T R A N S C R I P T

LEGISLATIVE COUNCIL ENVIRONMENT AND PLANNING COMMITTEE

Inquiry into Nuclear Prohibition

Melbourne—Friday, 11 September 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

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

WITNESS

Professor Stephen Wilson, Energy Economist.

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 switched to silent and that background noise is minimised. I would like to welcome any members of the public who are watching this live broadcast. Also I would like to welcome my colleagues on the committee: Mr Meddick, Mr Limbrick, Ms Terpstra, Mrs McArthur, Ms Bath, Dr Bach, Dr Kieu, Ms Taylor and Mr Hayes, the Deputy Chair. Some other members might join us later on during the proceedings. So, welcome, all, and also I would like to welcome Professor Wilson and thank him for joining us today and providing evidence. We appreciate your time, Professor.

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 law. However, any comments repeated 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 following the hearing. The transcript will ultimately be made public and posted on the committee's website.

Professor Wilson, we have allowed around 5 minutes or so to give us an overview. We have received your submission, so members have read that as well, so do not feel you need to cover every single one of those items. But 5 minutes, and then we will go to questions. As you can see, we have got a significant number of members already participating in this hearing, and I think we allocated an hour or thereabouts. So over to you, Professor Wilson, and again, welcome and thank you for making yourself available.

Prof. WILSON: Thank you, Chair, and thank you, members. I am really honoured to be invited to appear before the committee today. As you know, I have the privilege and responsibility of being a professor at UQ, where I lead the Centre for Energy Futures in the School of Mechanical and Mining Engineering. Our work in the centre ranges from supercritical CO_2 power cycles to replace the steam cycle in things like concentrated solar thermal power through to how to achieve ignition in nuclear fusion reactors. My own research includes the technical performance and economics of integrating power systems that are integrating increasing shares of renewable energy as well as the technical and economic challenges of making hydrogen from sunshine, wind and water and also the opportunities that are now emerging from small modular nuclear reactors. I have recently developed a masters program in renewable energy, and I teach some subjects that are, I think, relevant to the questions the committee is asking. One is energy markets, law and policy, and the other one is professional practice in the business environment, which has got a very sort of project development focus to it.

I should say of course that what I am saying today reflects my own views and understanding and should not be misconstrued as or taken to be the views necessarily of the university. I should say that my experience as a professor is about 10 per cent of my career experience. The previous 90 per cent, as I have provided in the document to you, comes from working as an Energy Economist on studies, advising utilities companies, governments, regulators, ministers and banks all around the world in more than 30 countries. I started off based in Melbourne. I was born in Geelong and then later moved to Hong Kong and spent almost a decade in London before I came back to lead the energy market and industry analysis team of one of the big mining companies. So in that time I have worked right across the energy value chain from the point of end use. I started off working on energy efficiency studies which were pioneered in Australia by the Victorian government, and I have worked right through to the upstream side, so to uranium mines and coalmines, oil and gas, and everything in between. I have been very fortunate to work right across the whole sector and to do climate studies and all of those things.

Now, I think the reason you invited me was that a previous witness mentioned me, and I think he was alluding to the talk I gave to the ANA conference last year. I was asked to talk about frameworks for decarbonising Australian energy rather than nuclear in particular, but I opened that talk by saying—and I have included the link to the YouTube recording of it—that without nuclear power generation in the system, I believe we will find it is close to impossible to deeply decarbonise the Australian economy. But then I also said I think it would be a mistake to think that nuclear power in Australia is inevitable as a result of that, and then I explained why I

had come to that view. I will just mention that in my teens and 20s and 30s I was quite afraid of nuclear energy and I was opposed to its deployment, but more facts and knowledge and understanding have changed my view. As Keynes famously said, 'When the facts change, I change my mind. What do you, sir?'.

I have provided you with some supporting materials, but I thought I would just wrap up these opening comments with just a series of observations which are related to those materials. The first one is that all engineering cost estimates need to be handled with care, knowledge and in context. We need to be really wary of any single-point value without an estimate class or an uncertainty range. Contrary to what we read almost every day in the newspaper, uncertainty is real, all pervasive and is at the heart of all business decisions. The key is in how governments, business and society manage that uncertainty. Levelised cost of energy, or LCOE, is not an investment-grade metric. It is not even a policy-grade metric, and it should not be misused as such. It is the cost of electricity at the system level, including all technical services, and as delivered to customers that matters. We cannot look at the economics of any one form of generation in isolation. Nuclear is not an exception; renewables are not an exception.

Decarbonising energy and electricity systems will be difficult and very capital intensive. Victoria benefits enormously from very low-cost power generated from brown coal. The economics of nuclear power actually have some interesting similarities with the economics of brown coal. The big difference of course is that there are no operating emissions from nuclear. So nuclear energy is the natural long-term successor to replace the Latrobe Valley fleet. I believe the challenges now facing the electricity market are greater than many people realise. The volatility of wholesale electricity prices has increased enormously and is increasing. The average level of wholesale prices has increased significantly in recent years. In theory that should lead to investment, which will bring prices down, but no-one can produce a bankable price forecast of this market. And as a result, the bankability of any new generation investment is now a key issue. This will be an issue for nuclear and for any other substantial generation project. So price volatility, price and cost uncertainty increase the value of real options. Applying a binding constraint to a system increases its cost; removing a binding constraint reduces its cost.

