T R A N S C R I P T

LEGISLATIVE COUNCIL ENVIRONMENT AND PLANNING COMMITTEE

Inquiry into Nuclear Prohibition

Melbourne—Friday, 14 August 2020

(via videoconference)

MEMBERS

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

PARTICIPATING MEMBERS

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

WITNESSES

Mr Ian Hore-Lacy, Senior Adviser, and

Mr King Lee, Director, Harmony Programme, World Nuclear Association.

The CHAIR: I declare open the Standing Committee on Environment and Planning public hearing for the Inquiry into Nuclear Prohibition, and can I ask participants to make sure that their phones are turned to silent and noise is reduced. Therefore when you are not speaking, please mute yourself.

I would like to acknowledge my colleagues here today and also the colleagues who have passed on their apologies. I would like to acknowledge my colleagues: Mr Hayes, Deputy Chair; Ms Nina Taylor; Dr Matthew Bach; Mr Andy Meddick; Mr David Limbrick; Ms Sonja Terpstra; Ms Melina Bath; and Mrs Beverley McArthur. Welcome.

I will acknowledge our witnesses for this session: Mr Ian Hore-Lacy and also Mr King Lee, Director of the Harmony Programme, all the way from the UK. Thank you very much for making yourself available, and I believe it is 5.00 am your time. We very much appreciate that you are making yourself available at this time. That is really appreciated by the committee.

All evidence taken at this hearing is protected by parliamentary privilege as provided by the *Constitution Act 1975* and further subject to the provisions of the Legislative Council standing orders. Therefore the information you provide during the hearing is protected by Australian law; however, any comment repeated outside the hearing may not be protected. In relation to Mr Lee, that protection only applies in Australia and unfortunately does not extend to the UK. Any deliberately false evidence or misleading of the committee may be considered a contempt of Parliament. All evidence is being recorded and you will be provided with a proof version of the transcript following the hearing, and the transcript will ultimately be made public and posted on the committee website.

We have got your submission and we have allowed 5 or 10 minutes to give us an overview of any particular points you want us to focus on, and then we will go to questions. I am in your hands. Who would like to go first? Is it Mr Hore-Lacy or Mr Lee? Who would like to lead?

Mr LEE: I will, Chair.

The CHAIR: Mr Lee, thank you. Did you just wake up or have you stayed up during the night?

Mr LEE: I have been up for the last couple of hours.

The CHAIR: Again, thank you. Please go ahead.

Mr LEE: Ladies and gentlemen, thank you for the opportunity to represent the World Nuclear Association and contribute to this inquiry into the benefits of nuclear to Victoria and removing the prohibition enacted by the nuclear prohibition Act. My name is King Lee. I am the director of the Harmony Programme at the World Nuclear Association. The World Nuclear Association is the international organisation that represents the global nuclear industry. Our mission is to promote the wider understanding of nuclear energy among key international influencers by producing authoritative information and a fact base and developing common industry positions in contributing to the energy debate.

We have over 185 members worldwide from 43 countries. Our membership represents virtually all of the world uranium mining, conversion, enrichment and fuel fabrication companies and all major reactor vendors and nuclear utilities providing 70 per cent of the world's nuclear generations. Our members also include nuclear engineering construction, waste management companies, research and also international services in nuclear transport laws, insurance and brokerage.

Thank you for the opportunity for us to contribute. Mr Hore-Lacy has retired from our staff and is a consultant acting on our basis. I would like to start the conversation by making two points. One, I understand that the Victorian state has made a commitment to legislate on the long-term target of net zero greenhouse gas emissions by 2050. However, I understand that the recent application of the Australian integrated system plan

for the electricity market still shows that Victoria in 2041 will have about 3 gigawatts of coal and generate 36 per cent of electricity from coal. So the first question is: with such a commitment, what is Victoria's plan to get to net zero? Secondly, quoting the International Energy Agency, it states that without nuclear investment, achieving a sustainable energy system will be much harder, will have implications for emissions, cost and energy security. So I would like to perhaps start our discussion.

The CHAIR: Thank you. Mr Hore-Lacy, do you want to add any comments before we go to questions?

Mr HORE-LACY: Yes, please. I just wanted to take off from there and, having listened to Professor Quiggin, to point out that his colleague at the University of Queensland, Professor Stephen Wilson, has a very different take on the matter and has been very public in saying that he cannot see how Australia will make significant inroads on reducing CO_2 emissions without nuclear power.

But Australia has been involved with nuclear science and technology for more than 50 years. It has got a substantial nucleus of world-class expertise at ANSTO in New South Wales and a reputable regulatory authority at ARPANSA based in Victoria. Uranium has been mined for many decades, and Australia's considerable dependence on coal for its electricity so far has enabled low-cost, reliable supply—both characteristics being vital for our economy. Intermittent renewables, wind and solar, have low capacity factor and are non-dispatchable and hence unreliable. Any backup is costly and only partial, and Professor Quiggin's remarks about battery storage I think are a little optimistic, shall we say, and certainly far from being proved and demonstrated at a sensible cost anywhere in the world—and I have followed battery matters fairly closely.

