average is less than one year's maximum permitted radiation—roughly 19.4 millisieverts, the maximum allowed being 20 per year on average for a worker—even at that total lifetime exposure of less than 20 millisieverts, with an average of just under 1 millisievert per year, there are discernible increases in the risk of cancer and chronic disease in those workers. Those studies have really firmly established, as others have, that even the relatively low levels that we get from background radiation, from medical exposures and from nuclear facilities, whether we work there or live near them, are a risk to health. I think this is really one of the most significant issues associated with nuclear technology.

The other aspect that I just want to briefly refer to and highlight to the committee that is a particular reason for being for our organisation, founder of the International Campaign to Abolish Nuclear Weapons, the first Australian-born Nobel peace laureate for our role in the Treaty on the Prohibition of Nuclear Weapons, which is close to entry into force—the very reason for that is that the most acute risk to health and survival on our planet is nuclear weapons and the risk of their use. There is no way of separating the potential to produce the materials that put the nuclear into nuclear weapons from the capacity to run nuclear reactors. If you can enrich uranium to run in a nuclear reactor, then you have got everything you need to enrich it a little bit further to weapons grade, and that has been the basis for the international concern about Iran's nuclear program, for example. If you have got enrichment capacity, then you can produce highly enriched uranium, which is one of the fuels that can drive weapons. The other is plutonium, and plutonium is inevitably created by the physics inside a reactor. Uranium atoms absorb neutrons and become heavier elements, including plutonium, so it is an inevitable part of the operation of a nuclear reactor that plutonium is created, and that can be chemically separated from the spent fuel.

Ostensibly civilian nuclear facilities and programs have been a route for a number of countries to acquire nuclear weapons—India and Pakistan, North Korea, South Africa, Israel. And even in the more established nuclear-armed states, civilian nuclear facilities—for example, in France and the United Kingdom—play a significant role in weapons, in that plutonium from the civilian sector is being used for their weapons programs. So the nexus here is essentially inseparable. For me as a public health physician there are other concerns, but it is that inseparable capacity of nuclear reactors and uranium enrichment to produce the fuel for the world's worst weapons that is the absolutely fatal flaw of nuclear reactors and uranium enrichment.

Dr BEAVIS: I would like to continue on a public-health approach. I will just talk on a few topics. I will start with nuclear accidents. It is self-evident that complex technology systems all inevitably fail at some point, and nuclear power plants are no exception. You would be aware of Fukushima, Chernobyl and Three Mile Island, but there have also been partial core meltdowns in at least nine other reactors that we know of, including in the US, UK and Europe.

Fukushima happened after a major earthquake and nine years later it is still leaking radiation. The former Prime Minister, Naoto Kan, said that there was a real possibility of requiring the evacuation of Tokyo because the 35 million residents there were subject to fallout if the wind had been in the wrong direction. As dumb luck had it, the wind was actually offshore after the Fukushima accident, but otherwise the evacuation of Tokyo had been a real possibility.

Both these reactor meltdowns happened because of cost cutting and poor regulation. Prior to the accident there were two separate models saying that higher seawalls and better protections were needed for tsunami, and these were not undertaken for cost reasons. In fact the formal investigation by the Japanese diet found that there was a combination of inadequate safety culture, mismanagement and deception on the part of both regulators and operators that caused that event.

Also, looking at meltdowns in a more general sense, if you look at the number of meltdowns that have actually happened—so the real-world experience—and average them over the number of years of operation, with 400 reactors worldwide you would expect a core meltdown every three years and a disastrous accident with a major release of radioactivity every nine years. So the nuclear industry's claims, for example, that generation III reactors will have one major accident per reactor per million years should be treated with some scepticism, as should their claims about small modular reactors.

Nuclear terrorism and deliberate harm are certainly a possibility. The head of the International Atomic Energy Agency said that there are daily cyber attacks on reactors. In fact, I quote:

> Reports of actual or attempted cyber-attacks 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.

In addition to the threat of terrorist attack there is deliberate sabotage by staff. There have been a number of airline mass deaths where people have died, presumed due to mental illness of the pilot. The most recent of these was a Germanwings crash in 2015.

