COMMISSIONER: This morning we return to topic 20, Nuclear Education and Skills Development, and we welcome Professor Aidan Byrne from the Australian Research Council. Professor, thank you very much for joining us this morning.

PROFESSOR BYRNE: Delighted.

COMMISSIONER: Counsel.

MR JACOBI: Professor Aidan Byrne is the chief executive officer of the Australian Research Council, a commonwealth entity which advises the Australian government on research matters and administers the National Competitive Grants Program for research and development. He was previously the dean of science and the director of the Australian National University College of Physical and Mathematical Sciences. Professor Byrne completed a PhD degree at the ANU where he later spent over 20 years of his career as a leader in research and research management, particularly in the field of nuclear physics. He is widely known for his ground-breaking research into nuclear structure and he has published over 200 papers, and the Commission calls Professor Aidan Byrne.

COMMISSIONER: Professor, I might start. Were the Commission to recommend further participation in the nuclear fuel cycle, a commitment from government and institutions and education would be critical. I'm interested in your views about, and examples of, long-term commitments to the education sector, their success as opposed to shorter-term commitments, and perhaps if you have examples you might provide some of those.

PROFESSOR BYRNE: So we have a fairly healthy, strong research system in Australia, and I perhaps could preface my remarks by making some comments that currently in my position, I have oversight of the research system in universities in Australia. Some of what I'm going to say is from my previous role as dean of science, head of physics of department and indeed a creator of a master of nuclear science program in days gone by. The Australian system, I think, is, as said, high quality, very good. Instances where the system has grown and developed a capacity over time that is not unrelated to the activities you're talking about here, one instance I think would be the establishment of the activity profile in Australia around photovoltaic.

So this is another energy technology domain, completely different in many ways, but not unrelated to the activities in nuclear energy. You know, I think this is an enterprise in Australia in terms of the research and the capability within our education systems that has evolved to quite a sophisticated level over a period of perhaps more than 20 years, with concentrations of activity in a number of institutions in Australia, over New South Wales, clearly very

significant, but other activity profiles, probably in all of the group of eight universities, so there's significant research (indistinct) universities, and that has grown to the extent that we have high-quality research being prosecuted in those institutions and a flow of students coming on into those domains and international connections being built on the back of high-quality research in photovoltaic areas.

Another instance that we can think of in a slightly unrelated technological area, but it's been in the news of late, is the quantum science and technology area, and again, interestingly, New South Wales featuring this. Michelle Simmons, her centre just received this week, and the government's Innovation Centre, more specific for quantum technology, but actually that is on the back of an investment in quantum technologies which is at least 20 years old. The ARC itself has been an important vehicle in that. The ARC funds individual researchers, it funds fellowships, but it also is responsible for creating Centres of Excellence which is discipline-focused entities.

In the quantum technologies areas, for instance, there would've been about three, four, even five, with various incarnations, Centres of Excellence around quantum technologies, again over a period of 10, 15 years. So that's been a significant investment, but not only that, an investment that's taken up to build capacity in Australia, and so if we think about 15 years ago, 20 years ago - I'm getting older, so I've got to add another five years because I forget - but 20 years ago there would be just a small handful of people in our universities looking at quantum technologies.

Now we would have probably five significant, and significant on a world scale, institutions with capacity in quantum technologies, and I think that perhaps is one of the stronger examples of how Australian research can actually develop over time with an investment that's been here for a substantial period of time and, indeed, get to a point where our researchers are recognised as significant contributors on a world scale.

COMMISSIONER: I think it might be useful, in relation to photovoltaic, if you could perhaps give us a view about what was the system that developed to support that area of - - -

PROFESSOR BYRNE: Well, interestingly, again - you know, this will come out wrong, but I don't want it to - the photovoltaics has been supported from a number of initiatives. Indeed, there was a Centre of Excellence too in photovoltaic research, and this is a number of years ago. I think it was 2003, but don't quote me on that one. But on top of that, there was additional government investment in those technologies through various mechanisms over the past sort of 15, 20 years as well. But the ARC, as a vehicle for supporting research at the basic level through its Centres of Excellence, I think was in

some ways pivotal to that. This was again the investment in New South Wales establishing a focal point of activity in that area, and again, I think, in part reflects the ARC's capacity to support research at a basic level within our fairly strong university system.