Replacing coal-based generation with these inevitably results in escalating system costs as the proportion increases. At high levels this will be unaffordable, as is increasingly realised if not publicly acknowledged, and a summary paper supporting this contention was appended to my submission. System costs must be considered on top of levellised costs of electricity generation in order to sensibly assess and compare different sources. LCOE, or levellised costs, such as quoted by Professor Quiggin, for renewables is on its own misleading. In fact every extra megawatt of wind and solar capacity is effectively locking in reliance on gas, as can be seen in South Australia with AGL now commissioning a new gas-fired power station and boasting about its flexibility. This is the 210-megawatt Barker Inlet power station using 12 reciprocating engines.

The Australian Energy Council says that the intermittency of wind and solar PV has consolidated the future of gas-fired generation in backup generation. Amen. And Germany's experience of Energiewende is verging on disastrous, despite its grid interconnection with neighbouring countries. It should be a warning to us, since we have no electricity import and export possibilities. Australia would be in a much worse position than Germany from similar policies relying on intermittent renewables, and these still only provide one-quarter of Germany's power.

So nuclear reactors are the low-carbon backbone of electricity systems in over 15 countries which do not have abundant hydro-electric resources. Concerning safety and waste, nuclear power is distinctly superior to alternatives—we have heard a little bit about that this morning. Despite contrary folklore and assertions, factual comparison is straightforward. Over 30 countries not noted for their reckless energy policies use nuclear power to generate about 10 per cent of world electricity from about 450 reactors, mostly large ones. World nuclear power capacity is about 400 gigawatts—about six times Australia's total.

Furthermore, the system cost of each power source needs to be internalised and attributed to them to influence their competitiveness and how they are dispatched in the market rather than those costs just being passed on to consumers across the board, as they are today. So beyond the vital question of market structures for power, questions of capital cost can be left to investors once impediments to the proper consideration are removed, which I think is what this inquiry is about. However, investors will need bankable price forecasts for electricity, and this is a challenge in any liberalised electricity market such as ours and many others.

I refer you back to Michael Shellenberger's comments about natural monopolies. Policies to provide electricity and other energy long term need to be clean, practical and effective. Nuclear power is therefore essential, and it is incongruous that one of the two main energies for clean electricity sources in the world is not able to be considered here at the moment, let alone deployed. There is little scope for increasing the other major clean source, which is hydro. So without significant contribution from nuclear power Victoria will only have the choice of continuing to burn a lot of coal for electricity, as King has just pointed out, with its CO_2 implications,

or having ruinously expensive electricity depending on levels of battery storage which are pure fantasy. We already have a taste of that with just 14 per cent wind and solar in the mix. So excluding nuclear power from proper consideration on its merits would be a serious mistake. Thank you, Mr Chairman.

The CHAIR: Okay, who would like to have the first question?

Ms TAYLOR: Why not? So, thank you for the contributions, and I am glad you mentioned Mr Shellenberger because I actually have a question about that. Obviously he is a self-proclaimed nuclear expert, and he told us this morning that one reason to adopt nuclear power is that it provides a pathway to building nuclear weapons, which may be in our interests. Is this the industry's position? Okay, so that is one question. One thing—and I am probably at the risk of being a little repetitive today: I have not seen a simple business case for nuclear. Is your organisation able to point us to a simple, one-pager financial model that shows how nuclear could work in our grid or a similar liberal democracy with a deregulated electricity market?

Mr HORE-LACY: The answer to the first question is no. Yes, Michael Shellenberger has expressed this view on previous occasions. There is obviously overlap of expertise and physics and so forth between nuclear weapons and nuclear power, but the technologies are quite different. I have been in the nuclear area 25 years now and taken a little bit of interest in that, but there is a huge difference in the whole engineering and everything else. But obviously you can move from anything to anything, given technical expertise.

In respect to the business case, nobody has done a business case for Australia but plenty of other business cases have been done around the world. And most markets are deregulated—for instance, about half the American states have deregulated markets, and nuclear power has a tougher time in those deregulated markets than it does just doing it on a cost-plus basis. And the UK has tied itself in knots with regard to finding a way to finance its nuclear power, despite a very, very strong positive government policy for nuclear in their market. But King Lee is much more of an expert on that than me, so I will let him take over on that.

Mr LEE: I just want to add to what Ian has just said. First of all, regarding nuclear weapons, there are international conventions and safeguards in place to prevent proliferation. I am here to talk about nuclear energy, so regarding proliferation, that is a separate matter. There is no linkage between peaceful use of nuclear energy and proliferation.