Now, some people have argued that nuclear energy is too expensive to matter—in other words, that nuclear prohibition is not a binding constraint. But claiming that it is too expensive to matter and saying that we should not lift the ban is either internally inconsistent or it reveals an unstated view that the constraint may become binding in the future. Many combinations of future cost reductions or system cost increases are possible. So to do nothing now may be a tempting path for the committee, for Victoria, for the Parliament, but in my view it is dangerous and inadvisable. Creating real options unlocks value immediately.

Conversely, laws prohibiting real options deny value—today, tomorrow and each day. The insight from this is that even if no-one ends up building a nuclear power plant in Victoria, the removal of the prohibition will create value from the moment of the repeal. I realise that this might be counterintuitive, but it is a view that is well grounded in real options analysis and in strategic decision-making. I have also discovered, to my surprise, that many ordinary people seem to understand this instinctively. So the work of this committee is very important because questions of this type are usually only addressed every five or 10 or 20 years. I appreciate the invitation to answer members' questions.

The CHAIR: Thank you, Professor Wilson. I have got one question; probably it is a long question. You did talk about your change of view, and I think you have covered why you have changed your view but I would not mind touching a bit more on that. Let us say nuclear, for whatever reason—right or wrong—is not in the mix and will not be in the mix for the next 50 years, for example. How do you think we should be able to respond going forward to achieve the decarbonisation and meet other electricity needs? What do you think should be in the mix in the absence of no nuclear? Do you have a view on that? What are the alternatives?

Prof. WILSON: Well, the first thing is the most important word that you used there is 'mix', and it is important to recognise that almost every power system in the world, apart from some quite small and sort of unique systems—maybe Iceland, with geothermal, and places like that—has got a mix. The reason that we have a mix, that we see that mix, was best put by one of the senior Japanese energy officials a few years ago at a meeting with the Australian government. This was three years after Fukushima. He said, 'We reviewed all energy sources and we found that none is perfect in every aspect'. So they have all got strengths and weaknesses and different characteristics and they tend to play complementary roles in a system. It is important

to keep that in mind. I would not expect that you would ever see a completely nuclear-powered grid; you would still have a mix.

Some people are really bullish on nuclear, some people are really bullish on gas and some people are really bullish on renewables. But I say to people it is very, very hard to be bearish on nuclear or to say nuclear should not be allowed and to be bearish on gas and to obstruct gas development and to say, 'We have to close the coal-fired power plants'. You get to a situation where you have a system that is going to be very expensive, increasingly unreliable, and it is probably not actually going to be able to meet any of the big three objectives, which are: affordability, reliability and sustainability. So that is the world that I think we will be sort of sleepwalking into if we are not careful. Does that answer the question?

The CHAIR: Yes, look, in a way I suppose you are saying, then, coal and gas are options and it is really the baseload batteries et cetera. Because a lot of members would like to ask questions, can I ask the Deputy Chair. Mr Hayes, are you ready to ask the next questions?

Mr HAYES: Yes. Thanks, Chair. Thanks, Professor Wilson, for your submission and presentation today. My question probably is not about nuclear as such but about the mix and the role of renewable energy. There is a lot of talk about hydrogen gas now, particularly clean hydrogen gas and Australia's potential to produce large amounts of it. Do you see that as a possible way of providing what has been called, rightly or wrongly, baseload power into the future and maybe having a big role in the Australian energy mix? I am asking you that as an energy economist, not as a nuclear sort of advocate.

Prof. WILSON: Do not misread me that I am a nuclear advocate. As you can see, I have worked in every energy form, so I think I understand the pros and cons of each. A lot of effort is now—there is a lot of excitement about hydrogen at the moment. A colleague who is about my age, maybe a little older, reflected recently to me. He said, 'This is the third time in my career I have seen people get all excited about hydrogen', so we need to keep that in mind.

Hydrogen is being proposed as a way of doing two things—this is sort of the main thrust of what people are thinking: one is to essentially timeshift variable renewable energy so that you can match to the time when people need energy, and the other one is to move energy somewhere else, so people are talking about exporting wind and solar energy in the form of hydrogen energy to customers in Asia. I have not heard it quite so explicitly proposed as base load generation as such, but that is the way that it is being proposed.

Now, we are doing some research on this. I have got some students doing some really good research in this area, and actually one of them is asking the question: what if we were to build a plant that turns wind, sunshine and water into hydrogen, what would the cost of that be? And he has run an optimisation on that, and he has actually mapped out what the cost would be in 4600 latitude and longitude points in the whole country. What it basically shows is in a world where people are willing to pay a really serious premium for this kind of energy, it might be competitive in certain places, including, for example, South-East Asia, but it looks really, really expensive. So I think the committee should reflect—in the context of this present inquiry on nuclear—on what would happen if the arguments that people have brought to the committee were applied to hydrogen.

It is very interesting because I think what would happen is people would say, quite truthfully, 'This is really expensive. This is way out of the money. Yes, maybe it might come down in cost in future, but at the moment it is way too expensive'. Therefore the logical conclusion, based on things that I have read, is that to be consistent people would then be forced to say, 'The Victorian Parliament should ban the use of hydrogen in the energy system'. Then someone might come along, and they might say, 'Well, you know what? Hydrogen is used—remember the Hindenburg? It is pretty dangerous stuff, and actually, it is used in the H-bomb, isn't it? So we definitely should ban hydrogen from our energy system'.

Now, I hope that if I were to say such ridiculous things, you would throw me out immediately, and so I am not saying those things. But what we are doing is we are investing early-stage research and development funding into this technology with our partners in Japan, who are putting in serious money and trying to work with us, to see if we can create a real option to make this an interesting, attractive possibility in the future, and that is precisely what we should be doing with nuclear.