MR JACOBI: You picked up the idea of there being a focal point. Were the initial Centres of Excellence established around an initial nucleus of research activity being conducted in one institution? Did you work out from there?

PROFESSOR BYRNE: So that is a general way. The Centres of Excellence program is one where the initiative comes from the bottom up. There are other mechanisms which have happened where initiatives come from a top-down approach, but the Centres of Excellence tend to be the identification of topical issues by a few researchers. The program is really oriented to make sure that it's thematic, multidisciplinary, around a kernel of researchers, but has a particular attribute that it's not just researchers from one institution. So it is very much about bringing people from various institutions to solve a thematic problem. You know, in general, our Centres of Excellence do perform very, very well, and it's a scheme I'm very proud of actually.

MR JACOBI: In terms of making assessments about what is significant for the purposes of a Centre of Excellence, how is that analysed in terms of the competing claims, I guess, from competing researchers as to what's important?

PROFESSOR BYRNE: Indeed. So as was mentioned in your intro, we run the National Competitive Grants process, so much of what the ARC is concerned about is having robust processes for the selection of the highest quality research with an emphasis being on the quality component of the research undertaken. Clearly, for some of these there are also national benefit in those dimensions that come into the criteria, but it is very much a competitive process where we are looking to select the highest quality bids that can meet the objectives articulated in the most effective way. I think our processes are reasonably strong and robust. Obviously we don't please everyone, but I think the sector has a high degree of confidence in our decision making.

MR JACOBI: I understand that the program is on a three-year cycle.

PROFESSOR BYRNE: Correct.

MR JACOBI: I'm interested to pick up as well, as opposed to the bottom up, the top-down aspect. How does a top-down aspect work in contrast to the actual research-driven grant applications?

PROFESSOR BYRNE: So the top-down approach would be where the ARC

provides research funding through different mechanisms. Usually we badge them under special research initiatives. This would be a decision of government to say that support needs to occur in particular areas. Instances of that would be contributions to things like the bionic eye project which was started a number of years ago. Another example of that would be the long-term commitment from the Australian Research Council to the NICTA initiative, the National ICT initiative.

So here, broader decisions are made by government. The ARC, as a research funder, becomes a component of that support, so decisions are made outside of the normal competitive grants processes. In some instances we run competitive processes. Another instance of that, we have funded a Centre for the Science of Learning. This was a government decision to invest in this area, and then we deliver a competitive process. We articulate, "Provide us bids in that particular area," and we run a selection process around that with the area being well defined.

Our typical Centres of Excellence program, as you said, runs every three years. We have an open program that gives us bids across all areas and we don't narrow it down. But as I say, there are instances and the Centre for the Science of Learning is one of those where the government says, "We need to do work in this particular area." We put a call out for bids and select accordingly. Similar set of parameters, I have to say. We look at quality of the research articulated, the quality of the team, whether it is the right people around the country participating in that and then make decisions accordingly.

MR JACOBI: Yes. You picked up the criteria; I am just interested to understand the extent to which the criteria embody an idea that the particular concept has to be of national significance as opposed to perhaps being of more regional or local significance?

PROFESSOR BYRNE: So again, I think the Centre for the Science of Learning would be a good example of that where it was clearly articulated by government that this was initiative that they wanted to see prosecuted, articulating the broader parameters and something fought for the national interest. So then we run a set of – a call for proposals around that thematic area.

MR JACOBI: Can I just pick up, you spoke with respect to the photovoltaics that there have been a series of centres of excellence established over a period of time and I am just interested to understand the extent to which one particular programme there might lead in to future programmes and the significance of early success to future and later funding?

