REPORT ON PROCEEDINGS BEFORE

STANDING COMMITTEE ON STATE DEVELOPMENT

URANIUM MINING AND NUCLEAR FACILITIES (PROHIBITIONS) REPEAL BILL 2019

CORRECTED

At Macquarie Room, Parliament House, Sydney, on Monday 18 November 2019

The Committee met at 9:00 am

PRESENT

The Hon. Taylor Martin (Chair)

The Hon. Mark Banasiak
The Hon. Mark Buttigieg
The Hon. Wes Fang
The Hon. Scott Farlow
The Hon. Mark Latham
The Hon. Natasha Maclaren-Jones
The Hon. Mick Veitch (Deputy Chair)

The CHAIR: Welcome to the third hearing of the State Development Committee inquiry into the Uranium Mining and Nuclear Facilities (Prohibitions) Repeal Bill 2019. The inquiry has been established to inquire into the Uranium Mining and Nuclear Facilities (Prohibitions) Repeal Bill 2019. The object of this bill is to repeal the ban on uranium mining in New South Wales, which has been in place since the enactment of the Uranium Mining and Nuclear Facilities (Prohibitions) Act 1986. This inquiry is a fact-finding mission to consider if New South Wales should investigate the viability of nuclear power as an energy source.

Before I commence, I acknowledge the Gadigal people, who are the traditional custodians of this land. I also pay respect to the Elders, past and present, of the Eora nation and extend that respect to other Aboriginals present. Today we will hear from representatives of industry groups, peak bodies and professional associations for nuclear-related fields, union representatives and an energy economist from the University of Queensland.

I will make some brief comments about the procedures for today's hearing. Today's hearing is open to the public and is being broadcast live via Parliament's website. A transcript of today's hearing will be placed on the Committee's website when it becomes available. In accordance with the broadcasting guidelines, while members of the media may film or record Committee members and witnesses, people in the public gallery should not be the primary focus of any filming or photography. I also remind media representatives that they must take responsibility for what they publish about the Committee's proceedings.

It is important to remember that parliamentary privilege does not apply to what witnesses may say outside their evidence at the hearing here today. I urge witnesses to be careful about any comments they may make to the media or to others after they complete their evidence, as such comments would not be protected by parliamentary privilege if another person decided to take action for defamation. Guidelines for the broadcast of proceedings are available from the secretariat.

All witnesses have a right to procedural fairness according to the procedural fairness resolution adopted by the upper House in 2018. There may be some questions that a witness could only answer if they had more time or with certain documents to hand. In these circumstances witnesses are advised that they can take a question on notice and provide an answer within 21 days. I remind everyone here today that Committee hearings are not intended to provide a forum for people to make adverse reflections about others under the protection of parliamentary privilege. I therefore request that witnesses focus on the issues raised by the inquiry terms of reference and avoid naming individuals unnecessarily.

Witnesses are advised that any messages should be delivered to Committee members through the Committee staff. To aid the audibility of this hearing, I remind both Committee members and witnesses to speak into the microphones provided. The room is fitted with induction loops compatible with hearing aid systems that have telecoil receivers. In addition, several seats have been reserved near the loudspeakers for persons in the public gallery who have hearing difficulties. Finally, could everybody please turn their mobile phones to silent for the duration of the hearing today.

PATRICK GIBBONS, Principal Advisor, Energy, Minerals Council of Australia, affirmed and examined

DAVID FRITH, Director, Industry and Environment, NSW Minerals Council, affirmed and examined

The CHAIR: I welcome our first witnesses. Do either of you or both or you like to begin with an opening statement?

Mr FRITH: I will start. Good morning everyone. I thank you for the opportunity to appear before the Committee today. I represent the NSW Minerals Councils, which is the peak industry association representing the minerals industry in New South Wales. We are separate to the Minerals Council of Australia, which Mr Gibbons represents, but we do have a lot of common member companies and we collaborate on a lot of common policy issues where applicable. The obvious distinction is that we tend to focus on New South Wales policy issues while the Minerals Council of Australia focuses on national policy issues. The NSW Minerals Council supports the bill to overturn the ban on uranium mining and nuclear power in New South Wales. As has been spoken about extensively in this inquiry already, the ban on uranium mining is somewhat of a bizarre situation given that the ban on exploration was overturned several years ago in 2012 and that uranium mining is undertaken safely and with significant economic benefits in neighbouring States, particularly South Australia.

The Committee has heard evidence about the forecast growth in nuclear power globally and we believe New South Wales, under any logical reasoning, should have the opportunity to take advantage of the economic opportunities that may arise should we discover any economically recoverable uranium resources in New South Wales. In terms of nuclear power, the security, reliability and affordability of electricity supply is crucial for mines which are large-scale industrial facilities that operate 24 hours a day seven days a week and use around 6 per cent of the State's electricity. Our members have already experienced a steep rise in electricity prices in recent years and they are concerned about the drop off in dispatchable supply over the coming decades, which is well known. The scale of the task to replace this capacity while reducing emissions and supplying secure, reliable and affordable power is immense and we believe that all options needs to be on the table.

Renewables will have an important and growing role to play in energy production, however, the Committee has already heard evidence about the increasing total system costs of the electricity supply system by pursuing a grid based on 100 per cent renewables and storage. We referenced another study in our submission that shows similar results. These studies demonstrate the need to plan for alternative low-emission, dispatchable generation technology such as nuclear or coal and gas with carbon capture and storage. We believe that all of these options need to be on the table to make sure that we can deliver a secure, reliable, low-emissions electricity supply at least cost.

Mr GIBBONS: I thank you for the opportunity to appear before the Committee. The perspective of the Minerals Council of Australia is that there are four indisputable facts about energy, climate change and nuclear power. First, climate change is real, and as global energy demand increases so too does the need to decarbonise our power supplies. Second, nuclear energy provides about 10 per cent of the electricity demand with zero emission power. Third, the power provided by nuclear energy is low cost and can meet the needs of industrial and household consumers 24/7. Finally, billions of citizens in 31 countries benefit from low-cost, zero-emissions nuclear power. Here in New South Wales you can explore for uranium but not mine it and nuclear is banned. The Minerals Council thinks that is nonsensical. The ban on uranium mining is an ideological hangover from the 1980s. It is an out-of-date policy fad that delivers nothing but costs plenty. Both the State and Federal nuclear bans should be lifted so that New South Wales can at least consider nuclear energy.

Most of New South Wales' large baseload plants, which provide around 80 per cent of electricity in New South Wales, will close over the next two decades. At this stage it is unclear where the replacement electrons will come from or at what cost. Intermittent renewables will play an increasing role in the provision of electricity, but they need to be backed up by other sources, whether it is gas and coal or storage. All technology options need to be on the table, including small modular nuclear reactors, which potentially offer some of the lowest cost and most reliable sources of 24/7 power, all with zero emissions. Finally, let us talk about the missed opportunities. Because it already has the Lucas Heights medical reactor, New South Wales should be the home of what could be a major nuclear industry. Look at Canada—60,000 jobs and 15 per cent zero-emission and low-cost power from nuclear. It is a $6.7 billion industry. These are the opportunity costs of the New South Wales bans. The Minerals Council urges the Committee to support the Uranium Mining and Nuclear Facilities (Prohibitions) Repeal Bill 2019.

The Hon. MARK LATHAM: Thank you both for your submissions and attendance today. I was interested in page four of the submission of the Minerals Council of Australia. It states that, "New South Wales has lost its comparative advantage in energy. Rising prices and falling reliability are forcing businesses to invest

overseas, instead of in New South Wales." What is the time frame on that? Often in the public debate there is a complacent feeling that these energy reliability issues will only become present once we have the closure of Liddell, Vales Point and Eraring. What is the feedback you have got about how businesses are looking at the investment environment in New South Wales right now? I have got some feedback from mining companies that they will not invest here in the future because of the shenanigans at the Independent Planning Commission [IPC]. More generally, is it true that there is growing concern in all kinds of industries that if New South Wales cannot fill that gap of dispatchable power as coal-fired power stations are retired that they will be taking increasing risks by investing in our State?

Mr GIBBONS: I think that is a really good question. In our submission we referred to a trade mission that came out from the State of Pennsylvania at the end of 2017. As part of the targeting of Australian businesses—and they were targeting New South Wales manufacturing firms in particular—their key pitch to those firms was, "Come to Pennsylvania because we can provide cheap and reliable energy." They were looking at what was happening in Australia and a lot of it stemmed from the closure of our larger baseload plants. I live in Melbourne and I have witnessed firsthand the closure of Hazelwood Power Station, which, until its closure, provided roughly 25 per cent of Victoria's power. Power prices spiked. A similar issue is about to occur in New South Wales with Liddell.

This is something that has been occurring. Businesses are looking at this every day. Energy crises are front and centre of a lot of businesses and they are taking a lot of attention. The idea that somehow this will only come when there is the closure of the Liddell Power Station—no. This is now. This has already been factored in. When you have companies like BlueScope—major operations down at Wollongong—investing $1 billion in the United States, it kind of says it all. We have seen this with other businesses as well. I think this is going to be an ongoing issue for Australia. Large industry, which requires 24/7 power—and it has to be internationally competitive—looks at Australia and it is a bit difficult to start making a business case for investment.

The Hon. MARK LATHAM: So you think this is having an impact right now. Does it therefore follow that lifting the ban on nuclear would send a signal to industry that the State is serious about keeping the lights on—that even if the Federal ban was not lifted at least in New South Wales it is a sign that we are trying to head in the right direction?

Mr GIBBONS: I agree. I think that lifting the ban on nuclear would send a signal that New South Wales is considering all options because, as a country—and certainly as a State—let us be frank, 80 per cent of the power in New South Wales comes from coal. The idea that somehow this can be switched off—we are not quite sure where the replacement electrons are coming from—and that somehow we will be attracting industry to invest in energy-intensive industries—there is a big question mark around this. So lifting the nuclear ban would show that New South Wales is serious about addressing what is now an energy affordability issue in the State.

The Hon. MARK LATHAM: With the New South Wales submission, on the final page, the second last paragraph, the first sentence reads:

> Arguments about the economics of nuclear energy are largely irrelevant to this inquiry.

Mr Frith, could you elaborate on what you meant there? It is one of the key points that detractors put forward—that no company will invest in nuclear, it is too expensive.

Mr FRITH: There is no point in speculating what these things are going to cost in the future, or waiting for the cost to come down and then having the debate around changing the legislative framework. I think there is a need now to set up a legislative framework to allow that development to occur, to allow planning for this industry to plan to set up in Australia. Whether the costs come down or not is largely, as we say, an irrelevant argument. It is about making sure there is the ability for all technologies, as we said, whether it is nuclear, coal with carbon capture and storage [CCS] or gas with CCS, renewables, storage—all the options have the ability to compete on an equal playing field.

The Hon. MARK LATHAM: On the first page of your submission it is written:

> Achieving emission reductions in the electricity sector is unlikely to be achieved by renewables and storage alone?

Is one of the appealing aspects for industry with nuclear that it is a proven technology? You can have arguments about different aspects of it but there is no doubt that in major economies internationally it is a proven way of generating dispatchable power, whereas it seems that, on a lot of the technological development about battery storage, the jury is still out. It seems to me to be a weakness of battery storage that the advocates say you need to go to pumped hydro. AGL talks a big game about pumped hydro. They have two small disused mining sites that they are conducting an inquiry about. Is one of the great advantages of nuclear at least that the technology is proven and it would give industry confidence that we are talking about something that is real as opposed to

speculation about where different technologies and energy sources might emerge in the renewable and storage sector?

Mr FRITH: As Mr Gibbons said, it is being applied around the world, and delivering reliable and affordable—in fact, some of the lowest-cost—energy in places like France. It is a proven generation source. At the same time, batteries are extremely expensive at the moment, but that does not mean we should be ruling them out for the future. I think there are going to be some reductions in battery costs as well. As I said, we need to have all these options on the table. One of the other benefits with nuclear, as well as coal and other thermal types of generation, is that they are dispatchable resources but they also provide a lot of system security service as well—grid inertia, frequency control, voltage control—and they can deliver that in a reliable way for long periods of time. Things like batteries are good for fast frequency response and other kinds of system services but in very short timeframes. The thermal generators and nuclear can provide that long-term stability to an electricity grid which, as the increasing penetration of renewables occurs, is going to be increasingly important.

The Hon. MARK LATHAM: Finally, Mr Gibbons, when that delegation from the United States spoke about their energy security—trying to steal, with some success, some of our manufacturing concerns and industry here—what was their main pitch about their energy security? What they could offer that we could not?

Mr GIBBONS: I did not meet with the delegation. I did see their flyers, basically. They were basically pitching, number one, cheap and reliable power. Then they talked about how they had multiple power sources, whether it was gas or nuclear. They also mentioned renewables but they said that they offer some of the cheapest power in the United States. That was literally their pitch.

The Hon. MARK LATHAM: So diversification of their power grid was a big advantage, whereas in Australia that base is narrowing, and some of the forecasts are pretty disturbing for keeping the lights on.

Mr GIBBONS: Yes.

The Hon. WES FANG: Thank you very much for coming and appearing before us today. We heard last week—I am not sure if you have had a chance to look over the transcripts of the hearings from last week—from the department that after the 2012 ban on exploration was lifted they had 39 expressions of interest received, of which six applicants were invited to apply for a uranium licence, with one response to that, which was subsequently withdrawn. Having spoken to members on both sides from the New South Wales standpoint and across the country, is the ban on mining affecting the ability for us to issue exploration licences for uranium?

Mr FRITH: Definitely. I think that if you are a junior explorer trying to raise money to spend on exploration, it is going to be extremely difficult when there is no ability to extract any resource that you find in the future. Also, I think the fact that the ban was overturned, and then the expression of interest process was undertaken at a time when uranium prices were dropping quite significantly since 2011—the combined effect of those two factors—probably led to the low interest. If you look at mineral exploration across any type of mineral it is quite closely correlated to the price of the commodity. When times are going well there is a lot of mineral exploration and when it is not going so well the opposite occurs. It is a combination of those two factors, but certainly the ban on uranium mining, if you are a multinational and thinking about whether to invest in a uranium exploration project in New South Wales or in South Australia, I think you would know where you would pick.

The Hon. WES FANG: Have you had feedback from your members that there would be interested parties if we were to overturn the ban—that we may have more interest in people applying for exploration?

Mr FRITH: From the Minerals Council of New South Wales perspective, I guess we do not have any uranium members at the moment. There is no uranium industry here so there is a general sense that the ban should be overturned for the sake of the principle. I am not sure about the Minerals Council of Australia.

Mr GIBBONS: We have discussed this within the Minerals Council of Australia and, picking up on Mr Frith's point around the companies, there would be interest in looking at applying for exploration licences if they could see a viable way through to doing something with that exploration licence. At the moment, why would they? I think as a question of principle they would if the ban on uranium mining was lifted.

The Hon. WES FANG: We heard from the department that there is possibly quite a reasonable prospect of there being uranium particularly in the western part of New South Wales. Given that there is already mining out in that part of the world, and also in the northern part of South Australia, is New South Wales in your opinion a good candidate for issuing exploration licences and mining?

Mr FRITH: The anecdotal feedback I have had from geologists is that there is potential resources in the western parts of New South Wales and I think I saw from DRG's evidence that that was the area where most of the expressions of interest were lodged. So it would appear that there is a potential resource out there but we really need to undertake the exploration work to find out what that resource might be. From the perspective of the

Minerals Council of Australia we would love to see more exploration and more mining in this State. The industry delivers significant regional economic benefits in places like Broken Hill already, but that could be increased right across New South Wales, and there are potential opportunities there to expand that contribution.

The Hon. WES FANG: Would either of your organisations have an opinion on the ability of Australia, or New South Wales, to perhaps be a player in more value-adding to the product? For example, at the moment in South Australia the yellowcake is exported before it is refined and processed. Do you have an opinion on whether there might be an opportunity for New South Wales, for example, to potentially value-add?

Mr GIBBONS: There should be. The issue in Australia nationally is some of the bans that exist within the Federal Environment Protection and Biodiversity Conservation Act 1999. This is going to pose a challenge. But you think about it this way: A country like Canada, which I think has the third-largest deposit of uranium, has a major industry based around where they basically value-add at every step. Here we are in Australia we have got the largest deposit of uranium in the world and cannot do anything other than put it out as yellowcake. In New South Wales you have got the medical research reactor; you have got all the infrastructure that sits around that. You have got a really high-skilled workforce sitting down at Lucas Heights and around there. We have got the capacity to do this. We should be doing this. To answer your question, Mr Fang, we should be doing it.

The Hon. MARK BUTTIGIEG: Obviously there are all sorts of target dates being bandied about in terms of the climate change emergency, for want of a better phrase. I think there is a general consensus that there is a deal of urgency around us having to deal with this and reduce emissions. What do you say to those who argue that the lead-in time, leaving aside the economics and whether or not that stacks up, but the lead-in time for these projects is just so great that even if we were to lift it tomorrow, have the exploration and start up the plants we would be 20 or 30 years down the track before we got viable reactors and, therefore, the horse has bolted, when we could have been investing in alternative technologies in that time? That is one of the key arguments, I think.

Mr GIBBONS: I think it is a strange argument. In our submission we have been pretty upfront about it. We say we are not quite sure that there is probably a role for large-scale nuclear plants in the current Australian energy market, but what we do see is small modular reactors. I know some of the arguments—people say, "Small modular reactors? No-one has built one". Well, I beg to differ. These have been around for 60 years. They sit in naval applications—in submarines and aircraft carriers, for instance, in ships. The only thing that is really different about small modular reactors is the way they are fabricated. They are built in a factory environment.

Think of it this way: It is an aircraft factory. Take the example of, say, the Boeing 787 or the Airbus A350. They were announced in I think 2002 or 2003. The first one did not roll off the production line until 2009. Between that period—and this is for both aircraft—between when they were announced and when they were first rolled off 1,300 orders were placed. You are dealing with a known technology. There are a lot of analogies between civilian jet aircraft and nuclear reactors. They are roughly the same age. The argument then I think swings onto, you know, these things will not be 20 or 30 years down the track. Small modular reactors—I think you have had a presentation from NuScale, which is the closest to commercialisation. It is expecting to be going through the US regulatory approval process sometime next year. It is expecting sometime in around 2026 or 2027 to be having the first reactors coming off the line. In the Australian and New South Wales context you should be looking at—

The Hon. MARK BUTTIGIEG: Sorry, coming off the line—

Mr GIBBONS: Coming off the factory line.

The Hon. MARK BUTTIGIEG: —meaning ready to plonk on a site?

Mr GIBBONS: Yes. In the Australian and New South Wales context there is no reason we should not be able to look at this, say, around about 2030. To come to your point around targets, let's be clear about the Paris targets. You have got a 2030 Paris target, where the Australian Government has committed to a 26 per cent to 28 per cent reduction on 2005 emission levels by 2030. But then the other element of the Paris agreement is net zero emissions by the second half of this century. I think this second part is an important—I think the thing to keep in mind is that if we as a country are starting to look towards net zero emissions by some time in the second half of this century then really you need all technologies on the table. To the point of your question—is it too late?—absolutely not. I think it sits right in the sweet spot of being able to at least have a consideration of a technology that allows you to significantly reduce emissions from the electricity sector but also has significant other applications outside the electricity sector.

The Hon. MARK BUTTIGIEG: So to Mr Frith's point and to your point as well, Mr Gibbons, I suppose one of the realities of this debate is that—and I think Mr Frith raised a valid point: you lift the ban and then you let the market decide the viability of the economics. If it is too expensive, it will not happen. The trouble is, of course, that this is a very political issue. As politicians, we have got to consider what the community's view is

on this stuff. You can well imagine the campaign that will be run if and when this happens and the sort of opportunistic imagery people will use about nuclear reactors in the backyard and all the rest. You have got to weigh that up against whether this thing is likely to stack up economically. Some of the evidence we have heard to date suggests that there are real problems with this stuff. For example, in Western Australia we have a real-life example of the market being free to determine. It is pretty flat over there. Nothing much is happening, is what we have heard. I thought that was one of the most telling pieces of evidence we have heard to date. What is your view on that?

Mr FRITH: I think this is in relation to uranium prices. As I mentioned previously and I am sure this Committee has heard already, those prices have been falling since 2011. What was a fairly buoyant market before then has kind of bottomed out and, as I understand it, is around the bottom of the cycle at the moment. It has not exactly been the environment for stepping up capital investment to increase production and increase volumes in the current market conditions.

The Hon. MARK BUTTIGIEG: But they have not had a ban for quite a while, have they? Uranium prices have been fluctuating over quite a long period and yet the market over there does not seem to have jumped on the bandwagon and fired it all up, so to speak.

Mr FRITH: How long has the ban been overturned in Western Australia?

Mr GIBBONS: I am not quite sure. To pick up on Mr Frith's point, what we are seeing at the moment is that uranium prices are low. But when you start to look at things like what the international panel on climate change is saying, it says to meet the Paris targets you are going to have to see a very substantial increase in nuclear power. Have a look at what the International Energy Agency [IEA] is saying. It just put out its *World Energy Outlook 2019* last week—again, significant increases in nuclear power under pretty well all scenarios. Yes, what is happening in the market is a function of demand and supply, but these things do go in cycles. If uranium prices start to pick up again you will see greater activity and interest in exploration and also in mining.

The Hon. MARK BUTTIGIEG: Can I ask—and I must be honest, I am not across the precise view on these people—but my understanding, and you people would know better than me, but these big players in the market such as BHP and Rio Tinto seem to be saying that the game is over with this stuff, the market is going towards renewables, that is where the action is and we are agnostic about that because we do not care whether we dig up cobalt or whatever it is you need in batteries; as long as the market is there, that is where our business is going. That is where the economics are. They are saying that renewables are the future for them. These are major players in the market who will, to a certain extent, dictate the way it goes. What do you say to that?

Mr GIBBONS: I cannot speak on behalf of the companies, but I would make an observation that the challenge across the sector is access to affordable, reliable power. However, we also exist in the real world. That power has to be coming from low-emission sources as we make the transition from relatively high-emission sources to low-emission sources. At the end of the day, all we are saying is that really you want to have every technology available. You want to have a truly technology-agnostic energy policy. I think if you would look at what companies are saying, they are also saying the same.

The Hon. MARK BUTTIGIEG: I suppose my point is that there is a real debate about the ability of us to move down a path where we are almost fully reliant on renewables—that debate is still live—and there is the downside to whether or not nuclear should be part of that mix. If the downside is too great then the answer is no. I think that is where the debate is at—that was my point. These companies seem to be suggesting that. Thank you for answering the question.

The Hon. SCOTT FARLOW: In the NSW Minerals Council submission at page 2 you remark:

> Modelling of the total system costs of various forms of generation technologies for the National Electricity Market demonstrates that while wind and solar PV initially provide the least-cost emissions reductions, their integration costs increase exponentially as they are deployed more broadly.

To that point, could we have on the current technology a wind and solar only electricity system in the future?

Mr FRITH: Combined with storage.

The Hon. SCOTT FARLOW: Combined with storage.

Mr FRITH: I think it may be technically feasible, but from the research that I have read it would appear to be economically destructive, for industry in particular. As this study—and I think you have heard some evidence regarding some modelling done by Dr Robert Barr as well from Electric Power Consulting—when you take in to account the exponentially increasing amounts of storage that are required, the additional capacity of intermittent renewables, solar and wind, that are required as you try to get to that 100 per cent, or even up to perhaps 50 per cent or 60 per cent penetration, other kinds of technology then become competitive. In this study that we

referenced in our submission done by Australian National Low Emissions Coal Research and Development [ANLECR&D] and RedVector, that was coal and gas with carbon capture and storage [CCS].

That showed that once you get to that 50 per cent or 60 per cent penetration of renewables, coal or gas with CCS then become competitive and you achieve those carbon reductions at least cost with those technologies. They have the benefit of not requiring the transmission investments that are required with increasing amounts of renewables throughout the State. They also, as I mentioned previously, provide those system services like inertia and frequency control and voltage control that are essential to maintain a secure grid, which solar and wind do not inherently provide. They have a number of benefits that reduce those overall system costs.

The Hon. SCOTT FARLOW: I want to understand the transmission costs across the State. When there is an energy source that is providing a significant amount from one location, there will of course be reduced transmission costs because it is linking to only one site. For instance, when we talk about small modular reactors in a grid system where there might be 600 megawatts or 800 megawatts being produced, that is a lower transmission cost compared to wind across a large area. Is that correct?

Mr FRITH: That is a fair observation. It is obviously a lot more predictable when you have got a dispatchable resource like potentially a small modular reactor, or dispatchable hydro, or coal or gas. Any of those kind of dispatchable and predictable technologies you know the capacity that is going to be required for that transmission infrastructure as well. Whereas with variable renewables, understandably it varies quite a lot and you need to plan for the maximum, but quite often you are not using that.

The Hon. SCOTT FARLOW: Mr Gibbons, I pick up on a point in your submission about the Levelised Cost of Electricity which says that on the basis of small modular reactors the Levelised Cost of Electricity could be about $60 per megawatt hour, which would make it lower than pretty much every other form of zero emissions technology that is available. Where does that figure come from? I know your point about nuclear substations and the like, but considering we do not have one in operation in the western world at the moment.

Mr GIBBONS: The study we cited was a study by the Canadian Small Modular Reactor [SMR] Roadmap. Basically in there it had a range of numbers. We are saying it could be as low as $60, but I think in our submission we have provided a table where we provide what the range is—it is $60 to $110. The Canadian roadmap is a serious piece of work done last year and it is basically looking at various technologies, going and talking to the individual companies and getting what is basically a bottom-up cost assessment of when they put all this stuff together how much it is going to be producing for.

The thing to bear in mind, picking up your point around no-one has built one yet, is the target market for SMRs is combined cycle gas turbines in North America. This is the technology that has driven power prices lower in North America, particularly in the United States, because with the advent of shale gas, cheap gas, they have been able to combine that with combined cycle turbines to produce low-cost power in the US. For SMRs to work they know they have got to target that market. Again, you have had a presentation from NuScale as they were explaining this, but what sits behind the NuScale number, which is part of the Canadian work, are some pretty rigorous cost assessments.

The Hon. SCOTT FARLOW: Further on that point, you say that part of this reason is because SMRs would not require additional storage, could be integrated with the existing transmissions and provide the full range of ancillary services critical for modern electricity grids. Does that go back to the point again that if you have solar or pumped hydro, or wind, they have to be located where either the sun is shining, the wind is blowing, or where the water is available, which is not where our current network distribution is set up? Is that part of the challenge you face with renewables and network costs into the future?

