Lyn Angel: We'd like to move on to the first session, where the focus will be on OPAL costs and production efficiencies. So, the first session will be broken into two thirty-minute sections. The first is issues related to claims around the OPAL reactor costs and production efficiencies – a number of international sources have actually been cited and, in the public domain, criticising the costs associated with the nuclear medicine production. So, this'll be a really helpful part of the session to see if we can get some clarity and consensus around the facts to do with that.

So, the theme – to stay on task – the reactor production has been reported to be inefficient and only viable due to government subsidies, internationally. So, the questions are: is Australia the same? And, if not, how does it overcome these production barriers? So, for an insight into the Australian context, I'm very happy to turn to Adi Paterson, the CEO of ANSTO, to begin the discussion. Thanks, Adi.

Dr Adi Paterson: Thank you very much. Good morning, everybody, it's great to be here and to be able to talk about what we're doing with the OPAL reactor and how it's contributing to the production of nuclear medicines. For me, this question is about economics and sustainability – historically, it is true that government's that had built reactors for research purposes, gradually developed the ability to make nuclear medicines. And the most important, diagnostic, nuclear medicine is technetium-99m – it's produced from molybdenum that is generated in reactors – and this is responsible for treating about forty million people a year, with a diagnostic isotope which allows to image disease.

So, this is really important, forty million people around the world - and an increasing number as developing countries become involved in this – are benefiting from this particular isotope. It's not the only isotope that is produced for nuclear medicine – iodine-131, which is used to treat thyroid cancer and other conditions – is produced in Australia, in the OPAL reactor and sent to hospitals every week, for people to receive these treatments. In addition, we're producing lutetium-177 – this is a therapeutic isotope, which treats cancers and which is being developed mainly in Europe, over the last decade and a half. And is starting to really increase the outtake – and there's some very active clinical trials in Australia, at the moment.

So, these are very, very important, medical, isotopes and they are dominantly produced in multipurpose reactors around the world. In fact, if you just take the molybdenum-99, the key isotope that is used as the basis of those diagnoses – more than 99% of that is produced by irradiating targets with neutrons. Basically, the reactors we are talking about are not power reactors – they are research reactors. And, they're essentially neutron factories, they produce lots and lots of neutrons – they can be used for science, they can be used to irradiate targets to produce nuclear medicines. They can be used to understand physics phenomena – and so, these

multipurpose reactors have the ability to be the basis of production, of these nuclear medicines.

As I indicated, historically, these reactors were produced for public, good reasons – but, over time, as the nuclear medicine community developed these approaches, it became necessary to work out how much it all costs. And, even today, I think we could argue – because, there's a group that meets in Paris every year. All of the countries that are involved in this – the clinicians, the producers, the reactor operators – need to discuss this. And, I think, there is a consensus that – across the nuclear medicine community, globally – there is still some subsidisation of the production of nuclear medicines. But, there is also a global, public good, because forty million people – at least – are benefiting from that. And they get direct benefits that are lifesaving for them.

There is, however, a mutual commitment between all of the producers, all of the countries involved – to eliminate those subsidies. And the question is, is that going to cost a lot more? And, fortunately, we have the answer – because, there is a very carefully worked out formula, that has been developed by consensus between all the countries that are involved. That takes account of everything from the original fuel for the reactor, right through to the disposal of the waste at the end of the process. And we use this formula in a common way, across all the countries, in order to show the level of subsidisation.

There are only two countries in the world that have fully disclosed how they are intending to do this, and that is Australia and South Africa. Both of whom are producing nuclear medicines based on low enriched uranium. There is not the risk that you have with high enriched uranium, which is still used in some countries. All countries have agreed to eliminate high enriched uranium and to only use low enriched uranium to produce the nuclear medicines. And we are able to demonstrate that, with the economics we currently have, that it is possible to economically produce Mo-99 – which is the predecessor of technetium-99. [M], which is used in these forty million diagnostic events around the world, every year.

Can I just say that the reactor production of Mo-99 is going to continue to increase? For example, China – a country with a very large population – uses less than half the Mo-99 that Australia uses, every week. They have a pressing need, for their population, to be able to provide nuclear medicines on a sustainable and ongoing basis. And thereby, providing for their population - and for the diseases that can be diagnosed – in that regard.

So, what we are starting to see is a generation of older reactors – OPAL is a young reactor and we are starting to see countries like Jordan, who switched on a reactor late last year. Very exciting for a small country like that to have the vision to think about nuclear medicines in their region – and the possibilities. China has a number of reactors, now, which – potentially – can be applied to the development of nuclear medicines. The [Cairo] reactor is a pretty young one, it was actually brought into use

after the OPAL reactor. And so, for the first time in a generation, we're seeing a new class of reactors – dedicated, multipurpose reactors, that can do nuclear medicine. They can produce a very, very high class of silicone that is used in high-quality electronics. And the electronics, for instance, that are used in wind turbines and things like that, have to be highly reliable.

The silicone that's irradiated in reactors is essential for that sort of technology to work well. but, we don't only do medicine, we also do science. And so, the reactor, although it is fully meeting the obligations of a fair market – in the production of nuclear medicines – provides, in the neutron factory, for science to be done in Australia. And the scientists who benefit from the reactor, as well, help us to develop new diagnoses, new, deeper understanding of our biology. How our bodies work – which can lead to a better understanding of how we treat disease in the future. so, we should not think of these reactors as having a single mission, they are multi-mission. They have got many, many stakeholders, but I think we can adequately demonstrate, now – and we're hoping that the global market becomes more transparent. So that we can have a level playing field and say that, "We are genuinely paying the costs that lead to the production of this isotope."

The isotope does have wonderful outcomes – iodine-131 is a lifesaving isotope. Lutetium-177 is going to have a dramatic impact on public health – and so, all of these things for us, are powerful. They are a testimony to the foresight and insight that was developed, that lead to the construction of the OPAL reactor. The OPAL reactor, today, is the hardest working reactor in the world – in its class. Achieving three hundred days, which means that Australia and New Zealand have got reliable supply – and ten thousand doses of nuclear medicine for diagnostic purposes. Iodine-131, lutetium-177 for clinical trials, to treat cancers – are being reliable and effectively produced and safely transported to 224 hospitals and clinics across our country -----

Lyn Angel: Adi? We're going to have to wrap up.

Dr Adi Paterson: And so, from my perspective, we need to argue this, not from whether the economics works or not - but can we create a fair and a transparent market?

Lyn Angel: Thank you very much, Adi Paterson. I'd like to now move on to Dr Margaret Beavis, from the Medical Association for Prevention of War, who will now provide her insights onto the topic. Thank you, Margaret.

Dr Margaret Beavis: Thank you. Thanks a lot. I'd like to start by acknowledging the traditional owners – and their elders, past and present – because, they particularly, for decades, have been really impacted by nuclear issues. Today, we're addressing the costs of production at OPAL – and I'm really pleased Dr Paterson introduced the OECD group in Paris, who do have a world overview of what's happening around the world.

They have said, quite clearly, that all technetium supply chain participants should be working towards full recovery – including costs relating to capital replacement. So, it's really important that we make sure that when we're talking economics – is talking the whole box and dice. Insurance, decommissioning, waste – the lot. I'd like to, actually, quote – and I'm afraid I'm going to have to read this from the OECD report in 2010. Because in 2010, they did a huge review where they looked at all the different components that went into producing isotopes – and I'll just read you this, "Because, in many cases, the full impact of molybdenum and technetium production, was not transparent. Or fully appreciated by governments, who are financially supporting research reactors – the full costs of waste management, reactor operations, fuel consumption – were not included in the price. Nor in the structure. And they provide a significant deficiency in the pricing mechanism. This is a subsidisation by one country's taxpayers, of another country's health system."