Secondly, to address your comment about a business case, I cannot say in detail regarding Australia, but if we take it for other countries and you look at countries, for example, Korea, I could go onto a website right now on the electricity power statistic information system of Korea. Nuclear is the cheapest source of electricity by a wide margin—cheaper than gas, coal and renewables—because Korea has to import all their energy sources. For China, the cheapest source of electricity for them is hydro followed by coal. Nuclear is the first cheapest. So for hydro it is 267 yuan per megawatt hour; coal, 370 yuan; nuclear, 395 yuan per kilowatt hour. Wind is 529 yuan; solar, 859 yuan; and gas is 584 yuan. So for China, which has huge capability in producing solar panels and wind turbines, currently nuclear is still cheaper than both of those sources. We have to be careful. I am not here trying to say nuclear versus renewable; I am here to say that nuclear is a clean, low-carbon energy source that is demonstrated as contributing to providing reliable, affordable electricity as used by 30 other countries.

In terms of an electricity market, take the UK. The UK currently is building its first nuclear reactor. You have probably heard the strike price of £92 per megawatt hour. The strike price was done in 2012. At that time a recent National Audit Office report indicated that was comparable to other low-carbon sources. So offshore wind was estimated at that time to be £91 per megawatt hour and carbon storage was estimated at £155 per megawatt hour. EDF modelling for subsequent plans for reactor Sizewell C, with a revised financing mechanism called the regulated asset base, estimated that it would cost the consumer £40 per megawatt hour. As Ian said, this is just the levellised cost of electricity. We should not compare nuclear, which is a firm dispatchable power, with renewable, which is intermittent, reliant on the weather. So by EDF modelling, if nuclear comes in at around about £75 per megawatt hour, it would lower the cost of the electricity bill to the consumer, so hopefully that answers your question.

Ms TAYLOR: Okay, so you have given me a comparison of some different energy generation models, I guess. China probably is not such a great comparison for Australia, because we could not classify it as a sort of liberal democracy as such. So I am just thinking, when we are looking at a financial model, that it might apply

to Australia. We are saying something in the UK, a model there, might apply to here; is that what you are saying? I am just thinking of trying to find a model that would apply in Victoria—that is translatable to the Victorian context, that is all—factoring in the kind of government we have et cetera.

Mr LEE: I mean, obviously every energy market would be slightly different because it depends on national and domestic resources in terms of whether they have coal or gas and the renewable resources as well. I think that is one aspect. In terms of, let us say, nuclear energy competitiveness, I gave you three cases: China, Korea and the UK. Why I chose those is both China and Korea have a consistent new-build program and domestic capability, and over that time it has shown that nuclear cost is one of the most competitive. For the UK, starting a new build program and its subsequent planned new build still remains competitive in that environment.

Ms TAYLOR: Are you talking about Hinkley Point? Is that what you are referring to specifically?

Mr LEE: I refer to Hinkley Point, which is probably under construction, and also to the planned mixed reactor called Sizewell C, which is currently going for planning permission and awaiting approval.

Ms TAYLOR: I know that for Hinkley Point, the cost for that has absolutely blown out. The cost is now expected to be up to £22.5 billion. So when you are talking about nuclear being more economically feasible for Australia and you see the blowout there and also the blowout with Flamanville, for instance, in France, it does not give me a lot of confidence. I am a little bit confused.

Mr LEE: Well, let us start with renewable offshore wind. At the same time when Hinkley was done, offshore wind was coming in at about £155 per megawatt hour, so they are over depressed by the cost reduction in solar and wind. Wind and solar have reduced their cost over time by deployment. I am highlighting that in the UK that was the first time in a long time for the UK deploying a reactor—the first of its kind—and this is the first project. In subsequent projects we will have achieved significant cost reductions, the same as has happened in wind and solar.

Ms TAYLOR: All right. And just to round off this point—I will not keep going on it—would you be able to provide the committee with a financial model? We have been asking through the morning, and the people that have presented here have not been able to provide one. It would be great if you could.

Mr LEE: I am not clear about what you are saying—'a financial model'. I can give you cases that have been deployed in other countries. I assume that when you mention 'financial model', you want one for Australia, and I do not know what has been done in the Australian or Victorian case.

Ms TAYLOR: Yes, like a business case for a nuclear industry here in Victoria.

The CHAIR: Can I just jump in? I think we are asking a difficult question there. I do not think we can expect the association to put a business case for Australia. But I think what would be preferred is if you can give us some figures, for example, from comparable countries and jurisdictions, like the UK and France, which you used as examples, for what has been the cost to build a facility so that can give members some understanding. If you are able to give some information about the cost of construction per kilowatt in similar jurisdictions to Australia—

Mr LEE: I would be happy to give you construction costs and the levellised cost of electricity for a range of countries.

The CHAIR: Does that make sense, Ms Taylor?

Ms TAYLOR: Yes. Look, we are really just seeing: does it stack up? At the end of the day it is just being able to assess, objectively: does this stack up? Would it stack up in Victoria? It has just been hard to get clarity on that. If you want, I can reframe the question after, if that might help as well in the follow-up.

The CHAIR: Yes, maybe we will come back to that. Can I go to Dr Bach, please? Sorry, Mr Hore-Lacy?