Mr HAYES: Thanks.

The CHAIR: Thank you. If I can get members to ask one question at a time, then we will come back and do the round again. Ms Bath and then Mr Limbrick and then Ms Terpstra. That is the order, and then I will come back to the others. Is that okay, Ms Bath?

Ms BATH: Thank you, Chair, and thank you very much, Professor, for appearing before us today. I have about 60 questions, so it is really hard to try and find just a couple.

Mr Hayes brought up something that was interesting to me because my electorate is in Latrobe Valley, it covers Latrobe Valley, and of course the Kawasaki Hydrogen Road project is taking coal and transforming it into limited amounts—a sample amount—of hydrogen and then looking at sequestration. I do not think you touched on compartmentalising—do you have a ranking of sun, wind, water, coal—and just a brief overview on that in terms of hydrogen.

Prof. WILSON: Of course we do make hydrogen at the moment, and it has got some niche markets where it is used, but what people are talking about is an enormous bulk-scale, new energy commodity market. So how do we make hydrogen at the moment? Principally, we pull it out of methane, and the steam methane reforming process results in some CO_2 emissions. So if you want to get genuine carbon-free hydrogen—as in not emit CO_2 to the atmosphere—you need to do something with that CO_2, like sequester it, for example. And it turns out that we know how to do these things; we do not do them because they are expensive. And then the question is: are there smarter ways to achieve the same goal?

Some of my colleagues at UQ are working on a new process which is an alternative to steam methane reforming. You still get the hydrogen out of the methane, but you use high-temperature pyrolysis so that the by-product is not CO_2 but solid carbon, and then you can find some markets for that. That is very, very early-stage laboratory work, and we are doing that in collaboration with some other colleagues in various places. It is interesting and exciting long term. As you have said, you can use brown coal as your energy source, and then you have also got the sequestration problem. What we know about CO_2 sequestration—we know how to do it in theory. We know that actually doing it in practice is hard work and it is not particularly cheap, but it is one of the avenues that we need to keep researching and working on.

And then the other big kind of category of places where you get hydrogen of course is through the electrolysis of water—so just split the H_2O into H_2 and O_2 and get it that way. You can definitely get the energy to do that from the sun—for example, through solar PV—and from the wind. The appeal of that, of course, is you do not have the CO_2 sequestration cost, but it turns out to be also quite an expensive process—very, very capital intensive.

The interesting thing that the research work that I am supervising has shown is that every time you try and find a lever to reduce the costs, you have another cost pop up somewhere else. It turns out that having lots of wind and a little bit of solar in most locations is the way to minimise your costs, but you have still got a bunch of other very substantial costs to deal with. That is basically the experience of all the strategies to try and avoid emitting CO_2—they are all expensive, and they are all capital intensive.

The CHAIR: Thank you. Mr Limbrick.

Mr LIMBRICK: Thank you, Chair, and thank you, Professor, for appearing today. I am very interested in some of the comments that you have made, but the primary one that interested me was the idea of repealing prohibition. Firstly, I agree with your statement that if you want to be consistent about something expensive therefore being prohibited, that would mean a whole bunch of things should be prohibited, and therefore the reverse logic should be that we should remove prohibition. But I was interested in your comment that removing prohibition can unlock value, even if a nuclear technology is not pursued. Could you maybe unpack that a bit more for the committee, please?

Prof. WILSON: The concept is the concept of real options. Most people will have heard of financial options. A financial option gives you the right to buy whatever the underlying thing is at an agreed price at a future date. The underlying thing might be the shares in a company, or it might be oil, or it might be natural gas or whatever it may be. The Nobel prize-winning work of Black and Scholes demonstrated that the source of the value in an option essentially can be traced to the underlying uncertainty—so the volatility and the price of the oil or the shares or whatever it is. Stewart Myers at MIT took that concept and said that can actually be applied to physical assets, and so he coined the phrase 'real option'. He said that you can actually look at every business

decision as the creation, the exercise or the discarding of a real option, and when you start to think about things that way it completely transforms the way that you think about value.

I noticed in some of the transcripts that various members had asked about the business case, and I actually think this is really central to the business case. A business case will involve things like discounted cash flow calculations, but I think thinking about the real option value is actually at the heart. If someone said, 'Stephen, you need to go and present a business case to the board for nuclear energy in Victoria', I would say, 'Well, it's safe and it's needed, and you should start the early work now to create the real option'. And I think the policy case that the committee is thinking about is actually a sort of mirror image of that. You know, there is no rationale for the ban, it is very likely we need the technology, every day that the ban remains in place is blocking value or preventing value. So creation of choices is really valuable, and it is particularly valuable where there is uncertainty.

Another really important concept here is that in any sort of economy or market there is this idea called the threat of entry. What is it that creates that competitive dynamic that keeps people honest, that ensures companies are sharpening their pencils and giving the best deal to the customers? One of the things is the day-to-day live competition, but another thing is the threat of entry in the future. So if you say, 'Nuclear's bad, we're not allowed to look for gas, we've got to close the coal plants', you are just shooting the competition dead, and that is not going to lead to good outcomes for customers, for consumers, for society, for the manufacturing sector. That is why I say that on day one of the repeal, even though it is not obvious and it might not be easy to put a precise dollar value on it, you will have created value—substantial value. You have in your hands the prosperity of the people of Victoria—and remember, I was born in Victoria and a lot of my family still live in Victoria.