This same report found that only – that by selling isotopes - you're really, only, covered between ten and fifteen percent, of the genuine costs of manufacture of these isotopes. We believe that nuclear medicine has a future, it's very important, that it's – as Dr Paterson said – a sustainable and economic proposition. We do not want sources that need large taxpayer subsidies. In 2011, I did a Masters of Public Health, and my major was in Health Economics. Now, health economics, talks about cost in two ways – cost is the dollars and cents, the transactions. But it also talks about indirect costs – it takes the big picture view.

And the big picture view – in terms of costs – the technical term, one is "externalities", which is like, side effects. And the other is "opportunity costs" – so, if you have one patch of money and you spend it, you cannot spend it on something else. So, I'm going to talk about the health economic costs, as well – which, I think, ANSTO and the Department, aren't aware, so much, of these costs.

Nuclear waste has huge impacts on communities. On February 17th, this year, Regina McKenzie – the Adnyamathanha traditional owner and neighbour of the proposed site – said, "It's tearing my community apart, it's tearing my people apart and it's tearing my family apart, as well. I never thought I'd see the day, when I see some people, in particular, cry in the street. But they have, because they don't want it." Similarly, Kimba -----

Lyn Angel: Margaret -----

Dr Margaret Beavis: No, this is cost – this is the side effects of the proposition that's going forward, and costs is what we're addressing in this topic. Similarly, Kimba – in Kimba, the town – last year, this time, when they were under consideration – the business owners in Kimba's main street were reported as declined to be quoted. Whispering their views and pulling the reporters into backrooms. One shop owner ----

Lyn Angel: Excuse me, Margaret?

Dr Margaret Beavis: Yep?

Lyn Angel: I am going to just draw that to a close and ask you to redirect your presentation, so that we are focusing on production, rather than the waste.

Dr Margaret Beavis: Okay, I'll go back to the other cost issue.

Lyn Angel: Thank you.

Dr Margaret Beavis: Because, I think, the other costs that are involved, of reputational damage - where both the Flinders Ranges and the Kimba region have the reputation for clean, green produce – there'll be costs to them, if that reputation is lost. The Flinders Ranges is an iconic tourist destination – again, there'll be costs if that reputation is, even by one percent of tourists - due to this proposition. So, again, this is talking about the costs of production.

Again, Lucas Heights – I should say – has changed its name. The residential suburb of Lucas Heights disliked the reputation of having a reactor – so, they actually changed their name to Barden Ridge. There are no residential properties in Lucas Heights. So, just to go back to cost – Australia is subsidising the production of these isotopes quite heavily and proposing to increase it for other countries. And just a couple of quick clippings, since I've been invited – one was Patrick McGorry, talking about suicide in Australians. Where about seven people a year are taking their life, every day – and there's been a fifty percent increase in people seeking treatment, without any funding increase.

So, if seven people a day – it's a leading cause of death in people between fifteen and forty-four. The public hospitals – many young people with psychosis can't get beds, because we have not enough money for our health system and early intervention in psychosis is a very important thing. Secondly, the public hospitals are in crisis – I'll just hold this up – but, basically, it's another clipping – you didn't see the other one, I don't think. But, basically, it takes up to three years to see an ear, nose and throat surgeon, in public hospitals in Australia. In some public hospitals – and they're the worst waiting times, currently - for elective surgery - since 2001.

So, just to conclude – I would like to say – there are direct costs for producing isotopes, but there are also the indirect costs. Both, in the terms of, the side effects on the communities that end up taking this waste – and also, the money that we cannot spend on our health system, if we are subsidising other health systems. There are – for isotope production – the real reactor costs, the community have not been acknowledged. Particularly, in regard to taxpayer subsidisation. And, particularly, the cost of the manage community damage that happens when a waste facility is proposed. Thank you.

Lyn Angel: Thank you, Margaret. Associate Professor Currie, I wonder if you have anything to add to the topic, please.

Associate Professor Geoff Currie: Sure, I'd like to have the opportunity just to, I guess, address the OECD report that Margaret mentioned, in terms of full recovery. I think, that full recovery costs – you focus on government subsidies and, I think, that's actually important. Because, if the government doesn't subsidise, in part, some of the production costs – not just in health, but in other areas – well, then, the cost actually increases at the other end – where the taxpayer has to subsidise healthcare. So, it comes out of the same barrel of money, from the taxpayer, and it's where it's actually doing its best work.

But, I think, that one of the issues that, probably, needs to be discussed, that hasn't – at this particular point. And Adi referred to it – and I'm just going to quickly scan up to the slides, if the guys in the control room can project the first slide. The looks of the international market – a lot of what we hear about in the OECD report and a lot of the criticism revolves around the image that's on the screen now. And that's the international model, where we actually have a reactor – and that reactor is producing molybdenum. And it's transported from that production site at the cost of time, decay, the transport costs - to another site somewhere else, where you actually have the molybdenum extraction plant. The molybdenum will be extracted from the targets and then, it's transported again to another site – where you actually have the generator production. Which is then, ultimately, shipped to hospitals and clinical departments.

And there's a huge inefficiency in that. And in Canada – and François may speak to this, later – that those distances can be quite a number of kilometres. And, in Europe, that can actually be crossing international borders, to move from one plant to the next. And so, we do actually have some efficiencies that are built into the cost. When I stick the next slide up – which is the Australian model – you actually see what the Australian government and ANSTO has been able to do very, very well. And that's create a far more sustainable model – and more cost-effective model – because, what you actually have is one site, where you actually have the reactor production, the molybdenum extraction and the generator production, to be shipped out to the hospitals. What that does, it has a central level of expertise, so your costs of actual expertise, equipment, transport – are all reduced. And you don't, actually, lose your activity that you've – due to decay – in that transport process. So, you end up with a far more efficient process.

So, that's going to decrease your commercial costs – but, as Adi mentioned, there's research that's associated with that, that offset those costs, as well. The neutron field – well, the neutrons are deflected into a neutron room, where you can irradiate any number of things. Including – I've got a colleague that was up there, recently, that used the neutrons to get a better understanding of bees, which will drive our understanding of diabetes. The – looking at silicon doping, cultural artefacts – so, there's a number of indigenous artefacts that are – without damaging it – that I would actually use that neutron field, to be able to examine.

So, those are all ways that we can, actually, reduce the overall cost and provide a more environmentally - and economic - solution. And, of course – as already

mentioned – using both low enriched targets, as well as low enriched fuel – the only reactor in the world, at the moment, operating commercially to do that, is another reduction process. So, I think, it's really important to look at the leadership that Australia provides, in this market. Both through the Federal Government process – working with ANSTO – to get that model up. And it's something that's the envy of the world.

So, I think that's pretty much all I wanted to, really, sort of, say. Other than, you know – people like Lucas Heights may have changed the name of their suburb, but the actual cost of real estate has gone up extraordinarily in the last ten years, despite the reactor being there. So, so I'm not sure that it has a big negative impact.

Lyn Angel: Thank you very much, Geoff. And now, it's a pleasure to actually include François Couillard into our conversation, who's been sitting very patiently, in Ottawa, in Canada. And we're keen to hear your insights, from an international perspective – thanks, François.

François Couillard: Well, good morning and thank you very much for the opportunity to participate in this very important panel – and very important for Australia, but very important for the world, I think. I had the good pleasure of visiting the ANSTO facility a few years ago, while I was in Australia for a medical imaging conference. The reason for my visit to the site, was that I had recently come back to the world of nuclear medicine – now, after having been away from it, for over ten years. And I had discovered that the global supply chain for the production of technetium and molybdenum-99 had become very fragile, with the announcement of the closure of the Canadian NRU reactor - and the precarious situation of the other ageing reactors around the world.

So, I was trying to figure out, for myself, the state of the situation – I wanted to convince myself that the new processing facility was actually going ahead and it was not just hype, by ANSTO. And, so, I went there, I visited, I met with the folks at ANSTO – and I was very impressed by my visit. The facility you have there, the reactor, the processing – the old processing facility, but the new one that your building – is second to none, in the world. And I had the good pleasure of visiting many of the other facilities – and I went to South Africa, as well – I visited the site in the Netherlands. I worked on the Belgian site and I worked in Canada, at the Nordion site – in addition to visiting the NRU reactor, in Canada.