Mr HORE-LACY: Could I just comment briefly? Look, you will not get a business case here until you have sorted out the market. As I have pointed out, until the electricity market is sorted out to allow something like nuclear, you cannot possibly have a business case, because it is a question of getting all the system costs at different levels of penetration—and they increase exponentially with levels of penetration, system costs

applying the renewables—and comparing that with whatever arrangements you make for nuclear. At the moment you could not do a business case for any generation in Victoria of any kind that is high capital and low operating cost with the sort of profile of project that nuclear requires.

The CHAIR: Thank you. That is why I have reframed the question. I do not expect a business case for Victoria. We are not expecting to put millions of dollars in to put a business case together. But I think what Ms Taylor has asked we might be able to get from your member organisation for similar jurisdictions—like, for example, the UK, you mentioned, the US and France. What is the typical cost per kilowatt after construction and post construction and operational stuff? So if you have got that information, that will be helpful. If you do not, you do not. Thank you very much for that. Dr Bach, please.

Dr BACH: Thanks very much, Chair, and thank you, Mr Lee—all the way from the UK—and also Mr Hore-Lacy, for being with us today. As you gentlemen have referred to, and other members have referred to as well, we have already received some fascinating testimony today—all expert testimony. We only ask people to come to our committee if they have expertise. That needs to be recognised, and we as a committee do recognise that. But nonetheless, and perhaps unsurprisingly given the space that we are looking into, some of that testimony has been contradictory. So I was fascinated by your responses about cost. I thought that was very clear, notwithstanding the fact that, as has been referred to, another expert witness had a different view. Can I push you on a slightly different matter? Because when it comes to a whole series of other concerns that people have raised, witnesses before us have almost spoken with one voice—and I am talking, for example, about the issues of disposal of waste and the wellbeing of workers, the broader issue of danger. But one matter where there remains some contestation is that of how much time it would take for a nuclear industry to get up and running here in Victoria. We heard from Mr Shellenberger earlier in the day. I think I am correct in saying, Chair, that it would be possible to get something up and running by the end of this decade. We heard from Professor Quiggin that it would take much, much longer than that. I wonder if you gentlemen might provide your expert views on that question.

Mr HORE-LACY: I am very happy to weigh in on that and just to point out that in 2008 the United Arab Emirates with a standing start and no background of nuclear expertise such as we have established in Australia decided that it needed to go for nuclear power so that it could export more of its hydrocarbons and get its electricity from nuclear. Ten years later it had four reactors built by Koreans, totalling 5500 gigawatts, and they were built and are more or less ready to run. There was a bit of delay because of language and cultural issues in terms of assuring safety and so on, but that was basically 10 years from a standing start, way behind where Australia now is, to having reactors—four large reactors built and ready to run. Now, I am not saying that we would get such a quick run through the regulatory processes in Australia, and your guess is as good as mine as to how long those might take. But that is a demonstrated track record, and add to that whatever assumptions you like to make about red tape.

Dr BACH: Thank you, Mr Hore-Lacy.

Mr LEE: I would echo that, and within that case in the UAE for the Barakah project, considering the UAE is what we call a newcomer country with no prior experience of nuclear, they had to formulate new laws and regulations and set up new institutions before they could construct. So the construction started in July 2012, and the first unit was completed in March 2018. There were some delays because the UAE wanted to operate the reactors with domestic operators, with time in training. So they have got their first reactors starting up this year and fuel loading right now. So that is one case, but also look at it in terms of construction time for countries that have maintained their build and construction. If you look at over the last decade nuclear constructions in Korea and in China and by Russia, their construction time for large reactors has been about five years and five and a half years—so very consistent.

Dr BACH: All right. Many thanks, Mr Lee. If I have got just a moment longer, Chair, I will ask a quick follow-up. Gentlemen, the overwhelming view of the experts who we have heard from—not so-called experts or self-described experts, but experts—is that when it comes to disposal of waste, that can be done with nuclear in a safer way and in an environmentally more friendly way than the disposal of waste from other energy sources; when it comes to the wellbeing of workers, workers are actually safer in the nuclear industry than in others; and when it comes to danger more broadly, again nuclear is safer than other energy sources. Is that also your view?

Mr HORE-LACY: Yes, that is certainly my view. In the years that I have been involved with the World Nuclear Association I have visited most of the waste repository sites and waste storage around the world and have been underground at Yucca Mountain and so on and underground at the Swedish repository pilot lab. My comment about waste is that it has been very safely handled for 50 or 60 years—totally undramatic and totally boring. It is very, very easily managed.

Dr BACH: Thank you.

The CHAIR: Thank you. Can I now go on to Mr Limbrick.

Mr LIMBRICK: Thank you, Chair. And thank you, Mr Lee and Mr Hore-Lacy, for appearing today. Mr Hore-Lacy, I would like to ask you about something that you put in your submission, which is something I think we need to understand a bit better. It is the idea of system cost versus levellised cost of energy. Now, I think what you were saying in your submission was that there is a balance between the amount of variable renewables you have on an electricity network and the amount of dispatchable energy like nuclear or coal that you have on a network, and as you have more variable renewables these system costs increase. Could you elaborate a little bit more on that and why that is something that we need to pay attention to?