Nuclear waste—there is nothing very cyclical about the nuclear fuel industry. It starts with uranium mining, enrichment, fuel fabrication, reactors to weapons or waste. Attempts to harvest and reprocess the waste stream are barely more than a fantasy after 70 years of research and billions and billions of dollars spent on how to use this waste. So instead globally we have mountains of waste all over the planet, which is largely stored in dry casks or in pools at reactor sites. There is a little bit at reprocessing facilities as an interim solution. Globally there is nowhere that stores high-level waste in operation, and Australia has been trying for decades to manage a small volume of waste. Under no circumstances should we start building another reactor unless we have identified and approved a site for deep geological disposal of this waste, because it is highly toxic and needs to be stored for at least 10 000 years. When you think that the pharaohs were 5000 years ago, it is a very long time to have to store something safely from the environment.

Nuclear medicine—I use nuclear medicine, and I support nuclear medicine, but some suggest that not having a reactor is holding back medical research. This is plainly nonsense. Medical isotopes are shipped around the world. Most countries do not have a reactor that produces isotopes. In fact the United States and the UK have done perfectly good medical research without having a reactor for many years; they import them. When ANSTO's reactor breaks down, which has happened not infrequently, or when ANSTO's reactor goes offline for maintenance a couple of times a year, we import our isotopes from South Africa. When in the last 12 months not only was ANSTO broken down but the South African reactor was broken down, Peter MacCallum imported isotopes from Europe. Lutetium, which is a promising isotope for prostate cancer, can be obtained from ANSTO, but it also can be easily imported from Germany.

There are other medical isotopes which are already being produced in Victoria from cyclotrons. Globally the world is moving away from reactor isotope production for nuclear medicine and towards using cyclotrons and accelerators. Cyclotrons are about the size of a four-wheel drive car. They cost $2 million, $3 million, $4 million, once you factor in the concrete around them—I could talk about cyclotrons more. But there is nothing to stop research happening in Victoria, and research into cyclotrons to increase the number of isotopes that could be produced would be a very worthwhile thing for this committee to recommend. Producing isotopes with cyclotrons does not have the huge amount of nuclear waste and avoids the huge cost of building a reactor. The synchrotron that we have down near Monash is also a huge resource for Victoria and something that we should be capitalising on in the nuclear medicine field.

What is stopping a nuclear reactor for medical purposes being built in Victoria is cold, hard economics first and foremost. We know that ANSTO needs $200 million a year at least in subsidies to run, and that is after it has got the export business in medical isotopes that is being set up—and there is no clear business case to tell us whether that is going to make money or not; there is no business case that factors in the cradle-to-grave costs of production. All this financial issue comes in before you have got the $400 million or $500 million it costs to build the ANSTO reactor initially. There is zero appetite to build another research reactor in Australia. For regulatory purposes it would come under the commonwealth jurisdiction anyway, just as ANSTO does. But a new reactor is not needed to supply medical isotopes. ANSTO already wants to try and supply about a third of the world's isotopes on the export market, and another one would just be a competitor and create a risk of flood in the market. One unreliable reactor supplier in ANSTO is enough for Australia, given its poor record in the last two years. If we explore cyclotron production, when that came online it would be at multiple sites and would be much more reliable in terms of nuclear medicine production.

The other thing that is also stopping another nuclear reactor in Victoria is the lack of a waste disposal pathway. There is absolutely no plan for a disposal site anywhere in Australia, and currently ANSTO stores its radioactive waste at Lucas Heights. It begs the question: where would you put the radioactive waste in Victoria?

Finally, in closing, health and safety across the nuclear fuel cycle is very problematic globally, but here in Australia there is massive failure of regulation with the BHP Olympic Dam mine, which mines uranium. After a failure in South America, where a number of people died, BHP was forced by stakeholders to do an audit of its dam facilities. Its own engineers said that at Olympic Dam there are three tailings facilities out of six that are at extreme risk of failure. This means the potential loss of life of 100 workers and environmental rehabilitation that would be impossible. Despite this being identified and known, Olympic Dam is being fast-tracked to expand, and there has been no mention made of the major breach of worker safety or environmental protections.