So, I've seen most of the most important production sites in the world - you guys are top notch. So, my perspective on this issue is influenced by my previous experience at Nordion. For those who don't know Nordion, Nordion was – at some point – the largest producer of molybdenum, and other reactor and cyclotron isotopes. When I was there, at one point, we had about sixty percent of the world market share for molybdenum. And I was successfully – well, I was successively responsible for global sales and marketing, around the world – and then, I was posted in Belgium,

responsible for the production and distribution of isotopes, across Europe and other parts of the world, from Belgium. We had a full plant there.

In my nine years at Nordion, I became very much aware of the increasingly fragile production and distribution in my environment – mainly, due to the state of the ageing research reactor network. There are, relatively, few producers and the only way it can all work out is if they collaborate with one another, to ensure mutual backup – in case of production stoppage.

I now work for a professional association, representing twelve thousand medical radiation technologists in Canada – and a stable, and reliable, supply of medical isotopes is a crucial, strategic issue for these professionals – and the patients that they serve. In terms of efficiency – reactors are still the best way to produce medical isotopes, like molybdenum-99. It is true, as Dr Paterson mentioned, that – in the past – the cost of producing molybdenum-99 in these reactors was not fully reflected in the price of the product. This is a legacy issue. But these reactors were not built, initially, to produce medical isotopes – they took on more and more significance, as the years went by. Now, producing medical isotopes via research reactors is still, currently, the most effective and reliable way, and efforts have been made for our countries to fully reflect the real production cost in the price of the product, at various production stages.

And I'm confident that, with the continued effort of the international community and governments all over the world, we can establish an ongoing, efficient, cost-effective method of supplying molybdenum and technetium, around the world. And thank you, again, for your contributions.

Lyn Angel: Thank you very much, François. And also, sticking completely to time – for each of your speakers – I appreciate that. So, we have, actually, a little more time now to see if other members of the panel have any contributions they would like to make. Peter?

Dr Peter Karamoskos: One hundred and forty million dollars is what ANSTO lost last year – ANSTO has never made a profit. Now, that's a fact – not meant as a value judgement, because not all organisations – particularly, research organisations – make money. But, when we talk about economic sustainability, at some stage, somebody has to pay for any deficits. There's a lot of reasons for that, but, certainly, one of them – as the Nuclear Energy Agency has reported – is that, in essence, reactor production of isotopes, as great as it may be – you've got a lot of huge neutron fluxes in reactors. It is not economically sustainable, because of externalities and deficiencies in the economic model.

So, when it costs a hundred and forty million – when it needs one hundred and forty million dollars' worth of subsidies to run its operations, this is not sustainable. If ANSTO was in full cost-recovery mode, it wouldn't have needed capital funding from the taxpayers of about three hundred and fifty – sixty-odd – million dollars, for the new reactor. That didn't come from retained earnings, it – a hundred and seventy million

dollars for the production facility – that didn't come from retained earnings. And about eighty to ninety million dollars for the Synroc facility – that is yet to be built – once again, is going to be funded from the taxpayer.

Once again, these are just facts. We're looking at close to eight hundred million dollars – and it's still not making money. Now, let's argue the facts -----

Lyn Angel: Peter, could I just, actually – just on that note itself – I'd like to ask -----

Dr Peter Karamoskos: This is from annual report.

Lyn Angel: ----- Adi to respond to that.

Dr Peter Karamoskos: Can I finish first and then he can respond?

Lyn Angel: Is it still in relation to ANSTO?

Dr Peter Karamoskos: Well, this is what – this is the public – yeah, yeah – so.

Lyn Angel: Yeah, yeah, yeah – okay, fine. Well, we'll just – yep.

Dr Peter Karamoskos: Now, Adi made the comment that ANSTO believes in full-cost recovery. That's a laudable thing – and, as I said, the Nuclear Energy Agency advocates that. Now, Geoff made the comment that – in a little bit – contradistinction – that, because of the positive externalities of nuclear medicines, it's a lot – there's a public good, but there should be subsidies. And that's a fair point, too. I don't think we should be totally neo-liberal economists.

The point is, if you really want to subsidise an economic good, then why would you subsidise the production that has been shown to be inefficient? Why not subsidise the end user? The nuclear medicine physician, the radio pharmacy that produces it? Because, that would put the subsidy where it matters most, then the producer – in this case, the reactor – would then have to fight on a level playing field with, potentially, other technologies.

Lyn Angel: Thanks, Peter. I'll just pull you there and ask Adi if he could respond – and we do have a question coming in from the viewer, that I'd like to refer to, after Adi. Thank you.

Dr Adi Peterson: Thank you. For a moment, I didn't recognise my organisation, because the figures are not accurate. ANSTO makes a statutory loss, every year – which, we agree with the Department of Finance. And that is, largely, related to the fact that we have some instruments in the neutron scattering area – and some accelerator facilities – which don't have depreciation capital associated with the projects that put them in. That leads to part of the statutory loss.

We also have a decommissioning provision, which is held by the Department of Finance. And that is revalued – it's a calculation, every year – based on the costs of

money and what that's likely to be in about thirty years' time. All of these can affect your statutory loss. This year, ANSTO will make a significant, positive margin, because we've just taken on the Australian Synchrotron – and that is a capital writeup. So, confusing the balance sheet with the P and L, is a problem. What we have to do is look at the cash implications, and the ongoing funding requirements and responsibilities – and that is costed according to the formula that's been agreed, in Paris. And it's only part of the reactor cost, there was never an intention in the building of the reactor to fully recover all of the costs from the production of Mo-99. We've got the public (28:09) research. That must pay its way by the – in the form of the government paying for the part of the activity.

So, the debate about nuclear reactors has been really interesting, because when we're doing great research, everybody agrees that it needs to be paid for by the government – on a merit-based access approach. But when we're talking about nuclear medicine, we want to take all of those costs and say that they must be recovered by nuclear medicine. That is not a true economic picture. So, I would like to move the debate to a much more positive debate, about – if we – by the pure evaluation in Paris, one of two countries that is fully declaring its costs. And that includes the costs of the waste and decommissioning.

Should we not be making sure that there's a level playing field for everybody? So that, as we indicate, we can then compare it with the cyclotron-based techniques and (29:01), and so on. And, I think, over time, that'll be a really useful debate.

ANSTO is not just a reactor operator, we're the largest accelerator operator in Australia. We know a lot about the cost of accelerators, we run the Synchrotron down in Melbourne – we have cyclotron facilities that we operate in Sydney. So, I'd really like ANSTO to be thought of as a place where you can come and talk about accelerators. You can talk about reactors, you can talk about the economics of both – and have a fair and balanced, science-based, and economically-sound debate.

Lyn Angel: Thank you, Adi. I believe, Barry **Elison** for – on the panel. And then I'll go to the question that's come through from the audience. Thanks, Barry.

Dr Barry Elison: Thanks, Lyn. Just a comment – ANSTO, as part of a research facility and a significant part of medicine – we, as a first world country, we subsidise all of medicine. Medicare's a massively subsidised agency, and I take Peter's point that, maybe, you should subsidise the end user, and so on. But, let's not forget – why pick on ANSTO, as such? This is a massive – health, is a massive subsidy. Every one of us, in health, get our salaries from the government. It doesn't matter which way it's done. ANSTO has part of that subsidy, that is required, for us to remain a first world country of first world ideals. And, if ANSTO needs to grow up, it will grow up.

I mean, I was around at the time when (30:25) was being used and the government was throwing money at it – and they had to. I was around when we put OPAL in and I was on Senate estimates committee, at that time. We had to put money into the facility

– it's done and now we're saying ANSTO must grow up, and they probably will. Health is subsidised from the get-go – we're all subsidised. Thank you.