Mr FRITH: Yes, and there is obviously a much larger area of land required for renewables as well. When you have got a concentrated source of energy, like thermal or nuclear, then you can locate it close to the resource or close to the population centres or load centres that you need to. With wind and solar, they are much more diverse and dispersed resources that are going to take up a lot more area of land and require a lot more transmission infrastructure.

The Hon. SCOTT FARLOW: Mr Gibbons, and Mr Frith may like to comment as well, with respect to the discussion you were having with the Hon. Mark Latham before and also in your submission about where we are going with the closure of certain energy facilities, 8,000 megawatts of capacity to be lost into the grid by 2030, are your members confident that there is an adequate replacement strategy for that 8,000 megawatts at present?

Mr FRITH: In a word, no. The news of Liddell being extended for the summer period over 2022-2023 was welcome news. But I guess there are still concerns about where the new dispatchable capacity is going to come from. Under various modelling it shows that New South Wales is going to become increasingly reliant on both existing interconnectors and potentially new interconnectors that may be built with neighbouring States. But

that is going to leave New South Wales exposed to the reliability of those interconnectors, and we have seen reasonably frequent outages of interconnectors in the last five or 10 years, some for extended periods. The ability of New South Wales to source dispatchable supply from within New South Wales and be self-sufficient is a concern to our members.

The Hon. SCOTT FARLOW: With respect to the uranium mining aspects of the bill before us—this will apply more to the Mineral Council of Australia—do you have members who are uranium miners in South Australia?

Mr GIBBONS: Yes.

The Hon. SCOTT FARLOW: With respect to those members, what is their appetite in terms of increased uranium mining in Australia and exploring those prospects?

Mr GIBBONS: I think there is always increased appetite for exploration. As to how much and the timing of it, it really is a function of the uranium price, as Mr Frith has spoken about. At the moment there are relatively low prices. Prices may start to pick up. This is a cyclical industry, and there will be great interest.

The Hon. SCOTT FARLOW: Has that been a long-term trend in the industry? After Fukushima Germany and Japan have both talked about the closure of nuclear facilities. Prior to Fukushima, was that a characteristic of the market, significant peaks and troughs in the uranium price?

Mr GIBBONS: It is generally cyclical. Again, it is talking about the volatility in the market, it goes up and down. Post Fukushima, yes, Germany and Japan, certainly Japan, closed their nuclear plants. But there is a process of bringing them back on. Germany is committed to a policy of closing its nuclear plants, but it is starting to find some of the real world challenges in doing so. Where this goes is, nuclear energy, it is being built in places like China, Russia. There will be a rollout of people building nuclear power plants around the world. It is a question of how quickly they do it. It is then a question of how much will uranium demand be increasing as a consequence of that.

The Hon. SCOTT FARLOW: I know Russia is largely dependent on the Kazakhstan uranium. China, would we export uranium to China?

Mr GIBBONS: Unclear. I will take that on notice.

The Hon. SCOTT FARLOW: Your submission also mentioned that it is not necessarily what you mine, it is how you mine it that is the important thing when it comes to safety and individuals. I notice in your submission you say in the Australian uranium industry with the Australian National Radiation Dose Register that the relative doses of radiation are 1 millisievert per year, which is less than what people are getting flying in aeroplanes. Have there been any significant safety incidents that have occurred for workers in uranium mines in Australia?

Mr GIBBONS: Not to my knowledge.

The Hon. NATASHA MACLAREN-JONES: On workforce matters, I am interested to know your opinions on opportunities or challenges, particularly with reskilling our existing mining workforce should we move down a pathway of uranium mining in New South Wales.

Mr FRITH: I think there are a lot of similarities between uranium mining and other types of mining. In terms of whether we have the workforce here that could be used in uranium mining, I think the answer is definitely yes. In terms of some of the safety implications as well, there are already mines in New South Wales that are dealing with low-level radioactive material as part of the mining process, particularly for mineral sands. It is not an issue that is unfamiliar to the general expertise of the New South Wales mining industry. The New South Wales mining industry, and the Australian mining industry obviously more broadly, is recognised as a world-class mining industry with companies like BHP and other multinational companies that are involved in uranium mining elsewhere but also involved in New South Wales. There would be a strong ability to bring resources and skills to New South Wales should that be required.

The Hon. NATASHA MACLAREN-JONES: The only other question I have is in relation to the details of the bill that is before us. In your submission you talk about making sure that we have the legislative framework for the long term. I am interested in your views of the bill. Is there anything that you think needs to be looked at in more detail or amended in any way to ensure the long-term sustainability of the industry, should the lift occur and so on?

Mr FRITH: Our understanding is that the legislative amendments are reasonably simple in order to set up the legislative framework and the bill addresses that. I am not aware of any other legislative requirements that would be required, except of course for the ban at the national level.

The Hon. MICK VEITCH: Thank you for your submissions and your attendance today. Mr Gibbons, your submission talks a bit about Canada and what Canada can show New South Wales and Australia. What are the lessons that we can learn from Canada?

Mr GIBBONS: The key lesson is the commitment that basically they do not ban this. They have a uranium industry that exports uranium. They mine uranium, they process it and they also have nuclear reactors. They export their technology and expertise around the world. This is what you can do if you have an open attitude towards this. That is the main point. When you look at Canada, it is a country fairly similar to us in many regards. It has a slightly bigger population, but a fairly large landmass and fairly similar cultural background et cetera. Canada gives us an example of a different approach. They have an industry and they are coming off the back of that; we do not.

The Hon. MICK VEITCH: My understanding of mining is that people look at the mining operation without realising there are a number of companies that also participate in that sector. They are not directly related to the mine itself, but they provide services to the mine. That would be the same in Canada, would it not, with their uranium mining?

Mr GIBBONS: Yes.

The Hon. MICK VEITCH: What are some of those companies?

Mr GIBBONS: You have the standard mining services-type companies that provide direct services into the mines. With uranium you would be talking about companies that specialise in the transportation of it—again, this is nothing particularly new or novel, you just have to transport some elements differently. You have companies involved in the design around nuclear reactors. Canada produces its own designs and these are high-tech, specialist type firms. You have the manufacturing processes, companies involved in actually manufacturing the components for it. It goes through the whole value chain. When we look at the missed opportunities here, these are activities that would integrate well with an established manufacturing base such as you have in New South Wales. If you talk about advanced manufacturing, this is the embodiment of it. When we look at it, we see this as a great missed opportunity not just for New South Wales but generally for Australia.

The Hon. MICK VEITCH: You talked about missed opportunities and in your submission you talk about short-changing New South Wales. Has the been any modelling on the estimated royalty take for the State of New South Wales if uranium mining was to go ahead?

Mr FRITH: Again, it comes down to working out what the resource is. Because we have not been able to explore for it for about 30 years, it is difficult to understand what the royalty implications might be.

The Hon. MICK VEITCH: What about South Australia? What is their royalty take?

Mr GIBBONS: I will take it on notice.

The Hon. MICK VEITCH: The issue for New South Wales is what is the forgone revenue of not having these things in place. You also talk about small modular reactors [SMRs]. Has the council done any work on what rolling out an SMR network would look like? The Canadians are looking at doing something similar with their far-northern provinces and communities in those parts. Are you aware of any work that has been done that we could look at around rolling out an SMR strategy?

Mr GIBBONS: Where we have come from is really just dealing with first steps, which is removal of Federal and State bans on this technology. Ultimately what we are saying is let the market decide on this one—what is required, what is the most feasible. The market cannot do that while you have the existing bans in place. I know others have started to look at this, but I am not sure that they have looked in the context of small modular reactors. In one of our submissions elsewhere we have referred to a small modular reactor being able to power a city the size of Canberra. This gives you a sense of the kind of magnitude we are talking about. There would be similar areas in New South Wales.

The Hon. MICK VEITCH: The issue that Mr Fang was exploring was around the 2012 legislation in New South Wales that overturned the ban on exploration but did not go the whole hog essentially, because it did not allow extraction. If we were to go the whole hog and adopt Mr Latham's bill to remove the prohibition on extraction, what is the time frame from exploration through to actually extracting? Are we looking at five, six, seven years?

Mr FRITH: It can be quite lengthy. Undertaking exploration, there are difficulties in getting land access for exploration activities—it does not matter what the commodity is. There have been examples for other resources of about a five to 10-year time frame from the time of exploration through to project approval and then, depending on funding, construction after that.

The Hon. MICK VEITCH: It is not an overnight thing. There is still a way to go.

Mr FRITH: Exploration is a very difficult process. It is a commercially risky and uncertain process. It depends on when you find something. If you are lucky and you find something on day one then it will still take another couple of years to prove up the resource and undertake feasibility studies. Unfortunately, the project approval process in New South Wales is quite lengthy as well and so you are looking at an up to 10-year time frame.

The Hon. MICK VEITCH: Turning to transportation of this product, it would have to go to the Port of Adelaide, I would suggest, from New South Wales.

Mr FRITH: It would depend on where the mine was located.

The Hon. MICK VEITCH: What other port facilities have the capacity to load uranium?

Mr FRITH: I do not imagine any in New South Wales at the moment.

The Hon. MICK VEITCH: That is right. It would have to go to the Port of Adelaide, would it not?

Mr FRITH: If we overturned the ban and we could plan around these things, there may be opportunities to exported through New South Wales ports. Based on current arrangements, we would have to assume through South Australia.

The Hon. MICK VEITCH: I have been around a while and I think if you are going to bring it from somewhere west of Dubbo, say, over the dividing range and into a New South Wales port, you might have a lot more issues than you would if you were to take it to the Port of Adelaide, which already has the facilities in place. As we heard when we were there, they have only had one incident in the whole time.

Mr FRITH: A reasonable assumption, yes.

The Hon. MICK VEITCH: I am looking at this in the context that New South Wales maybe gets the royalties but does not have to invest too much on infrastructure and capacity. The other thing about SMRs is the regulatory framework that is required. If we look at the Canadian example, are they the most advanced in the world with SMRs or is somewhere else more advanced, such as Germany or China?

Mr GIBBONS: I would say it is actually an American company, NuScale, who presented before you. You have NuScale, the Canadians, and the British, through Rolls-Royce, are also looking at it. The French have an SMR design, as do the Russians. It is a technology that has been worked up all around the world. As with all of these things, a number of companies will be putting up their various designs. We will see which ones are the most successful, as you would expect for most competitive processes.

The Hon. MICK VEITCH: Your submission talks about developing a regulatory framework for small nuclear reactors. What sort of work needs to be done to put that in place?

Mr GIBBONS: The starting point is a given: the removal of the bans at the State and Federal levels. But it is also about our existing regulatory bodies—the Australian Nuclear Science and Technology Organisation [ANSTO] and the Australian Radiation Protection and Nuclear Safety Agency [ARPANSA]—working with their international counterparts to develop a similar approach on this. They would be working with North American and European regulators to do it. It is something they should be able to do. It happens over a period of time. But I think in a country like Australia it comes back to a timing issue. If we are not looking at this for another decade this is the kind of work that can be done in parallel quite easily.

The Hon. MARK LATHAM: Can I ask about any specific advantages for the mining industry with these smaller nuclear reactors that you mentioned? The vision of a smaller reactor powering up a country town in Western New South Wales and the mining operation that is not too far from the town comes to mind. That would lower the transmission costs. On the other side of the coin, the Government and policy in general has helped to create a large number of wind and solar farms in Western New South Wales. Have any of those got the capacity to power up any of your mining concerns?

Mr FRITH: In terms of New South Wales mining operations—I am not sure if I am quite getting your question—most of them are connected to the National Electricity Market [NEM], so there is no requirement for a diesel generator or something like that. They are sometimes required in other types of mining contexts, particularly in the Northern Territory and Western Australia. I imagine that in those other types of mining contexts, having a small modular reactor would be a potential benefit. Is that—

The Hon. MARK LATHAM: Okay, they need to be connected into the grid. But aren't mining companies able to form contractual arrangements with the energy suppliers? If it is smaller reactor associated with

the powering up of a country town, that must lower your transmissions costs. It must be appealing to have some direct relationship there. Are any of those relationships in place now with solar and wind farms?

Mr GIBBONS: I know of a few existing contracts with some mining sites and energy providers, of which solar, wind and/or other renewables are part of the contract. It comes down to what your demand profile looks like as a mine site. Some mine sites might only operate during the day. There are plenty that operate 24/7. They need access to reliable power in that context. The kinds of contracts they have in place will invariably have some form of baseload power involved in them. What is that baseload power going to look like in 10 years time or 15 years time? It comes down to the earlier point we were trying to make, which was that our existing coal baseload fleet will close, because it is old. The average age of our fleet in Australia is 34 years. It is kind of like you are driving around in a XA Falcon or XF Falcon today. What are we going to be replacing that with? All we are saying is that we should have everything on the table for consideration. As to Mr Latham's question about whether you could have a small modular reactor powering a country town and mine site, the answer is: absolutely.

The Hon. MARK LATHAM: On the issue of uranium mining and its value to the international effort to lower carbon emissions, we often hear the criticism of the coal industry because we export coal and it is burnt in other countries and adds to emissions. Is there any calculation on the benefit of the uranium we export, given that the uranium cannot be used for power purposes in Australia so it is all exported? I saw a figure that it is the equivalent of a 140 per cent mitigation of Australia's own carbon emissions. It logically follows that the more uranium we export the bigger effort we make on the international front to address the climate change issue.

Mr GIBBONS: In our submission we have a figure that says we export uranium and that if we had it in Australia for provision of electricity it would be the equivalent of 96 per cent of our national electricity grid. That is just Australia's uranium exports. This is a substantial contribution to reducing emissions. This is the opportunity that awaits Australia if we are serious about it. We are able to export a genuine zero-emission energy source to the rest of the world. This is about using a technology that is capable of providing industrial-scale power that can meet the demands and needs of industry and households for reliable power. When you flip the switch at 2 o'clock in the morning it is going to work.

The Hon. MARK LATHAM: A lot of the emissions debate is about how you count it. There is a wonder about how land clearing laws get counted into the Australia obligations for Kyoto. If we counted in our uranium exports we would be in the clear—zero.

Mr GIBBONS: That is part of the conversation. We export a reasonable level of uranium—almost enough to power our entire national electricity market. We do not seem to talk about—

The Hon. MARK BUTTIGIEG: We do not have control over how that uranium is used, do we? It could be used for weapons-grade—

Mr GIBBONS: No, there is really stringent international and bilateral treaties in place on this. This is used—

The Hon. MARK BUTTIGIEG: So every bit of uranium we export goes into nuclear power?

Mr GIBBONS: That is what the treaties are there for.

The Hon. MARK LATHAM: That is the Indian agreement that the Gillard Government struck.

The CHAIR: Thank you so much for your time here this morning and for your respective submissions. If you took any questions on notice, the Committee has resolved that answers to questions taken on notice be returned within 21 days. The secretariat will be in contact with you in relation to those particular questions. Thanks again.

(The witnesses withdrew.)

KATH SMITH, Executive Committee Member, Women in Nuclear, affirmed and examined

JOANNE LACKENBY, President, Women in Nuclear, affirmed and examined

The CHAIR: Good morning. I welcome our next witnesses. Would either or both of you like to begin with an opening statement?

Dr LACKENBY: Yes, thank you. Good morning, everybody. My colleague and I are here representing Women in Nuclear Australia Incorporated, which is the Australian chapter of Women in Nuclear Global, also known as WIN Global. We are both members of the Women in Nuclear Australia committee and therefore represent the views of the committee and our members. Thank you for having us speak at this important meeting. The rest of the WIN committee would have loved to have been here but have other obligations.

I will read our statement shortly, but I would like to make the following points on record. The peaceful application of nuclear and radiological technology, including nuclear energy, provides many benefits to people, society and the environment. The global WIN community sees nuclear energy technology as a key part of the solution in the fight against climate change. Noting that Australia has signed up to the UN Sustainable Development Goals, and the UN acknowledges that women and children are most gravely affected by poverty, natural disasters, climate change and inequality, Women In Nuclear Australia supports the move away from fossil fuel energy towards sources that will improve the lives of the world's poorest and those that will be most impacted by climate change.

I will now move on to read our statement. Women in Nuclear Global is a not-for-profit association of women and individuals of other genders who work professionally in various fields of nuclear technology and radiological applications. WIN has over 35,000 members from 110 countries worldwide. One of the aims of WIN is to promote understanding and public awareness of the benefits of peaceful nuclear and radiological applications, including nuclear energy, amongst women and young people. WIN Australia includes members working in professions such as research, nuclear operations, security, health care, medicine, waste management, regulatory authorities, mining, nuclear radiation safety, industry policy and communications. WIN Australia values its position as a professional organisation and seeks to inform this debate through expertise and neutrality, rather than lobbying.

In 2015 WIN Global produced a document known as *Women in Nuclear declaration for the earth climate*. This declaration calls for immediate steps to reduce carbon emissions that include nuclear energy as an option. WIN Australia acknowledges the UN's sustainable development goals and understands that sustainable and reliable energy is a key part of meeting these goals. With around one billion people worldwide still without access to electricity, there is still much work to be done. We would like the Committee to note that nuclear energy is a proven, low-emissions technology with advanced safety management. The types of nuclear reactors under construction in the world today align with Australia's high standards and expectations for health and safety. Due to nuclear energy's low mining resource and land use requirements, high energy density and extremely low greenhouse gas emissions, nuclear energy is a feasible and suitable technology for Australia and New South Wales in terms of its low environmental impacts.

We suggest, firstly, that the Committee recommends that the New South Wales ban on nuclear energy be overturned to allow an educated community engagement and public debate, and the consideration of nuclear power as part of the energy mix for reducing carbon emissions and firming electricity supply in New South Wales; and secondly, that the New South Wales ban on uranium mining be overturned to allow New South Wales to contribute to the global effort to reduce carbon emissions. WIN Australia thanks the Committee for considering of our submission and for inviting us here today to ask further questions.

The CHAIR: Dr Smith, do you have an opening statement you would like to make?

Dr SMITH: No, my president has said it all.

The CHAIR: Sure thing. No problem.

The Hon. WES FANG: Thank you very much for appearing today and thank you very much for your detailed submission; it is really good to see so much work being put into the information provided. With regard to nuclear power, the bans are in place at the moment but we have a situation where we are reliant on nuclear processes for medicine and a number of things, and we have a nuclear reactor at Lucas Heights. How do we go about bridging the gap in the opinion of people that we can use nuclear in medicine but somehow it is prohibited in power generation?

Dr SMITH: The places in the world that have nuclear power have a positive community attitude towards it. When the Canadians were selling nuclear power reactors into Africa they invited some of the Indigenous population from Canada to go and talk to the people in Africa. So I think community-to-community communication is a great way forward. I also think that you cannot have just the voices of a particular group like the one here—strong professional people of a certain age—because the voices have to be diverse, in all meanings of that word.

The Hon. WES FANG: I imagine your organisation, being an associate of a global organisation, would have access to much research and experience from other jurisdictions as to how they have handled the transition.

Dr SMITH: Yes, absolutely. That is why I am saying that often community-to-community discussion is good. In Finland, which has built the first one of the generation 3-plus reactors and is now building a second one north of the Arctic Circle, they had a lot of community consultation. They actually had a shop front in the town that was considering being a volunteer community. So I think that there has to be ongoing continuation consultation. The people who were manning the shop were of a similar socio-economic and cultural background to the people that they were talking to. So there was communication on every level. There was communication from the government saying, "We need to improve our economics but we also need to manage our energy usage to make sure that we are carbon neutral by 2050, blah, blah, blah." So you can have it from the top but you need it from the grass roots as well.

The Hon. WES FANG: One of the things I find interesting about this debate is that we obviously have the mining exploration ban lifted but we still have the ban for mining itself in place. So there is an opportunity to lift that as well as repealing the ban on nuclear facilities within the State. If we do that is there a potential that we could, as a State, tap in and value add to the produce—that is, do you think there is the experience that we might have to be able to refine the product in this State to potentially join in the small modular reactor program at some point? Does your group think that we have the expertise in New South Wales to be a player in that field?

Dr LACKENBY: Just back to your previous question, I think that the benefits associated with the Open Pool Australian Lightwater [OPAL] research reactor in Sydney are well known. The benefits to people being nuclear medicine, research et cetera. So with the nuclear energy prospect for New South Wales for me it is largely about making known what the benefits are to the people in the community that come with nuclear energy, including the environmental benefits. In terms of the small modular reactor [SMR] program, I think New South Wales is in a fantastic position to take part in an advanced technology that will be around very shortly—within the next 10 years or so—and make this State a leader in its energy, with really low carbon emissions.

Dr SMITH: I think there are a couple of opportunities. We were listening to the conversation with the mining councils earlier. Even if you open it up, it is going to depend on economics as to whether or not uranium gets mined. However, there are 50 reactors under construction around the world. We may or may not be able to export to China but China is going to absorb a certain amount of the world requirement for uranium. The rest of the world is going to potentially have greater need for uranium. There are opportunities for uranium. The second is that when you have mines in a remote location you have all sorts of benefits to the local community, because you are providing not only the value chain for the mine itself but you have also got infrastructure. You have got places where people need to live so you have got local businesses and you have got that whole added benefit for remote communities. The Minerals Council talks very volubly and accurately about the value chain for mining, but there is also the local benefit as well.

With regard to enrichment, Australia is bound by the non-proliferation treaty, so we would have to negotiate to become an enrichment country. However, I think that—I may be incorrect, but I believe that we could potentially look at manufacturing. Once the enrichment is done you can take low-enriched uranium and make fuel rods. We could be in production for fuel. This is hypothetical, of course. The other part of it is that our neighbours Indonesia, Malaysia and some of the other south-east Asian countries are looking at nuclear power. We could potentially provide leadership or precedent in that sphere. Certainly if New South Wales moves towards nuclear power then we would provide leadership for Australia.

The Hon. NATASHA MACLAREN-JONES: I have a question in relation to a Roy Morgan poll that came out a few months ago. It indicated there was a gender difference when it came to men's understanding of or support for nuclear versus that of women. In your opening statement you made comments about particularly the educational role that your organisation would like to play in this space. I am interested in your views on the difference between men's and women's views of nuclear and support for it, but also if there is a difference in age, whether it is the younger generation versus older generation and so on and how that can be addressed.

Dr LACKENBY: Women, both historically and in the recent poll that you just referred to, do appear to not be as supportive of nuclear technologies as men do. However, something very interesting about that poll is that it actually shows that women will reserve judgement if they feel like they do not know the answer.

From memory that particular poll was about 67 per cent of men in support, 38 per cent of women but 22 per cent of women were undecided. That is the group of people that organisation such as WiN would really like to have a dialogue with so that they can understand the issues and then maybe have a bit more of an understanding whether they want to say yes or no. Absolutely, worldwide the polls tend to indicate fewer women do support nuclear. They also tend to not support fracking—it is not just a nuclear issue. There are many other issues that there can be quite a significant gender divide on. I must admit, though, I did not look at age. Dr Smith, did you have a look at the age?

Dr SMITH: In that Roy Morgan poll there did not seem to be a great deal of difference across the age groups, but in other discussions the younger generations tend to be more interested in climate change and are therefore looking for options that will address climate change. The other thing that we would like to raise is that it is not so important about gender, but your worldview effects how you view any form of energy production. There was fabulous recent research that we found last night.

Dr LACKENBY: This was presented in a World Nuclear Association "World Nuclear News" newsletter. It is a story about the way your worldview effects your views on nuclear energy a lot more than your gender does. Some of this research is out of Yale University. We would be happy to hand this over. It is actually more of a risk perception difference between men and women and their worldview, rather than just purely what your gender is.

The CHAIR: If we could have that tabled for circulation, that would be really handy. Thank you.

Dr LACKENBY: Excellent. It talks about whether you have a hierarchal worldview or an egalitarian worldview or individualist or—I think I am going to get this wrong—a communitarianism view. Those who ascribe to a hierarchal view believe those in power can decide what is right for everybody and who believe in individual rights are much more likely to support nuclear energy, because they see the risk of nuclear as being very low. However, those on the opposite end see the risk of nuclear being very high. We are not sociologists but we suspect that many more women potentially fit down in the group that see nuclear as having a high risk.

The Hon. MARK LATHAM: But you were saying in the Morgan poll—was it 32 per cent of women undecided?

Dr LACKENBY: It was 22 per cent, compared to I believe 7 per cent of men.

The Hon. MARK LATHAM: Right, so still a more significant group. In your submission you talk about community engagement. If the New South Wales Government was to run some kind of public education program, you would suggest targeting women who have communitarian-type views who are undecided as the group that most potentially could get a stronger understanding of the benefits of nuclear?

Dr SMITH: I would hesitate to tell you about your game, but it is the swing voters. You are going to have people who are pro-nuclear and anti-nuclear, but it is the swing voters who are going to decide the election.

Dr LACKENBY: The middle ground.

Dr SMITH: Yes, sorry.

The Hon. MARK LATHAM: Is there any plan for WiN itself to do specific things in this area? I know internationally you are a very strong organisation—110 countries, 35,000 members. What can be done? Does the international body often think, "There is a debate underway in Australia, some 22 per cent of women there are undecided," and that this is a nation where through lifting the profile of the Australian franchise that you can play a really constructive role?

Dr SMITH: It provides resources to the individual countries and how we choose to use them is up to us. It is very much a grassroots organisation. But we do outreach; our members go to school and to community groups and speak.

The Hon. MARK LATHAM: How much of that do you do at the moment? I have got to say that in all honesty—

Dr SMITH: You have never heard of us?

The Hon. MARK LATHAM: Well, that is a very blunt way to put it, but I might not be alone in that. However, the main thing for the future is we want to hear a lot more from you. We want to know and hear a lot more from you. What are you doing at the moment and what, potentially, in our recommendations could the Government here be doing to help facilitate your important outreach work?

Dr LACKENBY: Our work to date has been mainly focused around other peaceful uses of nuclear that do not involve energy—the good work of the Australian Nuclear Science and Technology Organisation [ANSTO]

and hospitals, medicine and those kinds of areas. We feel like we have been a little bit restricted by the bans on nuclear energy. Many of our members are actually government employees, which makes it difficult to go and speak about a topic that currently has some restrictions on it, some legal and policy restrictions around it. We are finding that with the inquiries going on at the moment we now have a bigger opportunity to come and to talk to politicians and also to the community, especially if those bans are lifted. We feel like we could have a much bigger impact on the population.

The Hon. MARK LATHAM: So your work so far has been about medical nuclear benefits, but there is no reason why you cannot get into this other debate on a broader scale about power?

Dr SMITH: Absolutely not.

The Hon. MARK LATHAM: Because there is no doubt that we are having an energy security debate, we have blackouts—you talk about "risk factors". If women are more worried about risk factors then the risk of blackouts and higher electricity prices are all big things in any household, are they not?

Dr SMITH: Absolutely.

Dr LACKENBY: Absolutely. I totally agree with you. It is definitely going to be a focus for us, going forward.