Mr HORE-LACY: Well, we need to pay attention to it because those system costs ultimately have to be borne by the consumer, and anybody here who has got Australian electricity bills will not need reminding about that. We are bearing those system costs at the moment for renewables, with just 14 per cent penetration of wind and solar. The point is, and I have done some calculations on this, if the 14 per cent goes up to 45 per cent, which is what the Labor Party's objective is—that is, 5 per cent hydro in 50 per cent total—the overall capacity requirement in Australia would have to escalate dramatically from today's 66 gigawatts to about 116 gigawatts by my calculation, with a lot more wind and solar PV capacity as well as backup gas. And that is just assuming the same output at 265 terawatt hours per year, let alone any future increase in that. That is hideously expensive to actually build all that extra renewable and gas capacity up to about double the level of normal maximum demand. The object is not just to generate. Even if your solar and wind were generated free—at zero cost for LCOE, levelised cost of energy—the costs of getting it to the consumer in a reliable way, and that is with the backup, is going to be huge. It just goes up and up as you get the percentage increase, and if you want to look at that more closely, look at Germany. The Energiewende there is bordering on a disaster, and the Germans are gradually waking up to that. That is despite the fact that they can dump their excess electricity across borders and import electricity when the wind is not blowing and the sun is not shining. We do not have that option.

Mr LIMBRICK: Yes. With these types of system costs, the things that you are talking about here are things like transmission infrastructure, which we have seen requirements of in Victoria, and things like batteries and pumped hydro. Before you mentioned about batteries and you expressed some scepticism about their ability to provide significant amounts of storage. I know that the South Australian one is not used for very large amounts of storage but more for balancing the network. Do you think that large-scale storage is not feasible or is feasible, and what types of storage would we be talking about here? Or are we talking about gas instead?

Mr HORE-LACY: Well, yes. There is a paper on our website on energy storage and electricity storage. Ninety-five per cent of the world's capacity for storage is pumped hydro. Now, Australia has big limitations in that respect, both in respect to gravity and water. You know, we do not have alps and so forth, so that is limited. So we are mainly looking at batteries. That big South Australian Tesla battery is a great success, but it is used, as you say, for ancillary services—frequency control most of all—and very little for energy storage. And that is the case with most large batteries being connected to the grid around the world; they are mainly for ancillary service purposes to stabilise the grid where you have got a high proportion of renewables. Actually storing significant amounts of energy, such as Professor Quiggin was talking about, would become hugely expensive.

Mr LEE: Sorry, just to add to that, large-scale storage does not exist at the moment, so there is a risk that those technologies may not be available or affordable. Just to highlight some of the system costs for Australia, again, I will refer to the Australian integrated system plan. Looking at that, to make the system work with a high percentage of renewables—and again, this is in no way a low-carbon system because it already contains quite a significant amount of coal into 2040—I think, when I look at the data, interconnection investment will have to be A$9 billion and transmission and grid reinforcement is $2.2 billion. And I think the CO_2 emission will only roughly halve and still remain—I would have to look at the data to check the emissions. So that illustrates the type of system costs that will be required as the share of renewables increases.

Mr LIMBRICK: That brings me to another point. Mr Hore-Lacy, with regard to these system costs, has anywhere actually significantly decarbonised without large-scale hydro and/or nuclear, and if they have not, how do we know what these system costs at high-level variable renewable penetration might be?

Mr HORE-LACY: Well, we have got the German—

Mr LIMBRICK: Because the technology does not exist, either, right? Or some of these technologies are, sort of, future technologies?

Mr HORE-LACY: Well, in answer to the first part of your question: no. No country has successfully decarbonised without large amounts of nuclear or hydro. Secondly, we do have Germany to dissect their numbers with regard to the effect of increasing reliance on renewables —about one-quarter of their electricity now comes from solar and wind, and it is crippling financially. It is providing some very, very interesting technical challenges too in their actual network, even though they are interconnected in all directions.

Mr LIMBRICK: Thank you.

The CHAIR: Thank you. Can I now go to Mr Meddick, and I will come to you later, Mrs McArthur.

Mr MEDDICK: Thank you, gentlemen. I just wanted to pick up on some comments that Dr Bach made that feed into the question that I have for you. We have had an enormous amount of witnesses come before this inquiry, even prior to today—proponents of a nuclear industry predominantly. It is not absolutely correct to say that they are all singing from the same hymn book in terms of 'These are the reasons why we should, and these are the reasons why we shouldn't'. It is completely incorrect to say that, but that feeds into what my point will be for you and my question, Mr Hore-Lacy, given what you have just said to the question that Ms Taylor asked and notwithstanding, Chair, what you have asked for. We will have people come before us on the opposite side to you, gentlemen, and others. It becomes a question for us to make a determination as a committee whether we believe one side over the other or not, because that is not the ultimate question before the committee: whether to lift the moratorium on nuclear energy in this state. You have said, Mr Hore-Lacy, there is this enormous amount of variables here in Victoria that have not been considered so a business case could not be mounted possibly at this point. Yet being put in front of us are the experiences on an economic scale of all other countries, and it is being said, 'Well, that will be replicated here'. But there is no proof to say so. Isn't it then pure speculation that it would be cheaper in this state, given that no-one can produce a business case for us that unequivocally pulls the numbers out and says, 'Here is a model that you can make that determination of'?