So to conclude, I think nuclear medicine—globally the world is moving away from reactor isotope production towards cyclotrons and accelerators, which are much cleaner and more reliable. Victoria should be focusing on its strengths: using the synchrotron, the existing cyclotrons that we have and building new cyclotrons to boost medical research into isotope production. A new nuclear reactor in Victoria would be a very expensive white elephant with an increased risk of harm to the community and would produce waste which has no safe disposal solution. Thank you.

Ms TAYLOR: Thank you for the very detailed reports to the committee—very much appreciate your insights and evidence. Yesterday I did find there was a theme of sort of downplaying any risks with nuclear with statements such as, 'The nuclear industry'—and I am paraphrasing—'has an excellent safety record' and 'very minimal impacts from Chernobyl in terms of death numbers'. But this seem to be contrasting significantly with the information that you have submitted and that you have just submitted now. I know I am trying to reconcile this gross disparity between those two forces. I am still trying to digest it, because I cannot understand how somebody can claim something is so safe when you look at the clear evidence that you have put forward today. What do you see as the genesis of that, and do you think it is justifiable to call nuclear safe?

Dr BEAVIS: Do you want to answer that one?

Dr RUFF: I am champing at the bit. No, I do not. As I reflect on this—and I have written a bit about this—I have worked in a range of areas in public health and in clinical medicine and there is no other area that I have come across compared with this area of radiation and health impacts that is so distorted and corrupted and misrepresented by vested interests, essentially. I mean, there is a level of involvement of vested interests in nuclear regulation and nuclear standard setting even that is absolutely unprecedented and poses intolerable conflicts of interest, even in the bodies that set international standards. For example, the International Commission on Radiological Protection—that sets the benchmark standards internationally that most governments adopt—is a body that includes nuclear industry representatives. Its secretariat is funded by the nuclear industry and staffed in part by nuclear industry representatives. It cannot by any means claim to be independent. The investigation in the Diet in Japan following the Fukushima nuclear disaster, that Margie mentioned, also uncovered that Japanese ICRP members had had their travel and other expenses paid by the electric utilities in Japan that are nuclear and that they had undue influence on the deliberations and recommendations that the committee made.

It is really crucial in this space to look very rigorously at who is speaking and what are their connections and who is paying them and go with the independent sources of information. The International Agency for Research on Cancer is the best of those. Even, I have to say, organisations that I am extremely proud of that the world needs, like the World Health Organization, have been deeply corrupted. WHO has been hamstrung by a lack of leadership, a lack of resources, a lack of internal capacity in this space and a deference to the International Atomic Energy Agency on Chernobyl. WHO put its name to reports led by the International Atomic Energy Agency that claimed that 34 workers who died of acute radiation sickness were all of the casualties from Chernobyl. IARC studies since, repeatedly, carefully, have estimated that, no, the best case is probably around 30 000 to 40 000 fatal cancers across Europe from Chernobyl. That is a WHO agency. WHO was pressured by the Japanese government to reduce the dose estimates that it included in its report about the Fukushima disaster, and it did. It is extraordinary, the level of conflict of interest that persists in this space. So I would really commend independent scientists and sources.

In Victoria and Melbourne there is some remarkable expertise, and I really want to mention to the committee—it may be a slight digression, but I just think it is important that anybody looking at things related to radiation knows this—Professor John Mathews is a hero and I think really deserves much more widespread recognition than he has. He conducted a couple of years ago what was then the largest population-based study of low-dose radiation health effects that had ever been conducted anywhere in the world. It involved 10 times the numbers of people and four times the total radiation exposure to the low-dose data from the Hiroshima-Nagasaki survivors.