Mr LIMBRICK: And just in the same vein, a lot of people have said, 'Well, we're not going to pursue nuclear anyway, so therefore lifting the prohibition is just a signalling exercise'. But to my mind signalling is pretty important. I would be interested in your views on that. Is signalling worthwhile?

Prof. WILSON: Yes. Signalling is so important that there are laws against companies using signalling techniques for anti-competitive purposes. That is how important signalling is.

Mr LIMBRICK: Yes, absolutely. Thank you very much, Professor. I had better let someone else have a go.

The CHAIR: Thank you. Can I go now to Ms Terpstra.

Ms TERPSTRA: Thank you, Mr Chair, and thank you, Professor Wilson, for your presentation. I just had a question that I guess flows off the back of the discussion that we just had about value. I am not entirely sure that I accept your proposition that by having the ban in place we are kind of blocking value. It is sort of like a hypothetical discussion really, because it is difficult to quantify what value is and what it might look like, because value can mean many different things to many different people; it is not just economics. But my question really is about: if we were to lift the ban on nuclear, what impact do you think that might have on Australia's ability to properly cost nuclear power? Would that make a difference in terms of lifting the ban or not? Would it have no impact or not? And I guess the second part to that question: is there the same level of volatility in the cost of power in other markets around the world that have nuclear in them as well?

Prof. WILSON: Yes, okay. I completely agree—you make a very good point that value is not just about economic or financial value. There are other sources of value. We teach this to the students in the professional practice class that I mentioned. We talk about all the forms of capital—financial capital, manufactured capital, human capital, social capital, natural capital.

Lifting the ban on nuclear will create value in multiple categories; it is not just straight up and down economic or financial value. It will create environmental value without doubt, it will create social value and it will help add to the human capital. And then you mentioned the word 'hypothetical' and the question of lifting the ban and getting a better understanding of what the costs and the economics of this class of technology look like in the Australian context. Lifting the ban will definitely improve our ability to come to a much deeper understanding of that and to reduce the uncertainty range, because at the moment the depth to which companies can go without breaking the law or are willing to go because the law is there is limited. So all we can really do is pretty high-level desktop translational analysis from overseas. We cannot get seriously into the depth of what would it really look like in Australia. But once the ban is lifted people can actually start to do that. Knowledge

is valuable, so having the knowledge of what would it really cost and starting to reduce the uncertainty range around those numbers has value because that then can inform other investment decisions. It is a subtle form of value, but information and knowledge, particularly when we are living in the information age, is enormously valuable, so allowing people to create that knowledge and that understanding of that information and reduce the uncertainty.

If you refer to the attachments that I have provided to the committee, there is a slide called 'Project development cycle with key decision stage gates'. It is this one here. You will see at the bottom there is a sort of risk spectrum. In the very beginning when you have got an idea, like when Edison thought, 'I can make a light bulb'—that was just a concept and the risk was enormous and the uncertainty was enormous. But by doing the work that is described here, you start to reduce that degree of risk. Actually, you see this in the renewable energy sector. How do wind farms get developed? Someone goes out and says, 'Oh, I think I can get an approval to build a wind farm on that farm over there', so he buys the land at the agricultural land price and then he goes and gets all the approvals and things that he needs to let someone build a wind farm, and then he bundles that up and ties a ribbon on it and sells it to someone. There is no wind farm yet, but he has created value. The price that he is selling that to the next guy for is much, much more than the price he paid for the land or the time cost of getting all the approvals. Why is that? Because he has derisked it and he has created value and then he has monetised that value and put it in the bank and then passed that to the next person, and then down it goes through this development cycle here until the day when the wind farm is actually physically built and starts generating electricity. That is the process; that is the derisking process and the value-adding process.

The CHAIR: Thank you. Can I go to Mr Meddick, then Dr Bach and then Ms Taylor.

Mr MEDDICK: Thank you, Chair, and thank you, Professor Wilson. I want to bring this back to I guess a rather simplified argument for a minute, if I can.

Prof. WILSON: Sure.

Mr MEDDICK: It has been stated here by many witnesses on both sides of the equation—both for and against—that the lack of fortitude that Australian governments of various colours have shown over the years to continue with a carbon price has been a direct inhibitor, and probably the single largest inhibitor, of investment in renewable energies, which has directly contributed then to the fact that they have to be massively subsidised in order to make them viable in the marketplace. My question is: should a prohibition on nuclear power—and let us live in an ideal world from yours and others' perspective here—generation in Victoria be lifted, and the feds follow suit to allow an industry to take place, given that we know how long it is going to take for the relevant approvals and all those sorts of things, take all that into account, just how much of taxpayers money will have to be used to subsidise a viable nuclear industry in Victoria versus other types of energy such as renewables, wind and solar et cetera? For how long would that have to stay? And what would be the net benefit then over how long? How long is that going to be a drain on taxpayers funds? Because, let us face it, there is only a limited bit of money, particularly at the moment. How much would have to be drained from the investment in renewables such as wind and solar et cetera to pool into the nuclear pot?