Dr SMITH: We would also like to table—this is the UN Sustainable Development Goal report, but there is one page in it in particular which talks about all of the impact on women of energy. If we could table that—there is a copy for each of the members, if they want it. The report itself is tens or hundreds of pages long, but we like this particular diagram.

The CHAIR: Thank you.

The Hon. MARK BUTTIGIEG: I found that little summary we got about the likelihood of women being less supportive than men fascinating. From what I could gather that was notwithstanding the worldview thesis—that had its own little separate demographic. Regardless of your worldview, if you are female you are less likely to support nuclear. Is that right? From what I could gather, notwithstanding the world view thesis, that had its own separate demographic, regardless of your world view, if you are a female you are less likely to support nuclear. Is that right?

Dr SMITH: Yes, and there is more likely to be "don't knows".

The Hon. MARK BUTTIGIEG: Have you done any research as to why that might be the case?

Dr SMITH: We have not, no.

The Hon. MARK BUTTIGIEG: How was your organisation formed? Was it an initiative to address that imbalance in gender perception? What was the genesis of the organisation?

Dr LACKENBY: WiN Global started in the early 1990s because it was identified that most of the people in the nuclear industry who were going out to do public outreach were men and that if you wanted to have a more effective dialogue with the entire diverse population you needed a diverse group of speakers. In the early 1990s a couple of female nuclear communicators got together and effectively started the organisation. Its first primary aim back in the early 1990s was around communication with the public on the benefits of nuclear energy. It has since evolved in that time to include the benefits of all peaceful nuclear and radiological applications, and also evolved to include mentoring, networking, support and sharing of information worldwide as well. It very much was about nuclear energy at the start.

The Hon. MARK BUTTIGIEG: How do you survive? Do you get funding from anyone? It is a voluntary group, is it?

Dr LACKENBY: One hundred per cent. There is some in-kind support from the World Nuclear Association, possibly the International Energy Agency [IEA], but it is voluntary.

The Hon. MARK BUTTIGIEG: On the medical electricity larger scale production dichotomy, can you outline for us—I think there is a general view with ANSTO, it is a good thing, it is producing radio isotopes for nuclear medicine and the waste is relatively low level. But if we go to a larger scale production we are going to have to deal with a lot more waste. Can you give us your view on that? My understanding is that the waste issue because of that facility is much more easy to manage than it would be if we had large-scale electricity production in the countryside, because you then have the issue of the rods that you have to dispose of, reprocessing, storage facilities, all that sort of thing. Could you give us a view on that?

Dr LACKENBY: To clarify, when you say waste, are you meaning particularly spent fuel?

The Hon. MARK BUTTIGIEG: Yes.

Dr LACKENBY: Not other low-level waste?

The Hon. MARK BUTTIGIEG: My rudimentary understanding is that the waste as a result of the medical facilities, like ANSTO at Lucas Heights, is much more low level, therefore easier to deal with. Whereas if you start putting in the modular reactors for electricity production, the waste is high level, therefore takes a lot more intensive remediation, if you like, or reprocessing and storage.

Dr LACKENBY: The Australian Government's current approach to the management of Open Pool Australian Lightwater [OPAL] spent fuel is to ship the spent fuel overseas to reprocess it to take out the useful materials and then to send back to Australia the leftover materials. The waste that we get from medicine production in Australia is what we call intermediate level waste. So, that is correct. We currently do not have any high-level waste or any spent fuel because we do export it and bring back the—

Dr SMITH: Residues.

Dr LACKENBY: The residues.

The Hon. MARK BUTTIGIEG: How are the residues dealt with over here?

Dr LACKENBY: They are currently stored at the Lucas Heights site in a purpose-built facility awaiting removal to a—

Dr SMITH: To the National Radioactive Waste Management Facility, which is currently under discussion.

The Hon. MARK BUTTIGIEG: If we were to go to electricity production, then you would end up having high-level waste, would you not?

Dr SMITH: No. The definitions of high, intermediate and low are not clear, or not easily explained. But with spent fuel it is highly radioactive for a time. As it is at OPAL, it is usually stored in water to—

Dr LACKENBY: For cooling purposes.

Dr SMITH: For cooling purposes, then it is shifted from wet storage to dry storage, and then to be reprocessed. What other countries do with spent fuel, some countries store it indefinitely. For example, in the US they store it, they put it through wet storage into dry storage and store it indefinitely at ground level. In Finland and in a couple of other countries they are building geological repositories for spent fuel. So you can store it in the long term. Most of the ones where they are storing it in geological repositories are being designed so you can retrieve it, which makes it high cost, but it means that they expect to want to use the uranium sometime in the next 300 years.

If you reprocess it, as we have chosen to do—the French reprocess all of the fuel from their power reactors. They make at the moment over 50 per cent of their electricity from nuclear. They reprocess all of their fuel and then they deal with the residues. I am not certain how. I think they have low-level repositories. Once you reprocess it, you are taking out the usable uranium. When you put a rod through a reactor it only uses up about 6 per cent of the uranium, so the remaining 90 per cent can be recycled, and the majority of it gets recycled in the French system.

Dr LACKENBY: It is actually possible to recycle about 97 per cent of a used fuel assembly. So that greatly reduces the volume of the waste you need to deal with, and also the length, how long that waste will last for as well.

The Hon. MARK BUTTIGIEG: That 3 per cent, that is the bit you have to deal with.

Dr LACKENBY: That is correct.

The Hon. MARK BUTTIGIEG: You mentioned in a previous answer to one of my colleague's questions on the small modular reactors, they are available in 10 years. Can you outline what you mean by that? Does that mean that small modular reactor technology would be available in roughly 10 years to get on the market and then deployed? Is that the idea?

Dr LACKENBY: That is my understanding, that with the speakers this morning, that the NuScale design is the nearest to commercial operation, 2026-27.

Dr SMITH: But it depends, the UK, Canada and the US are all pouring money into the development and licensing of SMRs. Currently there are licence applications in for a number of SMRs. In some cases they are

new technology. In some cases it is just scaled down technology. The advantage from my perspective on the SMRs is that it takes eight to 10 years to build a one megawatt reactor.

Dr LACKENBY: One gigawatt.

Dr SMITH: I beg your pardon—units. Which is, of course, two to three governments. Whereas an SMR will be able to be built in three to five years. That is how long it takes to build a submarine reactor. So they are anticipating it will take about five years to roll it off the production line. From a political point of view that is a big factor. From the point of view of specifying though, we are of the view that Australia will need a mix of energy sources, because there are so many evolving at the moment, there are pros and cons for all of them.

There is development going ahead in many spheres. The recycling of batteries is not yet routine. There is going to be evolution over time and most countries, even the ones who are highly nuclear, still have others in their mix. I think a diverse portfolio approach is perhaps a robust way to go. We are also not committed to one sort of technology in nuclear over another. It depends on what you are aiming to do and then what is appropriate for the economic, environmental and social needs of the application. We are not technology specific, we just think all possibilities should be explored.

The Hon. MARK BUTTIGIEG: You also touched on the benefits, the economic spin-off stimulus, to regional centres of mines. Has any analysis been done on the comparison between that sort of economic development as a by-product of building nuclear reactors or opening up mining, for example, versus renewable technology? It does not sound like there has been a whole lot done in this area, but in the construction phase both forms of technology will produce construction jobs and ramp-up and all the rest of it because that phase is capital intensive. Once they are up and running, it is largely a function of maintenance. Do you have any idea of which would be better for the economic benefit of communities in terms of providing jobs in the long term? It is probably more a question for someone who has done an economic modelling on it and I am surprised no-one has.

Dr SMITH: I think you have some witnesses later today who will touch on these things. We defer with great respect to some of the later witnesses today.

The Hon. MARK BUTTIGIEG: Fair enough.

The Hon. MICK VEITCH: The Committee has heard testimony that if we were to move towards the aspirational goal of nil net carbon emissions by 2050, the mix for our power supply needs to be well thought through or we would move from an industrial and manufacturing style economy to a recreational style economy, essentially because there is no reliability or assurance on the baseload, which is pretty much what I think my colleague was moving to. Would you agree that careful consideration needs to be given to the mix?

Dr LACKENBY: Absolutely, yes, with a long-term view of, say, by 2050, if New South Wales' goal is net carbon neutrality, there are different ways to get there.

Dr SMITH: Also, what sort of economy do you want for New South Wales in 2030 or 2040 or 2050? Do you want it to be industrial-manufacturing? Do you want it to be a knowledge economy? Do you want it to be a recreational economy. That is a question that is beyond our scope of expertise, but one that, if you can leave all of those open, that is probably the best way to go. I would like to add to that to say that the nuclear sector does, in some countries—for example, in the US where they have around about a hundred nuclear power plants—provide skilled jobs with long-term futures. Every time the nuclear industry in America goes to lobby on Capitol Hill, they work in lockstep with the union representatives there. That is a remarkable alliance.

The Hon. MICK VEITCH: Part of the risk areas that we have an eye on is the carbon cost of our economy. We can set some aspirational targets, but if we do not have an idea of what economy we are trying to move to, we get out of step. The risk is that we, as policymakers, pull levers that get it out of kilter. We need to be mindful of what the transition looks like. Earlier on there was discussion around educating the community and engaging the community in dialogue around uranium mining and the safety issues of nuclear. That is a part of any discussion around what the economy will look like in 2050 and what jobs will be in the economy. We have recently had a television show, the series *Chernobyl*. We currently have a policy that is 30 years old and has not been updated for the current technology advancements, but the TV series *Chernobyl* takes people back to the reason why we have the current policy settings. How do we overcome all that?

Dr LACKENBY: We could make a counter TV show about the effects of fossil fuels on human health.

Dr SMITH: As has been done, which means that nobody wants to do anything. In the end, we do want stable, sustainable, affordable electricity for the life that we currently have. You are absolutely right, but as a community we have an ongoing need to start having better energy and energy market literacy across the nation.

The Hon. MICK VEITCH: That is true.

Dr SMITH: We went through a period where we learnt a lot about economics, and that is great, but now we need to think about the energy environment and energy markets and our literacy needs to be that much better. With regard to *Chernobyl*, I would like to make two comments. One of them is that those reactors were the same vintage as some of the reactors in the US, but all of the ones in the US were retrofitted with devices that would not allow those sorts of things to happen.

Dr LACKENBY: Not just the US, but throughout the world.

Dr SMITH: Yes, throughout the whole of the West. The reactors in Chernobyl were allowed to stay back in 1960s technology. If you have a strong regulator, you have a safe environment. You need to have a look at Australia's health and safety record in building. Our behaviours and our safety are so much better than they are in a lot of other countries. Our regulators are strong and that is a good thing.

The Hon. MARK BUTTIGIEG: That is debatable.

The CHAIR: I thought the lesson from *Chernobyl* was that Communism did not work.

The Hon. SCOTT FARLOW: I want to put a couple of questions to you from what was said at a session last week to get your perspective. One of the things that we were told was that nuclear power could not possibly pass any reasonable economic tests. What would you say to that?

Dr SMITH: There are a lot of figures going around, are there not?

Dr LACKENBY: I guess it depends on what your objective is. If your objective is net carbon neutrality by 2050 and you put emphasis on that fact and there are incentives for very low emissions technologies that are economical then I do not think that is necessarily true.

Dr SMITH: We quoted in our submission the International Panel on Climate Change Working Group 3 Mitigation of Climate Change Annex III, Table A.III.2 on page 10 of our submission. The life-cycle emissions data is there. We also looked at cost. I think Dr Lackenby's point is perfectly valid. On page 14 of our submission we talk about the costs per gigawatt output over the lifetime of different things. You will see that solar, wind and nuclear are comparable and that Generation IV look like they are going to be the cheapest, but they do not exist at the moment. That is the Industry Super Australia; we do not have any vested interest in them and they do not have any particular vested interest in nuclear. There are numbers out there that can be used and can be generated in different ways.

Dr LACKENBY: It is true that the upfront capital costs of nuclear can be higher than other technologies, but today's nuclear plants are designed to last at least 60 years, possibly up to 100 years. In that time we have had to replace other technologies multiple times.

The Hon. SCOTT FARLOW: I take it the fuel source is also cheaper in comparison to the volume you would require in coal power, for instance.

Dr LACKENBY: Absolutely, yes, nuclear fuel is much cheaper than gas or coal.

The Hon. SCOTT FARLOW: One of the other things said to us last week was that no-one could have any confidence that satisfactory solutions could be found for waste streams and globally no country has a repository for high-level nuclear waste. What would you say to that?

Dr LACKENBY: We talked before a bit about reprocessing and the way you can take a used fuel assembly and reuse the material. There are designs for advanced reactors that would get 60 times more energy out of today's fuel than we are currently getting by using the fuel once. There is definitely a case for reusing fuel, which will reduce the waste as well.

Dr SMITH: The other thing is that the Finns are building a high-level waste repository as we speak. It is in the same location as the current low-level and intermediate-level waste repository. I would highly recommend a visit, but maybe not at this time of the year.

Dr LACKENBY: Nuclear waste is one of the better wastes because it is a solid material. The international nuclear community knows how to manage this material; it has been managed for decades and decades with no serious incidents at all. Other forms of energy can involve gaseous releases into the atmosphere that are not being controlled very well. WiN sees the issue of waste as probably less significant than the issue of imminent climate change and global threats to our environment.

The Hon. MARK BUTTIGIEG: It was an issue when they were dumping 44 gallon drums over the side of tankers in the Atlantic some decades ago.

Dr SMITH: Are we talking about the Russians again?

The Hon. MARK BUTTIGIEG: I do not think it was just the Russians, to be honest. It was happening on a big scale for a long time. To say that it has never been a problem is not entirely accurate.

The Hon. NATASHA MACLAREN-JONES: Following on from waste—only because I do not fully understand the low and medium levels—how does nuclear waste and its disposal compare to heavy metals, asbestos and things that are currently being used now, albeit not in energy? As I understand it, nuclear waste breaks down.

Dr LACKENBY: My understanding is that things like heavy metal and asbestos do not break down with time. That may not be technically correct and it may be a broad statement to make. But with the radioactive material, the more radioactive it is, the shorter its lifetime. If you can imagine that a very radioactive atom is like a small kid who is full of energy—they get rid of their energy very quickly and then become stable. Things like uranium have a longer lifetime because they are not very radioactive. They just sit there and give off some radiation now and then. The more radioactive a substance is, the shorter its lifetime. The less radioactive a substance is, the longer its lifetime.

The Hon. NATASHA MACLAREN-JONES: In some ways it is safer.

The CHAIR: That is a very interesting point. Colloquially, when you talk to a layman opponent of nuclear they will give an example of waste that lasts tens of thousands of years and what not. We have touched on high-level waste here, and that is a great example of what actually happens. Let's go down the hypothetical path of what would happen if Australia had a nuclear power industry. In reality, how long would our power waste last if we were not to reprocess it for whatever reason and were going to store it instead?

Dr LACKENBY: If the New South Wales Government or Federal Government—whoever it may be—decided to just store it, you probably are looking at 100,000 years plus to get back to the level of its environmental background.

Dr SMITH: There has been modelling done on it. I do not know what it would take to get back to base level. But it is not so useful to talk about how long it would take to get back to background level. We need to compare it to other levels of radiation that people are exposed to on a regular basis. From bananas to cheese to air travel, there needs to be a lot more lay examples of radiation sources that people are routinely exposed to and have no qualms about.

The CHAIR: I might throw some information out from the World Nuclear Association—it is not from your submission; it is a submission put together by the Minerals Council of Australia, which appeared before us earlier. It states that, "After 40 or 50 years the radioactivity of spent nuclear fuel falls to one $1/1000^{th}$ of the level at its removal from the reactor. After 1,000 years it has the same radioactivity as naturally occurring uranium ore." What kind of process might have taken place for those facts and figures to ring true?

Dr SMITH: The World Nuclear Association is an industry association. All the nuclear miners, energy production people and everyone concerned with nuclear technology pay a small fee to be a member. It is very reputable. If it is wrong it gets corrected faster than Wikipedia. It has briefs on every country in the world. It has briefs on every technology in the world. Its library, which is available to the general public, is a very reliable source of information. I trust them; not us.

The CHAIR: On that bombshell, we might wrap up. Thank you so much for appearing this morning and for your submission. The Committee has resolved that answers to questions taken on notice should be returned within 21 days. The secretariat will be in contact with you in relation to any questions taken on notice. Thanks again for your time and submission.

(The witnesses withdrew.)

(Short adjournment)

MARTIN THOMAS, Australian Academy of Technology and Engineering, sworn and examined

STEVEN RODGERS, Senior Policy Advisor, Energy and Public Affairs, Engineers Australia, affirmed and examined

The CHAIR: I welcome our next set of witnesses. Would either of you like to begin with an opening statement? I remind members and witnesses to use both microphones in front of them and to speak clearly.

Mr THOMAS: Before I begin I will mention that I am fairly hard of hearing. If the Committee can speak into the microphones that would be very helpful. Good morning. My name is Martin Thomas. I am honoured to appear before the Standing Committee on State Development today. I appear on behalf of the New South Wales division of the Australian Academy of Technology and Engineering [ATSE], of which I am an elected fellow and a past vice president. I was the founding chairman of the academy's energy forum, which focuses on energy issues. I am a professionally qualified engineer and a past national president of Engineers Australia, represented by my colleague Steven Rodgers today. Back in the 1980s and early 1990s I served as chairman of the then NSW Electricity Council. The council no longer exists, but in its day it was the industry's mouthpiece to the Minister of the day. I served four different Ministers. I will respond to questions on the basis of my personal experience. If I am unable to provide answers in the detail they require I am happy to take them on notice.

My professional career has spanned nearly all aspects of energy and electricity supply. As you can see, I am an old man and I have had quite a lot of experience. I never quite retired. I came to Australia to represent my firm, which was building diesel-powered stations for the mining communities of Western Australia. I subsequently built gas turbine power stations and have had a small involvement with coal-powered stations. I became a leader in Australian energy industry conservation, which, at the time, was very important. Finally, post retirement I was the founding director of the Australian Cooperative Research Centre for Renewable Energy. I do have a good background. Most important today, I was privileged to be the engineering member of the Uranium Mining, Processing and Nuclear Energy Review [UMPNER], led by Dr Switkowski, back in 2006. At that time, we thought the future in nuclear energy for Australia was assured. That was not to be. I have read most of—but not all of—the submissions. You would have read my submission. I would like to emphasis certain key points today, and I will keep them very brief. A transcript of what I am speaking to can be handed to the secretariat, if you wish.

The key points I would like to raise are these. First of all, your remit and my recommendation is repeal of legal constraints. I am saddened that such legal impediments were ever put in place and I can only recommend most strongly—I am supported by many of my fellow academicians—that they be repealed and that we do our level best to catch up with where the rest of the world is going. Australia is the only OECD nation to be so inhibited at the present time.

I would like to speak, if the questioning runs that way, on the importance of a diversified technology mix. I am not a partisan pro-nuclear or anti-renewables, or anything silly like that. I believe that these are very different technologies. Just in the different ways we select our motorcars for the purpose we require them, all means of transport and all means of generation are part of the mix. In fact when our report was delivered at the National Press Club, Ziggy was asked a question from the floor, "What do you think the percentage could be, Mr Switkowski?" He said, "About 25 per cent of Australia's energy mix." At the moment, of course, it is nothing. Today I would say that that is probably the direction I would move in, although predicting the future is difficult

I would like to discuss, also, some aspects of economic modelling. I make the comment that every academic I know of has his own model. CSIRO has its model and Dr Robert Barr, who I think has made a submission to you, has his model. In the case of CSIRO—of which I am going to be a little bit critical—I was asked by CSIRO last March—not this year but a year-and-a-half ago—to be, for the second time, the chairman of the external review of CSIRO. I believe that CSIRO is an absolute national treasure. It is something that we in Australia can be immensely proud of.

The CHAIR: Hear, hear!

Mr THOMAS: The work it does is, alas, under-appreciated. However, nuclear energy is not its field. On renewables and everything that goes with it CSIRO has made some wonderful advances, including hydrogen and so forth. I would particularly like to express concern that a widely circulated report, GenCost 2018, uses costs of A$16,000 per kilowatt installed, and thus leads to the conclusion that 100 per cent renewables plus firming would be or could be the solution for Australia. I can only say that in my view that is absolutely patently badly wrong. Other models, notably that of Dr Robert Barr, which has already been submitted to the Committee, shows that a diversified mix leads to the most balanced economic solution. Most importantly from my experience in the energy industry, particularly electricity supply—this is plainly obvious from the perceived or actual reliability of the system in this and other states—we have already moved too far towards the idealism of excessive penetration

of renewable energy, and we have dismissed, again for ideological reasons, the notion of adding to our stock of coal-fired power stations.

I am not today going to address the issue of climate change; it is beyond my ability to do so, although I have my own views. Therefore I support the mix. I am deeply concerned about the excessive advocacy given in the press and by certain individuals to renewable energy. Such views are widely picked up by the press and they tend to inform the community. I make the point—the previous speakers touched upon it—that between nuclear and renewable energy we are talking about two totally different things. To address the issue of cost at the terminal is utterly irrrelevant. The fact is, as the previous speaker addressed, a nuclear power station can last 60 years or probably more. Modern coal fired power stations are approaching that. Renewable energies can last possibly 20 years, maybe 30. Therefore they need to be replaced, as the speaker said.

I am sure you have been addressed about the issue known as capacity factor—that is, the ability not to reach the nameplate rating of X megawatts, but to deliver X megawatts 24/7. The ratings for renewable energy are anything between 15 and, on a very good day for wind, up to 40 per cent offshore wind, which we have very little of. Therefore, in terms of an investment in a megawatt of nuclear you would need an investment in 6 to 9 megawatts of equivalent renewables. That is just a plain engineering fact. It does not mean one should be used and the other should not—not at all—but does suggest that they have different roles to play in the spectrum.

I would like to address public attitudes, on the grounds that I have given approaching 200 public addresses to all manner of community organisations. I am giving one later today, as a matter of fact, to an organisation called U3A. I never push myself; I always get invited, and I am finding the reaction of the community is generally, once explained, very logical and very much supporting the motion that you are discussing today—that the legal impediments should be removed. The issues I address—and I am happy to discuss—would be the public perceptions of safety, how the waste is disposed of, what are its economics and what are its environmental impacts, good and bad. The advantages I have touched upon. The disadvantages are distinctly construction time, although for SMRs—which were discussed in the previous session—people are speaking of up to three years. But for us, standing where we are today, that is only part of the equation.

We would need to, in parallel, establish the regulatory environment that would be based on the existing Australian Radiation Protection and Nuclear Safety Agency [ARPANSA] and Australian Safeguards and Non-Proliferation Office [ASNO] organisations, both of which I have spoken to, and both of which have the potential, if so instructed, to inform an international regulatory agency which we could be proud of. Those organisations are internationally much more highly respected than they are at home. Financing is a challenge; I certainly grant that. There are risk elements and the initial capital cost elements. It is probably beyond a realistic economic imagination that governments could play no part in it and leave it entirely to the private sector. I am not an economist but life experience suggests that, like building the railways or the roads, some degree of public support will be essential.

I touched on regulation. I am very near the end. With respect to replacing coal generation your Government, Mr Chairman, has a daily increasing challenge of dealing with the fall-off. You have probably been given graphs of the retirements. Engineers can extend life but not interminably, and that is a challenge for you people. I am delighted you are approaching it. Power station siting is an issue—not in my back yard. A point I would like to add a little to, is that the sites currently occupied by coal fired power stations have many of the features appropriate. They already have the high-voltage system connections—there is no need for further interconnections—and, very importantly, a trained and competent labour force which would readily adapt.

Of course there might be some new additions for the reactor itself but most of the rest of the bits are absolutely standard. Cooling water would be there and access road and rail. They are already, by definition, remote from population centres, so they seem to be well suited. Very last of all—and then I will shut up—I got my organisation, the academy, to run a conference. I first planned it in 2010—post the Uranium Mining, Processing and Nuclear Energy Review [UMPNER]—and then Fukushima came along and all bets were off. I ran it again in 2013. Rather than bore you with any details, I can hand over to the secretariat the outcomes of that conference attended by 200 people and chaired by today's Chief Scientist, Dr Alan Finkel, a good friend of mine. I have to say that those views expressed then in 2013, with very minor changes for technology advancement, would exist today. With that, I say again that I am privileged to be sitting before you. Thank you.

Mr RODGERS: I will make a brief opening statement. A little bit of background about Engineers Australia: It is the peak body of the engineering profession and has about 100,000 individual members. Established in 1919, Engineers Australia is a not-for-profit organisation constituted by royal charter to advance the science and practice of engineering for the benefit of the community. I will not recap the position that we have got in our submission. I think our views there are pretty well laid out. In summary, what you will see in what we have written is a particularly neutral view on the issue, focused mostly on information and capability development

needs in order to build the decision-making capability of Australia to think about where nuclear is going. Some of the background to that is the fact that we have 100,000 members with some very diverse views.

That in itself is not an issue, other than in my research process consulting those members and discovering that two sides of the camp, the for and against, seem to be able to use the same information to get to a different conclusion. We have focused less on the question of whether the time is right now and more on what the prerequisites are. The reason this conversation is interesting is that small modular reactors are on the table as a technology choice. I think having a background in renewable energy industry development and seeing that that industry has been dominated by claims that are generally bigger than the ability to deliver, there is always a bit of scepticism that you need to bring to the table about claims of technology readiness. We couched our submission in the context of where we see the debate about new technologies for nuclear coming through.

The other part is that I do not think we as an engineering peak body claim to have the view on what the pathway is to social acceptance of nuclear as an industry—again, falling back to this idea that confidence is probably going to be built by contextualising the available information by the agencies that would end up having to run that body if you were going to have a nuclear industry. Mr Thomas has pointed out that the CSIRO does not have the capability. We know that that Australian Energy Market Operator [AEMO] is not really looking at this issue. ANSTO and others appear to have the capability, but I have never seen anyone give me the manual on how this would work. Those are the comments that really frame how we have come to this issue. I will keep it to that point and I will answer questions as we go.

The Hon. MICK VEITCH: Thank you Mr Rodgers and Mr Thomas. I will first go to the submission from Engineers Australia, Mr Rodgers, and your opening comments as well. Essentially, you are advocating a conservative approach to nuclear generation in Australia. I notice on page 11 of your submission you actually say, "A conservative approach is also warranted given the status of community acceptance for nuclear technologies in Australia". Can you advise the Committee how you see that conservative approach being applied to this area?