PROFESSOR BYRNE: Right. So perhaps a better initiative if I can start on

that because the photovoltaic had extra spending and off the top of my head, I can't remember exactly what they were. So that one I know for sure was created with a Centre of Excellence a long time ago but there were other government monies in the area of photovoltaics and renewables through other mechanisms. A better example of a chain of centres of excellence that can lead to the establishment of a discipline area, would be quantum science. So again, the first centre in quantum areas would have been actually one at the AU, run by Hans Bachor, Centre of Quantum Atom Optics and I am trying to struggle to remember when that was created but it was 2003ish probably. There was – in parallel a centre at Sydney, so two centres of excellence. Over the last few years, as I say, there would have been three or four other centres in various dimensions of quantum science that's allowed the discipline to expand in to a number of different areas. With the one that was in the news this week, Michelle Simmons being the third incarnation of that Centre of Excellence coordinated from the University of New South Wales, but there are centres of excellence in quantum technologies that have a stronger basis both in ANU, UQ and a need in the Melbourne area as well. So a series of ones that are revolving in to different dimensions of a broader thematic problem, on the basis of creating a cohort of very able researchers in quantum areas. The photovoltaic ones, as I said, received additional stimulus through other mechanisms and I forget exactly what they were, as I say, around renewable energy technologies. So there was an additional significant – and I think it was of the order of maybe even up to 100 million dollars that was put in to that area over time by the federal government, not through the ARC.

MR JACOBI: Can I just take you back and ask you to speak in relation to work that you did in your former role when you worked at the Australian National University.

PROFESSOR BYRNE: Yes.

MR JACOBI: We are just interested to understand, we are aware that you were responsible for establishing a really – a nuclear physics course at that university and we are just interested to understand what the driving forces for the establishment of those programmes were and what the model was that you selected for developing that?

PROFESSOR BYRNE: Indeed, and we looked at a number of models around the country. Now it's not a course in nuclear physics, so the ANU almost always actually has had a course of nuclear physics, the ANU since its creation had a Department of Nuclear Physics, indeed I was part of that department for many years. So it's not nuclear physics we are talking about because that has been a presence in that institution since the creation of the institution actually. So it's one of the oldest departments in that university. The programme I created was a master of nuclear science programme and I was head of this,

trying to work out exactly when it was, but I suspect about 10 years ago we started looking at that and this of course was in the environment when there was a lot of discussion of government about nuclear options and at that point within the Department of Nuclear Physics there, because we were particularly engaged in the conversation around nuclear power, in fact the country wasn't engaged in a conversation around nuclear power. We realised within that department that there was an appetite within the system for information around nuclear and nuclear issues because the ANU as an institution had had long possession in nuclear physics, we made a decision within that department that we would actually be proactive in communicating issues around nuclear science in general.

As part of that initiative we created a course, a master's course, so a graduate level course in nuclear science. IN order to make these courses viable, and I think this is true of all of the ones that have been created, even today with the nuclear energy engineering course in New South Wales, there isn't the cohort of people in Australia that have a focus on the industry in Australia at the moment, so almost by necessity you have to create them as relatively broad programmes. So they are not specialist programmes in nuclear engineering, they are broad based programmes which have components of all of the aspects of nuclear system as a whole and those aspects do include the basic nuclear physics to some degree but very often, because your audience is not nuclear physics or indeed engineers, it is not about nuclear physics, it's not about nuclear engineering, it's about the social impact of some of those nuclear technologies, it's about the political decisions around nuclear power issues like proliferation, weapons and so forth. It's also about basic radiological studies; not too many people really have a deep understanding of ionisation, ionising radiation what it really means for instance. It also then, if you have got a course on that, has to have some dimension about the full nuclear fuel cycle, so it has to think about the geology of the mining, uranium ores, processing of ores, those sorts of things which is in geological sort of domain if you like, a mineral processing domain. And indeed it has to in terms of the full cycle, also think about waste, waste storage and those sorts of dimensions. So they end up being very, very broad based programmes and useful because it does provide a significant robust system, that if you've got any engagement with a nuclear system, these courses can be beneficial to you.

MR JACOBI: I was just interested to pick up why you chose the particular model that you did of establishing a graduate level course and who was the intended intake for that programme?