Prof. WILSON: These are really good questions. The first thing that is really important to keep in mind when we talk about the subsidisation of renewable energy in Australia is that the lion's share of that is not sort of people in Treasury, in Canberra or Spring Street or whatever writing cheques. The lion's share of that is like a cross-subsidy between consumers and so the main mechanism has been the RET scheme and the certificate scheme, and so the need to buy certificates gets priced into electricity—so the money is actually flowing in the form of cross-subsidies as distinct from government subsidies. But it is of course all enabled by the legislation that creates that demand in the first place. So it is a different way of skinning the cat to putting a carbon price in place, and most economic purists will argue that a carbon price is a better design of policy for various reasons, one of which is that if the goal is to reduce CO_2 emissions, then you should not care how that is done, and going and picking particular technologies is considered by many people to be not ideal policy. I think we need to keep that in mind.

When you read all the arguments about carbon pricing and all that, I think it is important to keep in mind that those arguments are very, very correct in a textbook sense, a sort of economics 101 sense. They are not new ideas—they have been around for 20 or 30 years—but they have tended to bump into real-world problems of various types, including political problems almost everywhere where they have been implemented, including

places like the European Union. So while they are perfect in theory the experience and practice is somewhat different, and I think we have sort of got to the point where the argument is a pretty old argument. The horse might not be dead, but we are flogging it hard and it is not showing that much sign of life.

Then the question is: to what extent would nuclear be subsidised if we were to pursue nuclear? There are so many imponderables in that question that one cannot give a specific answer to it. But I think we should think about the situation we are in in Australia and what we can leverage. Let us look at the most mature of the emerging technology class, which is the small modular reactor class. The most mature that you have looked at is NuScale's technology, and you have spoken with one of their senior executives, Mr Mundy. That technology did not just appear out of thin air the day before yesterday. That started with a concept, just like in our project development cycle that I have provided you with and referred to before. That started with a concept in Professor Reyes's head at the Oregon State University in the mid to late 1990s and then it became a USDOE-funded research project and then they got approval to go to the next stage, so the American taxpayer has been providing research and development support to that for many, many years. It is at least 20 years now that that whole program has been running. It is just like Australia, under Professor Finkel's inspiration and in partnership with the Japanese, putting money into hydrogen—the same kind of thing.

Then they got to a point where they were actually able to bring in a keystone private investor, which is Fluor, as you probably know. So they have invested to bring that technology to the point where they were ready to go to the US Nuclear Regulatory Commission with the design and get all the approvals needed to build the first plant. It is about 20 years and the capital they have put into that is, I believe, somewhere between US$800 million and $1 billion. So for us, we can then leverage that. We can then benefit from that. We do not need to replicate that.

There definitely is a role for government in nuclear energy but there is a role for government in all forms of energy. Even in a pure market environment there is still a role for government. So the details of that and how much of that is provided in the form of early-stage financial support—that is a big, detailed question that is important to look at but I do not think it has a bearing on the question before the committee, which is: should the ban be repealed?

The CHAIR: Thank you. Just to remind the committee, we are able to extend until 11.15, so we have got a bit of time to go through a few more questions. Can I pass to Dr Bach, Ms Taylor after that and then Mrs McArthur, and then we will do a round again.

Dr BACH: Thanks, Chair, and thanks a lot, Professor Wilson, for being with us this morning. As you might know, because you have noted that you have gone back and had a look at some of our transcripts, we have heard a lot over the course of our hearings in particular about two issues: about cost and also about safety and danger. I noted in our last hearing that I am finding it difficult as a layman to seek to pick apart some of the evidence that we have heard, albeit on the one hand from some people on occasions who describe themselves as nuclear advocates and others who describe themselves as antinuclear advocates—and again, I think the evidence that we have heard from all witnesses has been interesting and is to be respected. But I am fascinated by your views on safety, given that it is plain to us, and you have already noted, that you are not an advocate for anything in particular. I think I heard you say earlier in your discussion, Professor Wilson, that your view is that nuclear is safe. Would you mind unpacking that a little bit for us, because that has been a topic of much discussion in our hearings.

Prof. WILSON: Yes, I have come to the view that it is safe, but as I alluded to, when I was in my teens and 20s and 30s I was afraid of it, so I did not think it was safe. My year 9 English teacher, who had better remain nameless, it felt to me, spent most of 1983 pumping the views of People for Nuclear Disarmament into the class, and in 1986 of course there was the Chernobyl disaster, and I wrote my year 12 special essay on that topic. And then some years later in Hong Kong I realised I was living not very far from a nuclear power plant, and I felt slightly uneasy about that, again because I did not understand.

The data tells me that nuclear is safe, and that is the view that I have come to now that I feel like I understand properly what happened at Chernobyl. The design was flawed; the engineers knew the design was flawed. They concealed that information from all the people who mattered, including the people operating the reactor, and it was sort of an accident waiting to happen. I am fairly confident I understand what happened at Fukushima, and I have come to the view that it is actually a stunning demonstration of the safety of nuclear energy. The magnitude of the earthquake was much larger than the engineers had designed for, for example, and it

withstood that very well. They put the backup generators in the wrong place. The story I heard is that the Americans put them in the basement because they were building reactors in Tornado Alley in the US and they did not really want to change the blueprints. The Japanese engineers knew they should have been up on the hill but did not have in the 1960s and early 70s the courage to tell the Americans what to do. And of course the consequences of Fukushima from a nuclear accident point of view are tiny, negligible—almost nothing—compared with the actual tsunami disaster itself. I have been very near that site. I have a friend who lives very close to there, so I visited the tsunami site on the fifth anniversary of the tsunami; you can see what happened.