Mr RODGERS: Some of the context is comments that the submission that Engineers Australia made to the South Australia royal commission, which dealt with the entire fuel cycle. In the submission you have got in front of you we have not tackled those issues. I think in the main that submission basically said the ability for Australia to develop a nuclear fuel cycle is feasible and we have some of the base skills to do that. In the submission in front of us we focused much more on the techno-economics of the question. We partly did that because I think that is actually where a lot of people go when they talk to this issue. We saw that as a leading issue to deal with. As part of that research, we looked at what is in the public domain about costs and otherwise and again realised there was not sufficient consensus for us to take a view on where the world was going to go.

We looked at where the institutions were at and realised they were not really talking much sense, either. We came to the conclusion that that is the obvious next step to get to: Find more information and build a view on how a regulatory regime would work in the Australian context in particular. We will, like in the mobile industry, have skipped the building of an entire telephone network and gone to mobile phones, for some countries. We will effectively be doing the same for the nuclear industry if we go down that route. We were contextualising that so it had some Australian relevance and getting past all these conversations I think we see as being the wrong context. The solid example for saying no—having that information would help us enormously in getting the conversation on a sensible footing.

The Hon. MICK VEITCH: My other question for you, Mr Rodgers, relates to the workforce capacity in Australia. If we were to recommend overturning the prohibition for both uranium extraction but also nuclear generation, is your view that we actually currently contain the skill sets required amongst our engineering fraternity to do this work?

Mr RODGERS: This is me reporting back on what I have been told from the members. The view is that there are at least two parts to that answer in terms of capability. One is in the regulatory space—having enough people to be able to ensure that these systems are operated efficiently and effectively. To that, my understanding is that there is a scale-up required. I do not have a view on the level of scale-up required, so I cannot give you that background. When it comes to the installation of small modular reactors, the advice I have is that the forging required to get the nuclear containment vessel pulled together can happen in global manufacturing facilities rather than purpose-built ones and that that unit itself can easily be slotted into a civil works project.

If we have, as we have mentioned in the submission, John Holland pulling together the open-pool Australian lightwater [OPAL] project as part of that consortium, our expectation is that we will end up with a certain degree of specialisation and an open question about whether or not that needs to be housed inside Australia in order for the modular reactors themselves to be built—an existing pool of capabilities that we can pull together or modify for the purposes of balance of plant. The operation question is where, again, I feel like we need more information to be able to tell what those skill requirements are.

The Hon. MICK VEITCH: Mr Thomas, I am just going to read from the last page of your submission. You state, "Adding nuclear power to Australia's generation mix would open opportunities to" and then there are four dot points. I want to look at the last two dot points in that section, where you acknowledge that the deployment of small modular reactors [SMRs] would be well suited for electricity supply to our well-established high voltage transmission and distribution systems and you also then talk about recognising that SMRs, progressively located at our ageing coal station sites, could employ established skills while minimising additional system costs. My question—and you did touch on this a bit in your opening statement—but essentially what is your view of, first of all, the regulatory regime that would be required for SMRs to be deployed in Australia?

Mr THOMAS: I will start by saying that of course it is not my speciality, but I have been privileged to speak to a number of people whose speciality it is, notably the chief executives of the Australian Safeguards and Non-Proliferation Office [ASNO] and the Australian Radiation Protection and Nuclear Safety Agency [ARPANSA]. I have asked them both, at a time when I was working for the academy to put in the submission to the South Australia royal commission, which was way after—three or four years ago. I said, "What do you think ARPANSA and ASNO could contribute to the Australian regulatory system?" Someone had put up the idea that we start afresh. The answer was "Absolutely not". The two of them, speaking together—I spoke to them at the same time—were confident that given the adequate support, which would be staff and financial support from the government of the day, they would be able to build an organisation which—as I mentioned in my opening, they are now world-class in what they do—would be able to build a world-class regulatory organisation.

To assist in this they would obviously refer to other nations of our type, Canada and others, who have set up their own. The United States would be, or was, particularly enthusiastic about assisting us with that. I think it is a matter of giving those people, ARPANSA and ASNO, the remit to establish a world-class regulatory situation. Of course we have got to have it. The advice I was given was that this would take probably about three years. That three years need not be prior to other commitments but certainly in parallel to it, part of the process of getting to a working power station, a very important part.

The Hon. MICK VEITCH: I have been asking this of a number of participants in the inquiry. I have an issue about we are moving towards this aspirational target of nil carbon by 2050 and I have a concern about the energy mix we will require, the design of our economy, the construction of our economy in 2050, the public policy levers that we are pulling to get there. A concern has been raised with us that we will move from an industry or manufacturing-based economy and if we are not careful we will finish up with a recreational economy. We will not have the baseload capacity. Do you subscribe to that view?

Mr THOMAS: That is a very fair question, and to the extent I am competent to speak on it I will give you my view. I think the target of freedom from carbon by 2050, when none of us will be here to see it, is a wonderful aspirational statement, very political. Whether it has any foundation in realism, I personally doubt. That said, I am certainly of course of the view that the science tells us we need to progress and decarbonise, but I am not of the view that we need to do it to dates upon which politicians will stand or fall at all. I think it is more a vision than a target, in my view. Your comment, could we if we do run towards that in an unrestrained way, create a recreational economy—I love the phrase, I will use that again if I may.

The Hon. MICK VEITCH: Go for your life.

Mr THOMAS: It is a good phrase. We certainly are, if I may put it from the other side of the equation, moving away from being the strongly industrialised country, which I came to over 50 years ago now—incidentally, the best decision I ever made, apart from marriage, in my life—and it served us well. Then we had a car industry, we had three or four aluminium smelters, Kurri Kurri, Portland, Tomago is still going but it is on the fringe. I have friends in other major industries I will not mention, but one of them was very much in the news in the United States not that long ago, who are deeply concerned about maintaining their industry levels here and already have moved a lot of what they can offshore where labour costs may be cheaper but power costs certainly are and maybe the political environment is more attractive, all of those things. I would be absolutely deeply saddened if Australia chose to allow itself, and it would be a matter of allowing itself, falling prey to the pressures that we must decarbonise at all cost, the Greta Thunberg syndrome if you like. When reality says we have jobs to get, and you people are very deeply involved in that.

I think Australian work people are amongst the best in the world. They are extremely well trained. We need to think a bit more about TAFE, but that is another issue. I can only say that it is a wish, not a recommendation, I could not make that, but a wish that you and your colleagues see a way to inhibiting that rather run away public argument now towards renewables will do it all, won't it be fun, we will all have time on our hands in the city. All that, all those arguments every single day in the press. I really hope we can get back to talking about real jobs. They will be different, of course they will be different. They always have been. But they are real and they are very important for our growing population and the wonderful people that we bring into this

country. Sorry, I should not have said that, because one of them is me and you may not agree with that. That is a rather woolly answer to your question but it is certainly what I believe as an older Australian.

Mr RODGERS: I might have to correct this in *Hansard*, sorry, because I am going to quote some statistics and I will have to go back to the source material to make sure that I get them right. The Australian Energy Statistics talk about Australia's energy use being from fossil fuels nearly exclusively, 94 per cent of all our energy is from liquid and solid fossil fuels. My feeling is that we are really at the start of this conversation about renewables. I think that we need to put that into perspective from there. When it comes to then breaking down where that energy is used, liquid fuels are one of the really important spaces of that.

Sixty per cent of our energy across Australia, across domestic use is in liquid fuels, 90 per cent of those are imported. When we think on the energy efficiency side, 50 per cent of our electricity use is in buildings. There is a conversation to be had about ensuring that we have a full policy suite to get to a place where Australia has a prosperous future and maintains its productivity advantages. That requires us to think about our generation options alongside demand side matters, including energy efficiency and demand and response, and thinking about the way in which we transform our transport fleet to be less reliant on liquid fuels.

The Hon. MICK VEITCH: If you could take on notice your answer where you use the statistics to ensure you have them accurately reflected.

Mr RODGERS: The numbers, yes, that is fine.

The Hon. MARK LATHAM: Thank you for your presentation today. Can I have one point of clarification, Mr Thomas, you mentioned a three-year construction time period for the small nuclear reactors. Is that a standard industry view? What could we quote, three-to-five years perhaps?

Mr THOMAS: Three to five would be probably more accurate. You had a presentation from NuScale and I have heard NuScale speak at a conference and I have asked them that question and three to five. Sorry, if I said three as a definite thing, no, change that to three to five. Sorry about that.

The Hon. MARK LATHAM: I wanted to clarify that. From an engineering point of view, could I get a perspective on the alternatives to nuclear? It is a vital question for the Committee to answer and that is, if not nuclear, what. Obviously, we are on a pathway of retiring 90 per cent of dispatchable baseload power, not only in New South Wales but nationally, over the next 30 years with the coal-fired power stations being at the end of their lifespan. From an engineering point of view, what is the viability of battery storage? The renewable advocates put a lot of emphasis on this. Year 12 science tells us that electricity is notoriously difficult to store and someone like the head of AGL has said that using current technology to go 100 per cent renewable with battery storage you would need 350,000 shipping containers full of batteries, which is a science fiction scenario. What is the outlook on battery storage?

Mr THOMAS: I support the phrase "science fiction scenario". Battery storage, again, as I said in a rather different context, mix is everything. Battery storage for very short term, very small elements of power, say when a circuit breaker comes out and a certain section of the non-isolated grid needs to be kept going, as in South Australia, that is probably a reasonably good example of a sensible use of battery storage. As a solution in the, what can I call the return of capital the AGL people made, batteries are extraordinarily expensive. They use rare earth, as you would know. While Australia, the blessed country, has quite a few rare earths, not nearly as much as China but nevertheless it has, the price and the multiple containers figure you used would be beyond imagination as an economic option. Environmental disposal of batteries at the end of life I cannot comment on, but nevertheless it is a rare earth problem. It is no less of a problem than the disposal of nuclear waste.

The Hon. MARK LATHAM: Mr Rodgers?

Mr RODGERS: I also like your idea about science fiction, but phrased slightly differently. I think it would be science fiction to think that batteries would be the only technology solution that we would apply, and Australian Energy Market Operator [AEMO] says so as well. This is going to be about a fleet of diverse options that work together. I do not know what that mix looks like, but I think that is a modelling exercise that Australian Renewable Energy Agency [ARENA] is currently doing through the integrated system plan. I do note, though, that when you are talking about batteries you were also talking about the Snowy Hydro 2.0 cell.

The Hon. MARK LATHAM: It is not a battery, it is a separate source of power that relies on speculation about renewable prices in the middle of the day. When they are cheap, you pump it up; at night time you slow it down. It is not actually a battery; it is a different form of power generation powered up by cheaper renewables in the middle of the day.

Mr RODGERS: This goes back to the grid idea. I think there are two problems to be solved in the grid. One is the bulk power transfer question, just that exact point. The other one is the much shorter millisecond level

response required in order to keep the grid stable. They are two separate issues where, in the first case, you can fill that void with a variety of technologies. In the second case, fast response technologies, such as batteries but also super capacitors et cetera, fit that bill.

The Hon. MARK LATHAM: Is there a rough estimate of how much a battery can do in firming up renewables? Legislators and policymakers have a duty of care to deal with technologies. We know that you cannot plan an electricity grid around things that are not yet invented; that would be grossly irresponsible because if they are not invented the whole thing closes down. We can only deal with what we know in terms of technologies at the moment. Could batteries firm up 10, 20 per cent of the grid. You have described 100 per cent as science fiction. What is the horizon for batteries? We have the biggest battery farm in the world, the Musk one in South Australia. We know what it can do. What is their threshold?

Mr THOMAS: It is a timing issue. Of all the solutions available to store electricity, and they are all expensive, the very short-term one is batteries to maintain the system. One I would mention, which I am not sure has been touched on in any of the submissions but is often ignored, is what you might loosely call rotational inertia—that is, the spinning generators in 30 gigawatts of coal-fired power that is keeping our lights on at the moment. If there were a system failure short term, that rotational inertia spins massive stored energy. The amount of stored energy is very significant. Again, it is short-term; it would be just a few cycles. That would ride through the system switch failures and so forth.

You go batteries, rotational inertia, which will be there if the nuclear pathway is followed because that uses conventional steam for generation, and then you would move on more to one of the most elegant of technologies, which is indeed pumped storage. I cannot comment on the economics of Snowy Hydro 2.0, that is argued mostly by people who know nothing about it, but the fact is that worldwide pumped storage, where it is economically and socially acceptable and financially affordable, turns out to be a very long-term investment in storage and smoothing and so on. In my heart, I would say, though I have not studied Snowy 2.0, that it is probably a sensible development for our nation. I hope that answers the question on batteries—very short term would be my answer.

The Hon. MARK LATHAM: You think long term in pumped storage. How viable is pumped storage on the Australian mainland, which is the driest and flattest continent?

Mr THOMAS: That is again a very good question.

The Hon. MARK LATHAM: Factoring in that companies would have to go out of their way to purchase sites and then construct elaborate engineering exercises to pump it up and flow it down.

Mr THOMAS: Absolutely. The truth is that we in Australia have used up probably 70 per cent or maybe more of our easily won pumped storage, which is in Tasmania and the Snowies. Yes, there is some left—again, diminishing return applies. I forget what the megawatt rating of Snowy 2.0 is; it is quite a substantial scheme, but there might be many more of those. Topographically Australia just does not lend itself. From a weather point of view, I should mention that pumped storage is not just storage. If it rains and there is catchment that flows into that, it becomes a hydro generator as well. All that needs to be taken into account. But you make a very good point that we are a dry continent and we cannot rely too much on the rain element of pumped storage. But we are running to the end of what we in this country can do in pumped storage itself.

The Hon. MARK LATHAM: The final one is gas peaking plants, the other thing that is spoken of. You can turn them on and, when the renewables are not functioning, the gas peaking comes on. Is that an easy technology or is it expensive and, in current policy structures, relying on private investment? AGL is talking about one in Newcastle, but that is yet to materialise.

Mr THOMAS: It is a very, very well understood technology. Every aeroplane has a non-industrial gas turbine on it. Typically industrial turbines are 25 megawatts and some are quite substantially larger. They can be made in many variations, open cycle or combined cycle. There are variants to suit the issues. The technology is not expensive; however, I will touch on this, which is very relevant to your Government: The gas price has gone up from the Citygate price, when I advised AGL probably 30 or 40 years ago at a gas price arbitration, of just over $1 a gigajoule.

We are now talking about export prices of $10-plus and going north of that. Why? Because although we sit on a massive reserve of gas in this State, Victoria and so on, it seems that the Lock the Gate activists and so on have far more power to persuade governments than the very excellent report done by my good friend Mary O'Kane a few years ago on gas resources in this State. The gas price is what will really dominate the economic position of gas turbines in the mix. That said, there comes a point where the cost of not having power is so great that any price of gas will work. You will certainly want to have gas turbines somewhere in the system as backup. I just hope you do not need to use them all that much if the gas price is higher.

The Hon. MARK LATHAM: Mr Rodgers, on pumped hydro and gas peaking?

Mr RODGERS: I will defer to the integrated system plan when it comes out later this year. I think that is the place where we should be looking for consolidated and focused attention on just that question.

The Hon. MARK LATHAM: But overall, in the combination of battery storage, pumped hydro, gas peaking there is a high element of risk in thinking that this can be an effective way of supporting a 100 per cent renewable Australian economy providing the mix of industrial, recreational and knowledge jobs that we expect in a first-world country.

Mr THOMAS: Absolutely. I am affirming your statement that that is a very high-risk approach, yes. Correct.

Mr RODGERS: I do not know the jury is in on how we get to what the aspirational goals are. I would add into that mix of technologies you have promoted the idea of distributed generation and demand response as some of the other elements that are going to have to fit into that. That fits into the broader idea that the way that our electricity system works with the diversity of technologies, the digitalisation of opportunities for two-way power flow from domestic to industrial or otherwise is going to change that.

The Hon. MARK LATHAM: The bottom line is to go 100 per cent renewable or nuclear as a dispatchable baseload would be a reliable foundation upon which you can do all those other things.

Mr THOMAS: Absolutely.

The Hon. MARK LATHAM: They would mitigate the risk of the alternatives that we are talking about. You see that, from an engineering perspective, as a commonsense approach.

Mr THOMAS: Correct. I wonder if I may make a short additional point to do with system reliability. At this time, the National Electricity Market operates on cost of energy-megawatt hours. When I worked in Britain over 50 years ago—and all Europe is the same—the notion of their so-called two-part tariff recognised different products, one called energy and one called the ability to supply power, whether you use the two-part tariff or not. The words "capacity market"—which I have used in a number of my presentations, as have many others—do not appear to have been taken up strongly. They are mentioned by the Australian Energy Market Operator [AEMO], but they are not taken up strongly in the policy planning.

I would suggest that capacity markets do need to be considered quite strongly in our long-term planning, otherwise what is going to happen—as has happened—is that there will be the very unfortunate early retirements of power stations. That happened with the Northern Power Station and the Hazelwood Power Station, as well as the attempt to shut down Liddell, which may last for a bit. The business models of coal-powered stations—which are proxies for nuclear because they are baseload—do not work without some recognition of the value of capacity and the ability to provide full load 24/7 or dispatchable on demand.

The Hon. MARK LATHAM: This is the curtailment problem that you identified in your submission.

Mr THOMAS: I should not have suggested that it was a Parliament problem, but—

The Hon. MARK LATHAM: No, a curtailment problem—the surging in and out of the grid.

Mr THOMAS: I have missed your meaning.

The Hon. MARK LATHAM: In your submission you said that the grid and the transmission network should be built around sound engineering principles, rather than the AEMO strategy, which is to take the cheapest available price. In the middle of the day, when the winds are blowing and the sun is shining in Western New South Wales, they will surge all the renewables in, which can destabilise the grid. There is an engineering principle that should be respected.

Mr THOMAS: Absolutely.

The Hon. MARK BUTTIGIEG: I want to explore some of these engineering concepts. Some of the imagery around the wording of some of these concepts seems to confuse a lot of people, for instance when we talk about "baseload" and "dispatchable" power. The argument that is often given is that we cannot go down the 100 per cent renewables path because it does not provide the baseload. The imagery that creates in people's minds is this big central fusion force that is generating massive capacity. You can see how people would react to that in a psychological way because it is like we just do not have the capacity for all this small-scale renewable stuff. At the end of the day, this is all a function of multiplicity, is it not? For example, if you had enough wind turbines, solar panels, pump storage and batteries suitably placed around the network, there is no technical reason—engineering wise—why it could not be possible. In your view as an engineer, is that correct?

Mr THOMAS: From an engineering point of view, the investment in the sorts of things I did during my life would be five or six times greater than the pathway that rational engineers are suggesting today. Yes, it can technologically be achieved with an infinite supply of batteries and pump storage and God knows what. Sorry, do not put that on the record.

The CHAIR: I do not think that is how this works.

Mr THOMAS: Sorry, I do need to preserve my respect. It can be done. But it would help to make this nation go broke.

The Hon. MARK BUTTIGIEG: How do the countries in Northern Europe that we are told are leading the way—Germany and Scandinavia—propose to meet their targets, which are far more ambitious than ours? They are not stupid people. They have a tradition of very sophisticated engineering and manufacturing. How are they achieving these targets?

Mr THOMAS: Let's take Germany first of all. Germany has its Energiewende. If it is of interest to you I urge you to go to the World Nuclear Association [WNA] write up on the German situation. In brief, the German power costs have been going up and the reliability has been dropping. The intrusion of wind farms—I have not been to Germany recently—is now getting significant push back from the community and they are nowhere near the maximum we were touching on earlier. In the meantime, nearby France, which has over 70 per cent nuclear, is one of the lowest cost providers, with relatively little hydro, which is another contributor to the low cost, and it provides quite substantial power flows to Germany and the other European countries on non-windy and non-sunny days. I believe one of the submissions includes a graph of power costs in all of the OECD countries. It is quite instructive to look at that. I can provide that if desired

The CHAIR: If you would like to table that that would be most helpful.

Mr THOMAS: I will provide that. I believe it appeared in the Alan Finkel report on system reliability some years ago. I will find the latest update for you. You asked about other countries. Scandinavia is fortunate in that it has masses of hydro. It has baseload hydro because the snow melt is more than adequate. Canada is the same, although Canada, as you know, has balanced that with significant nuclear power. It is one of the lowest cost providers. It does seem that where nuclear is a large or small part of the mix, the balance has been well achieved and the costs remain manageable. Where idealism—as in Germany post Fukushima—takes part and we shut down the power reactors, they are actually building coal-fired power stations, which is beyond absurd if you are looking at it from a moralistic point of view. Maybe the economics said that was good, but from a green stand point it does not make sense at all. I could go on with other countries.

I would also admit that not all nuclear projects are magically good. They are not. Some have had quite absurd overruns, particularly two in the United States, which you have probably heard evidence on. Unfortunately, those projects are often grabbed as being the direction setters for the nuclear industry, which they are not. I am drifting off your question, I will quickly go to the pricing in other countries—China included. China is a bit opaque about its pricing, but we have no reason to believe it is not quite low, and its technology is superb. South Korea is utterly superb. It is not opaque. In fact, a colleague of mine was part of a mission to South Korea. He urged that we build relationships with them. The prices there are well down, the costs are well down and the reliability is well up. I have waffled on for too long.

The Hon. MARK BUTTIGIEG: But those arguments are not necessarily sequential, if you know what I mean. In terms of the economics, for example, if you were to take the New South Wales electricity market, prices have risen exponentially in New South Wales over the last 10 to 15 years. That is not a result of a massive uptake in renewables. That is a function of the privatisation and deregulation of the retail market.

Mr THOMAS: Correct.

The Hon. MARK BUTTIGIEG: I am not sure what the input costs are in Germany to those rising prices that you highlighted. But it is not necessarily a causal argument that because Germany has gone down the renewables path costs have gone up. I am not saying it is not; I am just saying that I do not know. For example, in New South Wales we do not have a sophisticated market at all but prices have gone through the roof. I just wanted to raise that with you. With regard to the CSIRO—and I noticed you were correct in stating what a valuable organisation it is—it does not employ people who would take these studies lightly. It employs clever people who are well qualified to make those decisions. So when they are saying it is possible, people have to take that seriously, surely?

Mr THOMAS: I will give a very quick answer. I am not sure of your question. When CSIRO is saying what is possible—

The Hon. MARK BUTTIGIEG: In your introduction you mentioned that CSIRO is basically saying that you could get to 100 per cent renewables with firming. We had a discussion about firming in the sense of batteries, pumped hydro and some other sources. It is saying it is possible. It seems to me that a lot of this is a function of how quickly you think the technology in either field will advance. For example, with battery storage, my understanding is that the technology is racing ahead so quickly that the size and intensity of battery storage required may very well drop dramatically over time, as well as the cost.

Mr THOMAS: It certainly is relying on crystal ball gazing. Again, I can only speak as an experienced professional engineer. I do not believe that some of the cost trajectories are realistic or the whole of the story, because a battery—it is a direct current device—needs inverters and so on, and the cost of them is very well established and is huge. But the proponents of batteries tend to talk about the battery per se. Batteries can be extremely expensive. The one I have in my ear is a massive cost per kilowatt hour. But, that said, they are useful—as I said earlier to Mr Latham's question—for a very small part of the spectrum.

The Hon. MARK BUTTIGIEG: Mr Thomas, could I summarise. Let us be clear; you are saying that a sensible view would be of a mix. You touched on 25 per cent nuclear—

Mr THOMAS: Yes, possibly.

The Hon. MARK BUTTIGIEG: —as a ballpark figure. I understand it is a very nebulous concept. Your view is that the proponents of 100 per cent renewable energy sources place too much faith in that technological explosion. It is just that the trajectory is not there in your view.

Mr THOMAS: The answer to that question is certainly yes. In parallel, they ignore the system costs that are associated with those technologies, which are substantial.

The Hon. MARK BUTTIGIEG: System costs, meaning transmission and distribution?

Mr THOMAS: Yes, and voltage transition upwards from DC to AC through transformers, the losses thereof, the transmission costs and so on, and the difficulties of operating the system with these variables coming into them.

The Hon. MARK BUTTIGIEG: Thanks.

Mr RODGERS: I wanted to give some more information to your question. The Australian Energy Market Operator recently released a report that looks at where Australia is compared to other international jurisdictions that have high penetrations of renewables. I think it included, reflectively, in the top three of the countries that are trying to challenge integrating of renewables. South Australia in particular is up there. The study mostly focuses on the system security elements—what do you need to do to make sure that at every second or every millisecond you have a balanced supply arrangement. That focuses less on the bulk power requirements. It does not care where it comes from; it just assumes it is a variable source. I think that that study shows that there is not anyone in the world that has the answer, but it also points to the fact that that is not necessarily a reason to not resolve that challenge. That challenge, itself, involves making sure that we can end up with the most economically efficient kind of outcome. I think there are a broad range of technology choices in that.

The Hon. MARK BUTTIGIEG: I guess one of the problems for government is that we have to make a decision about where investment is going to go. If you had done a long-run economic analysis of the viability of railway lines in the 1900s or whenever they were built it may not have stacked up, but looking back in hindsight we know that these things were beneficial and have long-term gains, because government was prepared to make a decision and go down a certain path. It is the same sort of thing with this. It is a case of weighing up the cost benefit analysis of alternative sources of technology. You are saying that it should not be an either/or; it makes sense to look at a mix.

Mr RODGERS: The integrated system plan is the thing that I keep coming back to because the National Energy Market is a national energy market, so you cannot take New South Wales in isolation. That is where we look at a planning horizon that is 20 or 30 years into the future. That tells you the current thinking about that kind of issue. The market structure that we have talks about least-cost generation. In the absence of changing that framework we are not going to be at a point where we recommend a conclusion that is a blueprint for 20 or 30 years. We are going to be looking at accommodating different technologies as they emerge and become the most cost effective over time. That is some of the framework that we are going to have to end up using for decision making.

The Hon. WES FANG: I have a very brief question. It is probably more for Mr Rodgers, who is a senior policy adviser. It seems to me that one of the things that we have not discussed when we are talking about energy security into the future is a move towards, say, electric cars. We have renewable energy which generally produces power during the day for solar, and day and night for wind, but in order to be able to supply power at night we are

going to have to use some sort of storage. It seems to me somewhat ludicrous that we would be moving power, effectively, from batteries to batteries, in the case of cars, which will most likely be plugged in at night and charging overnight. With nuclear power providing baseload power instead of battery into storage, and then storage into storage, would there be less losses from transference through the grid, or is it not going to have that much of an effect? How much of a load will it place on our grid into the future if we have 50, 60 or 70 per cent of automated vehicles being powered by electricity?

Mr RODGERS: I will defer to Mr Thomas on the engineering specific questions because I am not an engineer. I was thinking your question was going to go to the issue of long-term energy security. The fact that we are 90 per cent reliant on liquid fuels is a national security question. When we move, if we move, to electric vehicles we find a partial solution to that challenge. Diversifying the technology mix, including nuclear, also contributes to solving that challenge.