PROFESSOR BYRNE: So indeed, I think the graduate level course is the right level course. I think for most of these you don't know – again, it comes back to the point that I made, you do have to address of course to a very broad audience. There is not the demand and typically if you set up a course in a

university system, you typically need – and this number varies, but you would need about a cohort of 20 students every year to keep a course going as viable. You are not going to be able to set up a whole undergraduate course with only 20 students. And indeed, you wouldn't want to do that. The aspects that you want to try and bring together in a course around nuclear science is as the capstone experience which is better suited to graduate courses than undergraduate courses. You do need people to come in to these courses from various dimensions. You need people coming in from an engineering base, for instance, so people coming in from civil engineering, electrical engineering, process engineering.

That is not something that you can do in a one-year course, or a two-year masters course in any way at all. That has to be foundational, it has to build on a whole series of things in control engineering, electrical engineering, process engineering. But that is very standard activity that can be drawn out of any core-engineering programme in the country. Similarly, if you have got people thinking about ionisation or ionising radiation, or even the medical use of ionising radiation, those people can have a solid background in biological, physical sciences that can be drawn out of almost any undergraduate science course, any physics course, any biology course. You don't need to create a whole separate course just to do that. The other aspects of it too, the licensing regulation, all of those things, people with background in law, policy and so forth bring useful skills in that area and you wouldn't set up a whole undergraduate course in that way. So the location of these courses at graduate level allows the people that have got a foundation in the other dimensions that you need to bring together to have, as I said, a more touchstone experience. That's a much more sensible way of dealing with a thematic problem. It's a model indeed that the Melbourne University sort of promulgated a number of years ago under the Melbourne model of education, so that is really providing a broad-based undergraduate education and then a specialist education at the next level which is the master's level or indeed going on to research at PhD level.

MR JACOBI: Having considered the issue as you did at that time, I was just interested, the Commission is required to contemplate that potential expansion of the nuclear industry and I am just interested in understanding your views about the sorts of models that you might think would be relevant for the Commission to consider concerning the skilling of the workforce that might be capable of resourcing a regulator or resourcing those that were minded to commission and operate nuclear facilities.

PROFESSOR BYRNE: So I think again the model that I described is still the right one, is that you want to in all of these enterprises draw people with a broad base of skills and what there won't be ever is a sensible capacity to create a significant undergraduate program in its entirety. I think, you know, even if Australia was to go down a very significant nuclear route, the best way still is

to use the existing capacity that exists within our system to provide people with high quality engineering skills, high quality physics skills, high quality experience in legislation and regulation which I think most of our universities have some capacity to do at various levels and some of our universities have a high capacity to do at all levels.

Then still the best mechanism is to use postgraduate courses to provide the integration required to get those people ready, to be more work ready in a sense, but to be better adapted to change and to a different sort of environment or a specialised environment, be it a regulatory environment or indeed a production environment. So again, if you think about both of those dimensions, a person sitting in a regulatory environment probably needs experience across a broader portfolio of issues, particularly those in the social science and humanities, doesn't necessarily need to understand the details, the nitty gritty details of the engineering or the nitty gritty details of the nuclear physics, but needs to have a broader appreciation of what those issues are.

On the other hand, somebody going into the industry as an engineer needs some serious engineering capability behind them that they would find either in electrical engineering, process engineering, civil engineering, depending on what dimension they were going into, doesn't necessarily need a detailed understanding of the regulatory activity but to get an oversight and insight into that is quite important as well.

So again I think, coming back to the theme, the graduate model is still the best way of trying to harvest the system that is not building a whole - it is building an industry, yes, but compared to the total sorts of things that university do, it's a relatively small scale operation, it still provides the best mechanism of achieving that drawing upon the capacity that exists already.

MR JACOBI: Did the ANU course establish linkages with foreign universities with specialties in nuclear engineering and nuclear science?