Lyn Angel: Thank you for making that point, Barry, appreciate that. And now, we've had a question from Cameron, who is one of our viewers, and he asked, "What has the OECD group said about costs, since 2010?" And, I would think Geoff Currie might be best-placed to be able to give us some insights into that, thanks, Geoff.

Associate Professor Geoff Currie: So, I guess, the answer to that question is that – and we've seen in the media and we've seen a number of things coming out in recent times, and it's been quoted here by Margaret and myself, today – the OECD report of 2010. There's a lot of things around radio-nuclear production that have been quoted in that, some of the costs of their – clearly, identified in the OECD report as being estimates, optimistic estimates for the future. What's not in that is a proper calculation of costs associated with LEU-LEU reactors, like the OPAL reactor. So, those costs that are hyper-inflated, around reactor production, are associated with the higher-enriched reactors. That's the first thing, the second thing is that they have very optimistic calculations of the costs of production, associated with cyclotrons – and they recognise, in that report, that it hadn't been done at that time, they really didn't know what the costs were. And they were being very optimistic.

And most of those estimates that they had put in there have been, since, shown to be false – and we'll discuss that in one of the later sessions. But, I think, that, even in that report with those optimistic projections, is the cost of alternative productions like cyclotron per working unit of activity – in excess of the low enriched uranium reactor that we have in OPAL. So, I think, that – and since 2010, not much has been said. Is that, we don't have an updated report from the OECD to come back and, actually, say, "Well, now let's look at the realistic cost of LEU reactors and the realistic costs of what we know with the attempts to do cyclotron production."

Lyn Angel: Thank you, Geoff. Any other of the panel members comment? Dale?

Professor Dale Bailey: Yeah, I was just gonna speak on behalf of the nuclear medicine community, that we really do enjoy a very reliable supply of radioisotopes from OPAL. We have, however, in the past decade, experienced periods of shortages – there have been worldwide shortages, where people – as François has pointed out – there were ageing reactors that were unable to supply, that were shut down in an unscheduled way. And we had an emergency committee meet in Australia, chaired by ANSTO, to ration the limited amount of molybdenum-99, technetium, that was available and everyone in this room would be affected by that. Especially those working in the field.

But through that process, we were able to maintain the supply – especially, in priority manner to the most needy patients. And, we have to remember that we're the biggest island, habituated on the smallest continent in the world – we need our own supply, we need to maintain that and, I think, it would irresponsible to suggest shutting down

a very successful operation that keeps us in a position where, frankly, we don't need to think about where tomorrow's radionuclides are coming from. We know that they are going to be there, because we have a reliable reactor producing – and a reliable system of ANSTO - and a distribution network. I'm aware that, during the shortages, when we were importing it was at the whim, essentially, of the airline pilot whether he carried the molybdenum to Australia that day, or not. If he thought more money could be made from offloading the lead container – and putting on more cargo – then he would do that. And we did experience shortages due to that reason, in that time.

So, I think, we need to maintain this local supply and production – and expertise, as well – that goes with that, because – hasn't been mentioned, yet – but we are very much a friend to our local neighbours in the region. In South-East Asia, the people in Botan – the ANSTO equivalent in Indonesia, certainly, looked to us for guidance in what they're doing in terms of medical isotope production. And we're very willing partners and friends to them, in helping them do that.

Lyn Angel: Thank you, Dale. Quick comment from Margaret and then, we'll need to wrap up the session and move on to the -----

Dr Margaret Beavis: I just want to clarify – we're not saying, "Close ANSTO, now", we're saying, "Australian production will need to continue until we've got sustainable and reliable, secure, supply." But, we are saying that the ANSTO model to increase production in subsidising other health systems is a problem. I also understand – and correct me if I'm wrong, Geoff – that, in fact, the low enriched uranium is significantly more expensive than the highly enriched uranium, so I just wanted to correct you there. That it's a more expensive process.

Associate Professor Geoff Currie: Well, Adi, will you -----

Dr Adi Paterson: I can comment on that. I think, it goes back to the same situation that you raised, is – where is the fully costed model? I mean, the shipping of HEU around the world is something that I don't think that we would ever support and, really, a lot of those costs are absorbed, still, by governments and they are not fully costed in. So, I think, if you look at the direct cost in the reactor, there is a higher cost, because you've got less uranium that is gonna fission. But, if you take the total integrated cost of, actually, managing highly enriched uranium target production – that has a disproportionate effect, which is not counted into the model. I think, if you look at it in a sober way – and we're very, very glad that both Belgium and the Netherlands have now indicated that, within the next three years, they will go to LEU-LEU. I think, everybody will be happy about that.

We will eliminate HEU from the nuclear medicine production cycle. And then, I think, the debate changes fundamentally, because the debate in 2009, when there was a supply crisis, all of the papers that were written by the people concerned about the reactors – was the concern about HEU. But HEU will be eliminated, LEU does not have the same security profile. And so, therefore, I think we need to move away from

just thinking of reactors as really bad things. These are safe, reliable, modern and fully secure reactors, that can produce nuclear medicines for millions and millions of people.

The HEU will be eliminated and that's one of the greatest things that has come out of this process.

Lyn Angel: Thank you, on that -----

Panel Member: Lyn, just to clarify there – HEU – I don't think some of the (37:01) people might know what HEU is and why it's dangerous.

Dr Adi Paterson: Highly enriched uranium, it's the weapons-grade material, that has been in a lot of the other reactors. Australia was the first nation in the (37:12) reactor to eliminate HEU, both from the production of nuclear medicine and from the fuel. And we did the same thing with the OPAL project from day one, there has not been an ounce of HEU in the OPAL reactor. So, this is a safe reactor, meeting the best requirements, internationally.

Lyn Angel: And, on that note, that actually speaks to why we have – going ahead with this webinar and having the expert panel members – where errors or interpretations can be addressed, as we're moving through the session. So, thank you very much for all of that.

Associate Professor Geoff Currie: Sorry, Lyn, can I just, quickly, add – just because Margaret just mentioned it, a minute ago -----

Dr Adi Paterson: If Geoff's gonna add, I'm gonna add.

Lyn Angel: Yeah, look, I think we'll draw it to a close, Geoff – you might have an opportunity in one of the other sessions. So, what I've actually – remember, this is a summary from a non-expert – is, quite clearly, it sounds like the Australian scene is a leader, in this area. And that – but there is a global desire to really become more much transparent about trying to capture all of the costs. And ANSTO is providing, not just the production for patient diagnosis and care, but also for the research – and, I think, all of us around the table are very aware of the need for an absolute appetite, and passion and commitment, to research, to continue to see what's going to be ahead in the foreseeable future.

But, at the same time, making sure that our health in the Australian community can still be leading edge, in that regard. So, what I'd like to do, is make some effort to work through a few points, to see whether or not we have a level of consensus around these points. I'm not going to go back to toing and froing, and arguing the toss, but we may have a time at the end of all of the sessions to come back to some of these consensus points.

So, can we agree that the OPAL reactor production – and cost efficiencies, in the Australian scene – are not reflected in the broader, international discussion on the HEU reactors, which is just the point that we finished on. Is there a consensus around the panel members on that point?

Panel Member: Could you just say that again, one more time?

Lyn Angel: The OPAL reactor production – and cost efficiencies – are not reflected in the broader, international discussion on HEU reactors? Which is where, I think, we landed on that last point?

Panel Member: Does that mean it's more economically efficient?

Dr Adi Paterson: I think, we talk about transparency.

Lyn Angel: Yes.

Dr Adi Paterson: There's no normative economic model that people can see through, in a transparent way.

Dr Margaret Beavis: Yeah, there isn't a transparent model.

[TALKING OVER EACH OTHER]

Lyn Angel: But there's certainly a commitment to move as far as we're able, to that.

Panel Member: Well, as a global position, I think, it's important that -----

Dr Margaret Beavis: That's right, we all think that transparency and accountability are good.

Lyn Angel: The second point is the OPAL reactor has recognised efficiencies that, actually, do benefit Australia.