Mr THOMAS: Can I add very briefly to that? You touched on the issue of losses, which is very infrequently addressed. Grid losses typically would be about 7 per cent to 8 per cent from large central power stations to us the users. Grid losses will be—I am guessing here—in the region of 12 to 15 per cent, maybe more, with a very widely distributed, far-distant generator associated with batteries. Yes, they will work, but the system losses would be quite substantial. There is another quick answer I might give you.

My colleague touched on electric vehicles. Despite the agony of my wife I intend to buy one fairly soon. I have written a paper for our academy, about three years ago, on exactly the question you asked—the impact of electric vehicles on the grid and the notion of not only grid-to-vehicle, but vehicle-to-grid flow. That would be a very sensible application of batteries which are already there for the purpose of driving a motorcar but also in supporting the grid. That, I think, is technologically fascinating and is probably not a great deal more difficult to manage than the technology in this phone—in fact, probably much simpler. I hope that is helpful.

The Hon. WES FANG: It is very helpful. Thank you very much.

The Hon. MARK BUTTIGIEG: I might just do a two-second follow-up, because this is very interesting. A large part of your losses in an electricity distribution network are the result of lower voltages trying to push current through the wires, which is why they step up to higher voltages, as you know. Then the loss is reduced. So if you did not have to have big coal fired power stations up in the Hunter valley or down in the La Trobe valley or wherever they are—and then you transmit them a long way—because you have local decentralised generation units wouldn't, in theory, the system losses come down?

Mr THOMAS: It is a very interesting proposition. Could I answer it in this way? Supposing we had a small modular reactor on the village green where I live, which is St Ives. There is plenty of space there, and if it was underground it would be barely noticed. That said, the losses from that into the system consumers would be very much less. However, the reality of getting power plants much nearer to the load is limited in commercial and social life. It is probably not limited in the notion of the very large consumers—for example, aluminium smelters, which I touch on.

In fact, in Finland, where this tie came from, the ownership of some of the nuclear power stations—I am not quite sure what the actual model is—is a mix between private and public, the private part being the forestry people, which is one of their main industries. It is quite an interesting model. I have discussed it with various industrialists in this country. Of course, so long as nuclear remains illegal it is not a very interesting conversation. However, it is quite intriguing that you could get power plants much closer to the load that they serve.

The Hon. MARK BUTTIGIEG: The same logic would apply to a renewable source, for example.

The CHAIR: I do not think we are going to have wind turbines in St Ives any time soon.

Mr RODGERS: I think the answer you are looking for—

The Hon. MARK LATHAM: They are going up on Manly Beach though, aren't they?

Mr RODGERS: The concept that covers what you are talking about is the virtual power plant. There is lots of material on that.

The Hon. MARK BUTTIGIEG: Sorry, I dragged this over time.

The CHAIR: We might have to leave it there. Thank you very much for your time and your submissions as well. If any questions were taken on notice the Committee has resolved that answers taken on notice be returned within 21 days. The secretariat will be in contact with you in relation to those questions. Thank you again for your time. It is much appreciated.

(The witnesses withdrew.)

(Luncheon adjournment)

MATTHEW MURPHY, National Industry Coordinator, Electrical Trades Union, affirmed and examined

The CHAIR: I welcome our next witness, Mr Murphy from the Electrical Trades Union [ETU]. Would you like to make an opening statement?

Mr MATT MURPHY: Briefly, Chair, I wish to express my thanks on behalf of the union for the opportunity to make a submission and provide evidence. The Electrical Trades Union operates throughout the energy industry. We are heavily involved in extractive resources; the transportation of coal; and the generation, transmission and distribution of electrical power all the way to industrial and domestic consumers from the generation point. We are also heavily involved in renewable energy, from bulk, non-synchronous and synchronous generation all the way to local photovoltaic cells and battery walls. Despite this involvement across the whole electrical power sector the union has a longstanding opposition to nuclear energy in Australia. The official policy of the ETU dates back to the 1950s. It results from the experience of members on their return from Japan at the conclusion of the Second World War.

The ETU takes the view that there are significant dangers inherent with nuclear energy. We remain deeply sceptical about safety in relation to the extraction of uranium. Mining is an inherently dangerous industry. Nothing about the extraction of uranium makes it safer. We are also deeply sceptical about the operation of nuclear power plants. The risk of catastrophe is inordinately borne by the workers in the power station itself. Finally, the union remains concerned about a feasible solution to the waste storage matter. As the union with probably the most members exposed to energy policy in Australia, we also assert that those members need transparent direction on a coherent energy policy. Our members are already losing employment security as a result of a lack of coherence in the energy policies of State governments and the Commonwealth. The union requires a clear path forward for investment so that our members, the broader community and the Australian public can have certainty in the electrical power industry.

A significant issue with nuclear energy is that even if it was to receive any form of assent today we would still be 15 to 20 years away from having a functioning power plant in Australia. In four years' time Liddell will have closed and there is already new generation planned or proposed to fill that gap. Australia lacks a legislative, regulatory, employment skills, infrastructure and waste-disposal base to even begin construction of nuclear power plants, quite separately from the operation of them. As an example, I quote from the Australia Institute's submission to the Commonwealth Standing Committee on the Environment And Energy, which states:

> Nuclear is slow to build, often delayed and faces cost blowouts.
>
> A nuclear power plant in Australia could take a decade or more to build. First there would need to be long process to establish regulation, skills and supply chains.
>
> Long construction times and delays have plagued the nuclear industry throughout its history. This is a major factor behind cost blowouts. Remedial actions required to fix issues increase costs. Construction delays also increase financing costs as interest accumulates without revenue being earned to pay down debt.
>
> All large infrastructure projects are prone to construction and cost blowouts, but nuclear blowouts are particularly widespread and costly.
>
> Two-thirds of all nuclear power plants currently under construction are already delayed, and nearly half of those had seen *increased* delays in the year to 2017-18.
>
> Nearly all nuclear plants experience cost blowouts. Pressure to avoid delays may itself be a reason costs blow out.
>
> Reactors completing construction over the last decade took on average 10 years to build. Construction times ranged from 4.1 years to 43.5 years.
>
> These figures exclude the many power plants, including those under construction, which have been under construction for 6.5 years on average, with many far from finished. It also includes the many builds that were cancelled, sinking large losses. The figures may also exclude years of design, government and financing negotiations and other preparation.

The union does not see nuclear energy as being able to satisfy the immediate problems that our industries face, nor can it ameliorate the job losses that are already on the way via the Australian Energy Regulator determinations or around the integrity of the national electricity market. It is a longstanding position of the union that it believes in public ownership of electricity generation, transmission and distribution assets. Having said that, public ownership of nuclear energy would not get us over the line in this circumstance. We take the view that the risks involved are unwarranted when there are far more feasible alternative energy sources.

I make one final point in closing, in relation to our longstanding opposition to nuclear energy. We most recently considered this when we held our centenary conference in July of this year. We are a democratic organisation. The issue was debated on the floor of the conference among more than 250 members across all the industries we represent. We had proponents of nuclear energy come and speak, as we did opponents. At the conclusion of that debate our pre-existing position of opposition was reaffirmed unanimously. My point is that

our policies are reviewed and modernised based on the best information of which we can avail ourselves. Chair, I stand ready to answer any questions that you or your colleagues might have. Thank you.

The CHAIR: Thank you. Before we start with questioning, can I just ask that if you have a written version of your opening statement it might be handy for Hansard to check it off for accuracy.

Mr MATT MURPHY: I would also be delighted to email it later today.

The CHAIR: That would be helpful. Thank you.

The Hon. WES FANG: Mr Murphy, thank you very much for coming in today. I found your opening statement extraordinary.

Mr MATT MURPHY: Thank you.

The Hon. WES FANG: Primarily because you reference that part of the ETU's opposition to nuclear power is because of the experience of people returning from Japan and that the policy dated back to the 1950s. If that was the case then I might say that I am against telephones because they had party lines back in 1950, yet I hold something in my hand now that has more computing power than probably NASA used to put a man on the moon. Technology has changed. Experiences have changed. Your referencing weaponised nuclear power has absolutely nothing to do with power generation using uranium, for example. How can you link the two?

Mr MATT MURPHY: I cannot. You can, because it is a massive straw-man argument to produce a mobile phone in relation to the argument.

The Hon. WES FANG: How can you reference the experience of Second World War Japan as having any relevance to opposition to nuclear power in the 21st century?

Mr MATT MURPHY: It is pretty clear that the adoption of nuclear energy for power generation would increase the opportunity and the chances for using the technology to be weaponised. I am sure you are aware of the two nuclear weapons that were provided to Japan at the conclusion of the Second World War.

The Hon. WES FANG: I must say, I would dispute that statement, but I am not here to answer questions. Do your members refuse medical treatment?

Mr MATT MURPHY: No.

The Hon. WES FANG: They are happy to use the medical advances that nuclear medicine has brought?

Mr MATT MURPHY: And the alternative medicines of developing the same products.

The Hon. WES FANG: Can you expand on that?

Mr MATT MURPHY: There are other methods of generating medical isotopes than nuclear reactors, as I understand.

The Hon. WES FANG: But it is through the science of nuclear that nuclear medicine and the study of isotopes has come about. Using the same argument that we are against 1950s,sorry—

Mr MATT MURPHY: Nuclear weapons, is the term you are looking for.

The Hon. WES FANG: Yes. World War II as an example, presumably your members would be against nuclear medicine and all the advantages that have come from that.

Mr MATT MURPHY: Again, I think that is a man entirely constructed from straw. I do not see the correlation of our members refusing medical treatment on the basis of where that treatment is derived from. Then you talk about nuclear weapons.

The Hon. WES FANG: I am trying to frame it. I do not understand how you can use experiences in World War II to have an opposition now to power generation using nuclear means.

Mr MATT MURPHY: Are you familiar with the term that those who forget history are condemned to relive it?

The Hon. WES FANG: I am aware of that. I am a close student of history. However, just because the nuclear industry can be used for weaponry does not mean it does not create a clean, green source of power that will provide baseload power for this country for generations to come.

Mr MATT MURPHY: You are asserting that uranium provides clean, green power?

The Hon. WES FANG: Are you asserting it does not?

Mr MATT MURPHY: I think nuclear power, the record of incidents in relation to overseas speaks for itself. It is not clean, and it is clearly not green. The question of baseload is an entirely different matter. I have seen baseload. I have seen it on dials as a tradesperson with the old Electricity Commission of New South Wales, I know what baseload is. I know how it can be generated, and it is most effectively generated by a mix of synchronist and non-synchronist matters. Battery technology is another one. But, our concern is, and as I said, Mr Fang, it is supported by our members.

This is not a position enunciated by officials to the exclusion of members. That is the important thing to remember. Our members have debated this and they have established the position they have instructed us on. They take the view, and I am entirely happy to remain at the point of disagreement with you on it, but there is a correlation between nuclear energy and the use of nuclear weapons. There are a number of countries in the world, some signatories, some not signatories to the Treaty on the Non-Proliferation of Nuclear Weapons, who have nuclear generation and also nuclear weapons.

The Hon. WES FANG: Again, I dispute that. I am happy for you to take this part of the question on notice, but can you provide the research that links the two?

Mr MATT MURPHY: Links what?

The Hon. WES FANG: Links nuclear power with nuclear weaponry?

Mr MATT MURPHY: Does France have nuclear weapons?

The Hon. WES FANG: I am asking you, can you provide—

Mr MATT MURPHY: It is simple. It is as simple as opening your eyes. It is not a question of demonstrating research.

The Hon. WES FANG: You have stated here in your testimony under oath that nuclear power leads to an increase in nuclear weaponry.

Mr MATT MURPHY: I say there is a correlation. I can have it read back to you if you want.

The Hon. WES FANG: Can you provide the evidence of correlation? Thank you.

Mr MATT MURPHY: I can refer you to a map.

The Hon. WES FANG: I would appreciate if you could take the question on notice and provide it to me. You have said that 250 members at your latest conference voted against supporting nuclear power. You said it was unanimous. All 250 members in unison voted against nuclear power with no dissent?

Mr MATT MURPHY: That is correct, yes.

The Hon. WES FANG: I find that extraordinary from your organisation. I will ask some more questions later.

The Hon. MARK BUTTIGIEG: You are in the National Party, you must have seen that before.

The Hon. MARK LATHAM: You said in your statement that the union policy is public ownership of the energy sector.

Mr MATT MURPHY: That is correct.

The Hon. MARK LATHAM: Reading the submission that was lodged by Allen Hicks, does the union see any future role for the coal industry?

Mr MATT MURPHY: Mr Latham, as I indicated to Mr Fang, we are all aware of what baseload is. However, baseload we believe can be best provided by a mix of technologies, and coal is part of that, yes.

The Hon. MARK LATHAM: What sort of action would the union recommend to stop the systematic retirement of the coal-fired power stations in New South Wales? Is it union policy to rebuild some of these as they close, the old Vales Point, Eraring and so forth?

Mr MATT MURPHY: I am not sure we have a policy to rebuild on those sites, and with the emerging technologies available that we even support that. With your indulgence, if I could recharacterise your question; are we opposed to the construction of new coal power stations. My view is, and I would have to take this one on notice, sure, but I do not believe on the basis of the national secretary's view we would be in opposition to that.

The Hon. MARK LATHAM: What would you see as the ideal mix of energy sources in New South Wales? How much coal, how much renewables, obviously no nuclear, according to your submission?

Mr MATT MURPHY: No, I think it is pretty clear we are in opposition to that, Mr Latham. I am not able to give you a percentage. We have not considered the percentages of an appropriate mix. I have to say that is not something we have done as a policy position. I am happy to encourage that in the organisation but it is not an answer I can give you with respect to a direct percentage of the ratios today.

The Hon. MARK LATHAM: In terms of funding this, has the union done any work on the cost, public ownership of newly constructed coal-fired power stations, public investment in battery storage, pumped hydro, solar farms, wind farms to meet this goal of full public ownership in the energy sector?

Mr MATT MURPHY: Not to that specific, Mr Latham. I think it is fair to say that we take the view that some of the renewables, particularly water is probably a little bit more controversial than we need to go to, but certainly solar and wind generation is infinitely cheaper than coal and that the fuel is not being paid for, the fuel is readily available and pretty cheap. Certainly that is what I remember from my apprenticeship. With respect to direct costings, no, we have not done that work. There are some matters contained within our submission to the Commonwealth inquiry with respect to costings, but we assert more broadly that renewables such as wind and solar come infinitely cheaper than perhaps coal, and certainly nuclear.

The Hon. MARK LATHAM: But you would acknowledge that given the scale of retirement of the coal-fired power stations that there would be expansion of wind and solar and capital funding.

Mr MATT MURPHY: Yes.

The Hon. MARK LATHAM: And you are advocating that is undertaken by government with this Clean-Co renewable energy company?

Mr MATT MURPHY: That is correct, that is what we have pursued and achieved in Queensland, Mr Latham.

The Hon. MARK LATHAM: The union's position is that you have no fixed view about the energy mix, you have no data or research on the cost, which must run into tens of billions of dollars of public ownership in this sector, but you are firmly against nuclear. That is your one fixed position that is able to be articulated in a clear, simple way.

Mr MATT MURPHY: That is a fair characterisation, Mr Latham, yes.

The Hon. MARK LATHAM: In its submission to the inquiry the Australian Workers Union [AWU] has put to us that rising power prices and unreliability of supply is on the verge of collapsing Australia's manufacturing base, thousands of member jobs are at risk and the AWU believes nuclear power can help. Do you at least share the AWU's concern about the collapse of manufacturing in Australia?

Mr MATT MURPHY: No, not at all.

The Hon. MARK LATHAM: What is the reason for disagreement there?

Mr MATT MURPHY: I have been part of a project that has seen $89 billion-worth of foreign investment with the construction of 12 submarines and nine frigates onshore. That is manufacturing. Yes, that is in certainly South Australia and Western Australia, rather more broadly than every State. I do assert that having looked after manufacturing for a long time for the union, manufacturing has simply changed. There are still unions and organisations out in the broader Australian economy who expect to find what I term a thousand member shop. They do not exist any more.

Manufacturing has changed to smaller, high production and more high technology outputs of around 30 to 40 employees in smaller areas. That is not collapsing. I do take significant issue with the assertion—and you will have to correct me because I do not have the submission to hand—in relation to reliability of electricity supply. I do not accept that is true in any way, shape or form. And having had discussions with the Australian Energy Regulator recently, and our branch is also active in that space, the issue of rising power prices is more complex than a simple assertion in relation to the nature of the generation.

The Hon. MARK LATHAM: Given that the major parties in the New South Wales Parliament do not have a commitment to doing anything about replacement of coal-fired power stations and federally it seems unlikely, how does the union respond to the scenario where it might be your policy to have public ownership of new coal-fired power? If it is not going to happen in reality, how do you respond to the prospect? It does not seem feasible that we will be moving to 100 per cent renewables. Do you realistically think that your public ownership model can sustain manufacturing in this State, or will we be moving closer to a recreational economy?

Mr MATT MURPHY: The most comprehensive answer I can give you, given the circumstances, is that we are pragmatic, as most around the table probably are. We accept that certain things will occur and certain

things are already in place. The structure and ownership of the New South Wales power industry certainly does not comply with our policy, nor are we in a position to enforce it. Into the future, I am not sure that our policy will refer to the exclusion of other organisations either. We do seek a voice, however, for public ownership. I detect an inference from you about the cost to the taxpayer in establishing this type of infrastructure and it is acknowledged, but our experience is that it is more important to keep the money onshore and to produce infrastructure internally than to have it owned by offshore private interests that use Australians to subsidise consumers in other countries. I think Singapore is a good example of that.

It is fair to say that yes, we do support public ownership. The recent privatisation under the States has led us to that view. It is not purely an ideological view; it is one that we have considered quite carefully. We have tried to work within the framework of the National Electricity Market with all the players, but it has been somewhat difficult. We do see assets being sweated between the distribution and the transmission sectors. We see those assets getting sweated to the extent that they need to be bailed out by governments, which is another impost on the taxpayer. That is not purely by itself a reason to have public ownership. More of a question for us is: Is electricity a human right or a commodity? If you commoditise it, you exclude some part of the population from having electricity who simply cannot afford it if it is priced on the market.

The Hon. MARK LATHAM: I think it is both those things. I agree with your analysis that the Baird Government's privatisation is a faulty model. We put a lot of eggs in the basket of a small number of companies that have active incentives to short the market and drive up prices. The absence of a government generator in the market is a missing link in competitive pricing signals that would normally guide this market in the right direction. I brought forward to the New South Wales Parliament legislation to lift the ban on nuclear power and uranium mining. I did that for the reason that coal is doomed, which a logical person would think is a fair conclusion. We have heard evidence from engineers, scientists and practitioners in this area that the scale of upgrading renewables and battery storage, hydro and gas peaking plants is either a public investment that is beyond the scope of government or a technical science-fiction scenario that cannot be implemented.

How do you keep the lights on in New South Wales? It may be that at the point it goes off a cliff in New South Wales nuclear will be coming online. If they had acted on the Federal inquiry in 2006, nuclear would be coming online now and we would be in better shape for keeping manufacturing jobs. That is the view that I think was expressed in the AWU submission. Do you think the ETU is clinging to things that are not feasible, going back to ideology from World War II to things that are not going to work in 2019?

Mr MATT MURPHY: No, I think there are times where we can be bold of and now is the time to be bold. We should spurn nuclear energy for the reasons that we have outlined. Nuclear energy is seen, in my view and in the view of the union, as some sort of panacea or limitless power for a small mass input, for example. We believe that is false. One of the examples to use is that some of the conventional wisdom with respect to Chernobyl is that there were around about 30 to 40 direct deaths as a result of the incident. Nobody seriously believes those figures in relation to fallout and progression of the accident throughout Europe over a period of time. Nobody really believes or accepts those figures of direct deaths. The number of incidents we have in industry leads us to be very sceptical in the introduction of any type of technology on the basis of safety, especially where there is some precedent for us to be concerned, such as nuclear energy.

The Hon. MARK LATHAM: Both the major parties in New South Wales have had a lengthy debate about energy policy going back to proposals for privatisation under the Iemma Government. How long has the ETU been involved in these debates as an advocate?

Mr MATT MURPHY: A significant period of time. I had the unpleasant experience of being part of that debate going all the way back to when it was first raised by Premier Carr. I had significant input into that with Mr Schmidt, who was the secretary of the New South Wales branch three or four secretaries ago. He initially was confronted with that debate, so I have a long history with the privatisation argument particularly in New South Wales. As a national official, I have dealt with South Australia and Victoria and Queensland and, to a lesser extent, Western Australia.

The Hon. MARK LATHAM: At no time in those many years has the union produced a costing.

Mr MATT MURPHY: No, not that I am aware of.

The Hon. MARK LATHAM: Do you think that is irresponsible for the jobs of your membership? You are advancing a policy that is not costed on technologies that are not proven on scenarios that do not generate the type of dispatchable energy that New South Wales needs to keep your memberships' jobs in place.

Mr MATT MURPHY: I would certainly utterly reject the assertion that the organisation is being irresponsible. We are busy with a lot of things; there are a lot of things to deal with. The legislative attacks on us recently have taken up a lot of resources. Can we do better? Yes, we can do better as governments and oppositions

and political parties can always do better. I am happy to take your remarks back and have that discussion with the national secretary. A more comprehensive and coherent approach is entirely possible, but I certainly reject the assertion that it is irresponsible.

The Hon. MARK LATHAM: Thanks for your answers.

The Hon. MARK BUTTIGIEG: Mr Murphy, one of the framings put on this debate, which we can see playing out here today, is the jobs argument. We are told that not only is it low carbon but it is going to produce jobs, so we should not muck around with this namby-pamby renewable stuff, which is pie in the sky. We are told to go back to the gutsy baseload dispatchable route to create all these jobs. Yet your union, which has major coverage in the electricity industry, says that it appears to be a great opportunity for jobs in the renewable sector. Can you flesh that out? Is any analysis being done on the jobs likely to be created by going down a renewable path rather than nuclear?

Mr MATT MURPHY: I can certainly give you my experience. Having had responsibility for the renewable sector nationally since around 2002, we have increased our membership density, particularly in wind. We have good agreements in wind and in solar. One of the issues that we face with solar has been the use of foreign unskilled and unlicensed labour. We have advocated that the electrical connections for solar panels all be done by licensed electricians for obvious reasons.

There is absolutely an employment benefit in renewables. Certainly with wind generation and solar we have got agreements. We have members covered by those agreements. Where it tends to fall down—and this troubles me a great deal with the nuclear proposal—is around the ongoing efforts to make work more insecure. I have just returned from a ship building conference in France where many, many international unions have experienced the same thing. There is an effort to make work more insecure. One recent local example in the energy industry is that the Victorian distributors are in the process of going to full contracting out. There is a privatised distribution network service provider that used to have employees and now it does not have employees. It is all done by labour hire.

As an employee, your motivation and commitment to safety, doing the job correctly and ensuring the reliability of supply to the public is affected by the nature of your employment and how secure or otherwise it is. Now there are all these people who have been moved into unsecure employment who are probably not quite as interested as they might have been to ensure that the system is stable and has some level of integrity. That troubles me with regard to this mad session of casualising work and how that might apply in an industry that requires a little bit diligence, such as nuclear.

The Hon. MARK BUTTIGIEG: On that point, the industry has experienced growth in the renewable sector, notwithstanding that we do not really have any direction from government, there is a big cultural war about targets and there has been no decisive path set. Nevertheless the market seems to be moving forward with this stuff and you are experiencing growth in membership in those areas.

Mr MATT MURPHY: That is correct. There is an inertia within the organisation as well with what we currently have—the coal option. Yes, we have members in the traditional part of the energy market, but there is an inertia there. It is like electricity—there is a path of least resistance. It is easier to maintain your little patch where you have got good density, rather than to go out, be bold and go into new areas. But we have done that. We are concentrating on growth. Growth is immensely important to us as an organisation. Even if 97 per cent of scientists are indeed conspiracy theorists and we are being sold a pup with climate change, it is like losing eczema—what don't we get? We will still have a clean, efficient industry with no emissions.

The Hon. MARK LATHAM: How many extra jobs are we talking about?

Mr MATT MURPHY: Again, under these circumstances, I am unable to provide you with detail. I do know that in South Australia we picked up about 200 in the early 2000s. I cannot give you the Queensland figures because that is still a matter of debate with the Queensland Government over licenced and unlicensed work. The issue for us is that the construction of the wind generators and the construction of the solar farms give us membership, but the operation of the solar farms gives us good steady baseload membership.

The Hon. MARK LATHAM: In New South Wales?

Mr MATT MURPHY: In New South Wales.

The Hon. MARK LATHAM: How many?

Mr MATT MURPHY: I think we picked up the ones around Canberra in the early 2000s and a few since then. It is mainly centred around the Canberra activity. It around 100 to 150.

The Hon. MARK BUTTIGIEG: Are you saying that regardless of the labour intensity in the construction phase, there is some sustainability long term? Have you got any idea of what an equivalent nuclear labour substitution would be? This is not a valid analogy, but it might give us a rough idea. How many sparkies would we have out at ANSTO?

Mr MATT MURPHY: In my time looking after ANSTO I think we had about 12. But that goes back to the 1990s. They were really property people, rather than being involved with services to and from the reactor itself.

The Hon. MARK BUTTIGIEG: I want to touch on some of the other things you raised. I want to get your view on this because it seems to me that this is an important aspect of the debate that is being put out there. I do not necessarily buy the argument—although there may be some validity in terms of the difficulty in overcoming it—about the baseload dispatchable concept. They say it is not going to work because with all those wind turbines and solar farms, when the sun does not shine and the wind is not blowing you have to store the stuff and you have to have these big lumps of power on tap to keep the system turning around. What is your response to that from an electrical engineering background?

Mr MATT MURPHY: Pretty positive. I would refer you to the Snowy scheme, which is essentially a large battery. Yes, there is some delay in activating it, but it is an electrical storage. You are using water to store electrical power, essentially. There is that to fill the gaps. When I completed my apprenticeship the then Snowy Mountains Hydro-Electric Authority [SMHEA] provided around 10 per cent of the State's generating capacity, with a couple of the rumps, such as Brown Mountain. There is a contributor to baseload, subject, obviously, to drought or the misuse of water allocation.

It is a contributor and a load gap filler for the grid. The ongoing battery development in South Australia has been successful as a stop gap measure to essentially filter out the peaks and troughs in the delivery of electricity supply. We certainly could expand and we are active in advocating for the expansion of off-shore wind, which is very, very reliable. Do not forget that the on-shore wind assets run at around 92 per cent availability. They are the figures we negotiated through enterprise agreements to deliver and we were always successful at delivering above 92 per cent availability for the ones in South Australia.