John’s study of almost 700 000 young Australians who had had a CT scan, compared with over 10 million who did not, showed that having one CT scan before the age of 20 increased your risk of subsequent cancer just over the next decade by 24 per cent and an increment of 16 per cent for every additional CT scan, involving a couple of millisievert. It is an absolutely landmark study that changes the approach to diagnostic imaging and medical radiation and highlights the extreme vulnerability of children, and particularly girls. This is also a gender issue. Women and girls are about 40 per cent more susceptible to long-term cancer induction for the same dose of radiation as men and boys. It is not often seen as a gender issue, but it is. And it is very much an age issue. Children are about three to four times more vulnerable for the same dose of radiation to long-term cancer induction than, you know, old folk like me. So it is particularly the vulnerable groups in the population that need protection.

But John has had enormous difficulty in having that extraordinary study even accepted and considered by the United Nations Scientific Committee on the Effects of Atomic Radiation—completely dismissed by ICRP. There is an extraordinary amount of misinformation that is basically because of the corruption and involvement of vested interests intruding into areas where they have absolutely no place.

Ms TAYLOR: Right. Goodness me.

Dr BEAVIS: I would add that that study has changed how people globally investigate children with abdominal pain, that you are now much, much more hesitant to use a CAT scan on a child. And so in the medical spheres it is accepted that this is good data, it is solid research and it should change what we do, because otherwise we will have increased cancers down the track. And yet in the radiological space, as Tilman says, there are so many vested interests and so many players it is getting hard to get accepted. You just have to think of when you go into an X-ray place; the first thing you see is a sign saying, ‘Are you pregnant?’, because we know that X-rays in pregnant women increase leukaemia down the track. So in medical circles the risks of radiation are plain to see, but in nuclear vested interest circles there is a lot of doubt cast on them, even though it is more because of the vested interest rather than because of the reality.

Ms TAYLOR: If I may, another question to follow up on the theme of public health, which is actually my greatest—well, it is a toss-up between public health and the environment, both are big concerns of mine with regard to this inquiry. Thinking about workers, because it was trumped out yesterday that if we are really thinking about workers we would be trying to generate jobs for them in the nuclear industry, I proffer that the health of the workers is the paramount priority, and that we certainly need to be fostering jobs but they should be sustainable jobs. So what would you say to risks posed to workers at the front line, you might say, in the nuclear industry?

Dr RUFF: I briefly mentioned the IARC studies—the International Agency for Research on Cancer studies. The studies of medical radiation exposure have really transformed our understanding of radiation and confirmed that at any dose there are health impacts. Obviously the more you get, the worse it is, but there is no level below which there are no impacts. That is absolutely clear now and that has been the logical, prudent basis for regulatory standards in just about every country, including Australia, that so-called linear no-threshold—that there is no threshold below which there is no risk and the risk is proportional to the dose. So the more you get, the worse it is, and the younger you are when you get it, the worse it is. Most of the people who work in uranium mining in Australia are pretty young. The average age is less than 30 in the last data I saw. They are a relatively small cohort. The industry has for over a decade never cracked close to $1 billion a year in export income. It employs, on the most recent estimates I have seen, a maximum of about 700 people. It would actually be cheaper to pay them to spend their time on yachts in the Caribbean than to pay them salaries for what they do for the income they generate.

There are risks to those workers. Happily, Australia has now introduced a lifetime dose register so it is possible now for somebody to have access to their data and for their exposure to be measured and recorded. If they leave the workplace or move to another mine, those data are still available and are still cumulatively recorded. Studies that were done of miners at Radium Hill in South Australia some decades ago, particularly for the underground miners, showed a very significant excess—a five-, six-, seven-fold increase in lung cancer in the workers at Radium Hill. The in-works studies of the International Agency for Research on Cancer, which is the best global database, some of which goes back to the late 40s and looks at almost half a million nuclear industry workers in different industries, show very clearly, as I mentioned, that even tiny doses—less than the average annual background dose that we all get from the rocks and from space—cause a measurable increase in cancer of a whole variety of different types, including blood cancers, like leukaemia, but also solid organ cancers, and also increases in chronic disease and cardiovascular disease, especially heart disease in particular. Those risks are at least as great as has previously been estimated.