I think if we are to be consistent, if we really still believe despite all the data, all the facts and all the evidence that nuclear is dangerous, then we should apply the same logic to everything else we do in our lives. So we should never, ever, again get on an aircraft—it is far more dangerous. Aircraft are far, far, far safer than road transport, so we should never again get in a car, and in fact half the people in road accidents are pedestrians, so we should never leave the house; right? If we really understand risk and safety, this is the way that we should behave. Having mentioned aircraft, I sat down and did a comparison of the nuclear industry and the aircraft industry and all the attributes and characteristics of the two, and I think it is relevant to things like support for industries and technologies and it is relevant to things like Australia accessing technology from overseas. You find an amazing number of parallels between these two industries, and so I would recommend that as a framework for thinking about these things that is actually very useful. Does that answer your question?

Dr BACH: Yes, it does; it does, Professor Wilson, very well. I suppose as you were talking I just noted that for many hours of the day it is in fact illegal to leave one's home in Victoria at the moment. We have been taking your logic to extremes for no good reason as it was applied recently. Thank you, Professor.

Prof. WILSON: Thank you.

The CHAIR: Ms Taylor.

Ms TAYLOR: I suggest you zero out credibility when you diminish everything to a plane crash. I think that does not enhance your credibility in my book, and when you reduce the significance of major disasters around the world—

Prof. WILSON: You have just gone on mute, sorry.

The CHAIR: Nina, can you unmute yourself? Yes, that is better. Start again.

Ms TAYLOR: I was just saying, every time a nuclear proponent diminishes the significance of national disasters, it does not enhance their credibility—

Dr BACH: This gentleman is not a nuclear proponent.

Ms TAYLOR: I think he can speak for himself, Dr Bach.

The CHAIR: Excuse me. Can I just ask all members, no interjection; I am not going to tolerate any interjection from any member whilst another member is asking a question. We have been doing pretty well so far, so thank you very much. Ms Taylor.

Ms TAYLOR: Thank you. I am just making that point. It does not enhance credibility when people who may have an inclination towards nuclear tend to diminish natural disasters. It does not enhance my confidence in their position on that topic.

Now, if we are looking at the step-change scenario, the AEMO ISP report has said that renewables can occupy 96 per cent of power in the national energy market by 2042 and 99 per cent of that could be in Victoria. By contrast, SMRs, when we look at the commercial readiness scale, we look at them not really being commercially ready until the late 2030s, so why are you such a strong proponent of nuclear?

Prof. WILSON: I am not a strong proponent of nuclear; I just think it is irrational to ban it. We might go down that road, or we might not; it is up to us. But if we continue to choose not to, then I think the other objectives we are trying to achieve will become very, very, very difficult. One of the things I said in my opening remarks was that the challenges now facing the electricity market are greater than many people realise, and that is what I am seeing in the market data. You do not hear a great deal about it in the public domain, but

when you talk to people privately who are the real experts in the system, what you find is that they understand the nature of the problems, the challenges and the kind of scenarios that people are proposing where you have got very, very high shares of variable renewable energy dominating the system.

I have got a PhD student working on this, and he has done an international literature review. And all the sound papers in international peer-reviewed energy channels have a wide range of estimates on what they think it is going to cost to go to very high shares of variable renewable energy. But there is a general broad agreement that the costs increase in an ever-steepening curve. So a lot of people in their minds are doing linear extrapolations, but it is not a linear problem. The cost just gets steeper and steeper and steeper, and one of the reasons for that is that there are significant technical challenges that get harder and harder and harder as you add more and more intermittent resources that cannot match to the demand.

The single most important thing about an electricity system—and this is just a fact of the universe—is that you have got to generate the electricity at the instant that it is consumed. It is like the ultimate real-time commodity. So you have to balance supply and demand to within basically plus or minus 1 per cent every millisecond of every day, and because the system that we have got was so robustly engineered, and it achieves that trick with such a high degree of reliability, we have grown up taking it for granted so that when I flick the light switch the light will come on with a 99.998 per cent probability. But what it takes to achieve that trick is phenomenal, and it is extremely technically challenging. The system has been engineered with very, very wide buffers around it, and what we are doing is we are just pulling those redundancies and safety margins and buffers away.

No-one really knows how this system is going to work, and I think we are getting closer to the saturation point than people realise already. There are some charts I provided in my backup material that are just simple scatter plots of price versus demand for the same month 10 years apart in Victoria. There is another month I have included as well. That is just the tip of the iceberg of the problems that we are seeing in the system. At every level—from that millisecond level to the way we control and balance the system through to investment in long-term planning—we are introducing really, really big problems, and I think that when ordinary people start to see that and realise that, they are going to have something to say about it.

Ms TAYLOR: I really do not follow your point there because I do not believe that the AEMO are naive about the difficulties and challenges of meeting energy needs into 2042. I think you are inferring that all these people are so ignorant—

Prof. WILSON: No, I am not.

Ms TAYLOR: all these laypeople that do not know the facts and only you have the magic solution, and nuclear is the way.

Prof. WILSON: No.

Ms TAYLOR: Do you know what I mean? Can you see how that is not landing very well?

Prof. WILSON: I understand what you are saying, and I fully appreciate what you are saying. And I am not saying that AEMO is naïve, and I am not saying that the engineers at AEMO do not know what they are talking about. What I am saying is that when I read those documents—and I am not saying that I have the greatest understanding of the system of anybody. I do not—these are large and complex systems—but I bring a certain amount of knowledge, technical training, from engineering and from economics, and I bring a certain amount of experience from 30 years in more than 30 countries around the world on system design, market design and policy and all these things across every form of generation in all levels of the system. So when I am reading those same reports that you are reading I am reading between the lines. I am bringing all that and I am reading between the lines, and I can see the places where the engineers are very carefully couching what they are saying. And the ordinary person reads it and thinks, 'Oh, that's fine. We can have lots of renewable energy, no problems at all'. It is like: no, if you really understand what is happening, they are being very careful about what they say. You know, people are so frightened; I am saying things that other people are frightened to say.