As I said to Mr Latham, there is still a role for coal in the energy mix. You have to remember that the battery system is Snowy and Snowy 2.0—when and if it occurs—and what that will deliver. We have come so far with the level of technology that we can integrate alternative energy sources into the grid in very short time periods. I remember switching at Queanbeyan substation. In the 1980s when you were bringing the Queanbeyan feeder into the Canberra system you actually had to plug in a synchronisation plug. That was a lot of fun to do because you had to make sure that it was in fact synchronised because it was alternating currents. Mr Buttigieg, you can explain that to your colleagues later if you like.

The Hon. MARK BUTTIGIEG: I would be happy to.

Mr MATT MURPHY: But it was a system where another input had to come out of the system and you had to synchronise that so it was safe and did not drop the whole State system out. We have gone past that. We have methods that automate that now that are 1,000 times—

The Hon. MARK BUTTIGIEG: In a nutshell, the concern over variability and synchronisation can be readily overcome with technology.

Mr MATT MURPHY: That is correct.

The Hon. MARK BUTTIGIEG: I want to ask you about the other chasm that seems to be coming out of the inquiry in terms of the two sides of the debate. On one end of the argument you have mobs like NuScale that obviously have an economic interest to prove that it is all okay. They say that we can get these modular reactors plonked on the ground in five years with no worries. They say it is happening in America now—they have not got regulatory approval yet. Earlier you said that there is no way we could get functioning reactors in this country within 15 years' to 20 years' time. Can you elaborate on where you got that from? Can you provide some clarity on why that is more accurate than what NuScale is telling us, for example?

Mr MATT MURPHY: The Australia Institute report that I reference earlier has some references to support those assertions. It stated 10 years from assent if it was passed today. We estimated 15 years to 20 years. That is on the basis of experience rather than hard data. Living within the vocational education training [VET] system as it is currently constituted, we have had to do this with a submarine and ship project and establish the schools for that. The announcement was made for the Attack class in 2017—a $50 billion allocation; $6 billion has already gone down the drain and we have not cut one piece of steel yet, and we have not trained one worker

to work on it—not one. There is no electrician out there, available, that the French would have building their submarines. So the VET system moves very slowly.

If you are going to introduce nuclear technology for electricity generation those skills are difficult to transfer when we do not have any base. It is not a question of going out to ANSO, grabbing a couple of sparkies out there, who are probably contractors by now, and saying, "Can you tell these sparkies how to work on nuclear power," because it is not the same. It is a 10 megawatt nuclear reactor at Lucas Heights. We are talking about significantly more than that—probably in the range of about 660 up north at Vales Point and Munmorah, and 500—

The Hon. MARK BUTTIGIEG: You are talking about gigawatts.

Mr MATT MURPHY: Gigs, yes. I am talking about gigawatt output, so it is not that easy. There is no regulatory framework, as we speak, for the introduction of nuclear power. Seriously, the way the Commonwealth moves with respect to legislation it would take a significant period of time to get that up. So there is no regulatory framework; there is no legislative framework that supports that. There is no skills base to support it and there is no infrastructure available. As soon as you have waste, how do you transport it? Even the security issues associated with transporting nuclear waste—we do not have a credible, dedicated security organisation to look after that. Yes, you could farm that out to one of the various police forces but you cannot farm it out to the Army. Constitutionally you cannot do that.

The CHAIR: Mr Murphy, that is the second time this afternoon that you have used the submarine building program.

Mr MATT MURPHY: Yes.

The CHAIR: You earlier referenced it in using it as an example of manufacturing continuing in the future in Australia. Do you know of any other jurisdictions in the world that have a strong manufacturing base with a future that does not use either coal, gas or nuclear power?

Mr MATT MURPHY: I am not aware, Mr Taylor Martin—certainly not off the top of my head.

The CHAIR: Equally, earlier on you mentioned safety as one of the real reasons why the ETU is opposed to nuclear power. Do you happen to have a comparison to, say, the coal industry, which is basically what this debate in Australia is about—replacing coal with nuclear—with respect to how safe the coal industry is versus jurisdictions that use nuclear power?

Mr MATT MURPHY: I can give you a two-part answer on that. One is that the generation, transmission and distribution of electricity has inherent risks with respect to electricity itself. The method of generation is a separate and additional risk. Coal has a interesting correlation, in my view, with nuclear energy in that the health risks can manifest many years after an employee has worked there. These are extremely difficult figures to generate. We simply do not have them. I suppose that my finest answer that I could provide you is that we urge that we err on the side of caution.

The Hon. MICK VEITCH: My question is to do with the submission of the ETU, which said that any energy transition must include a "just transition of the workforce and communities". When you are talking about a just transition, what are you talking about?

Mr MATT MURPHY: Mr Veitch, "just transition" essentially is for those workers, particularly in regional communities—that is the best example—who may service a coal-fired power station. If that power station reaches the end of its working life and is to be replaced by whatever methodology other than coal, that there be a form of security provided to those workers as to how they get to the new jobs. I am not a fan of the terminology "just transition"; I think giving it a special name is not as productive as it otherwise could be, but it is certainly ensuring employment and social security—I am not talking about welfare payments—and certainly a more broad social security nuance for employees in regional communities to move to new jobs, new incomes and secure employment for the benefit of them and their families.

The Hon. MICK VEITCH: What would be the ideal time frame for that transition?

Mr MATT MURPHY: The transition would align with the transition to the new technology. That would involve the VET system—the training system, as well. Certainly having people go across to a new form of technology requires that sort of training. You could phase it so that you were a little bit in front or, if required, a little bit behind the transition of the new technology. It is probably fair to say that you may not require the same number of people but there will be people of a higher age bracket who will transition out of the available work force leaving you with, hopefully, a fairly neat transition.

The Hon. MARK BUTTIGIEG: I would like to follow-up from my colleague. This is being done, as I understand it, in what was probably one of the most coal intensive countries in the world—Germany—as we speak.

Mr MATT MURPHY: Yes. There has also been some success—I am probably risking it by raising it in the New South Wales Parliament—with the La Trobe valley in Victoria, as well.

The Hon. MARK LATHAM: But if the jobs are in the Canberra district, how do people in the Hunter Valley get them?

Mr MATT MURPHY: Mr Latham, I do not think it is unreasonable to conclude that wind blows and sun shines in the Hunter valley, either. There may be other—

The Hon. MARK LATHAM: Economically, places away from the Hunter valley have stronger wind and stronger sun. I am not aware of any solar or wind farms in the Hunter valley.

Mr MATT MURPHY: Not at this stage, no.

The Hon. MICK VEITCH: You have a lot of hot air in Canberra, Mark!

The Hon. WES FANG: I just want to follow on from a line of questioning that the Hon. Mark Buttigieg started. You spoke about ANSTO. Did you say that 12 sparkies had been working in ANSTO?

Mr MATT MURPHY: There were 12 when I organised it, but that was in the nineties.

The Hon. WES FANG: So a 20 megawatt medical reactor had 12 sparkies there. How many do you think a gigawatt—

Mr MATT MURPHY: Sorry, 20 megawatt?

The Hon. WES FANG: Yes.

Mr MATT MURPHY: Where?

The Hon. WES FANG: ANSTO. It is a 20 megawatt facility. A 20 megawatt medical facility has 12 sparkies. How many employment opportunities do you think a gigawatt nuclear reactor facility would have?

Mr MATT MURPHY: Mr Fang, I did explain before that the electricians at ANSTO at the time were property electricians rather than the operation and maintenance of the reactor itself. There is no direct correlation between megawatt output and the amount of employees for a given technology. It is an impossible answer to give, I am sorry.

The Hon. WES FANG: You did proffer that an opinion that the ANSTO site at Lucas Heights only had 12 electricians. You brought in the correlation so I—

Mr MATT MURPHY: I was asked a question about how many electricians there were at ANSTO.

The Hon. WES FANG: I am going to take you to the ETU's press release after you did the vote, where they unanimously rejected nuclear power. Allen Hicks said:

> … our comrades in the Australian union movement stand with us in our opposition to nuclear power, uranium mining and export.

Have you guys spoken to the AWU?

Mr MATT MURPHY: Every day.

The Hon. WES FANG: How do you justify a statement like that when one of the biggest unions in the country is supporting nuclear power?

Mr MATT MURPHY: I am not aware they are.

The CHAIR: We will find out more this afternoon.

Mr MATT MURPHY: I guess we will.

The Hon. SCOTT FARLOW: One quick question in terms of your membership. If I was to take Liddell or Vales Point, are your members predominantly the ones who are working on the floor, or is that covered by another union?

Mr MATT MURPHY: No, Mr Farlow, it is a mix of unions. The CFMMEU is active in generation in New South Wales. That is a traditional thing. It varies from State to State.

The Hon. SCOTT FARLOW: So largely your membership is drawn from the distribution network?

Mr MATT MURPHY: Transmission and distribution, yes. Just because it generates electricity does not mean you require an electrician to make a turbine turn.

The Hon. SCOTT FARLOW: It was for clarification; it is not a loaded question.

Mr MATT MURPHY: It is a good question and I am merely giving you the courtesy of providing you a comprehensive answer. You do require an electrician to make sure there are lights on for the mechanical fitter to make sure the bearings are intact, rather than ensuring electricity comes out the end.

The CHAIR: Well said. Thank you very much for your time this afternoon, and for your submission. If any questions have been taken on notice the Committee has resolved that answers to questions taken on notice be returned within 21 days. The secretariat will be in contact with you in relation to those.

(The witness withdrew.)

STEPHEN WILSON, Centre for Energy Futures, University of Queensland, sworn and examined

The CHAIR: I would like to welcome our next witness, Professor Wilson. Would you like to make an opening statement?

Professor WILSON: Yes, thank you. I thank the Committee for its invitation. The New South Wales inquiry is a very welcome development and is, I think, complementary to the Commonwealth House of Representatives inquiry running in parallel on the prerequisites of nuclear energy in Australia. I am a professor in the School of Mechanical and Mining Engineering at the University of Queensland. I am also on the board of the Energy Policy Institute of Australia [EPIA], which is an apolitical, technology neutral organisation focused on good energy policy. My comments and answers today are mine; they are not intended to represent the views of either the university or EPIA.

I am an engineer and an energy economist. In the 1990s and 2000s I worked in consulting firms advising governments, banks and companies on electricity, gas and other energy studies on projects in Australia and over 25 other countries around the world. For five years I ran the industry and market analysis team for energy, including uranium, in one of the large global mining companies. As a Victorian now living in Queensland, via many years in Hong Kong and London, I would hesitate to advise New South Wales what it should or should not do. However, I do think it is important to remember that geography alone means that we could not have the electricity market without New South Wales.

There are many other reasons that New South Wales is pivotal to our nation's energy sector and especially to electricity. The current policy settings within and beyond New South Wales are putting enormous strains on the electricity market. As I said to the Commonwealth inquiry last month, I believe we are currently testing the electricity market to destruction. At the same time, the looming retirements of the main power generation plants in New South Wales, Victoria and Queensland present a major generational opportunity.

As I said in my keynote address to the recent Australian Nuclear Association conference, without nuclear power generation in the system I believe we will find it is close to impossible to deeply decarbonise the Australian economy. I will add that other Australian States have long operated mines safely supplying significant quantities of uranium to customers in our region and around the world. I believe it is our duty to the world not to deny the world access to our rich resource endowment. Repealing the ban on uranium mining in New South Wales is simply good common sense. As you know, Australia's only nuclear reactor operates safely in suburban Sydney. The ban on other nuclear facilities does seem like a quaint relic of another age. I must confess that as a young man I was antinuclear, but I have changed my views. People can change their views.

The Hon. WES FANG: The Electrical Trades Union can't.

Professor WILSON: I am finding it hard to find antinuclear people among the students at the university. I think the passage of the repeal bill would be an excellent example of New South Wales' natural leadership. Thank you.

The Hon. MARK LATHAM: Professor Wilson, do you have any insights into why probably more than any other western nation there is an antinuclear feeling in Australia? This is particularly at a time when people claiming to be concerned about climate change are saying that the challenge is so severe that they can only have two children now and we are facing the extinction of our species and other species as a consequence. This is put in the public debate as the most supreme issue, going to the very survival of our planet and our civilisation. Why, in those circumstances, would there not be an acknowledgement in Australia that nuclear has a role to play in decarbonisation? Even the Green New Deal in the United States, they talk about having an open mind about nuclear—they do not like it, but they think the other problem is so severe that it needs to be factored in and that if it can be made safe it needs to be part of the equation. What is it about our country?

Professor WILSON: That is a very good question. I think fear is a factor and I think lack of knowledge is a factor. These kinds of questions are questions of opinion and perception. For example, my own brother is quite afraid of and opposed to nuclear energy. I think there is something very deeply emotional there. Notwithstanding your observations, I do sense that a shift has happened and is underway in attitudes in this country. I think fewer people are afraid of nuclear energy today than was the case 20 or 30 years ago. I made the comment that I am struggling to find antinuclear students at the university, which surprised me when I came to that realisation. I think it is changing.

I think that we have had the great luxury in this country of not needing to go to nuclear power plants until now, of not needing to really consider it as a live option. We have just got such an enormous resource endowment relative to the size of our population and our economy. It has been sort of an easy thing to be opposed to nuclear.

I think that is part of it. But I think as people are more educated and come to understand more about what this resource is and what the technology is then we will see more people coming to the view that actually it is not something to be afraid of and it is something that we should embrace.

The Hon. MARK LATHAM: I suppose the second factor is that the tone of this inquiry is such that once Government bans something there is sort of an assumption that it is fundamentally irrevocably dangerous, immoral, unacceptable and the onus is on us to prove that the ban should be lifted. If you look at the improvements in technology and the fact that this ban was a consequence of Chernobyl, which was so long ago and in a system that bears no similarities to the way in which we govern and regulate industries in New South Wales, should the onus not be on those wanting to keep the ban going, given the importance of energy security and the way in which the nuclear technologies have improved dramatically over time?

Professor WILSON: I think that is a very reasonable view and I am inclined to agree with you, yes. Just to expand a little bit on my further comment about being able to have the luxury of this sort of policy stance previously, I think the reality is probably that the ban was not what an economist would call a binding constraint. In the hypothetical world where the ban in New South Wales and the Commonwealth ban never existed, we probably would not have necessarily built a nuclear reactor up until now. However, of course, things have changed and the opportunity and the need to do so is much more real now than it was at that time.

The Hon. WES FANG: Thank you very much, Professor Wilson, for coming and appearing today. At the hearing last Monday we had the Nature Conservation Council, the Australian Conservation Foundation and Friends of the Earth Australia. They were against nuclear power. Amazingly, today we have had the ETU against nuclear power. However, your experience is that the majority of students who are coming through your classes and I guess many of the people who you deal with are all open to nuclear power. Is it a case that the opposition is primarily ideological and not based on, say, factual information? I will quote from the ETU's press release, "The dark path to nuclear power."

Professor WILSON: The dark path to nuclear power? Well, okay. So I think, is it ideological? There may be an ideological component to the views of some people who are opposed to it. I agree that is quite likely and possible, but I do not think it is necessarily the whole explanation. My perception is, and partly this reflects my own personal experience. As I said, when I was young I was anti-nuclear, just by studying engineering and had a highly respected physics teacher at high school who was pro-nuclear. I think part of the explanation is a generational thing. Among people of my age and older with memories of certain events of their time growing up formed a view against and have not reviewed or changed that view. So there is probably an ideological component as well but you need to research carefully to tease out the difference.

The Hon. WES FANG: Do you think that the opposition is a well informed opposition, or is it again an ideological one? I will expand on that. When we questioned last Monday the other groups I previously mentioned, I would characterise it personally that they did not like the vibe of the thing. If I am characterising the testimony that we have just had from the ETU, I would say it was pretty similar, we do not like the vibe of the thing, it has been an opposition for 70 years and we are not going to move on this.

The Hon. MARK BUTTIGIEG: Point of order: The honourable member is now making inferences that this Committee—

The Hon. WES FANG: I am.

The Hon. MARK BUTTIGIEG: —and certainly I do not agree with.

The Hon. WES FANG: I said "I".

The Hon. MARK BUTTIGIEG: Proffering a point of view to try to lead the witness into an answer that he wants is not in order.

The CHAIR: I think the professor is perfectly able to handle himself answering the question. I will draw the Hon. Wes Fang back to the fact that other members may take offence.

The Hon. WES FANG: To the point of order—

The CHAIR: I am making a ruling. I ask the Hon. Wes Fang to continue without drawing inference on previous witnesses. I am sure the Hon. Wes Fang is perfectly capable of making the point without doing so.

The Hon. WES FANG: Possibly. In short, given that you are experienced in the economics and the physical, mechanical reactions, you have a unique perspective on this, and you were against nuclear, can you see relative merit in some of the arguments against nuclear power?

Professor WILSON: Relative merit? I would rather respond to that by saying I can understand why people might be opposed. We have used the word "generational". I introduced the word "generational". You asked about ideological. There is probably a third word that would be good to use, which is emotional. Some people do have an emotional response to this issue, no question. I think there is a bigger question here that is very important for the State of New South Wales and for Australia as a nation, which is how do we as individuals arrive at our views on controversial questions like this, and how as a nation do we make decisions on topics like this that can become emotional, that can become ideological. How do we discuss these things with each other without becoming emotional? I think they are really important questions for us as a society to engage with and to find a way to have these conversations that gets us to a decision that we can be comfortable with as a nation and that will be in our wider national interest.

All of us can make a contribution. Everyone around this table, everyone in the university, everyone out in the street can all be part of this conversation, encouraging people. My little way of approaching this is I have started a not scientific one question, one person survey of Australia. I just ask people, "Tell me, do you think we should embrace nuclear energy?" I asked the Uber driver on the way over from the electricity future summit just now. It turns out he was born in Delhi and he told me about his wife's cancer treatment, and we talked about medical isotopes and all the rest, and he said, "Yes, I think we should. And this is why." And he explained. It was a very rich and lovely conversation. I think we can all have those conversations and it will be very helpful.

The Hon. WES FANG: One of the other questions that I had, you are in a unique position to answer this, again, as I said, because you have economic experience as well as experience about the technology. Some of the testimony we heard last week was that the technology itself is not capable of standing up in an economic sense. Those from the Nature Conservation Council the Australian Conservation Foundation and Friends of the Earth said that nuclear does not stack up, it is too expensive, it will never work here but we want you to maintain the ban anyway. In your opinion does nuclear stand up to the relative merits of technology agnostic energy production and if we were to remove the ban on uranium mining and nuclear facilities for New South Wales do you believe that there would be the economic opportunity for the commercial deployment of the technology?

Professor WILSON: So, really good questions.

The Hon. WES FANG: Mine generally are.

Professor WILSON: There are several questions packed in there. There is the question of the economics and the question of the ban. I take the old-fashioned view that we should always, each of us, try to be internally consistent in our view. I do not believe it is internally consistent to say nuclear does not make economic sense and we need to keep the ban. If it does not make economic sense, you do not need the ban. That is clear, that is just logic. I have given my views on the ban and the fact that I think the ban should be lifted. The question on economics implicitly is asking if we did lift the ban, would we then expect to see investment in nuclear power plants or in mines or both. That is a big question. On my journey from being anti-nuclear to my current views I went through a phase where I thought that the nuclear power just was not going to be able to compete in electricity markets and therefore the hopes of the mid twentieth century had not been fulfilled. The joke was it will be too cheap to meter. Apparently the quote was a little bit misunderstood. It is difficult to answer the question on economics without stating a set of assumptions or conditions that you are adopting to answer that question.

The Hon. WES FANG: What about the environment with which it will be introduced?

Professor WILSON: So, what price would a nuclear reactor need to charge or recoup from its customers or from the market in order to justify the investment, is a way of framing that question. And if we go back five or 10 years, the answer to that question would almost certainly have been, above the wholesale price in Australia. If we look today, the answer to that question is almost certainly, around the wholesale price level or below. What has happened in the meantime is that we had an electricity market in Australia, which for the first decade and perhaps a little bit longer of its life an economist would say was pricing the short-run marginal cost of electricity—in other words, it was pricing the fuel cost, the variable operating and maintenance cost and not much more.

We had a market based on a large installed base of generation that had been built previous to the market and there was no need to build much in the way of new capacity. Now we are seeing a market that is pricing definitely at and arguably above the long-run marginal cost of electricity. I am of the view that nuclear generation could definitely make economic sense in the Australian electricity sector, but that is not the whole story. The next thing is, under what conditions would you expect to see investment in those assets? That is another question.

The Hon. SCOTT FARLOW: To follow up on that, we have heard today a band of prices for nuclear on a levelised cost of energy [LCOE] basis per megawatt hour. We heard anywhere from $60 per megawatt hour LCOE proffered by the Minerals Council of Australia for a small modular reactor. The ETU said $160 per megawatt hour LCOE. Where would you put it?

Professor WILSON: The first thing I would like to say is that we should be very careful about using the levelised cost of energy as a metric. It can be used and abused. I like to use the more traditional economic term of the long-run marginal cost. We must remember that in the case of nuclear power you have very high upfront fixed investment costs, which need to be recovered over what is a very long operating life. One of the questions is: Over how many years are you going to be willing to recover that upfront capital investment?

The Hon. SCOTT FARLOW: We heard from Women in Nuclear 60 to 100 years for a modern nuclear facility.

Professor WILSON: Nuclear reactors around the world, typically the ones built in the late twentieth century, were licensed for 40 years with the option of two 20-year extensions. The reason they only licensed them for 40 years was they were not sure about things like what effect neutrons would have on fatigue of steels and that sort of thing. They then discovered that it was not an issue and so most of those plants have been relicensed for another 20 years and may get another 20 after that. They are very long-lived assets. The financing periods for these things will be much shorter than the physical engineering operating lives.

What sort of costs are we talking about? If you look around the world at the cost of generation for a nuclear plant, you can find an enormous range of outcomes. Rather than looking at paper calculations, if you look at actual instances you will find an enormous range of outcomes sensitive to things like how well the engineering project was managed, whether it was delivered on time and on budget. The most extreme case is a plant in the United States that was built and has never operated, so it has an infinite cost. You have an answer between very low, very reasonable, very attractive numbers and infinity. It all comes back to your ability to manage the project effectively.

The Hon. SCOTT FARLOW: We have no experience in Australia of producing something like this, so you would think that potentially the cost would be on the high side. I imagine that the only thing that we have done in this space is Lucas Heights in terms of a built, managed and delivered project.

Professor WILSON: Yes, and that project was, to my understanding, very well managed and delivered. We do have the ability to do these projects in this country. Lucas Heights was built by an Argentinian company. Before I ask my engineering class a question on nuclear, I ask them who thinks Australia is less capable of doing engineering projects than Argentina. I cannot get a single student to raise their hand—this is an international class of students; they are not all biased Australians. I ask them where they think we have procured our reactor from. No-one guesses Argentina. It is an unreasonable view to suggest that Australia cannot do projects like this. I am sure we can, but we need to be conscious that we need to do them well and properly.

At this stage of the process to come up with single-point estimates for numbers like LCOE or long-run marginal cost, as I prefer to call it, is inadvisable. At an early stage of the project development cycle, and we are at stage 0 at the moment, there should be a range around these estimates and there should be clear understanding of the sensitive factors that give rise to that range and the inputs to that calculation. I can produce almost any answer you like by just fiddling with those assumptions. The point is to understand the drivers and the things we need to manage well and control. Can we get to a reasonable cost of delivered electricity under the right conditions? Yes, we can.

The Hon. SCOTT FARLOW: New South Wales has a zero net emissions target by 2050. If we were to remove all coal-fired power generation in New South Wales and replace it with renewables, could we have a 100 per cent reliable baseload power network in New South Wales in your view?

Professor WILSON: No. I wrote a paper on this a couple of years ago, co-authored with some colleagues at UQ. So that we understand what the net zero aspiration means, we said what it means. One of the things that we need to remember is that the power sector is only one part of that story. Variable renewable resources, non-dispatchable with very low capacity factors, will not be able to deliver affordable, reliable electricity.

The Hon. SCOTT FARLOW: If we were to take nuclear off the table, which is the current situation, is there any other alternative technology that could provide us with that baseload with zero emissions?

Professor WILSON: I do not believe so.

The Hon. SCOTT FARLOW: From your perspective, nuclear is the only one.

Professor WILSON: That was my opening statement at the Australian Nuclear Association conference. I said that my first slide would say what I was about to say. I said that I believe it will be close to impossible to deeply decarbonise the Australian electricity sector without nuclear power.

The Hon. SCOTT FARLOW: I have one other question. We have heard some arguments for exploring nuclear say that the process will take 15 to 20 years, we do not have an equipped workforce in Australia and it is not as simple as plucking out a few people from ANSTO to work in a nuclear reactor. What do you say to those arguments?

Professor WILSON: We do have skills and capabilities in Australia; we are not starting from zero. The fact that we have the ANSTO facility and a reactor means that as a nation we have kept alive the real option, which we can then exercise. We are not starting from ground zero by any means. We have a whole range of skills and capabilities that are relevant and deployable to the construction of a nuclear power plant. We clearly have the time to enhance and augment those through the education system and through selective strategic hiring between now and the date that we start physically building the project. I do not see that as a problem or a constraint.

The CHAIR: I want to pick up on your recent answers to Mr Farlow's questions about deeply decarbonising and your assertion that we could not meet the 2015 net zero emissions target without nuclear. Could you expand on why some of the witnesses—for instance, the ETU and Friends of the Earth—have said that we do not need nuclear and that we can go down the path of renewables plus firming and everything will be fine? Please expand on why they might be wrong.

Professor WILSON: I do not want to speak for other witnesses but I will explain why I have come to the view. The most important thing to remember about electricity is that you have to balance the supply and demand continuously in real-time, every second of every minute of every hour of every day. If you cannot do that, the whole system can fall over. It is not like, "oh, we forgot to buy milk. The supermarket ran out and there was none in 7-Eleven, so we miss out in our house. But everyone else got their milk." It is not like that with electricity. If you cannot maintain that knife edge balance of supply and demand continuously, you can find yourself in a cascading blackout and the system can go black within 60 seconds.

We had a demonstration of that recently in a neighbouring State and it has happened in other places around the world. That intrinsic aspect of electricity systems is important. When you start adding generation resources onto a system that are not dispatchable and not able to respond to the demand, you do not notice anything for the first few per cent. In fact, you can probably slightly reduce the total system cost for the first five per cent or so, depending on the make-up of the system. But when you get to 25 per cent, 30 per cent and 35 per cent, you start to notice it affecting costs. When you get to 40 per cent, 50 per cent and 60 per cent, things start to become technically very difficult.