Panel Member: It's got asserted efficiencies, but I don't know if they're recognised. I mean, why don't we see the numbers? If we're talking about economics, we need the numbers, we can't just have assertions.

Panel Member: Yeah, but, I think, there's no question that there's an efficient supply of radiopharmaceuticals to this country, let alone to export. I don't believe there's any – that's uncontroversial. We get our isotopes, because they're an efficient organisation.

Panel Member: Well, they're effective, I think.

Lyn Angel: And, particularly, picking up on François's insights -----

Dr Margaret Beavis: They are effective.

Panel Member: And efficient.

Panel Member: Well, we don't know that.

Dr Barry Elison: Well, we get – well, I'm sorry, the effective means and efficiency in the context of – every morning the stuff arrives. Every morning, patients inject it.

Dr Margaret Beavis: It's the quality, too.

Dr Barry Elison: And costs have – whether it's right or wrong – the costs of nuclear medicine have stayed the same for ten years. Is that a measure of efficiency? That's the only measure we have. I don't think it's right or wrong.

Panel Member: But, Barry, the reactor wasn't operational for, pretty much, the first two years of its life.

Dr Barry Elison: And they managed to help us out.

Panel Member: From South Africa. South Africa said -----

Dr Barry Elison: It doesn't -----

Panel Member: It doesn't matter from us, and it shouldn't, but I'm just saying – if we're relying on a reactor and it goes down, if we don't have an alternative supply, then we're stuffed. That's the single point failure in the linear supply chain problem.

Dr Barry Elison: But we did have an alternative reaction, because no patient suffered because of it. Because these guys have a contingency. And that was a long time ago. Since it's been going, it's been a very efficient organisation, not only for Australia, but for the rest of the world. These -----

Panel Member: And you see the seamless -----

Dr Margaret Beavis: I think, you could make it effective -----

[TALKING OVER EACH OTHER]

Panel Member: Seamless transition during, you know – when it's down for service, that we see that in our community now. It's absolutely [essential.]

Dr Barry Elison: But you only measure -----

Lyn Angel: So, the question, perhaps – is there still a question around efficiencies versus effectiveness? And we may be able to revisit that, in time. The third point is that, is it necessary to continue to monitor production and cost efficiencies, moving forward?

Panel Member: I would imagine there's no base around that -----

[TALKING OVER EACH OTHER]

Panel Member: Can I say, ANSTO's accounts need to be a little more transparent. You seem to aggregate a lot of your costs, you don't separate out your research costs from your radiopharmaceutical costs. And so, if we're really going to be transparent and debating the toss, those figures need to be disaggregated from your accounts.

Lyn Angel: Okay, so, I think we need to be moving forward. So, for our livestream viewers, don't forget, you do have the opportunity to contribute questions or comments – and also, you have poll questions. I'm not sure how that's going, we haven't had any engagement with that, at the moment. But, as we move through this morning, please avail yourself of that opportunity, to be fully engaged in the process.

So, now, we're going to move to the second segment – and it's a focus on export to market. So, global shortages in molybdenum-99 supply have been widely report in the northern hemisphere and have, indeed, increased demand for Australian product. The public arena has seen reports of significant increases in waste and responses from ANSTO that increased waste will be minimal. At the same time, it's worth reflecting, on what our role is in the global market.

So, the theme questions for this next session: global shortages in molybdenum-99 supply have seen increased demand of Australian product. How has this increased waste production? What is Australia's role and responsibility in the global market? And will demand increase more, internationally? So, to help us kick off that, I'll turn again to Adi Paterson, thanks Adi.

Dr Adi Paterson: Thank you very much, indeed. This is a really, really important part of what happens with nuclear medicine. I think, as we indicated in the early years, when we were bringing OPAL to full operations – we imported our Mo-99 from South Africa. In fact, what has happened since the crisis in 2009 and 2010, the reactor community has been organised, internationally, to combine the analysis of our schedules to minimise any possibility of market disruption. And so, I think, what we're seeing now – over the last five years, certainly – is one of the most reliable supply periods. Because, what we had done, bilaterally, between Australia and South Africa to protect each other's supply, is now done internationally. We have an international meeting of the reactor producers, two or three times a year, they discuss schedules, they look at when there are going to be outages – and this is used to protect the global community for those forty million doses a year. That are supplied, mainly, in the developed world.

I think, the other part of the export, though, is starting closer to home. We have regularly supplied New Zealand during this entire period, so, New Zealand does not have a nuclear reactor – but they rely entirely on Australia for the supply of their iodine-131, their Mo-99 and other isotopes. So, our closest neighbours directly benefit from the investment made by the Australian Government and they are part of a long association in nuclear medicine.

We also supply, on a weekly basis, into South Korea. We supply China, we supply Japan - and since we've got the increase in production with the reliable operation of OPAL, we also now supply the United States. We sometimes supply Brazil and other countries.

Now, why should we do this? Why should Australia supply nuclear medicine to other countries? The reason we do it, is because those countries need to have the benefits of healthcare that we enjoy – and part of the design of the business case for the OPAL reactor, was that we would start off by achieving reliable supply, domestically. And we would then expand our supply to support the – it was a known fact that ageing reactors were going to be a challenge, even at the time that we were building the business case for the OPAL reactor. And so, we have increased our supply over time.

And so, the United States, is now benefiting from the investment made by the Australian Government. We have benefited, historically, in the age of subsidisation, from many other countries which shared technology with us at no cost. Which helped us build facilities that allowed nuclear medicine to grow and flourish – and we have one of the strongest nuclear medicine communities in the world, because of the capacity to draw on the knowledge of other countries.

So, if one still believes in a global community that works together to advance health, to advance positive outcomes for our societies, more generally. Then you have to believe that, if ANSTO can export nuclear medicines to countries that need them, that is something that is well within the framework of what we do as a nation. To show that our local environment and our global citizenship is a virtuous one.

Public health is one of the biggest issues that is going to face the developing world and, so, therefore, we are actively working with developing countries to see if we can move this technology in there. We have to do that on a basis where we can demonstrate that we don't become a burden on the Australian taxpayer. Therefore, Australia was the first country in that group in Paris - that we've talked about - to commit to, and to ask all the other groups to commit, that we would fully cost the waste and decommissioning costs into the cost of nuclear medicine supply.

We do that calculation, already. A number of other countries are working with us to learn how to do that calculation. Now, the good news is, that the waste costs are a tiny fraction of the total production costs. And therefore, the incremental costs of waste and decommissioning is, actually, quite a deterministic number – and it's quite small.

Mo-99 turning into technetium-99m, remains the lowest-cost isotope - by a factor of between five and ten – of all the isotopes that we use across diagnostic nuclear medicine. The reason it is used so much, is it is so cheap – and that is one of the problems with it, of course. Is that if there is a small subsidy, it becomes invisible in the greater scheme of things.

And so, getting this level playing field is, actually, quite complicated – but ANSTO and Australia have been committed from day one to that fully absorbed cost being reflected in the work that we do in Paris. We have led that, rather than waited for people to ask us to do that. It's the only way, in ten or fifteen years, that we will be able to demonstrate internationally, that these subsidies – which are not good things – and lack of transparency – which is not a good thing – have been eliminated from this very, very important global healthcare system.

So, I'd like to make a distinction between the notion of a subsidy and full-cost recovery. We are seeking, internationally, to get full-cost recovery. If there's a subsidy further down the chain, in the United States, in Europe – or to wherever else the supply goes – that's a national issue. But the agreement is that when the nuclear medicine crosses the border, there is full-cost recovery. And, I think, if we make a distinction between those terms, we'll see that export is fair, it's transparent, and it's beneficial to our society. Both in terms of cost, but the tremendous reputation we get from supplying something that is quite scarce and needed, desperately.

Lyn Angel: Thanks, Adi. Thank you very much for that. I'm now going to ask Margaret for your views, thank you.