PROFESSOR BYRNE: Yes. So we were evolving at the same time as the Dalton courses in the UK, so we had lots of conversations with them but didn't overly draw upon their resources because we essentially evolved it at the same time and their courses - and indeed at the same time they were going through the same process of revitalising the educational process against resurgence of activity in the UK around nuclear at about the same time. So it wasn't as if we could simply draw upon their materials to adapt to ours but we did have communication with them about what they were doing, we did look at their course structures and share materials across both ways, but didn't overly draw upon those people.

Because they have kept a stronger interest than us, I think they are probably

more advanced than we are. They certainly have obviously a deeper commitment to nuclear issues in the UK than we do in Australia so they do have a stronger requirement of pipelining people within their system so they are further advanced than we are now.

MR JACOBI: Do you have a view that if you were to expand, that such linkages would be a necessary step as part of the process?

PROFESSOR BYRNE: Absolutely. No, it's a very small community and it's by far and away the most effective way for all sorts of reasons, you do want to keep current, you do want to make sure that you are doing things at the highest possible quality level, so interacting with colleagues overseas, it's always been the game for research at the highest level, research and education is no different in my view and working with similar organisations overseas delivering similar materials is the best way to make sure that Australia can deliver high quality education in this area as well, no question about that.

COMMISSIONER: Can I just ask you, are there institutions that stand out in your mind that would be institutions we should seriously consider in that process were we to recommend these activities?

PROFESSOR BYRNE: You mean institutions in Australia or institutions overseas?

COMMISSIONER: Both.

PROFESSOR BYRNE: So I was very impressed with the structure around the Dalton system in the UK. I think what impressed me there was that they were doing again what I was describing earlier, the integration of various components that already sat within their system and providing an overarching coordination. Now, I haven't because of my current job paid a lot of attention to how they have tracked over the last few years, but I still think it's probably one of the better models.

If you think about other institutions that are head and shoulders above the rest of the world, I mean, MIT in the US, their nuclear program has been around for a long time and they have produced some very high quality material and that's a special institution too, but if you are looking for, you know, a nuclear engineering place that really has been going for a long time working at a very sophisticated level, that would be certainly up there as well.

Coming into the Australia environment, there's a relatively small number of institutions where it makes sense to try and develop this at some significant level. Interestingly, it could be any university in the country in some sense, but there are some with better capacity to do it. Obvious ones, of course, are the

University of New South Wales because they in the very dim distant past used to have nuclear engineering. That lapsed. They have revitalised that. I am not sure, and you probably know this because I'm sure you have talked to them too, exactly to what extent that program is up and running. My impression of it, it's still relatively small scale and only viable at the moment because it works closely with ANSTO, but having ANSTO fairly close to New South Wales is a synergy.

If I was still at the ANU, you know, the connection between the ANU and ANSTO is still similarly strong. The ANU, as I said, has had a long history of nuclear physics. The master in nuclear science program that was probably created 10 years ago is still running and it's had students continuously, so that's now got some rungs on the board in terms of longevity there. That could also be a place to do it. Adelaide would not be out of the question, or the Adelaide universities, because there's three at least, if not more, in the Adelaide region, because they would have the combination that you require of fairly strong engineering department, reasonably good capacity in the biomedical, reasonably, well, very good capacity in physics as well. So, you know, again, there would be no reason why a university in Adelaide couldn't run with it either actually.

Similarly any of the Group of Eights, as I said, a number of universities in Queensland, UQ QT, as institutions able to combine engineering at a sophisticated level with the other health dimensions societal research domains, all of those have the capacity to do that. So there wouldn't be a dearth of institutions where you could deliver these courses from. The Dalton model is a good one in that it drew capacity from different universities. Now, the circumstance in the UK, I think, is actually different. The geographical spread that we have in Australia is always a challenge for just about everything. Dalton was able to bring, and I forget exactly how many, but at least five, if not 10 institutions together focusing on delivering education.

That's more and more possible these days. Most institutions are providing short-term or distance components or both into their education delivery. So the notion that you have to go in person to an institution all the time to access educational training is actually one that's evolving very quickly within universities. So again, both models are possible relatively straightforwardly within the Australian system.