Mr HORE-LACY: I can come back to you on that. I think there are a few significant variables from Victoria—I did not say a huge number, but there are enough—and those variables apply in every electricity market. What I am saying is: it is the electricity market, not just the technology, that is at issue here. And secondly, I understood the inquiry was about nuclear prohibition rather than making a judgement as to whether a particular form of generation was going to be competitive with other forms of generation. I am certainly making some comments that address that question, but I thought the issue for the inquiry was a matter of nuclear prohibition so that nuclear power can be on the table and considered on its merits in every respect—including economic—alongside other options.

The CHAIR: Can I just interrupt? Can I just remind members and both of you—you are right—the committee is not looking at the cost-benefit analysis, because it is not something we are considering. So we will not be giving much weight to that, for or against, because I think it has to be a separate exercise. But I agree with Mr Meddick, and that is why it is very difficult which argument would provide for or against—

Mr MEDDICK: I understand that, Chair. I completely understand that. But that is what is being put in front of us. Witnesses who come before us present the economic argument so I am bound to ask a question on that, and it is in part of the consideration, then, in my opinion.

The CHAIR: Can I ask maybe, gentlemen, if you are able to take that question on notice, because you are part of a worldwide organisation. That is why I made my comment earlier. If you are able to go away and come back to us—you have got members all over the world and resources—you should be able to give us a snapshot or an analysis from your point of view. That would be excellent.

Mr HORE-LACY: Yes, I will leave that to King Lee, and if I could just finish answering that question, the other issue is about practicality. I go to Professor Quiggin dismissing the whole idea of 'paper reactors', as he called them. Some of those paper reactors are under construction. But, look, there are four types of small reactor now in operation. There is the CNP-300, which provides 8 per cent of Pakistan's electricity. It is a Chinese reactor—300 megawatt. There are about 16 Indian reactors of 220 megawatts that have been running for years and years and years. There are three remaining small EGP-6s up in the north of Siberia, and they have just been replaced by a floating nuclear power plant with more modern KLT-40 reactors—two of those—at 35 megawatts, and that is actually operating. They are a pair of small reactors on a barge supplying electricity today. Finally, which is much more relevant to the discussion about small modular reactors, using those terms, there is the RITM-200, and that is a 50-megawatt reactor, two of which are currently driving Russia's newest icebreaker. A civil version of that is a small modular reactor which has the steam generators inside the pressure vessel, which means it is a readily transportable single unit that can come from a factory to a site or to an icebreaker or to a barge or whatever. All those are operating, and then there are others that are under construction. So it is not exactly a pie-in-the-sky hypothetical exercise to be talking about these small reactors, which is, I think, part of the discussion that has been going on already today.

The CHAIR: Thank you. Ms Terpstra.

Ms TERPSTRA: Thank you, Chair. And thank you, Mr Hore-Lacy and Mr Lee, for your contributions today. Just a very straightforward question given your expertise and knowledge in this area: I know in terms of advantages and drawbacks there are arguments on both sides, but perhaps could you just summarise the main drawbacks that you see with nuclear power, if any?

Mr HORE-LACY: The main hindrance is the high capital cost despite the low operating cost, giving you a competitive electricity price, but the high capital cost requires financing. Typically with a perhaps four- to five-year build time—and that is apart from are the ones that have blown out that we keep hearing about—that is a challenge. I think it was Shellenberger or probably Ben Heard who said that so much depends on the discount rate, the interest cost. That is really the main drawback. I see no technical drawbacks as an environmental scientist who has been focused on this area for some years. I think some of you have got this copy of my book—this is the 11th edition of my book—which gives an overview, a layman's level overview, of the whole industry.

Mr LEE: Maybe if I add to financing, there is the other issue. Whether it is a pro or con, that is for you to consider. For nuclear large reactors it is complex, major infrastructure over a long time—potentially over 100 years commitment—so that would require strong political support over a long period. We mentioned that it might take about 10 years for the first reactor to get constructed. Reactors are now designed to operate for 60 and up to 80 years. For example, reactors now operating in the US have an operating life of 80 years and potentially longer. So that provides a huge long-term, stable, reliable source of electricity and source of energy, but obviously that needs a stable environment for that to happen.

Ms TERPSTRA: Thank you.

The CHAIR: Ms Bath.

Ms BATH: Thank you, Chair. Thank you, gentlemen, for your presentation today. My first question is just some housekeeping to clear up for me. You mentioned Professor Quiggin from Queensland University, and we had him on just before. Could you clarify for me: what are his qualifications? I think you mentioned something about his commentary or his position—that in order to have zero emissions by said date there would have to be nuclear power included in that. Can you just clarify that?

Mr HORE-LACY: Sorry, is that addressed to me?

Ms BATH: Yes, thank you.