So it is very clear that the annual occupational accepted limit is not a level below which there is no risk to workers, but it has just been the traditional compromise, actually, based on science some decades old now, that that is a reasonable compromise between cost saving and health impacts. But there are significant issues for uranium miners in Australia. At Olympic Dam we know that because of the risk, particularly of the inhalation of radon daughter products, especially polonium, some of those workers are getting around 10 millisieverts per year. That is a sizeable exposure. If you are a worker in your 20s, you have got 50, 60 years of life expectancy left. That will measurably increase your cancer and health risks in the long term, apart from the occupational risks of mining—of injury and noise-induced deafness and so forth. But this is not a safe space to be working in in terms of those exposures, and of course cigarette smoking compounds the risk of lung cancer with radon exposure so that is a particular additional hazard for those workers.

The CHAIR: Look, I have got a couple of questions here. You talked about the risk to children, particularly those within a 5-kilometre radius. Are you saying that will apply to Lucas Heights in Sydney—that there is a serious risk for the population—because my understanding is that it is in the middle of suburbia. That is where the reactor is.

Dr RUFF: Yes, it has increasingly been encroached upon by the suburbs of southern Sydney. Look, we do not have those local data. I am not aware that that has actually been looked at. It would be an appropriate thing to look at actually. The findings are fairly—well, very—robust and have been shown in a variety of settings. The UK was where the concern was first generated about clusters of leukaemia in proximity to nuclear facilities. The US Department of Energy funded a large study just over a decade ago that looked at all of the data and concluded that there was a clear effect, and that was before a large German study that really was absolutely definitive, and French data since have supported that. So it is very robust data. It is really, I would say, pretty irrefutable. Nuclear power reactors tend to be much larger—hundreds of times bigger in terms of the volume of radioactive material that they contain than the relatively small research reactor in Sydney. The hazards are qualitatively the same, but given the much smaller reactor one would hope that the risks for surrounding areas in Sydney would be less. But the best way to find out is to actually interrogate the data.

The CHAIR: That is right. I understand the risk—

Dr RUFF: I am not aware of any studies in Australia that have examined that in relation to Lucas Heights.

The CHAIR: Yes, that is why I wanted to clarify that, because I do not want to leave some of this evidence you are giving unchallenged. Whilst I agree with where you are coming from—I am not necessarily disagreeing with that—I just want to make sure of that. Similarly with jobs—the argument of the proponents about jobs was not in relation to direct jobs; it was really how we can phase out of coal and support the heavy manufacturing industries, for example. In Australia there are tens and tens of thousands of jobs—probably hundreds of thousands of jobs—in heavy industry, steel, aluminium et cetera. That is what the proponents are trying to argue with phasing out coal—how to maintain Australia as a manufacturing country with heavy industry—and that is the debate about whether nuclear is the answer or whether renewables can actually eventually fill the gap left by coal. So that is what currently the debate is about. It is not necessarily about direct jobs rising out of nuclear, of which in Victoria we have not got many anyway. So I think that is where the debate is. Have you got any view on that?

Dr BEAVIS: I think you would need to talk to someone with expertise in the jobs provided by the renewable energy industry and the storage industries, because I think that is beyond our expertise. My understanding is that there is certainly the ability to create a lot of jobs in the renewable energy and storage situation, but I cannot give you data on comparing those two.

The CHAIR: One last question from me, which I am really keen on: nuclear medicine—the benefit versus the hazards as a result of that and how much benefit humanity has got out of that versus the risk. Also we have heard this morning—and I think, Dr Beavis, you talked about it—we do not necessarily need the current technology of nuclear medicine to be able to actually achieve the same result. There is other technology that we can use. I think it was something about—

Dr BEAVIS: In terms of nuclear isotopes—

The CHAIR: Isotopes, yes.

Dr BEAVIS: There are a number of different isotopes, and as I said there are cyclotrons in Victoria that are already producing a number of types of isotopes. The one that ANSTO is planning to export is technetium, which is used to do bone scans when they are looking for bone secondaries, and it is used for some heart scans and occasionally used in sports medicine.