The CHAIR: Thank you. Can I now go to Mrs McArthur.

Mrs McARTHUR: Thank you very much, Chair, and thank you, Professor Wilson. And thank you for being prepared to say the things that other people may not be prepared to say. You have given us a factual

presentation of what is important in achieving the goals in energy of affordability, reliability and sustainability. These are the goals that we should be looking at. I am interested in the whole concept of mix and ideology.

I live in an electorate—the same electorate as Mr Meddick, although we might differ in views on these things—where I am enlightened to see the variation in the mix that exists. We have got a carbon capture and storage just very close to where I live. We have got Deakin University involved in hydrogen research in Warrnambool. We have got thorium that actually exists in my electorate. We have got massive amounts of renewable energy production occurring. We are even looking at battery storage at another place down the road. We have got onshore conventional gas that should go ahead; a moratorium should not have been placed on onshore conventional gas. We have got waste-to-energy proposals. We have got all sorts of energy occurring, even from waste from farms, heating hospitals. I looked at the wave energy proposal that exists. But we have got power coming across Victoria from Ms Bath's electorate to an aluminium plant, losing massive amounts of power along the way, in a very unproductive sense, and we have of course closed down 25 per cent of that baseload power capacity in the Latrobe Valley as well. So the mix is vitally important.

I for one am technology agnostic. I agree totally that we should have a mix of all forms of energy to increase supply, and that seems to be what is important. I have got dairy farms that have to use diesel to operate because there is no three-phase power; there are just single SWER lines. We have got a major issue now in our electorate where we have got massive amounts of renewable energy, encouraged by the government to get to their emissions target of zero by 2050, but we have got no way of them being able to connect to the grid. So they have invested vast amounts of money in renewable plants and wind farms in particular, but they are lying idle because there is no power in the grid, and we are in an extraordinary battle over whether power should go underground or above ground.

So this mix is vitally important. Whether we have nuclear, HELE coal-fired power stations, conventional gas exploration—all these forms of energy—renewables, everything should be in the mix. I think that is what we should look at, and I thank you for putting that proposal forward. I do not see you as a nuclear proponent. I see you as an advocate for sustainable, reliable and affordable energy, and that is what is important in this country and in this state. But I am wondering why we have got to this point, where ideology has crept in to this whole notion, where we have moratoriums, prohibitions on sensible ways of achieving an energy that is so vitally needed across this country and across this state. You know, 'Don't let the facts get in the way of a good argument'—that kind of scenario. How are we going to overcome this kind of ideological objection to a form of energy, which is going to be vitally important in the mix?

The CHAIR: Thank you. That was a long statement and a short question. So Professor Wilson?

Prof. WILSON: So it is a question that I have reflected on a little bit, and over a glass of wine we could probably have very long and interesting conversation about it. I want to respond to it by sharing with you a little bit of a personal experience of mine. It is related to the change in view that I had myself, from being afraid and against to being not afraid and relaxed and in favour, if it makes sense. I owe a great debt of gratitude to the students at the university, who three years ago at the debating society put on a debate. The proposition was: 'Australia should embrace nuclear energy'. At that time I was just an adjunct professor. They asked a colleague of mine and he was prebooked. He said, 'Do you want to do this?', and I thought 'Okay'. So I suddenly found myself second speaker for the affirmative in this debate that I had not planned to be in. The reason I am telling you this is at the start of the debate they asked the audience, 'So who agrees with the affirmative and who agrees with the negative?', and I almost fell off my chair because two-thirds of the students put their hand up and said they agreed that Australia should embrace nuclear energy. Now, as it happened, a series of emotional arguments swayed a big chunk of them towards the end of the debate.

But I have taken inspiration from that. I decided to conduct a sort of one-man, one-question, one-second survey of Australia. So I just go up to random people, like the hairdresser or the Uber driver or the policeman outside the New South Wales inquiry—the equivalent of your inquiry—and I say, 'So tell me, what do you think? Should Australia embrace nuclear energy?', and I am amazed at the answers. The policeman outside the inquiry in New South Wales said, 'Yeah, of course'. I said, 'Really? Why?'. He said, 'Well, all those other countries can't be wrong, can they?'. Bev next door, who is 89, when I was going to some event, she said, 'What are you doing?'. I said, 'I'm going to this event about nuclear'. She said, 'Oh, about time too!'. I thought, 'Gosh!'. But my own brother is still very much afraid of the safety, and he is opposed to it. But by asking that question and then just listening to what people say, every time I have asked the question I have learned something really

interesting. Like one response was, 'What's nuclear energy?', and that was from a British guy. So what I am encouraging all the members of the committee to do is just do not be afraid. Just say to people, 'Should Australia embrace nuclear energy? What do you think?', and just see what they say. It is an amazing experience. I have found it incredible.

Mrs McARTHUR: Thank you, Professor. When we are allowed, Professor, we will be out on the street asking the question.

The CHAIR: Mr Hayes.