Mr HORE-LACY: Oh, sorry. Well, I did not mention Professor Quiggin. I mentioned his colleague, another professor, Stephen Wilson. Stephen Wilson is an energy economics expert, and he is the person that I would go to first. And in respect to some of these questions that have been raised today on system costs and so forth, his group in the University of Queensland has done a fair bit of modelling and a fair bit of analysis of published papers on this, and I would strongly refer you to him. I have not interacted with Professor Quiggin—I

just heard him this morning—but Professor Stephen Wilson is the person who I would esteem. And of course Ben Heard is no slacker in this area; he is really a very capable analyst of some of these sorts of things. He is the one who has called out some of the stuff that has been published from reputable sources but which was inadequately based, and he is right on top of all that, and that is ancillary to his day job.

Ms BATH: Thank you, Mr Hore-Lacy. So Stephen Wilson is an energy economist as opposed to the other gentleman, who was an economist per se. Thank you.

My other question goes to the terms of reference that we have, and it relates to removing prohibitions. Indeed term of reference (2) talks about the benefits analysis related to medicine, scientific research, exploration and mining. So can I take you and Mr King Lee to those sorts of areas? We have been focusing very much on energy, but what about the medical opportunities and scientific opportunities, if you feel you are able to answer along those lines.

Mr HORE-LACY: I think you might have Adi Paterson appearing before you at some stage. He is the main person to ask as head of ANSTO, but several of those things are happening already under ANSTO. What is prohibited is nuclear fission power for electricity, or process heat. We have not really talked about process heat, but that is potentially very, very important and quite unable to be delivered by solar or wind. And with respect to uranium mining, outside of Victoria that occurs fairly readily in Australia. I think we are the fourth largest uranium exporter in the world, and our uranium exports, I think I am right in saying, enable at least the amount of electricity being generated overseas as is generated in Australia. So uranium mining is well established except that it happens to be illegal in Victoria.

The CHAIR: Mrs McArthur, then Mr Hayes, then Ms Taylor. So if we are able to make quick questions and hopefully quick answers. Mrs McArthur.

Mrs McARTHUR: Thank you, gentlemen. Look, one of the most important things I think you have said is that no country has successfully decarbonised without large amounts of nuclear or hydro. What do you think has led governments to this position of disconnect with what are the facts versus what is the noise around the fact that we have got a prohibition on something—to even be able to discuss it effectively or to even look at the possibilities of it. How have politicians got into this space of listening to ill-informed noise when we are happily exporting uranium, as you have just said, powering the rest of the world to the amount of electricity we produce, we need, in this country? What are we going to do to turn this conversation around?

Mr HORE-LACY: Good question. How have we got into this situation? I think by undue misrepresentation of the costs of renewables. And you see, we have got 14 per cent of solar and wind at the moment. That is manageable. It is expensive—it pushes the costs of electricity up significantly—but even Professor Quiggin was talking about the cost of those sources simply in terms of the generation cost. That is to say, when a kilowatt hour is churned out it costs very little; that is true. But there is a big difference between that metric and the metric of delivered cost to you and me, let alone to industry and aluminium smelters. I think that beyond that there has been a big cheer squad from the environmental lobby about how wonderful all this sort of free energy is; all we have got to do is harness it. There is a sort of romantic notion with a capital 'R' for romanticism involved in it.

Mrs McARTHUR: Well, how are we going to turn it around, Mr Hore-Lacy?

Mr HORE-LACY: I was hoping that some erudite people such as those on the Zoom screen in front of me would be able to—

Mrs McARTHUR: Well, I guess this is a start. We do have to correct misinformation and noisy argument that is not based on fact. I agree that is what has to happen, so thank you for the work you are doing, gentlemen. That is most important.

Mr HORE-LACY: It has gone to 11 editions.

The CHAIR: Thank you—and number 12 is coming. Mr Hayes?

Mr HAYES: Thanks very much for your submissions, gentlemen. I just want to ask either of you—and this question does go to the nuclear prohibition side of things. Now, the prohibition was probably introduced about

community safety concerns. We are running out of time, but I want to just quickly address the safe storage of waste. You will obviously say it is possible, but how can we store waste in the long term on an ever-increasing basis, and nowadays would you say there is a disaster-proof nuclear reactor?

Mr LEE: Nuclear waste has been stored over the last 50 years safely so far. That is happening right now, so that is proven. In terms of long-term disposal of high-level waste, the global consensus is for what we call deep geological disposal. Those disposal facilities are currently being constructed in Finland. So there is proven scientific consensus on how we can manage safely and dispose of nuclear waste.

I believe there were previous questions. But look at how the nuclear industry is one of the few industries where we capture and manage our waste and do not disperse and release our waste in emissions.

Mr HORE-LACY: I refer you to Ben Heard's comments this morning too. Sorry, the rest of your question?

Mr HAYES: I did also ask about nuclear reactors. Could they be considered disaster proof now?