The cost function—the total system integration cost function—increases very, very steeply. One of my Doctor of Philosophy [Ph.D] students is doing his Ph.D on this topic. His literature review has found that there is universal agreement around the world that the integration cost function rises steeply as you approach 100 per cent variable renewable energy. There is no agreement whatsoever on exactly what the numbers are so there is this huge range of estimates. Some people think you can get all the way to 100 per cent for just plus $25 per megawatt hour integration costs. The analysis of other authors shows the costs go to infinity well before you get anywhere near 100 per cent. One of the things Gabriel is focusing on doing is getting a little more certainty around that and see if we can move towards some sort of agreement on what the cost function actually looks like. But to me there is no doubt that it is formidable.

The Hon. MICK VEITCH: I want to go back to the conversation you were having with Mr Fang about community awareness. People have hardwired, ideological positions on either side of the debate as those in the middle are trying to form a position. It would be fair to say that community education has got a long way to go. Television shows like *Chernobyl* have an impact—whether people like it or not—developing people's views on these topics. What community awareness exercise do you think should take place to inform better inform society about modern nuclear energy arrangements as opposed to those of 30, 40, 50 years ago?

Professor WILSON: I have been thinking about this quite a bit. You mentioned the HBO mini series *Chernobyl*. I thought I had better watch that because that is exactly the sort of thing that influences people's thinking. I watched it, then I watched it again with somebody else. It is phenomenal filmmaking, very graphic, very frightening, very vivid and real. Hard to watch in places. I got to the end and I thought, I am not more frightened than I was before. In fact, I feel more comfortable about nuclear power now than before I watched this series. Then I asked myself why that was. I think there is a demystifying element to that. It is a bit like aversion therapy, you are afraid of spiders so you face the spiders.

I asked people whether it made them more or less frightened of nuclear power? I found other people had had the same reaction as me so I actually think that series is helpful in opening up the conversation and in understanding what went wrong in that particular case so that it is not a mystery. I wrote my year 12 English special project on Chernobyl and there was a dearth of information available at the time. At the time I was very anti-nuclear, as it happens. We do understand what went wrong there and that is helpful. How do we have the

conversation with people? I think it is important for people like me—who think this is something we should seriously consider and do—that we do not assume what questions people have in their mind and tell them the answers to what we assume are their questions. We should ask people what their questions are and what their concerns are. We should listen to their questions and think about them so we can give them good answers to those questions. That is the right way to have a public conversation about these things that is not emotional.

The Hon. MICK VEITCH: Do you think it is generational? I have no views about this other than trying to work out how to engage the broader community in a constructive conversation. The hardwired, ideological positions that people take, is that a generational issue? People like us with grey hair that lived through Chernobyl—rather than watched the television series—can recall what it was like at the time. Is that what it is?

Professor WILSON: That is part of it. The experiences we had, that formed us as we were growing up as we were young adults, is one part of that. If you look at the reaction in the United States to Three Mile Island where the safety systems did everything they were designed to do and if you look at the reaction of the West to Chernobyl, it was completely the opposite to the Soviet Union which continue to operate the other three reactors until very recently. Then you look at the reaction to Fukushima, you can see there is quite a shift in the reaction to those three events.

The Hon. MICK VEITCH: Again, part of this is people's understanding and awareness of exposure to radiation. A couple of people I know are completely opposed to uranium mining and nuclear energy because they are concerned about radiation. I asked if they understood what a millisievert was and their exposure. One has just come home from London. I think there is a general lack of awareness of the day-to-day exposure levels. Do you think that is part of the issue?

Professor WILSON: Yes, I think that is part of the issue. Providing people with that kind of basic information, which very few of us received in our high school science classes, is a job that needs to be done. Definitely.

The Hon. MICK VEITCH: This committee is hearing from both sides and you will have gathered from the questioning that we have not had much middle ground. We have had either side of the debate. We are testing Mr Latham's bill here in this forum to see where this lands in the Chamber. Personally I do not think it ends even if the bill gets rolled. I think this is a conversation that will continue for some time. As legislators, is there a better way of approaching this than by informing the Committee and engaging the community's feelings and sentiments one way or the other. Or are there other ways we could do this?

Professor WILSON: Other than this Committee?

The Hon. MICK VEITCH: Other than this forum, yes.

Professor WILSON: The Committee is a vital part of the process. That is the normal, proper way that these things are handled. Parliament is made up of representatives, each approximately representing equal numbers of citizens. All members of Parliament can be having these conversations with their electors. I think that is really important. Whether members are for or against the bill, it is incumbent upon all members to have the conversation with members of the community and find out what they think. My personal experience is that I have been very surprised by the views I have encountered.

I asked my Uber driver, I asked the lady cutting my hair, I asked my brother, I asked my 80-year-old neighbour Bev whose husband was a navy in World War II. I asked her to bring the bins in the next morning the other month when I was going down to Canberra for a nuclear event. She said, "Why are you going to Canberra?" I said, "I'm going to a forum on nuclear energy." She said, "Oh, about time!" I said, "What do you mean?" She said, "Of course we should have nuclear energy." She just floored me with her reaction. If we just open up and have these conversations with each other, I think we can be surprised about the views that people have, which are not always what we might expect or what we might think.

The Hon. MICK VEITCH: My last question is to do with the regulatory framework and the Australian Radiation Protection and Nuclear Safety Agency [ARPANSA]. If the prohibition—particularly on generation—was to be overturned, do you think that the current regulatory regime in Australia would need to be strengthened in any way to accommodate the overturning of the provision? If so, what would that look like?

Professor WILSON: That is a question on my mind that I do not feel I have all the information to answer right now. But I am planning to get across that question in the next three to six months. I think we need to compare what we have got today and then look at other OECD countries and look at the regulatory regimes that they have, how they work, what works and what does not.

The Hon. MICK VEITCH: Sort of map out what we have got?

Professor WILSON: Yes, like a gap analysis. We are not starting from zero, but we may need to do some building.

The Hon. MARK BUTTIGIEG: Thank you, Professor. I must apologise; I missed your introductory statement. I gather you are a professor of economics?

Professor WILSON: My original training is in engineering and most of my career has been in energy economics. My home is in the engineering school, but we have a course called Master of Sustainable Energy and I teach a course called Energy Markets, Law and Policy.

The Hon. MARK BUTTIGIEG: Thank you. Does the Centre of Energy Futures out of the University of Queensland receive any independent source of funding outside the university?

Professor WILSON: We do research projects on a range of topics that are funded by a range of people looking for answers to research questions.

The Hon. MARK BUTTIGIEG: Does the nuclear industry provide any funding?

Professor WILSON: To date, no.

The Hon. SCOTT FARLOW: But you would be happy to take it?

Professor WILSON: If the nuclear industry has questions that we can help them do research to answer, then of course we would be glad to do that work. But some of the larger work we are doing is actually focused on things like solar, thermal and other areas.

The Hon. MARK BUTTIGIEG: The reason I ask is not to be facetious; it just strikes me that, as you would expect, people who have an interest are advocating one side of the argument, like most things. It seems to me the way to get to the bottom of this is to try and reconcile a set of disparate facts. I could characterise it like this: If you did not think waste was an issue at all, if you did not think the lead-in time was an issue at all and if you did not think the construction cost was an issue at all, then there probably would not be an argument. But there is, because there is a debate over those figures. Some people are saying it is going to take 20 or 25 years to build reactors; other people are saying it is going to take five years.

Some people say the cost is prohibitive; other people are saying it is fine and it stacks up. One side of the argument says that we can readily deal with the waste; we can reprocess it and store it. The other side is saying, "Well, it is not that simple." On top of all of that you have got the view on one side of the argument that if the technological uptake—the curve—is steep enough in terms of renewables, you will actually get there. The other side is saying that it is not that steep and it is not going to get there; you will never have 100 per cent. As a Committee member with a view but also an open mind, I am genuinely confused because there does not seem to be any authoritative figure on this who is saying, "This is the real science on it. Here are all the answers to those questions."

I want to get your view as, probably, someone with a background who has got the wherewithal to make those sorts of judgements. I know it is a long-winded question, but I make this observation as someone who has studied economics as well: Companies such as BHP and Rio Tinto are not tin-pot backyard operations; they are multinationals who are looking at the world market. Their whole raison d'être is to try and predict what is happening in the future, and they are saying that it is clear where this is going: It is going down the path of renewables. It makes me wonder about the viability of nuclear if they are not beating that drum. I want to get your views along those lines.

Professor WILSON: I do not think these kind of questions can be answered by, let's say, a computer model.

The Hon. MARK BUTTIGIEG: There are just too many variables to model.

Professor WILSON: Yes, that is right. The conclusion that one comes to on these sorts of things is usually determined or very heavily guided by the inputs and the assumptions, and there is uncertainty around those inputs and assumptions. I think that there is a problem in the world we live in today, and I see this in companies and I think I see it in governments around the world as well: to try and get out of the need to make judgement calls or executive decisions by hoping that an appropriately sophisticated model will sort of pop the decision out for them. With things like this, there is always a decision to be made. In a democratic society we have a process for making those decisions, and today is part of that process.

The Hon. MARK BUTTIGIEG: On that point, because it is a good juncture, we are prepared to model complicated beasts like the macro economy of Australia. We pay Treasury officials to run thousands upon

thousands of inputs and spend endless weeks and months on this sort of stuff. But we cannot do it for a segment of the Australian economy like a hypothesised nuclear industry, for example.

Professor WILSON: We still need to use models. That is one of the questions I ask my Masters students in the oral exam: Why do we need a model at all? Why do we not just use common sense or do some back-of-the-envelope calculations? The correct answer is the reason we need models is because there are so many variables and so many moving parts that no human mind can keep them suspended all at the same time.

The Hon. MARK BUTTIGIEG: So it gets us closer to the truth.

Professor WILSON: The reason to use a model is to understand and get insight into what is going on, and then to have informed debate where everyone is using the same inputs and can see the effect of assumptions, and then to step back and make a decision.

The Hon. MARK BUTTIGIEG: So there has been no work along those lines?

Professor WILSON: Whereabouts?

The Hon. MARK BUTTIGIEG: In this area: modelling the cost-benefit analysis of, say, 100 per cent renewable versus a nuclear mix of 25 per cent.

Professor WILSON: That is the work I referred to earlier. The literature review that Gabrielle undertook on the published papers in this area shows that of the work that has been done, there is this enormous divergence of views. So it is clear that more work is needed to understand why people are coming to such a wide range of views, so that we do not have shouting matches but can start to narrow down the uncertainty and understand what is giving rise to that. Where are we going wrong? Where are there factors that are causing different results by different modellers?

The Hon. MARK BUTTIGIEG: What that tells me, Professor, is that given the lack of maturity of those various debates in academia, this is going to be a political decision, in essence. People have views and the facts cannot be reconciled via models or some sort of objective source of wisdom, so we are going to have to make a political decision based on where we think the community is at. That goes to your earlier point and my colleague the Hon. Mick Veitch's point that the community conversation is not yet sophisticated enough to bring politicians along at this stage. That is what I am hearing.

Professor WILSON: Yes. Notwithstanding what I have just said, the outlines of the choice that is before us are clear. We, as a community, have a choice to make about what kind of energy system and what kind of electricity system we would like to have. Ultimately there will be a political dimension to those choices. I think that is very clear.

The Hon. MARK BUTTIGIEG: What do you say to those companies who, as I say, have an economic future in getting this stuff right? As an economist you look at those and you think, "That is a good proxy for where the market is projecting into the futures market of nuclear energy," if you like. What do you say to those companies who are saying that this is not the way to go?

Professor WILSON: I have the experience of having been inside the beast in exactly some of those of conversations that you refer to and I would not necessarily put too much weight on what particular companies say publicly or what they conclude. They are trying to use the same processes as everyone else. Of course, one of the big things you are doing in a company is trying to second-guess what political decisions are going to be made and where the policy settings are going to be set. That is not easy to do and usually the only way to handle those sorts of questions, as well as other things you cannot control, is through scenarios. That is exactly what we did in my team when I was involved in that kind of work.

The Hon. MARK LATHAM: Professor, is it that complicated to need a model when one graph tells you that we are systematically eradicating old forms of electricity generation and we will need new forms. It is an argument about what form that takes. The knowledge that we can lift the ban In New South Wales does not mean that any nuclear power station will be constructed in our State, given that there is a Federal Government ban. It seems to me that lifting a ban that does not result in enabling a facility to be built is not a big decision.

Professor WILSON: I agree that it is not a big decision. It is a necessary but not sufficient condition. For me it is a straightforward, commonsense decision. Other things would need to happen as well in order to have nuclear power generation in New South Wales or in Australia.

The Hon. MARK LATHAM: We will see what the Senate committee says. The sobering reality that the whole future of the energy sector in this country will probably rest on the vote of Jacqui Lambie.

Professor WILSON: That is a very interesting analysis and it may well be quite accurate. You are quite right to show the chart of the plant retirements. I have been saying in public forums for some years now that this is a central issue. Whether or not we were building wind and solar, we would still have the whole mainstay of the east coast generation fleet reaching its fiftieth birthday in the next 20 years. There will be choices to be made about what to do about it.

The CHAIR: On that, thank you very much for your time this afternoon, Professor Wilson. The Committee has resolved that answers to questions taken on notice be returned within 21 days and the secretariat will be in touch with you if any questions were taken on notice. Thank you again for your time, we very much appreciate it.

(The witness withdrew.)

(Short adjournment)

JOHN PATTERSON, before the Committee via teleconference, affirmed and examined

BARRY MURPHY, sworn and examined

The CHAIR: Good afternoon, Dr Patterson. My name is Taylor Martin and I am the chair of the Standing Committee on State Development. To help set the scene for you, Dr Patterson, we are in the Macquarie room at New South Wales Parliament. Here with me are other members of the Committee, including the Hon. Mark Latham, the Hon. Mark Buttigieg, the Hon. Scott Farlow, the Hon Natasha Maclaren-Jones and the Hon. Wes Fang. You are appearing alongside one other witness, who is here in person, Mr Barry Murphy. Mr Murphy, would you like to begin by making an opening statement?

Mr BARRY MURPHY: Thank you, Mr Chair, I will. Thank you for the invitation to talk about this. I understand members of the Committee have seen my summary CV as an executive and chemical engineer in the oil and various other industries, all of which used fossil fuels, and have read my submission. On that assumption, and having listened briefly to the previous witness and your discussion about getting something done, I summarise in a few words what I think New South Wales should do for the immediate and longer term in dealing with this question of repealing prohibitions on developing a viable and necessary nuclear power industry in New South Wales and Australia. Firstly, we are all aware of the Federal inquiry into the so-called "prerequisites" for nuclear power in Australia, which is currently underway.

Surely the most obvious prerequisite is for the Federal Parliament to lift the 20-year-old ban on this technology, resulting as it did from a purely political deal that had no scientific or engineering merit whatsoever. Yet, it remains the law of the land. Secondly, on the assumption that the law will soon be changed to remove this ban, I hope, I believe the New South Wales Government should work with the Commonwealth and relevant Australian and international experts, to select and bring about the construction of two appropriately sized small medium reactors [SMR] within New South Wales, within the next 10 to 15 years.

In my view, those should be placed where, by flexible and intelligent operation, they could provide: all-weather, reliable, emissions-free backup for renewables and storage to help power the National Electricity grid; and/or thermal energy and electricity for the desalination of sea water or brackish water, making it available for local use, or be delivered by rail or road transport to regional communities where necessary. One such SMR design that is nearing final approval in the United States can enable the all-weather desalination of up to 190 million litres of water per day, sufficient for a community of 300,000 people. At the same time, it can provide 400 megawatts of emissions-free electricity for that same community. This type of application could be ideal for Australia and we need to know more, but of course no-one, here or overseas, will invest their time on this unless that overarching Federal ban is removed with full bipartisan support.

Lastly, I fear a temptation could grow that the political answer might be to limit the size of nuclear power plants that could be built. In other words, remove one ban and replace it with another. With all due respect, I suggest that this would not be the answer. Let need, economics, good science and engineering, as well as strict regulation in any particular case, guide the decision. Mr Chairman, I think we all know that, historically, Australia has had a deep-seated aversion to the use of nuclear power. Given the circumstances we are now facing, it would be a tragedy if we allowed this to continue by default, rather than raise it to the highest level for proper examination, informed assessment and, hopefully, wide community support. In my view, this is a golden opportunity for New South Wales to show the way.

The CHAIR: Thank you, Mr Murphy. Dr Patterson, do you wish to make an opening statement?

Dr PATTERSON: Yes, thank you. Thank you for inviting me to appear today at this public hearing on the Uranium Mining and Nuclear Facilities (Prohibitions) Repeal Bill, which I support. I agree with everything that Barry Murphy has said. Although I am a retired staff member of the University of Adelaide and the Royal Adelaide Hospital, I am appearing as an independent witness. I acknowledge that I have been a member of the Australian Nuclear Association for about 20 years, since I supervised a Master of Science project on the Olympic Dam tailings dump at Roxby Downs in South Australia. Although I live in South Australia I was born in Sydney and grew up in New South Wales.

My concern about climate change drives me and the need for nuclear power is part of its solution. I believe that nuclear power offers the best prospect of drastically cutting carbon emissions. I have a PhD in experimental nuclear physics from the Australian National University. I have worked overseas at Caltech in California, in the UK and at Adelaide University as well as in the medical physics and radiation oncology departments at the Royal Adelaide Hospital. This makes me naturally pro-nuclear because I understand it.

The first point to make is that Olympic Dam, where the project was done, is one of the largest uranium deposits in the world and it is a vital part of our South Australian economy. If it was in New South Wales, it would be against the law to mine that deposit. The second point is that the public by and large do not appear to understand nuclear or radiation. I believe they have been fed a lot of lies and half-truths, which makes them very fearful. I had experience of this when I sat in on the citizens juries following the royal commission on the nuclear fuel cycle. It is our experience in the Australian Nuclear Association that when the advantages of nuclear power are explained to a receptive audience, a large majority of them will support it.

Recently, a plebiscite was held in Kimba, here in South Australia, regarding the establishment of a low- and intermediate-level waste storage facility. It passed with 62 per cent public support, because the public was given plenty of information about significant benefits in terms of funds and employment. Jeff Baldock, on whose property it may be established, described it as "a once-in-a-lifetime opportunity to secure Kimba's future". Like much of New South Wales, Kimba unfortunately is in a severe drought situation.

Similar public support has occurred in France and in Finland when waste depositories have been established there. My strong belief is that we should be using some of Olympic Dam's uranium to provide reliable, dispatchable, emissions-free electric power for our grid and to help relieve the current high electricity prices. Thank you.

The CHAIR: Thank you, Dr Patterson.

The Hon. WES FANG: Thank you very much, Mr Murphy and Dr Patterson, for appearing before us today. You have touched on one of the biggest problems we have with this bill, which is public perception. The evidence that has been given to us by academics and people with first-hand knowledge of nuclear power systems has said that modern systems are safe, reliable and able to produce power with no carbon emissions. But we have heard from other groups who suggest that there is effectively a dark path to nuclear power. How do we overcome any negative perception in the public and the negativity that is peddled by certain groups and unions?

Mr BARRY MURPHY: Yes, certainly; was that a question for me?

The Hon. WES FANG: Yes, and then I will ask Dr Patterson to answer.

Mr BARRY MURPHY: I understand exactly what you are saying. I have been spending what seems like a long time developing my own knowledge in this area, based on my years of energy and electricity experience and I have come to the view that there is no easy path. But when you actually do it, I share the experience you have just described. I gave a two-hour presentation a week ago to one of the University of the Third Age groups at St Ives. I was warned beforehand that there was a hard core of people who reckoned climate change was rubbish and I was going to get a tough time and all the rest of it. At the end of it they were unanimous saying, "You go and tell that inquiry that we want this to happen". It is possible, but it is a long road and I do not minimise that at all.

But when it comes to radiation it seems to me that—and this came up earlier when I was here—we all have a misconception about that. It all comes from the sun. If you watched TV last night, they were all lying on the beach in the radiation. We get an average of 3.5 millisieverts per year; this is a biological measure of radiation. Finland, for example, gets twice that but yet they have a lower cancer rate than we do by quite a margin. We are all subject to background radiation from airlines and so on. Cornwall gets 7.8. Somebody noted the other day that if it were Fukushima, Cornwall would have to be shut down. There are a lot of things like that that we simply have to put the hard yards in to try to help people to know more. I especially say that about political people, with all due respect.

The Hon. WES FANG: Is there an onus on those of us who are in elected positions and perhaps organisations and unions not to spread mistruths about nuclear power?

Mr BARRY MURPHY: Well—

The Hon. MARK BUTTIGIEG: Point of order: The member is implying unions in the plural all have a similar anti-nuclear position. That is not the case and the member knows very well that we are going to hear from the AWU this afternoon who actually have a pro-nuclear position. Chair, I ask you to get the member to withdraw that implication.

The Hon. SCOTT FARLOW: To the point of order: If you were to be so sensitive about that, you would assume that all members have the same position as well. I think it was a fairly general statement that the Hon. Wes Fang made.

The Hon. WES FANG: I certainly was not singling out any union.

The Hon. MARK BUTTIGIEG: The clear implication was that all unions are anti-nuclear.

The Hon. WES FANG: No, not at all.

The CHAIR: I think everybody here and everybody reading *Hansard* can decipher what is commentary and what is not. I will allow the question for now but I ask members to consider the views of others in their line of questioning.

Dr PATTERSON: If I could make a comment here, there are two big points made by people who are arguing against nuclear. One is the public will not accept it and the second one is that the cost is too high and the delays are too long. I do not believe either of those is correct. I cannot see why the public in Kimba or in France or in Finland would accept it and not the Australian public if things are explained. I think that is where the issues are. The media do not always look for factual and helpful explanations. They try to point at the controversies; that seems to be what they require to get their audience. Unfortunately, the controversy involves Chernobyl and Fukushima, and these get repeated time and time again. Both of those reactors would not be approved today. They are both old technology and the Russians particularly had some horrible old things and they just would not be built today. But trying to colour our views of the latest generation nuclear reactors, like the NuScale small modular reactors, in terms of these old bogeys is not fair and it just creates this unnecessary fear.

What needs to happen, I really do believe, is the young people need to take part in realising that nuclear is a major way of combating climate change. I do believe the young generation is really strong on climate change. They want to see something done. With a little more education—they already get a lot, I guess—they would come to see nuclear as not a huge bogey. After all, they go to the dentist, they go to the doctor, they have x-rays and some of them have nuclear medicine. All these are part of our modern health system and they are accepted. People do not argue against them. Occasionally I have interesting discussions with my doctor and dentist, but in each case they generally understand where the public is coming from and the fact that, as long as they recommend it, they will go ahead. My feeling is that it can be worked on and it can be solved. It is not something you need to put up a roadblock on.

The Hon. WES FANG: Dr Patterson, we heard some testimony today that linked the use of nuclear power for electricity generation to an increased risk in weaponising nuclear energy. Can you see any justification at all for providing a link like that?

Dr PATTERSON: I think the link is that plutonium is a by-product of the nuclear fuel cycle and presumably it could be separated out as it has been done by a few countries, but I cannot see our Australian regulators ever allowing that to happen. At the moment the nuclear spent fuel from Lucas Heights is sent over to France where it is reprocessed and, as far as I understand, they do not extract any plutonium from it either; they get rid of the high-level waste and they send us back the remainder, which is then stored in concrete canisters at Lucas Heights. So I think it is a furphy, I really do. There is no prospect in our regulatory system by the Australian regulator of allowing that to happen. That is my theory anyway.

The Hon. MARK LATHAM: Mr Murphy, if I can just ask something out of your opening statement? Why do we need nuclear power to create the electricity generation for desalination of water?

Mr BARRY MURPHY: There are three ways of doing it; one is reverse osmosis, there is multi-effect distillation and there is multi-stage flash. They are three different ways. The way that is normally used, as is out at Kurnell, is reverse osmosis. It needs a lot of power to drive the pumps that force the seawater through special membranes to remove the impurities—it takes quite a lot of power. The reason I raised the issue, and Dr Patterson has mentioned NuScale—that is the name of the company I was referring to—their system consists of 12 separate, individual modules which you can mix and match to suit what it is you are doing. In fact, if you choose to do desalination and generate electricity at the same time in the normal way, that combination of opportunities is ideal. You can have two of those modules providing desalination and 190 million litres a day, and the other 10 modules can be busy generating electricity that goes to help the grid or the local town. So there are lots of possibilities that I think you can do.

The Hon. MARK LATHAM: So for no particular reason you just use that as an example of what is possible, or are you saying we need widespread desalination as a solution to the drought?

Mr BARRY MURPHY: No, I am not implying that. I am careful about climate change. I try not to use the word "belief" because it is not a matter of religious belief, it is a matter of science, but the fact is that I have been studying this since I gave up full-time work and did a lot of other consultancies and so on and I have come to the view that in Australia we have potentially a very serious problem, given where we are. The New South Wales science institute has said they cannot provide a direct, clear link with climate change. Scientists are very conservative, so they are being very careful, and I am not implying that there is, but the fact is that we have droughts in Australia, whether it is climate change or not, and they last a long time.

We have now got 25 million people; back then we did not have nearly as many. Potentially these sorts of problems that we are experiencing now, they could repeat themselves and I think desalination combined with the opportunity to generate emissions-free electricity, because we are worried about climate change, in my view is the ideal combination. There is up to 720 megawatts of total capacity in these plants, so they are absolutely ideal, and they are about to be approved by the Nuclear Regulatory Commission in the United States—it is almost guaranteed, in September next year. I am afraid a lot of countries are signing up to get in the queue and if we do not get busy and get on with ourselves and sort ourselves out quickly and we decide a year from now that it is a great idea, we will find ourselves on the end of a very long queue and it will cost us a lot of money and a lot of time to catch up.

Dr PATTERSON: Could I make a comment about the desal please?

The CHAIR: Of course.

Dr PATTERSON: Where I think the nuclear can come in is what is happening here, what I would like to see and what I think may happen is that nuclear will become part of the energy mix in which renewables will continue to play a major part. When renewables are going strong, when the wind is blowing and the sun is shining, their power is the cheapest power there is. The problem is that when those things stop, when the wind stops blowing and the sun stops shining, you have got to revert to some other form of back-up power. At the moment it is gas, open cycle gas turbines, or coal, as you have at Newcastle. But the point is that a NuScale reactor, for example, needs to find something to do in that stand-by situation when it is not needed and if it is not needed when the renewables are there, then put it to work and let it do some desalination and then you have got an alternative use for it. That is the point I would like to make, that you do not want to let these things sit idle because there is a cost factor involved and they should all be utilised to their maximum capacity.

The CHAIR: Would it be feasible to produce hydrogen in that time and use—

Dr PATTERSON: You could use it for hydrogen by all means, that is up and coming. It is called an energy carrier, by the way, because the source of energy has to be something else; it has to be nuclear or renewables or coal. But hydrogen will enable you to transport it from one place to another and to use it to provide electricity by burning it to run turbines and so on. So it is a carrier.