Dr Margaret Beavis: Okay, I'm going to revert to slides for this entire presentation, I'm hoping the guys in the booth have got the slides up, so my face won't be on the screen. So, my apologies. This is where I'm getting the information from, this is – someone asked for information, since 2010, this is the 2016 figures on medical isotope supply from the OECD. The Paris group that we all think is the world's bee's knees.

Okay, in this report – except, my slides are not forwarding, do you have another forwarder? In this report, it showed – nope, could you get my slides? Okay, I'll talk to it. If you can get the next slide going, that would be good.

Basically, the world demand for technetium has been dropping steadily, whether this is due to new technologies – I think, there's a number of reasons for this. But, it's very clear that – in four years – world demand has dropped by twenty-five percent. Okay, ANSTO continually talks of a future global shortage, so we'll go to the projections by this group. They have projections for growth in mature markets, like the US – so, you'll go up 0.5% - and 5% in developing markets like China, or whoever.

Which adds – so, the total projected growth, worldwide, you assume there's going to be no further drop – is 1.2%. The reason this is important is because the future slide – I'm going to run through five graphs, which, again, come from the Paris group – and which, again, I apologise for the complexity of the graphs.

However, if you keep your eye on the red line, which is projected future demand, and then, also, the green line – which adds 35%. And the reason there's a 35% addition, is because reactors are so unreliable, to run a global market, they need to have thirty-

five – what's called – outage reserve capacities. Because, when a big reactor – supplying, say, 25% of the world – goes down, it's called a single point failure.

So, we want to – for reliable, global supply – stay above the red line and the green line. Okay, so, look at the red line and the green line, with this slide – I'm sorry – the print is tiny, so it's a bit horrible. This is looking at current reactors, the future world supply – this includes no new capacity from now and includes the closures of the French and the Canadian reactors. Now, predicting five years ahead – they used to predict twelve to fifteen years ahead, but they now realise that the technetium is changing so much - that technology and the medical use of it is changing so much – that they're only predicting five years ahead.

As you can see, we are well clear – the blue line being irradiation capacity, the pink line being processing capacity – we're well clear for the next five years, for world supply. This is – now, I'm going to – these next two slides talk about adding new reactors, worldwide, that are planned in Europe, North and South America and the far East. And only half of the non-planned, non-reactor production. Again, you can see, not only are the red lines and green lines well clear – in other words, we have plenty – but also, the international community recognises that non-reactor technology – which is the dark blue line – is a real thing, and actually going to add to capacity.

So, instead of saying, "Cyclotrons are not going to work", the Paris group have factored them in. Although, this is only half of what they're saying will happen. Again, there's two steps in making the isotopes, so there's the irradiation – so, now I'm going to go to processing. So, the processing – again, we are well clear of the red and green lines, there is no impending shortage, there is the 35% outage capacity – you can see that the total processing capacity, the pink line, is ample. And the brown line is the conventional processing capacity. So, once again, alternative technologies are making a difference fairly soon.

Now, this slide – if Australia were to delay, for one year, its intention to increase its isotope supply to 25%, from 1% - this is what would happen. If, for one year, there was a delay, still we are well clear of the red and green lines. The total irradiation capacity is the blue line and the total processing capacity is the brown line. So, you can see – in fact, by 2021, there's quite a significant glut and cost recovery will be very, very difficult.

Now, they also model a two-year delay – and this doesn't include any of the alternatives. So, if you take out – if you agree with the argument that the cyclotrons are not going to work, if you look at this, this is projecting future supply – and this is 2016 data from the Paris group, worldwide. So, you can't get better data than this. If you look at it, all of the lines run above the green and the red line. So, the total processing capacity – that top pink line, the – I won't go through all the lines, but you can see that, even if there's a two-year delay in Australia coming online, there is still

plenty of supply for the next five years. And probably a glut, when we get to five years' time.

So, I have three conclusion slides – the first one, is that Australia's increased production capacity is not needed because of shortages, but reflects a business proposition on the part of ANSTO. Secondly, that there is sufficient capacity worldwide, for nuclear medicine with technetium to continue, regardless of Australian production. The second conclusion, with either one year or two-year delay in ramping it up – there's still plenty of technetium from existing reactors in nuclear medicine, worldwide. There is plenty of time for consultation – does the Australian community really want a lot more nuclear waste? There is time enough for an enquiry into the future of nuclear waste production – and the management of that waste – in Australia.

And Lucas Heights, earlier this year, got government subsidy and funding - and has sufficient capacity to store nuclear waste - well into the 2020s.

The third conclusion is that current waste proposal is well below best practice, what's being put forward – and that Australia should be partnering with the Canadians to explore cyclotron manufacture. Because, the first principle in managing toxic waste, is to reduce production.

Lyn Angel: Thank you, Margaret. And -----

Panel Member: Can I just ask – ask Margaret a question?

Lyn Angel: Sure.

Panel Member: If we've got capacity in Australia, to produce and contribute, why wouldn't we? I don't understand.

Dr Margaret Beavis: Well, I think – well, the reason is, if you're looking for a public health good – it's very important to look at cost-effectiveness. If you really want to be a good global citizen, and help people overseas, you'll give them mosquito nets or you'll give them worming tablets.

Lyn Angel: So, just on that – I hope that that will be addressed, too, by the other panel members – but it's a good question and it's part of the theme for today. So, Peter, you're next, so you've got five minutes.

Dr Peter Karamoskos: Yeah, okay, just before I start – because, the problem is that if you flood the market with product, you drive down the price to marginal cost – and then you make the whole box and dice uneconomic. So, the last thing you want is to flood the market, I mean – the NEA was absolutely clear on this – you have reserve capacity, but you have funding so that you don't need to use that reserve capacity. In other words, you don't have a perverse economic incentive to, then, fill that capacity – because, otherwise, you will drive down the worldwide price of the product, as you

utilise your over-capacity. We saw that in the airline capacity wars, we see that in a lot of commodity markets.

Panel Member: But isn't that better for the consumer? I mean, if that happens with oil -----

Dr Peter Karamoskos: No, because -----

Panel Member: ----- it happens with coal, it happens with iron ore.

Dr Peter Karamoskos: Well, it's a short run - it's a short run thing. So, we'll have an economic debate, later.

Lyn Angel: We might leave this discussion 'til after Peter had – Peter, you've got less than five minutes to actually be talking, so if you could keep to point, that would be great. Thank you.

Dr Peter Karamoskos: Okay, the – look, I think it's important to know how we got to where we are. I mean, reactor production of isotopes came into being as part of the Atoms for Peace program in the mid-last century. In 1971, cyclotrons were producing isotopes and they – the feasibility study was done – but there was no desire, nor funding, to expand this research, because of the glut of molybdenum-99 from reactors. So, there was no incentive. Here we are, forty years later, and all of a sudden, cyclotrons are part of the game.

Now, this is about the export market, so let me just come back to that. If we're really going to entertain being exporters, then we can't, simultaneously, argue the fact that domestic production is critical to security of supply. You either believe in importing the stuff – in which case, you are an exporter – or you believe in importing the stuff – in which case, the local production capacity is purely a policy choice and not a medical necessity.

Now, we've seen some, sort of, arguments here, that seem to run counter to each other – so, I just want to put that out there. This is a policy choice for domestic production - it might be a good policy choice, it might be a bad policy choice – but it is not a medical necessity. Isotope production, and its distribution, is a globalised industry. Most countries import their isotopes – Australia has chosen to produce its isotopes – fantastic. If that's what you believe. But it's not a medical necessity.

So, then, we come to the issue of waste. If we export our product, are we not subsidising other country's waste externalities. As Martin Ferguson said, many years ago, trying to just the radioactive waste dump – he said that, "If you use nuclear medicine, then you have a moral obligation to deal with the waste. If you want a nuclear medicine industry, then deal with the waste."