Mr HORE-LACY: Pretty much. There have been three significant accidents with nuclear reactors in 60 years of experience. Three Mile Island—destroyed the reactor, nobody got a significant radiation dose from it, and a lot was learned from that. A great deal was learned from that accident in 1979. Chernobyl, nothing much was learned from it, except that that was a reactor that should never have been operating in any country and could only have been licensed in the Soviet Union. The remaining reactors of that kind have been very heavily modified, frankly, to the extent that I would be happy to live next to one. That was in 1986.

And then you have got the Fukushima accident. You got a tsunami which killed upwards of 15 000 to 19 000 people, and nobody was hurt from radiation from a very, very major accident, which was caused by the fact that the backup power was not available because they had the reserve generators in the basement instead of up the hill. If the Fukushima power plant had been built 5 metres further up the hill, probably no-one here would have heard of it. So there was nothing much wrong with the reactor intrinsically, it is just that the backup power was removed by the tsunami.

Mr HAYES: Would power plants be able to run from nuclear fusion in the near future, or is that still a dream?

Mr HORE-LACY: This is the first edition of my book, and I think in that I suggested that nuclear fusion was about 30 years off commercialisation. That was in 1978. When I was writing this 11th edition I think the general reckoning is it is about 35 years off commercialisation.

Mr HAYES: From now?

Mr HORE-LACY: From now. It will probably happen one day, but it is a long way off. Meanwhile, we have got nuclear fission, which is very well proven, very reliable and very safe, and the safety case is actually made brilliantly by Fukushima. If you can write-off four reactors from a tsunami due to the fact of their location being susceptible to tsunamis and not hurt anybody, not irradiate anybody and certainly no fatalities, that is not a bad recommendation. Three of them I think melted down.

Mr HAYES: Thanks very much.

The CHAIR: Ms Taylor may have the last question.

Ms TAYLOR: I am just wondering: is it true that if we had a nuclear power industry, we would most likely import the fuel from overseas?

Mr HORE-LACY: It depends what you mean by importing the fuel uranium. We would import the finished fuel, yes, because I think, and by most people's reckoning, it would not be economic to build those facilities for fuel fabrication and enrichment and conversion in Australia because there is surplus capacity overseas at very competitive prices, but it would quite likely be Australian uranium that we might use. So it is a question of the source of the uranium versus the processing of it.

Mr LEE: And that would be, I guess, dependent on the size of fleet and the economic case to what extent Australia wished to manufacture the fuel.

Mr HORE-LACY: Most of the cost of the fuel that you actually drop into the reactor is in the processing of it, not in what the mining company gets. If you are a shareholder in a uranium mining company, you are probably aware of that—uranium prices are pretty low—but there is a fair bit involved in converting the uranium that is sent from Olympic Dam into a fuel that you can drop into the reactor.

Mr LEE: Mr Chairman, can I make a comment? We talk a lot about energy and costs. Perhaps I would like to introduce that regarding jobs and employment, because I think there is an overall case, if not a social economic case, in terms of weighing up the energy system. When you look at all studies that have been made in terms of nuclear with other energy systems, it is proven that for nuclear, as already mentioned, it is a long-term infrastructure project. It provides long-term, high-value jobs, and from both ours and a number of other studies nuclear workers have higher pay, higher skill, have more stable employment, have greater spillover into the local economy. As a case in point we mentioned about the UK case for Hinkley. That will create 25 000 employment opportunities and 900 permanent jobs on site over the 60 years of operation, and we talk about the cost of the build: 64 per cent of the £20 billion investment will be delivered by UK companies.

Again, I do not want to make nuclear versus renewable, but if you look at if that will require a high balance mix, where are those jobs going to be? Are they going to be domestic and build up the domestic supply chain, local, or are you going to buy these significantly from overseas?

The CHAIR: Okay. Well, thank you very much. Mrs McArthur, you had one last question? You better be quick.

Mrs McARTHUR: One last question. I am just curious, gentlemen, as to how you think the green lobby has any credibility in arguing for elimination of carbon emissions without including this form of energy.

Mr LEE: I think what we have to be careful. As I said, we have to look at the ultimate goal and what you want from your energy system. If you go with low carbon or let us say net zero, how are you are going to achieve that balance, and that has to be both affordable and you have to be on the right path. I cannot say for Victoria for sure that is the case, but if you look at it from a global point of view, the current UN emissions report, if the world is going to try to reach it—we are not on the right path to achieve the Paris agreement globally, and if we aim to do that, we need to halve globally our emissions in the next 10 years and for power generation almost get to zero. So the question is: is it going to be realistic to do that with only renewables? You need to make sure that all energy sources are included to ensure that you are on the right path. As Ian already said, for a number of countries, nuclear has helped them to reach very low carbon levels. In France and Sweden and so forth they have proven and demonstrated it. For Victoria to exclude that option, is it reasonable?

The CHAIR: On that note, thank you very much, particularly Mr Lee for getting up early. We really appreciate that you have joined us all the way from the UK. We would like you to stay safe. And also I just want to thank all the members for your contributions. That concludes our session, so thank you all. All broadcast and Hansard equipment must now be turned off.

Committee adjourned.