Mr HAYES: Thanks, Mr Melhem. Yes, thanks, Professor Wilson. One more question: a previous submitter also raised the issue of a carbon price or a carbon tax as being a way of rapidly decarbonising and also assisting the nuclear industry in getting established—and other forms of energy production too. Do you see this as being a good way to move, or would you consider that to be negative signalling in the market and having a distorting effect?

Prof. WILSON: The theory says yes, but the practice tells me that it would not necessarily help, partly because it has been such a fraught issue. We have had a carbon tax; then it was removed. Would that be bankable? I am not convinced that it would be. So it has this kind of very puristic theoretical economic appeal about it, which I perfectly understand, but from a very practical point of view as a policy instrument and from a development point of view, I do not think it is a magic bullet, let me put it that way. The history of people trying to come up with solutions—technology solutions, engineering solutions, policy solutions—to these challenges is littered with all these magic bullets, and people get very excited about the latest magic bullet, and then a few years later it falls by the wayside. So yes, that is the view that I have come to.

Mr HAYES: Okay; thank you.

The CHAIR: Last question from Ms Taylor, unless someone else has got a burning question apart from that.

Ms BATH: Chair, can I have it?

The CHAIR: I will just remind everyone we have got 3 minutes, so they will be quick questions, quick answers, because I need to move on to the next one. So Ms Taylor, Mr Meddick, Ms Bath. As I said, at quarter past we need to conclude this hearing.

Ms TAYLOR: Yes, well, I would not presume that we have not asked people in our community about nuclear. You are presuming that we have not had these discussions with everyone. I have had these discussions with many, many people in the community, so I think that is a little presumptive on your part.

Prof. WILSON: Sorry about that.

Ms TAYLOR: Now, when we are looking at the burial of waste, because that is an inevitable part of nuclear energy, the federal government has selected Kimba as a site for nuclear waste, despite the fact that the Barngarla traditional owners unanimously vetoed the proposed facility's owners. If we look at the US, because they do not have a ban, the US is struggling to find a home for its nuclear waste. As a result most of it stays on site, in some cases long after plants are decommissioned, at taxpayer expense. So what does that mean for Australia?

Prof. WILSON: Shall I respond?

The CHAIR: Can I ask the other two members to ask their questions, and in the event we do not have time we can take those questions on notice. Mr Meddick.

Prof. WILSON: Yes, sure.

Mr MEDDICK: Thank you, Chair. Mine is more, I guess, a particular statement to summarise. We have had people from both sides of the argument, Professor Wilson, both pro and anti. The anti people tend to try to counter the arguments of the pro, but this statement that Mrs McArthur brought up earlier that the antis are all dealing in emotive statements only and are driven by ideology is blatantly incorrect. The anti people have actually presented cogent arguments. It is the pro people who have just dismissed those arguments and said

they do not even want to argue the point. They do not want to address them. They just want to say, 'That's nothing; that's just based on emotion and ideology. Don't even think about that'.

I would like to leave with one statement here that someone said to me in my electorate when I asked them about perhaps lifting this moratorium, and it is a very, very cogent statement: 'Just because we can doesn't mean we should'. I will leave it there.

The CHAIR: Thank you. Ms Bath. Professor Wilson, I will come back to you in a second.

Ms BATH: Thank you, Chair, and thank you, Professor Wilson, for being so professional today in all your responses. Professor, you spoke about levelised cost of electricity—and this might be one to take on notice—and looking at a viewed system as a whole, including technical services. Now, my question goes to: it is one thing to make the energy at the factory, at the ignition point, whatever that be—wind, solar, carbon, coal, hydrogen or nuclear—it is the other thing I think have we a big problem with in Australia, our connectivity and our transmission. So I would like you, if you would not mind, to respond perhaps in writing, because we have run out of time, about some of the flaws in our connection system, our transmission system, and some of the flaws that would be overlaid by various different mixes and what needs to happen in that space.

Prof. WILSON: Sure. I would be happy to do that.

The CHAIR: Now, Professor Wilson, there were three questions there, but would you like to make a closing remark to maybe try to answer these questions, if you can, briefly? But I will be very pleased if you are able to supplement that later on by a written response; that would be excellent as well. Over to you.

Prof. WILSON: Thank you, Chair. I made a note: there is a question on waste; there is a question on just because we can does not mean we necessarily should; and then there is the question of LCOE verses the whole system, including the network, the transmission and those considerations. I will just make a very brief remark on each and then respond as a follow-up on notice.

Waste is not my specialty. It is clearly one of the issues that needs to be discussed, and it is clearly something that—we are not going to build nuclear power plants if the community is not comfortable with what the proposal is for managing the waste. The personal view I have come to is that it is a very manageable problem. It is just a question of managing the policy and the politics and how the community feels about that.

Just because we can does not mean we should. Yes, absolutely. So, ultimately, at the end of the day it is up to the community what technologies they want to have producing their electricity, but the important thing for me is that everyone has a clear-eyed understanding of the pros and cons of the choices that are before us.

Then on LCOE, I provided in the materials a side-by-side comparison of two LCOE calculations that come to extremely different results, and it is just to show that you can use that metric to produce a very wide range of results. That is not its only shortcoming, and so I am happy to provide a little bit more material on that that might be helpful for the committee.

The CHAIR: On that note, Professor Wilson, we really appreciate your contribution today and your making yourself available. It has been an excellent session, so thank you very much for your time and do enjoy the sunshine in Queensland. We are a bit jealous you have got the grand final.

Prof. WILSON: Yes, we will try to treat that responsibility with the respect that it deserves.

The CHAIR: Thank you.

Witness withdrew.