At the moment with technetium in Canada there is really good research showing that this can be done using a cyclotron. My understanding with the cyclotron in Canada is that the use of that material has been held up. There are arguments about state versus federal funding, and there are also arguments about actually getting it regulated so the technetium that is produced in a cyclotron is safe to use in people. Just like putting a drug through testing before they will release it to the public, they have to put the technetium through it. The process in Canada has been demonstrated to work. They have got one cyclotron that was able to produce enough technetium to do the data supply for a city—a city like Melbourne would probably need three cyclotrons—but at the moment it is bogged down in regulation, and I understand it is not working at present. However, it is coming down the track.

Similarly, the UK and the US are looking into cyclotron and accelerator production of nuclear medicine. They are not looking at building reactors; they are looking at doing that, because they feel it would be cleaner and they would not have to deal with the waste. Also nuclear reactors break down; they are not particularly reliable. When they do break down it is problematic in terms of supply. For instance, in Victoria, if we had three different cyclotrons providing the technetium for this imaging, then if one of them broke down it would not be a disaster; we would still have two to run.

Dr RUFF: Can I just add a little to this. I think there are a couple of issues. One is that half a dozen reactors around the world basically provide all the isotopes for medicine, so it is not as if every country needs one. We have needed a handful of those.

The CHAIR: Unless you have got a travel ban imposed because of a virus, but you are right—you are spot on.

Dr RUFF: Yes, and part of the reason for that is they are very expensive and you buy into all of the problems of reactors—you know, accidents, waste, potential attack. They are expensive facilities to run, and not everybody needs to run them.

Some of those reactors are actually still run on highly enriched uranium, directly usable in weapons. There has been a long program that is gradually getting those converted to only use low-enriched uranium, which happily the Lucas Heights OPAL reactor now does. So even if you need reactors, there are safer ways of doing it, but not everybody needs one. But then what Margie is talking about is that the key thing is the production of the isotopes; that is what you want. It is now clear that we can essentially produce all of what we need for medicine that currently comes out of reactors from machines that do not create waste, that do not create bomb-usable materials, that you switch off at the wall and walk away from. And that is where we need to invest.

Dr BEAVIS: We need research to get that happening in Victoria.

Mr LIMBRICK: Thank you, Dr Beavis and Dr Ruff, for appearing today and your evidence. I congratulate your organisation on the prevention of war and these things that you do. Actually the libertarian movement that I am part of is strongly anti-war. In fact my first political action that I ever had was to attend a Gulf War protest back in 1990 where we chanted, 'No blood for oil'. This to my mind is one of the very significant factors in thinking about energy. We all know that there have been many, many global conflicts about energy and resources and primarily oil. But to my knowledge there has never been a conflict over uranium supplies. We have had wars over oil, these sorts of things, and if we can use technologies such as uranium and nuclear technologies to remove the necessity for dependence on fossil fuels, does that not decrease the probability of war?

Dr RUFF: I guess I would argue that it is not the choice, that renewables, especially wind and solar, essentially rely on materials that are ubiquitous in the earth's crust—silicone, minerals that are extremely widespread, of which there is no shortage or potential source of—

Mr LIMBRICK: That is not entirely true, though, is it? There was almost a very big conflict recently over the issue of rare-earth production, because it is dominated by China and they cut off supply, over a political conflict, to Japan, and Japan panicked about that. I mean, there is potential if there is a centralised supply of rare-earth materials, isn't there?

Dr RUFF: I am not an expert on rare earths, but my understanding is that they are widely enough distributed for monopoly of supply to not really be much of a problem, but I would be happy to take that on notice and seek further advice, if that would be helpful. But essentially these facilities that harness the power of the wind and the sun are widely dispersed, have really no security risks associated with them, produce essentially no waste, are really safe from severe accidents, so from a security and conflict point of view they have a very major advantage over both nuclear and fossil fuels. I would perhaps just suggest that uranium may have been involved certainly towards the end of the Second World War. The Soviets were very quick about taking over Eastern Europe, particularly the area of Wismut, where the large uranium deposits in East Germany were. They were taken very quickly, even before the war formally ended, as a strategic resource—the Russians obviously being aware then of the American nuclear weapons development program. But essentially uranium is fairly ubiquitous and widespread, yes, so I am not aware of any conflicts directly related to it.