As I say, the UK has an advantage that the geographical separation of institutions is not as strong. That facilitates, in some sense, cooperation. It's a little bit harder but not impossible in Australia either. So you could develop, I think, with a bit of goodwill a consortium of institutions in Australia that would probably necessarily involve ANSTO as well as two or three or four institutions in Australia to deliver really high quality nuclear course that could

touch all dimensions of the problem.

MR JACOBI: I just want to pick up the other aspect as well, which is the potential for connection with industry, and I'm interested to understand the extent to which it was possible within the ANU program to provide connections with industries so that those students who were graduating had a connection and experience of the relationship to the workforce that they were about to enter.

PROFESSOR BYRNE: Yes. So again, the ANU - and I don't have the exact numbers, but I suspect the average number of people in that course is probably, you know, the five to 10-ish number. If I characterise that, half of them would probably have been international students. They come attracted to this course and the learning environment and the high quality education system we have in Australia. A good, probably, third of the others in that system actually come from the government sector, so people sitting within the bureaucracy of government. So they are already deeply embedded in half of the employers of people that would come out of these programs.

I think if you think about what is needed in terms of education and what parts of the sector need highly skilled people or people with an understanding of some of the skills required, there are obviously two tracks: one is people who you would want to have in the regulatory and licencing part, and the other that you want to have in the operational part. The course at the ANU, because of where the ANU sits, in some ways was attuned more to that regulatory side and there are a good number of people from departments that did have an interest in the nuclear and the nuclear issues in the broad, and that's nuclear and nuclear security. They were deeply connected into that part of the cycle.

Now, because there isn't the other side of the industry in Australia, much less connection. Some of the people did go in, I think, to ANSTO and so on. So that was there, but there isn't, you know, really a nuclear industry in Australia outside of the mining industry and they were keen to pick up graduates through earth sciences, geology programs, rather than this one in particular.

MR JACOBI: Just two more things. The first was in terms of thinking about where the skills might need to be. I'm interested to understand whether in Australia, perhaps in related areas, there have ever been skills audits or an analysis of the sorts of capabilities that might be required that you might be able to point to and say, "Look, that's a good example of the way to think," about thinking about building educational capacity might be relevant to future industry needs.

PROFESSOR BYRNE: Look, I can't off the top of my head. I think there have been some skills audits, but I - certainly not particularly, I think, in this

area, not that I'm aware of. I think it might be well worth - I'm sure your people have done it - to go back to the (indistinct) review and look at what they did there, because I'm pretty sure they did look at the skills requirement for the nuclear industry back then, but that's a hazy recollection.

MR JACOBI: Can I just pick up, finally, the issue of time frames? Based on your experience with the ANU program, I'm interested in your view about the sort of periods of time that you require to establish a viable graduate level program that might be of substance so as to be able to supply skilled postgraduate students to industry.

PROFESSOR BYRNE: So my experience with the master of nuclear science course, we got that up in relatively short order, which really means we got it up within about a year. But that's a different question than the one you asked. So you can get a program on the books and running within a university system within a year in most places, and we did that comfortably with the master of nuclear science. What is more difficult is to have it as a credible program, and to have a credible program you need a bit of longevity in the program. You need to have people have confidence that the graduates who come out of that program have skills that are desirable and are at the right level, and actually, if you start from scratch that's very hard to achieve in a short time.

Clearly, the students have got to finish. So your minimum is the duration of the program, and really you want masters programs to be, I think, two-year masters programs. The ANU one was a one year one, but most people did it part-time and stretched it over a longer time. So that's a minimum. So if your program is a two-year program you can't get it up any shorter than two years because no one has gone through it. You need some quality control. You need to make sure that it's robust against the changes in personnel that you have, and all of these programs will have changes in personnel.

So if I was trying, in a general sense, to look at programs to determine have they got over that initial boom that you get when you create a new program, that's having a program with a longevity of five years, and after five years you've had a couple of cycles of graduates; you've dealt with the first change of personnel in the system in terms of the lecturing staff and so on; you've got the course program probably down pat; you know where the weaknesses are; you've addressed the weaknesses; and then you have a program that you can probably say that you've got a fairly robust program that can actually deliver what the community wants. That's five years. That's probably the answer to your question.