The Hon. MARK BUTTIGIEG: Mr Murphy, what you are saying, and I think from the other gentleman we just heard the same sort of argument, is that you would get a sort of a bang for buck, if you like, because you could theoretically stick these things, the obvious place would be in regional towns, power the town up with the modular reactors and then solve the water crisis by installing desal plants at the same time so that when they are not supplementing the renewables in the general grid or the town they would be pumping into the desal. That is essentially the idea?

Mr BARRY MURPHY: That is pretty much it, yes, certainly.

The Hon. MARK BUTTIGIEG: I just want to explore some of the things that were touched on because I think a problem with this debate is there is not precise clarification over the arguments. When people talk about the analogies that are used with ambient exposure to radiation because of rocks and medical instruments like X- rays and things like that, are we saying that those everyday exposures which portions of the population are exposed to as a by-product of their day-to-day duties, are we saying that that is comparable to the ambient radiation you get from nuclear facilities when they are fully functioning and there are no accidents? Because I think the concern is that if there is an accident and you have radiation escape, that is what you are comparing it to, is it not? Surely we are not saying that because the ambient exposure to radiation is this level then that is comparable to when you drive past ANSTO, so do not worry about it. That is not the argument, is it, surely?

Dr PATTERSON: Can I just say that the latest generation reactors are fail-safe in the sense that they can shut themselves down automatically; they can cool down by air cooling without needing to have water cooling. So they are very much safer than the older generation. I have to admit that you cannot guarantee perfect safety. For example, aircraft fly and we all go in them, but they cannot be guaranteed to be safe either. It is part of modern life, and there is a small risk involved with even crossing the road.

What we are saying is that with nuclear, some of these risks are greatly exaggerated out of all proportion. In the case of a nuclear power plant in normal operation, the radiation level outside of it would be minimal. There is concrete barriers and shields around the nuclear reactor itself as well as stainless steel to enclose all the workings of it. It is very safe. As I said, you cannot guarantee absolute safety but on the other hand you can make it come very close to it. We can reach that level in Australia as well as they can overseas. There has not been any major accidents apart from the two we mentioned earlier that I am aware of. There was the Three Mile Island one a fair while ago that did not result in a large scale escape. It did not cause any casualties. It was pretty much contained.

There was a little bit of an escape into the atmosphere, that is all. This was something like 30 years ago. Things have moved on since that and we have learned such a lot. It is like new aircraft. Every time a new aircraft is built it makes use of all the designs and safety features that have been evolved over the years. Every new model, except lastly the 737 which caused a bit of a problem, nearly all of the most recent models are safer than anything that has preceded them. That is my thesis: Safety can not be guaranteed but you can get very close to it.

Mr BARRY MURPHY: Getting back to the question that you raised, the background level sitting here now in Australia is 3.5.

Dr PATTERSON: Or less.

Mr BARRY MURPHY: I am talking about the average for a whole year. The allowable level for nuclear power plant workers sitting in the control room and doing their work in the United States is 2.5. At the boundary of a nuclear power plant in the United States it has been measured at around 0.2. They make the point that you would have to sit on the boundary for 10 years.

The Hon. MARK BUTTIGIEG: This was precisely my point. It is not a criticism, it is a misunderstanding. There seems to be this co-opting of the argument that because your ambient exposure in a non-reactive area is the same or higher, then it is all okay. What people are concerned about is the imagery and the historical knowledge of Chernobyl and Three Mile Island and Fukushima. If there were to be an accident, and I take note of the submission that was just made that the likelihood is going down all the time, then obviously the exposure is must greater than it is permitted to be. That is the essence of people's concern. It is not the fact that when everything is going okay there is a problem.

Mr BARRY MURPHY: No-one was killed by radiation at Fukushima—nobody.

Dr PATTERSON: Nobody.

Mr BARRY MURPHY: In the case of Chernobyl, that would never have happened in a western designed nuclear power plant. They are not allowed. They have never been built like that before.

The Hon. WES FANG: Mr Murphy, can you confirm: Fukushima was hit by an earthquake, then as tsunami—

Dr PATTERSON: By a tidal wave.

The Hon. WES FANG: And the tidal wave and nobody died?

Mr BARRY MURPHY: Of radiation.

The Hon. WES FANG: Of radiation. I wanted that point clarified.

Dr PATTERSON: Can I clarify also that there were something like 20,000 casualties of people escaping through road accidents, forgetting the medications or just from nervous exhaustion, but none in the plant except for one worker who had an accident falling off a crane. That was nothing to do with radiation. That was just an industrial accident. That was the only casualty on the Fukushima site.

Mr BARRY MURPHY: There were actually 18,600 people swept to their death by the tsunami but it is always characterised as a nuclear argument unfortunately. It can be misleading.

Dr PATTERSON: It is very sad. I cannot help but emphasise how sad it was for those people who went through that experience.

The Hon. MARK BUTTIGIEG: I wanted to clarify that point. We make all sorts of judgements in society about what is an acceptable risk. The fact that probably your highest chance of getting killed or injured is getting in a car every day does not stop you from getting in a car. The question here is: Is there an alternative path we can go down that forecloses that risk?

Dr PATTERSON: Can I add a point while you are on risk? Do not forget that coal-fired power stations like Liddell in Newcastle—they are not free of risk, particularly when it comes to the pollution fumes that they put out. People breathe this into their lungs and they suffer from emphysema and all these diseases of the lungs. You have to include that sort of thing as well if you are talking about risks. There is risk to coal-fired. There is risk to gas turbines. There is risk to all these things. Nuclear cannot be singled out as being the only power generation that has risks. Even wind generation and solar have some risks involved with them. We need to keep everything in perspective.

The Hon. MARK BUTTIGIEG: I want to get your views on that point. There is a view emerging from the submissions we have heard that our regulatory system is so sophisticated and above most other nations. Whilst a lot of the view is that we would require some expanding in the capacity in terms of expertise, we could do it.

The problem we have to juggle as political decision-makers is not just the fact that it may be true or we may think it is true, it is the fact of what people in the public think. You can imagine that if we cannot regulate a building sector for simple things like the construction of multistorey buildings, the perception would be can we actually get this right? My question is: It would require a focused effort on increasing the regulatory regime, would it not?

The Hon. WES FANG: Point of order: There is absolutely no relevance between the building industry situation and what we are discussing here today which is the repeal on the uranium mining and nuclear facilities.

The Hon. MARK BUTTIGIEG: To the point of order: I was simply making the analogy that the public expect us to do the job of ensuring that there is faith in a regulatory environment and they cannot have faith in the building sector.

The Hon. WES FANG: A very tenuous link.

The Hon. MARK BUTTIGIEG: It will be difficult for them unless we increase that regulatory regime.

The Hon. WES FANG: Is that all your ETU speaking notes?

The CHAIR: Order! I was a listening quite carefully to the member's question. It was largely relevant to regulation around the nuclear industry in and of itself. I will allow it.

Mr BARRY MURPHY: Yes. You are right in the sense that we have an awful lot of catching up and work to do, but as you have heard from other people, there is no reason why we cannot be as good as, if not better. I am not saying we are better, I am saying we are way behind that is not a fault of any individuals; it is the political process I am afraid that has let us get into this situation. I am trying to encourage and want to support you in your political decision to let this roll, let us get rid of this Federal thing. I hope you will support the idea here in New South Wales to show the way. I have instituted some scholarships at the University of Queensland to try to get students to learn more about this. It is a slow process but they have been around the world and it works.

If you and your legal colleagues in Canberra take this step, I guarantee you would be amazed at the degree of interest that will suddenly blossom. I hope people like me and others can help you and help everybody including myself to get this right for Australia because we will be left behind and I am afraid that will not do any of us any good. If I may say so quickly, without being rude: This would be just the very first step. What we should have next is a fair dinkum, full-blooded inquiry by scientists, engineers, regulators—the lot. I have got a little diagram which I will leave with the secretary and a whole lot of other things I have written on nuclear energy in Australia; what the Australians need to know, that is all that is. We need to know enough.

Dr PATTERSON: That sounds good.

The CHAIR: Thank you very much Mr Murphy and Dr Patterson for your time this afternoon.

Dr PATTERSON: Can I make one brief point: If this bill is repealed, it does not mean that you will get a nuclear reactor immediately. It will take years—probably a minimum of 10 to 15 years—to get through the regulations and get all the approvals done. All that you are doing is allowing it to happen. It does not have to happen unless there is public approval. I would like to make that clear. We need to let it happen. We need to let businesses, for example BHP, that want it to come up with a business case to do that. But then you have to approve it. There is a lot of steps to come yet. I thank you for listening to me and I appreciate the time you have given me.

The CHAIR: Thank you very much, Dr Patterson and Mr Murphy. We appreciate and thank you for your time.

(The witnesses withdrew.)

MISHA ZELINSKY, Assistant National Secretary, Australian Workers' Union, affirmed and examined

The CHAIR: Good afternoon, Mr Zelinsky. Thank you for making time this afternoon. Would you like to begin by making a short opening statement?

Mr ZELINSKY: I will be very brief. First, thank you for the opportunity to come along. This inquiry is an important one. It is part of a suite of inquires that are happening around the country that are investigating the question of nuclear energy, nuclear power and uranium extraction. It is no secret that the Australian Workers' Union [AWU] is supportive and has a longstanding policy of being supportive of the industry. We have membership coverage of the entire sector, from exploration right through to storage. We certainly see that it is an industry with vast amounts of potential. Specifically on the question of nuclear energy and uranium extraction, Australia is unique in the developed world in that is has no nuclear energy generation. We are a standout in that regard. When you consider the fact that we have at least a third of the world's known uranium deposits, it seems strange that we do not use that opportunity.

As the country shifts away from coal-fired power into renewable energy, we have to deal with the twin challenges of energy affordability and emissions reductions. We obviously want both of those things. From an energy affordability question, our members work in energy-intense industries such as aluminium smelting, which is essentially conduit electricity. They work in steel and glass—lots of things that take a lot of energy to produce. We are certainly eager to see solutions that make sure that those industries remain viable. Going forward, we want to make sure that the footprint we have right now does not just remain as it is, but also expands. We want those industries to continue and to thrive. Australia is so energy endowed in any aspect of energy—Ross Garnaut is saying that the Australia should be the world's smelter. We certainly agree with that. We take the position that we need to take the ideology and emotion out of this debate.

We think that it is right and proper to be emotional about the future of the planet, but we should be dispassionate and unemotional about the solutions. Nuclear power should be part of the suite of the solutions. Uranium mining is part of that. I know that is part of the discussion point today and we have attached the submission we made to the Federal inquiry on that matter. We think the issues sit together. We certainly support more uranium extraction and the use of uranium throughout the entire supply chain of that industry. That is how we approach this. We come here to add our support to that issue and advocate for the particular interest that our members have. They do not really care where the power comes from as long as it keeps the lights on in the shops that they work in.

The CHAIR: Hear, hear!

The Hon. MARK LATHAM: Mr Zelinsky, congratulations on an excellent submission. It draws the essential link between energy security and job security. In the body of your submission you quoted the 2014 BIS Shrapnel prediction that faulty energy policies in Australia cost the economy 336,000 jobs. Has there been any update on that over the past five years or is that the mention of jobs that the union thinks is at stake?

Mr ZELINSKY: It is no secret. When you talk to any heavy manufacture they will say that they are under the pump when it comes to energy. Unfortunately, that particular report was dealing with a question of gas exports, which is another area of policy that we have gotten wrong. When you look at our energy market or policy—or lack thereof—we could not have designed a bigger stuff up than what we currently have. We have a plan to go nowhere. The theory would have been that when you look at Australia's endowment of brown coal and black coal, as well as the amount of gas and renewables we have, we should go from coal to gas to renewables over time, with gas providing firming. Unfortunately, unlike any other country in the world, we export our gas without any restriction whatsoever for the domestic market. That means that we have out-of-control gas prices at the exact same time we are trying to transition. We are leaping to step one to step three.

At the same time, we seem to have an ideological drive—for no clear reason—to deny ourselves what every other country has, which is nuclear power. We have no plan whatsoever. That figure was a projection. We are already starting to see closures around the country that are related to energy. We talk to manufacturing CEOs—I will not disclose who—and they tell us all the time that their number one problem is energy prices. There are three problems from our members' point of view. The first is the viability of the sites. The second is that high energy prices mean lower profits and lower wages. The third is that when they go home after not receiving a pay rise they then see that their energy bill has gone up. They get it twice. That is the long answer to your short question.

The Hon. MARK LATHAM: It is an important point. During my time here I have detected a downturn in business confidence about investing in New South Wales—and not just in mining but also in manufacturing. Is

that the union's experience as well? Whilst we think of these debates as coinciding with the closure of Liddell or Eraring down the track, are investment impacts being felt right now in New South Wales?

Mr ZELINSKY: One example is BlueScope Steel in Wollongong in the Illawarra—it is my home town and where I live. We represent those workers and they did a lot of hard work to keep that site open in 2015. All of them voted to take pay cuts and some of them voted themselves out of jobs to keep the place open. The company is now profitable. They elected to invest money—about $1 billion—to expand their facilities in the United States, rather than in Port Kembla and Wollongong. The principle reason was energy prices. That is a real material example. It is not just the risk to what we have—our existing footprint—but also the risk of a loss of investment in new capital, equipment, plants and sites. There are plenty of examples of that. Incitec Pivot in Queensland was looking to expand its site and put in a new fertiliser plant in Queensland, but it ended up doing it in Alabama because the of the gas prices that Alabama promised them. As I said, we want to protect what we have—that is clearly very important to our members—but we also want jobs to be available in new plant facilities and upgraded facilities to make sure they are viable in the long term for all Australians.

The Hon. MARK LATHAM: Finally, what sort of impact are you having inside of the labour movement with this kind of approach? Earlier in the day the Electrical Trades Union gave evidence that, I have to say, was not very consistent what you are saying. In fact, it was 150 degrees in the opposite direction. It seems to me that your approach marries together traditional trade union concerns about jobs and investment and the state of the economy and newer concerns that people left of centre have about climate change. It seems to me that nuclear offers a solution on both sides of the equation. It is a reliable, dispatchable form of power that is zero emissions. Why is it so hard, given that nice equation, to get more support, other than just your union? Why do some unions oppose it?

Mr ZELINSKY: I will leave other unions to speak for themselves. As you would appreciate, the union movement, the Labor Party and the labour movement is a broad church. There are a lot of different views. We have always held this opinion. It is not a secret. We have not sprung this on anyone recently. This is the longstanding position of our union. We are in support of the nuclear industry. I think the traditional approach to this has probably been viewed through a lens of the Cold War and nuclear energy being viewed in the prism of the nuclear threat. The number one exponential threat probably growing up post World War II through the end of the Cold War was nuclear annihilation. You can understand what people felt concerned about that.

The principal threat we now face is climate change and I would have thought that we need to think more differently about nuclear power. As you say, given that it is energy abundant, and it is low in emissions, I think it is something that we should consider. It is not the silver bullet but we would think it is part of a mix and that is certainly the position we take. It is a dispassionate position. We do not know if it is viable because it is banned, so lift the ban, see if investment comes and let us see what happens. The Government has a role to play with providing confidence in that sector and a plan. Investment cannot flow if it is banned.

The Hon. WES FANG: As the Hon. Mark Latham indicated, the Electrical Trades Union [ETU] appeared earlier. Its submission and an opening statement was that the opposition to nuclear power comes out of members who had come back from Japan after World War II. Do you see an ideological reason why nuclear power should not be allowed to operate in Australia? How would you respond to a union that would be risking jobs in a new economy sector like nuclear to support a 70-year-old ideology?

The Hon. MARK BUTTIGIEG: Point of order: In defence of my beloved union—the AWU are my brothers and sisters too, be in no doubt—I want to clarify the record. The witness was referring to the genesis of the ETU policy coming out of the sector. He was not suggesting that that is still the rationale. I think it is a misinterpretation.

The Hon. WES FANG: To the point of order: I actually questioned the witness about that and he admitted that, yes, it played a role. I am new to the union movement. I do not know that much about it.

The Hon. SCOTT FARLOW: They might sign him up, you never know

The CHAIR: With all due respect to both sides of the debate, we have not yet heard from Mr Zalinsky on this matter. I hazard a guess he is probably quite capable of balancing up the tightrope of what is going on with the ETU and what is going on with AWU, and I would like to hear what he has to say.

Mr ZELINSKY: Again, to the point taken by the Hon. Mark Buttigieg, the ETU is entitled to its opinion. We debate these issues all the time in a dispassionate way and there are always differing views. If you are new to the movement, welcome. These things go before a conference and we will debate them, resolutions get passed. If they do not get passed, it is just how it is done. We have our debates out in the open. They are not personal. On this one we think the ETU is not quite right but a lot of the time we agree with the ETU on many issues. That is just par for the course.

The Hon. WES FANG: I was about to ask you that. In the ETU press release after it unanimously backed its opposition to nuclear power, Allen Hicks said, "Our comrades in the Australian union movement stand with us in our opposition to nuclear power, uranium mining and export." Have you had a conversation with him and perhaps explained to him the value of reliable power not only to jobs in the electrical sector but also across the manufacturing sector and how valuable it is to your union?

Mr ZELINSKY: I will not go into private conversations I have had with Allen or others but we make our point. We are not hiding from it and we are here today to make our point out in the open. The ETU has put its plan out in the open. The internal machinations of the Labor Party will make their decisions but then the public will make a decision as well. We know we are, kind of, on our own on this so we are not in any way surprised. The position of the Labor Party and the Labor movement is what it is. It is quite longstanding, as is our position. We will soldier on. I do think that the debate is shifting somewhat and we should be cognisant of the shifting dynamics of the energy market and the shifting dynamics of where the world is headed.

It is back-of-the-envelope type calculations but if Australia had the global OECD-type average we would already be at our Paris targets. We think that is interesting and we do not think we should ideologically deny ourselves from potentially having that. It may or may not work. I am not an energy market economist nor am I a nuclear scientist but I think it is an interesting proposition and one that we should not just ban outright, and that is our position.

The Hon. WES FANG: Thank you for your excellent and fantastic submission.

The Hon. SCOTT FARLOW: It might be the kiss of death from the Hon. Wes Fang. I thank you for your submission and for what is seemingly a pretty pragmatic position from your union on the basis of workers and the need for continuing an advanced manufacturing economy in Australia, or which your membership base in the AWU, I take it, is largely drawn from. Is it?

Mr ZELINSKY: We are very diverse but we do certainly have a large chunk of membership in heavy energy intensive manufacturing, yes.

The Hon. SCOTT FARLOW: With respect to some of the points in your submission and the jobs figures in the nuclear fuel cycle. I think you estimate it at 10,000 jobs over the next decade in uranium mining. That is the first time I have come across that figure. Do you have any support for that? Do you know where that comes from?

Mr ZELINSKY: Do you have that reference? I think the majority of our figures are referenced.

The Hon. SCOTT FARLOW: Unfortunately I could not find it in there. It is probably about 10 pages in. You can take it on notice.

Mr ZELINSKY: I will take it on notice, and I can provide that figure to you.

The Hon. SCOTT FARLOW: It is the first time I have seen that figure and I am interested to see what sort of projections you had to support it.

Mr ZELINSKY: It is an IBIS*World* figure, I think, from memory. With your leave, I will take it on notice.

The Hon. SCOTT FARLOW: I take your support and your firm position in terms of supporting nuclear power but from the analysis that your union has undertaken and your membership has seen, do you believe that we can meet a zero net carbon emissions figure by 2050 without some form of nuclear power or hydrogen which I think has been mentioned as well in the market and with the same sort of reliability in the grid?

Mr ZELINSKY: I refer back to my comment that I am not an expert in this area. Again, we are certainly interested in addressing the twin challenges: energy affordability and carbon reduction and emissions reduction. When you have a technology sitting there that is used around the world, that we have an enormous amount of that input, the uranium, and we have the know-how, and when you look at where the technology is heading with small modular reactors—I was listening to some of the earlier evidence around the technological advancements in the sector—when you know that it can provide good, reliable power and effectively zero emissions, it strikes me that it should at least be considered as part of the mix. That is probably as strong as I am prepared to go because I cannot speak to that other figure with authority.

The Hon. MARK BUTTIGIEG: I will follow up with the point just made by the Hon. Scott Farlow. This question has been asked a couple of times about whether people think we can do it without nuclear. You touched on gas as a firming supplement. Putting this in the context of the sort of political imperatives people have to navigate, things like the antipathy towards nuclear, it may very well be that the pro-nuclear arguments are all correct. But if you cannot bring the public with you, you may have to find an alternative route and one of those

routes may very well be a mix of renewables, for example, gas peaking plants and battery storage. Can you see that as an alternative pathway rather than nuclear as a possibility?

Mr ZELINSKY: Our union is very pro-gas industry. Unfortunately as we sit here CSG or onshore gas is banned in New South Wales and in Victoria. If that is the alternative it is not looking to prospective at this point either. What we have done to our gas export market is scandalous at the same time as locking up further gas exploration is crazy as well. It would be very difficult, I would have thought, for us to rely on gas to do the leg work for us if we are going to export it all and then refuse to extract more of it.

The Hon. MARK BUTTIGIEG: We have the same political hurdle in a sense. We have a ban on nuclear and a ban on gas. The obstacles are similar in theory.

The Hon. SCOTT FARLOW: With both.

The Hon. MARK BUTTIGIEG: With both, yes.

Mr ZELINSKY: It is no secret we support the Narrabri project going ahead. We support gas reservation on a national basis, much as the rest of the world has it. It exists in Western Australia. Western Australia has a gas reservation policy and it has seen hundreds of billions of dollars invested in that economy. So we would support more gas extraction in addition to the consideration of nuclear. We would say lift the ban and see what happens.

You have touched on gas. It is certainly a real problem in the energy market. Gas is an input for heavy industry. It has tripled or quadrupled in cost in a couple of years. That has put huge pressure on. When you have high electricity prices being driven by unreliability in the grid and gas export prices, we have a crazy situation where we are effectively trading away our energy advantage for no real benefit. Emissions are still going up, jobs are becoming more precarious and our members are screaming because they are hearing from their boss that their jobs are under threat. So we are here today to say we need to get an answer and it cannot be ideological. We cannot do nothing, which is currently what we are doing.

The Hon. MARK BUTTIGIEG: One of the other things that has been touched on today and in previous hearings, and more generally, is the concept of "just transition". It is an unfortunate phrase because it implies you can just mouth the words "just transition" and everything will be okay—that we will create jobs for you and you do not have to worry about your future. Has the union got a position? Because no matter what the mix ends up being, it is clear that there will be a degree of job destruction as a result of going down the path of a mix of renewables—whether that is nuclear or gas or whatever—to firm up the load. The point is that there will be a transition from an old industrialised economy into new areas of jobs growth but the problem is always that there is a whole lost generation until those new jobs are created. Has the union got a position on how we might bridge that gap? This sort of thing has been done elsewhere in the world. What is your view on that? This is one of the issues we have not really grappled with.

Mr ZELINSKY: I think you are talking about the future of coal in part of that question, which I will leave for the mining and energy division of the Construction Forestry Maritime Mining And Energy Union to talk about. Our members are certainly not eager to transition out of their jobs at present. If you are an aluminium worker or a steelworker you are quite happy with your job. They want to make sure that the energy input—whatever it is, wherever it comes from—as long as it is getting the job done, they are quite happy. Our members are prepared to make the tough choices when it is required. They took pay cuts, as I said. They voted themselves out of jobs to keep that place open—to keep the engine room of the Illawarra economy going. So our members are always happy and open to taking tough choices when a clear pathway and rationale for that reason is laid out.

I have never spoken to a member who is eager to destroy the planet or does not want to see energy emissions reductions but they do not want to see that come at the expense of their job. It feels like they alone have to shoulder the cost. It is incumbent on all of us to be more sensitive to those who are asked to bear the costs. The costs tend to fall on regional communities and there is a role for government to do more than just say "just transition", which sounds like bulldust. To a working person, it is transitioning to what? If they see most of their blue-collar people who have been laid off, it is transitioning to unemployment. That is not something that working people are interested in. Work provides agency. People are prepared to go with you if you lay out a plan with confidence and say, "We are going to back you in." It is probably going to take governments stepping up to the plate and really making sure that they invest strongly in the communities that are being asked to bear the burden.

The Hon. MARK BUTTIGIEG: On that point, if the Government were to proactively invest up-front in whatever technology—let us be agnostic about what it is—and create the jobs first so that people see the real jobs there and they are able to go into them before their industry is shut down, that is what we need, is it not?

Mr ZELINSKY: Yes, I think that would certainly be part of the solution. Anything that is tangible is going to be more believable than something that is written on an envelope or written in a pamphlet. For a long time blue-collar workers, particularly in regional areas, have been promised so-called green jobs and they have not really materialised. So you can understand why they would treat those things with a heavy dose of scepticism.

The CHAIR: In your opening statement you mentioned that the AWU has longstanding support for this sort of policy change. Would you be able to give us an idea of how longstanding that longstanding support is?

Mr ZELINSKY: It was our policy under Scott McDine. It was our policy under Paul Howes. It was our policy under Bill Shorten. So that goes back a fair way. I would have to take it on notice as to how long we have been in support of it but I would say we have been in support of it for as long as it has been an industry in our coverage rules. That would be my guess.

The CHAIR: Sure. I ask simply out of curiosity. Earlier in the day the future of manufacturing was discussed. Do you know of any jurisdiction in the world that has a strong manufacturing base without some sort of baseload power, whether that be coal, gas or nuclear? Is there a jurisdiction that exists on renewables?

Mr ZELINSKY: Purely on renewables?

The CHAIR: I ask in the context of you mentioning earlier that aluminium is basically congealed electricity.

Mr ZELINSKY: It is.

The CHAIR: That is a very good way of putting it.

Mr ZELINSKY: With aluminium, I would struggle to name one that currently exists. I do not think the technology is there. There is a statistic—and I would invite the Committee to double-check this—but from memory, the Tomago smelter in Newcastle could be run for eight minutes on the battery out of South Australia. So the technology is not there. I am sure it will get there eventually but we are not quite there yet. Certainly, we do not think our members should have their economic futures traded away unnecessarily, given that we can bridge that gap with the right policy framework.

The CHAIR: In the absence of further questions, I thank you for your time today and for the exceptional submission you made.

Mr ZELINSKY: Thank you for having me.

The CHAIR: The Committee has resolved that any questions taken on notice are to be returned within 21 days. The secretariat will be in touch.

Mr ZELINSKY: Thank you very much. I appreciate it.

(The witness withdrew.)

The Committee adjourned at 16:35.