Well, that's not what an export model does, it basically creates an externality on the production country to deal with that waste. Adi says it's not much waste – cost is

minimal – well, you go tell that to the people where these proposed locations are meant to be. I mean, Michael mentioned it himself – this is a critical issue. Australia needs to find somewhere to bury its waste, to dispose of it properly according to international best practice. It's absolutely critical. So, despite it being a minimal cost – and I don't know if it is – there are the externalities involved with that.

There are the reputational issues, political externalities – the department is sweating on this, this is not a minor issue – and you export the product, you increase the waste. Who gave the – who developed the social licence to impose on people that waste, where they had no say in its overall production? It's one thing to talk about domestic production, it's another thing to quadruple that supply – or more – from 1% to 25% - and then impose it on, often, unwilling communities.

Lyn Angel: Part of this is about how much that increased production will impact on the level of waste, so if we can actually -----

Panel Member: I can tell you that.

Lyn Angel: Okay.

Panel Member: We have about five hundred cubic metres of intermediate level waste, about two thirds of it is from ANSTO operations, so far. That is predicted according to the Jacobs report, that was commissioned by the department just after 2050 – to increase to 2000 cubic metres. ANSTO, at the moment, has about seven or eight thousand cubic metres of liquid, intermediate level, waste – Adi, I'll give you the chance to correct me, if I'm wrong. We're running out of space – the two containers have just had – have recently had – licence approvals to increase that capacity. They are only meant to have 50% capacity each, so you can decant one into the other, if there was an accident.

So, you know – waste is an issue. It might not be so much of a cost issue, if that's the case, but it is certainly an issue. It's an issue for the department, it's an issue for ANSTO – which relies on its licence approvals proceeding, to get right – and it's an issue for the country to deal with it. Because, we're imposing waste on future generations, who will not have had the benefit of what produced that waste – much less a say in how that waste is dealt with. That's what local communities need to deal with.

Lyn Angel: Peter, we'll leave it there, thank you – and ask Geoff Currie to -----

Dr Adi Paterson: Can I just correct two facts?

Lyn Angel: Yeah, we're going to be really tight with this, but very briefly.

Dr Adi Paterson: Yeah. The first thing is that, if you rely on the report in Paris, you might mistakenly believe that Australia's supplying 1% of international supply. It's currently 16% percent – so, we're a major part of that curve, that's reliably supplying

the world, already. And, so, we are not a 1% supplier, we're a 16% supplier – and we already are doing this on behalf of the global community. I think, we need to take that into account, if you think there could be supply problems – because, if 16% disappeared, it would be quite significant.

The second point that I'd like to make, is that the suggestion that the cost burden – or any, even, reputational burden – would apply to any community, is simply false. Because many communities do want to accept the responsibility that we all take, for our nuclear waste. There's no in and out here, we are a producer of nuclear medicines and so, we, as a society, have to have a positive and effective way of dealing with the waste.

Lyn Angel: Thanks, Adi. Geoff Currie?

Associate Professor Geoff Currie: Yeah, so – I guess, that my perspective on this is that we're global citizens and we can't selectively take ourselves out of the global economy. Whether it's health economy or anything else – now and then – is that the waste, we can talk about the waste increase at another time. But, we actually import – there's some radioisotopes that we don't, actually, produce in Australia, we import. And the countries we import them from - for the good of the health and the wellbeing of every Australian – actually, store their waste of production for us. And so, that's the first point I wanted to make.

The second point is that when Margaret talked about that 25% drop, that's an artificial drop in the use of molybdenum and technetium – because, we came from a period where we actually had a glut of molybdenum available. And so, when we used to ship it to department, you would ship in excess of what was actually, necessarily, needed and used. And, whereas now, we're a far more responsible community – we only order what we need, we do multiple (01:03:00) on generators. So, we're actually doing more patients, with less product, as part of our responsibility – and that's a global thing that's occurred.

So, that 25% doesn't, actually, reflect a need – we're actually doing more with less. I think, that – yeah, and it is a good thing – and I think that – I would have thought that the MAPW, would have actually been very excited about the fact that ANSTO product would be in demand overseas – because, it's LEU. If we take that out of the global market, then what MAPW is essentially saying, is that, "We want more high enriched uranium being used for medicines, globally." And, I think, that it's actually really important. Because, earlier, you made the comment that you don't have an interest in shutting down the reactor, but the media release from both Peter and yourself, last week – under the heading of MAPW – clearly says, that "We're aiming to close the reactor in the next few years."

That is your own media release.

Dr Margaret Beavis: The question – the – ANSTO is arguing we should close it now, we don't agree it should be closed now. You're making a lot of false statements to the communities about – saying that we want it closed now. That is not true.

Associate Professor Geoff Currie: No, but your words are that "Close the reactor in the next few years", so, I think, that we need to be really mindful of where all of that sits – and what our role is, as global citizens, in a market that has some volatility. That has 16%, not 1% role – that Australia plays. And that it's an important 16%, because we're dealing with LEU – we're not dealing with high enriched uranium and that has to be – sorry?

Panel Member: Production or irradiation, that 16%?

Dr Adi Paterson: It's export-level, in the export market, globally.

Panel Member: Right, well, there's heaps of irradiation capacity – even if you pulled out 16% irradiation, you'd be fine. It's the production that's the critical part.

Lyn Angel: If we can just respect Geoff's timeframe, because François is still waiting to have his say.

Associate Professor Geoff Currie: Yeah, and so – so, the last point I wanted to make is the glut of the seventies – I think, that it is an incorrect assumption. That, in the seventies, we didn't actually have a big supply of molybdenum coming to departments. And, a few people around the table remember, that we used to get daily milk runs of reactor-produced technetium-99 directly produced in a reactor. And that's what used to get shipped out on a daily process. And the product was not as reliable as molybdenum – it didn't have the same radiochemical purity – and it has the same barriers that the cyclotron product would have.

So, it wasn't necessarily what occurred in the seventies.

Lyn Angel: I think we'll leave that there, Geoff, and – in the interests of time – if we could go straight to François. I have got a question that's come through from one of our viewers, that I'd like to have an opportunity at the end. So, over to you, François.

François Couillard: Thank you. Estimates of demand growth vary greatly, there's probably very good reason for that. For one, the information is often, commercially, sensitive information about market share, by one vendor over another – something that they guard very closely, to themselves. So, when they're asked by the OECD to supply information, the information that is accumulated is often an estimate – and you don't know exactly how accurate it will be.

What I'm – my own assessment is, in some countries like Canada, demand has fallen. Mainly, due – as Geoff mentioned – to efficiencies in the utilisation of the product. After the crisis in 2009, 2010, the nuclear medicine departments have grown to be much

more effective in the use of the product. So, in countries like Canada, the US – the demand has fallen, but in others – like, China – it is still growing.

The OECD – all that being said – the OECD, probably, remains the best source of information, both for demand and for supply. I haven't found anything that closely matches it. And they're forecasting a slight increase for the years to come. The role of Australia is pivotal in ensuring a stable supply, in the future. The current supply and demand model is managed by a group called the (01:07:03) – which is an international association of isotope producer. And they ensure that the schedule of all the reactors and processing facilities are coordinated, so that not too many reactors are down at the same time. And they create a model that is on a week-by-week basis – estimates the demand versus supply.

And they have a line that shows the minimum supply, at nine thousand curies per year. The production that comes from Australia is pivotal to that and if you ask (01:07:37) to supply you with their latest forecast, they've included the start of your new processing facility – and it's essential for the ongoing supply assurance of the whole supply chain.

Now, that's more tactical. That's day-to-day, week-to-week – OECD is a longer, strategic planning process. Now, it's true that there are many various projects underway, to increase production capacity – and this is essential. All research reactors involved in the global supply chain of molybdenum-99 are scheduled to close by 2030 – except, the OPAL reactor. Every one.

That means we, absolutely, need either new – well, new production sources. Either reactors or something else. There's – right now – we know there's several research reactors, new research reactors planned for France, Germany, the Netherlands – but it is difficult to assess when, if ever, they will actually be commissioned. As you all know, nuclear is a very politically sensitive issue.