Now, that's from a program from almost zero or building on other programs. If you start with a program that's already there and you have to launch out into some specific areas and you have to coordinate back and pick up people in

different areas - say, for instance, if you want to pick up reactor engineering and set up a program that puts out graduates who have some real experience in reactor design. That too might take longer, because that says do they have the prerequisite skills that they would get through an undergraduate program that may not have thought about some of the issues around reactor design.

Now, a lot of the things that you think about in terms of reactor design, as I said earlier, are core parts of an engineering program: how do you build fail-safe systems; how do you have process control? All of those things. But if you're building something that you're relying on these people to own and operate, that requires, again, coming back to my baseline criteria. The minimum time is the duration of the program plus a little bit. So you really will want, if we are to go down this route, to have those underpinning engineering programs with a slightly stronger dimension, or at least some of them addressing more sharply issues around nuclear engineering as opposed to general civil or general electric, and then it's the total program time plus a little bit.

So that would be a three or four-year engineering program - and many engineering programs in the country are four-year programs - plus the capstone which brings in the other dimensions of the nuclear problem. So that's a five, six-year one. So again, you're talking about a little bit longer before you have those people onboard. Now, having said that, that's the build time of a reactor, right. I mean, you're talking a decade in planning, design, or longer, before you could have a reactor working. So a decision made in the country to proceed with, say, a nuclear reactor would be the time cycle you would have to have people onboard in a pipeline sense.

Now, clearly, you need people onboard sooner than that, both within the build program - you need people onboard sooner that within the regulatory side. There are some people in the system on the regulatory side already. The signal to go will be a few years before the actual go point. There probably would be enough time in the system to start ramping up at the appropriate level. So when you get to the point where you need those people there and pipelined, the education system can probably adapt in an appropriate time.

MR JACOBI: I just want to pick up on that. In terms of – you talked about the position to go. How significant is the commitment of the government to the education sector being able to deliver a particular outcome?

PROFESSOR BYRNE: Look I think it's critical. Universities are reasonably responsive institutions will move in to a particular space if they see a market. But for a market to be created, it requires positive decisions of government to proceed in a particular area. You know I think the master of nuclear science – so if you look in the past history perhaps of courses that are around the system,

there was a course designed a bit after our course at the ANU and the University of Sydney which had a stronger focus on medical physics. I don't think that exists any more as a nuclear science or nuclear programme at all. The programmes that sort of have remained are ones around nuclear medicine and I think Adelaide indeed, or South Australia certainly – Adelaide runs a programme on nuclear medicine, so those programmes have a different market if you like, that is in radiology those sorts of things. That is another interesting model if you like; I mean what is the demand in the country for people trained in nuclear medicine? There is a strong demand in hospitals, it's small but it's strong and there are a number of institutions. So Adelaide, Sydney and so forth that do nuclear medicine, those ones have had a longevity because there is a constant demand because there is obviously not just a government commitment but there is a commitment to radiology in hospitals.

So when there exists an articulated position that the university system can see as providing longevity, the system will move in to that space to provide the training, facilitated potentially by scholarships to give assistance to students. So attracting the students is an important part of what the universities do but if it's an environment where it's a stop start or no – or an ambiguity about whether things are going to go ahead, most universities will be very, very reluctant to commit too many resources in to creating programmes because they just don't see the demand materialising. Then of course they will graft it on to other ones where they can. But unless there is a deep commitment to going down that route, they will wither fairly quickly, I would imagine.

COMMISSIONER: Professor Byrne, thank you very much for your evidence this morning. Very much appreciate the time you have devoted to this.

PROFESSOR BYRNE: Been a pleasure. I hope it's helpful. Thank you very much.

COMMISSIONER: Was indeed.

PROFESSOR BYRNE: Thank you.

COMMISSIONER: We will now adjourn until 09.30 when we will have Mr Ross Miller from the Australian Nuclear Science and Technology Organisation.

ADJOURNED **[8.43 am]**