Mr LIMBRICK: On the issue of waste, you mentioned that there is no waste from renewables. But the reality is that there are orders of magnitude. More materials are required than with nuclear just because the energy density is much lower; therefore you need a lot more concrete and steel and rare earths and all these other materials. It is theoretically possible to produce these things without fossil fuels, but they are all produced—like the concrete is made from coal, the steel is made from coal. There are theoretical methods to produce these things without coal. So they are not really substituting for fossil fuels at all. They are a more exotic way of using it. But this waste that is produced—we have no solutions for this waste either, do we? Because some of these things, like the solar panels, contain things like cadmium and lead and these other things that do not have any half-life. They are toxic forever if they are not managed properly. We spoke earlier in a hearing about turbine blades. We have no solution for that, other than I think Germany is looking at putting them in a waste-to-energy system, like burning them, effectively. What I am getting at is there are waste problems with every energy production source. We have also heard that burning coal produces radioactive material as well, in the fly ash. In the production of wind turbines, with the rare earths, we have radioactive materials that are by-products from the rare earths. So these issues around waste and radioactivity are not unique to nuclear energy at all, are they?

Dr BEAVIS: I think that again comes down to orders of magnitude. I mean, you look at Japan, which has a stockpile of plutonium that would be able to create thousands of nuclear weapons. The waste that would be coming out of concrete, the waste that would be coming out of blades—none of those are able to go to be nuclear weapons. And for countries that adopt nuclear power, a necessary by-product of that nuclear power is plutonium. Plutonium is easy to transport. If a terrorist wants to get hold of some plutonium, I think they probably could if they wished to because it is much easier to transport than other forms of nuclear waste. Yes, these toxins occur, but the orders of magnitude of danger to the population and to humanity are considerably different.

Mrs McARTHUR: I would just like to take you up on a couple of things. You mentioned 'mountains of waste'. That is quite an extravagant term. Perhaps you will describe where the mountains of waste exist.

Dr BEAVIS: I will give you the actual numbers.

Mrs McARTHUR: In terms of deaths as a result of nuclear power plant accidents and so on, I am just wondering we have at the moment got 489 000 people who have died as a result of COVID-19. We have had over 400 000 people, it is estimated, who have died in the last 10 years in the Syrian war. We have got cancers here in Australia, yet we have not got nuclear power plants operating. The threat of death from nuclear power plants seems to be not in perspective with what is happening with deaths around the world. Also, you say, 'Nuclear power plants are vulnerable to terrorist attack and sabotage'. Where have they been attacked and sabotaged and how much plutonium has been stolen by terrorists?

Dr BEAVIS: I will go back to the first question. There are 370 793 tonnes of nuclear waste in the 2015 stockpile, as reported in 2018 by the IAEA. Whether that is a small mountain or a big mountain—I find 370 000 tonnes hard to envisage. So perhaps mountain is—anyway, I think that is semantics. But there is certainly a lot of it, and certainly there is no facility anywhere in the world that actually can adequately store this. When the Germans tried to put it down a salt mine, their high-level waste, they actually had to go back years later and retrieve because it was leaking into the watertable. There have been a number of other failed mines. The one that is coming along most is in Finland, where they have spent 40 years researching where they can put their high-level waste. They are spending, I think it is, 4 billion or 5 billion on the Olkiluoto feed waste facility. That is only going to be for their own waste, so they will not take waste from any other country, and it is the first of five that they are needing to build for their nuclear industry. So the waste of this industry needs to be taken very seriously and to be stored in a deep geological repository for a very long time.

The question of nuclear attacks—certainly one of the reasons why waste is stored at Lucas Heights is because they have good security. There have been a couple of attacks on Lucas Heights where people have—I cannot give you the precise details but I can give you on notice. But certainly Lucas Heights has had approaches. I think it is interesting that the head of the IAEA says that cyber attacks on nuclear facilities happen on a daily basis, so I think that is evidence of concern on nuclear attacks.