As we'll discuss later, in the next topic, alternative production methods – like cyclotrons – are promising, but will certainly not replace reactor supply any time soon. And I'll talk about the Canadian experience, later. Now, I would like to take a few seconds to address some of Dr Beavis's comments.

The different slopes – if you look at them, closely, the different lines – until 2019, we're actually in a very tight situation. Yes, the line is above – the supply line is above the demand line – but, just, very tightly. That's until 2019. What the charts don't show is what happens beyond 2021 – and, as I just mentioned – every reactor, except for the ANSTO one, is scheduled, right now, to close by 2030. So, what's happening in all those years?

All the scenarios shown, are – some of them are shown as being conservative, in that, they cut off – maybe, they have increased – they decrease by 50% the probability that new sources will be in production in a timely fashion. But that's, actually, still, probably, very conservative. A lot of these reactors – a lot of these new production methods –

are very risky, they're – and they face huge regulatory burdens – and economic burdens.

So, I'm not so sure that even the most conservative projects are, actually, that conservative. And they're probably still quite risky. And, also, you mentioned about the cyclotron capacity being included in there, as a show of fate – well, actually, the cyclotron capacity is not included in those projects. They've been kept out because of the uncertainty behind these projects. So, the other new sources of production are not cyclotron-based.

So, in conclusion, the demand is there and it will not go away – and patients around the world really count on you guys. So, please, please, hang in there.

Lyn Angel: Thank you very much, François. Now, I would like to just take this question from [Prab Takar], who asks, "What has happened to the waste since the OPAL system began? Who bears the cost of the disposal of this waste, now and in the past?" Thanks, Adi.

Dr Adi Paterson: So, the only waste that has had significant processing in the OPAL era, has been the low-level waste. And that's things like boots and gloves that are used in the production of nuclear medicines, it's not radioactive materials, as such. And that is currently being kept on the Lucas Heights site, in interim storage facilities that we have available.

We have – for the full life of the reactor – we have a contract in place, with Areva in France, for the reprocessing of the full fuel cycle, for the full life of the reactor. This is a wonderful thing, because it means we have absolute predictability about the future processing of the fuel that will be used in the OPAL reactor. And those people who have seen that single canister that has come back from France, the entire life of the OPAL reactor will produce one – possible two, more – of those canisters.

So, this is not a massive volume problem. It is something that we know a lot about, it's highly predictable – and these volumes of waste from the fuel side of the reactor are very small.

Lyn Angel: Thank you, Adi and I can see that we're just about at the end of this session – so, we're not going to have any time for further discussion from the panel members. But we may be able to revisit that in one of our other sessions. So, certainly, I'm getting the sense that – particularly, from François – in terms of the role that Australia, and particularly ANSTO, plays on the international stage is quite significant. And is already playing.

The science tells us that the increase in waste produce is, actually, not as significant as one might assume, when they hear the percentages of increase of production. And

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Panel Member: Don't think I agree with that, at all.

Lyn Angel: ----- and – I haven't got to the consensus, yet – but, in terms of the global role that we play on this stage, in terms of being the leader – the facility providing research for continuing to look at, and improve, the science around all of this. Which is really important, in terms of future-proofing. I think, that's part of a choice that Australian citizens, I suppose, are part of that discussion – as to what sort of (01:13:25) we do and what responsibilities we do have, on the global market.

So, I've got three points that I'd actually like to test the waters on for consensus – and again, we haven't got a lot of time to discuss them. Can we agree that exporting has a fairly small, but not negligible increase, in overall waste production?

Panel Member: No.

Panel Member: We can agree to that.

Panel Member: I agree.

Panel Member: No.

Panel Member: Yep.

Panel Member: No, absolutely not.

Panel Member: No, there's no consensus on that.

Panel Member: It's going to quadruple the intermediate waste we have and we don't even have a disposal solution for it. It's going to be stored. That's not international best practice, if it was insignificant, we wouldn't be here debating all this.

Dr Adi Paterson: I think, on the fuel cycle, it's incontrovertible that the change in the waste from the fuel cycle – as I've just described – is one canister returning from France. So, that is absolutely an inaccurate statement.

Panel Member: That's a little bit misleading, Adi, because -----

Dr Adi Paterson: Not at all.

Panel Member: ----- you've got decommissioning stuff, you've got the targets that are dissolved -----

Panel Member: We're talking about waste.

[TALKING OVER EACH OTHER]

Dr Adi Paterson: It's not about the fuel cycle waste – the target waste is, correctly, a different issue. But, the prediction that it scales with the nuclear medicine, is incorrect. Because, you're actually producing more in the same time, for the same production of -----

Panel Member: But, Adi, are you producing more waste by manufacturing more isotope? Yes or no?

Dr Adi Paterson: I think, that that's absolutely -----

Lyn Angel: The question is whether it's linear.

[TALKING OVER EACH OTHER]

Panel Member: For the people out there, listening, it's an issue. For the communities that will be impacted and need to make an informed judgement, it's an issue.

Lyn Angel: And I'm just – bringing back to the issue of consensus – that it isn't negligible. That it isn't produced – the waste, produced -----

[TALKING OVER EACH OTHER]

Lyn Angel: Alright, so, the second point is the benefits to Australians offset the detriment.

Dr Margaret Beavis: Of an export market?

Panel Member: Absolutely.

Dr Margaret Beavis: No, absolutely not.

Panel Member: No.

Dr Margaret Beavis: Most countries in the world import their nuclear medicines. Australia chooses to have a reactor, as a policy choice – it's not to do with nuclear medicine.

Panel Member: It's not a medical necessity.

Lyn Angel: So, the third point around our global citizenship is – export is our role as global citizens, but not something that should be actively pursued commercially. So that when supply increases, globally, we retract from the global market. So, in other words, when it's not needed – we're able to pull back. Would there be consensus around that, in terms of, the way forward?

Panel Member: So, you're suggesting ANSTO only irradiate one day a week, if only one day a week's required?

Lyn Angel: No, if the -----

Panel Member: No, they meet demand.

Lyn Angel: That's right, meet demand. Do not exceed demand.

Panel Member: So, are you going to chase market share or – if somebody else – or are you gonna -----

Panel Member: I think, the point was well-made, that there's this 35% supply margin. The reasons for that is that your biggest player is about 25%, in any of these markets. The reason that you have that green line at 35% is not because it's a messy market, it's because, sometimes, reactors switch off.

Dr Margaret Beavis: Or go down. Or fail.

[TALKING OVER EACH OTHER]

Panel Member: Unplanned shutdowns.

Dr Adi Paterson: Yes, it does – planned and unplanned ones.

Panel Member: Well, your planned ones are your weekly reserve capacity.

Dr Adi Paterson: I don't have a notion of weekly reserve capacities.

Panel Member: Well, that's what the Nuclear Energy Agency and I think it's critical to know that.

Dr Adi Paterson: We don't work in those terms – what you do, as has been indicated, is we have regular meetings of this (01:16:47) group. Which, actually, looks at the tactical, short-term supply – and the tactical, short-term supply says that we can produce, at the moment, enough for the world. The outage reserve capacity, if you read the reports, is a national issue – it is not an international issue. And they aggregate that to 35. And, basically, when you analyse that, that means that if one of the large reactors is off, everybody has to have reserve capacity – which will come from all of the other reactors.

Panel Member: Yeah, so it's an international issue.

Dr Adi Paterson: It is, and that's why we're -----

Lyn Angel: Okay, I'm going to just wrap up this issue now and remind all of the panel members – and those who are viewing this – the importance to try and keep looking at the science, sticking to the science – and then seeing how the decisions that are made using that science, and sticking to the facts, actually allow us to proceed and move forward.

I'd like to actually close the session and thank everybody for their contribution. We're going to have a ten-minute break, but can I remind the viewers that you do have the opportunity to put your questions and comments forward – and also, to engage with the polling questions.

So, we'll come back at about a little after twenty to eleven. Thank you very much.

END OF RECORDING (77:54)