Mrs McARTHUR: Cyber attacks happen all the time.

Dr BEAVIS: Yes, but a nuclear power plant is effectively a nuclear weapon in place. If you can effectively attack the cooling systems of a nuclear power plant, then the rods overheat and they explode, as happened in Fukushima, so it is not something to be taken lightly. A cyber attack that interfered with the cooling systems would be catastrophic.

Mrs McARTHUR: But so far none of these things have happened. There has not been plutonium stolen—

Dr BEAVIS: But the IAEA is saying that they are happening on a daily basis.

Mrs McARTHUR: But nothing has resulted. We have not had plutonium stolen by terrorists. Is there any evidence of that?

Dr BEAVIS: There is plutonium that has been taken. I can get into that as a question on notice.

Mrs McARTHUR: Take it on notice. That is fine.

Dr BEAVIS: Plutonium has been taken from stockpiles, and there is an amount of plutonium that is no longer accounted for. In various decommissioning processes of nuclear weapons, nuclear materials disappear. So I do not think it is something that should be taken lightly.

Dr RUFF: If I could just add, the International Atomic Energy Agency does maintain a trafficking database, and it has recently been expanded on by the Monterey institute in California. There are hundreds of instances per year of theft and disappearance of nuclear materials, and there have been tens of instances particularly involving highly enriched uranium, which is easier to transport. Most of those appear to originate from the former Soviet Union and largely have been intercepted in different regions. Some of those have been weapons-relevant quantities. Plutonium, less frequently, but I can provide information about that.

I would just emphasise that there have also been attacks on nuclear reactors. Israel bombed the Osirak reactor in Iraq. It bombed a reactor in Syria that was under construction—it had not been declared to the International Atomic Energy Agency—and ostensibly with North Korean assistance. There have been attacks on South African nuclear facilities and on reactors under construction in Argentina and in Spain. There have been a number of attacks on nuclear facilities—happily none of those in a fully fuelled functioning reactor that has resulted in radioactive release. But I think the Fukushima disaster is particularly instructive because what happened there, because of bad design and a massive earthquake and tsunami with disruption not to the reactor itself but to the cooling water supply and power to the pumps for even very brief periods, resulted in a really catastrophic meltdown of multiple reactors. What happened in Fukushima because of those factors could just as easily happen because of a small terrorist cell, particularly with insider assistance, if they disrupted the power supply and the water supply to the cooling. They would not have to have aircraft and physically bomb a reactor at military scale. That is an extreme vulnerability. So in a sense these power reactors and the spent fuel ponds associated with them, which often contain much larger amounts of radioactive material—in Fukushima, 70 per cent of all of the radioactivity on site was in the spent fuel ponds—are big sheds. There are no multiple, carefully engineered layers of containment around those, which also actively require circulating water to cool them. Those are profound risks from the point of view of malign intent.

The CHAIR: Thank you. We are running out of time, but Mr Limbrick has got a quick question. A quick answer would be excellent.

Mr LIMBRICK: Just one other issue on nuclear weapons. It is my understanding that Russia and America a number of years ago, in the process of decommissioning their nuclear weapons, were actually using the plutonium that was in the nuclear weapons when they were decommissioning their excess requirements, because the Cold War was over. They were actually using that to power nuclear power stations. That is how they were getting rid of a lot of this material. Is this not the ultimate swords into plowshares type arrangement?

Dr RUFF: Certainly that arrangement, which has now unfortunately ended, happened under the Nunn-Lugar arrangements, which have now been unfortunately ended—yes, it did for about a decade. Roughly half the nuclear electricity that was generated in the United States was from highly enriched uranium from old Soviet weapons downblended to low-enriched uranium and run in the power reactors. It turns it into radioactive waste, which is a problem you have to deal with, but it is certainly better than having it in weapons.

The CHAIR: On that note, Dr Beavis and Dr Ruff, thank you very much. It has been a very valuable contribution. On behalf of the committee, I would like to thank you.

Mr LIMBRICK: Thank you so much.

Dr RUFF: Thank you so much.

Witnesses withdrew.