COMMONWEALTH OF AUSTRALIA

Official Committee Hansard

HOUSE OF REPRESENTATIVES

STANDING COMMITTEE ON INDUSTRY AND RESOURCES

Reference: Developing Australia’s non-fossil fuel energy industry

THURSDAY, 8 DECEMBER 2005

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HOUSE OF REPRESENTATIVES

STANDING COMMITTEE ON INDUSTRY AND RESOURCES

Thursday, 8 December 2005

Members: Mr Prosser *(Chair)*, Mr Hatton *(Deputy Chair)*, Mr Adams, Mrs Bronwyn Bishop, Mr Cadman, Mr Martin Ferguson, Mr Haase, Mr Katter, Miss Jackie Kelly and Mr Tollner

Members in attendance: Mr Adams, Mr Cadman, Mr Haase, Mr Hatton, Mr Katter, and Mr Prosser

Terms of reference for the inquiry:

To inquire into and report on the development of the non-fossil fuel energy industry in Australia.

The Committee shall commence its inquiry with a case study into the strategic importance of Australia’s uranium resources. The case study shall have particular regard to the:

a) global demand for Australia’s uranium resources and associated supply issues;

b) strategic importance of Australia’s uranium resources and any relevant industry developments;

c) potential implications for global greenhouse gas emission reductions from the further development and export of Australia's uranium resources; and

d) current structure and regulatory environment of the uranium mining sector (noting the work that has been undertaken by other inquiries and reviews on these issues).

WITNESSES

Committee met at 11.36 am

BLACKWELL, Dr Boyd Douglas, Facility Director, Plasma Research Laboratories, Research School of Physical Sciences and Engineering, Australian National University

HOLE, Dr Matthew John, Chair, Australian International Thermonuclear Experimental Reactor Forum

O'CONNOR, Professor John, Spokesperson, Australian International Thermonuclear Experimental Reactor Forum

CHAIR (Mr Prosser)—I am pleased to declare open the 11th public hearing by the House of Representatives Standing Committee on Industry and Resources for its inquiry into developing the non-fossil fuel energy industry in Australia. The committee has commenced the inquiry with a case study into the strategic importance of Australia's uranium resources. The inquiry was referred to the committee by the Minister for Industry, Tourism and Resources, the Hon. Ian McFarlane, on 15 March 2005.

The committee is pleased to welcome representatives from ITER Forum to the hearing today. Thank you for your submission. I understand that you wish to give a brief presentation. Although the committee does not require you to give evidence under oath, I should advise that the hearing is a formal proceeding of parliament and remind you that the giving of false or misleading evidence is a serious matter and may be regarded as a contempt of parliament. I also remind you that the committee prefers all evidence be given in public. However, at any stage you may request your evidence be given in private and the committee will consider that request. I invite you to proceed with your presentation before we move to questions.

Dr Hole—Good morning, Chair, members of the committee and guests. I am a plasma physicist and engineer at the Research School of Physical Sciences and Engineering at the Australian National University. I am also chair of the Australian ITER Forum, a group of multidisciplinary scientists and engineers from several Australian research institutes, presenting the case for Australian involvement in the next step fusion experiment—the international thermonuclear experimental reactor.

With me today are Dr Boyd Blackwell, director of the H-1 National Plasma Research Facility and Professor O'Connor, professor of physics at the University of Newcastle. I am here today to explain to you the principles of fusion energy, which offers the world a near zero greenhouse gas emission base-load power supply, capable of sustaining civilization for millions, if not billions of years.

The Australian ITER Forum comprises over a hundred scientists and engineers who support a single mission-orientated goal: controlled fusion as an energy source. ITER Forum scientists are drawn from five universities and ANSTO, and span multiple research disciplines: plasma physics, development and analysis of advanced materials, and surface physics, through to atomic physics. Both the research disciplines and the research institute list are growing.

Thermonuclear fusion is the combination of two lighter nuclides to form a heavier nuclide. The process is the exact opposite to fission, in which a heavier nuclide splinters into lighter products. The easiest reaction to initiate is the combination of a deuterium and tritium nuclide to form a stable helium nucleus and an energetic neutron. The energy output of fission and fusion is millions of times greater than that of coal.

Fusion is the process that powers the sun and the stars. In the sun, gravity is sufficiently strong to overcome the repulsive force between similarly charged ions. On earth, gravity is too weak, so instead the material has to be heated to 100 million degrees centigrade. To constrain the material at such high temperatures we use strong magnetic fields. The most advanced magnetic confinement geometry is the tokamak, a doughnut-shaped vessel in which the plasma resides. The plasma is kept confined along lines of magnetic force. In essence, these act as a thermos flask, keeping the plasma hot.

Magnetic confinement fusion is intrinsically safe. There can be no chain reaction, explosions or meltdown. At worst, a loss of magnetic confinement will damage the first wall of the system. Magnetic confinement fusion cannot be used as a weapon or in weapons development. Fusion is also environmentally and politically friendly. The fusion process itself generates zero greenhouse gas emissions. Greenhouse emissions are totally derived from the construction and processing of materials and fuel used in the reactor. Unlike fission, the products of fusion are not radioactive. Rather, radioactivity is generated indirectly by neutron activation of the first wall and vessel structure.

Compared to fission technology, fusion offers low-level radioactive waste. Figure 1 on slide 5 shows the radioactivity per unit power generation of fission and fusion power plants following facility decommissioning. Even employing present-day ferritic technology in the vessel structure, a fusion power plant is 3,000 times less radioactive than its fission equivalent 100 years after shutdown. Indeed, within one human lifetime the entire fusion power plant could be completely recycled. Using future vanadium alloy structures, fusion is a staggering one million times less radioactive after 30 years than fission.

Turning to slide 6, the fusion fuels deuterium and tritium are abundant. Deuterium is present in water—indeed, in this jug of water lies the equivalent of 800 litres of oil. Tritium does not occur naturally and must be bred by neutron activation of lithium, a mineral of which Australia has four per cent of the world’s resources. Even using the most extravagant world energy use predictions, there is sufficient D-T to power the earth for tens of thousands of years. This is beyond civilisation time scales. Using a next generation fusion reaction—a deuterium-deuterium reaction—there is sufficient fuel to power the earth for millions of years. Australia is also well endowed with many of the advanced materials used in the construction of a fusion reactor. These include the structural elements vanadium, tantalum, titanium and zirconium and the superconductor niobium. Rather than being sold in their raw state, these elements could be value added by processing and component manufacturing.

Slide 7 shows that conceptual designs for a fusion power plant have many similar characteristics to other base load generation schemes. The heat of reaction is converted to steam, which subsequently drives an electric generator. Figure 2 on slide 8 shows the spectacular progress towards fusion power over the last 40 years. The fusion performance measure is a normalized product of pressure and confinement time. The ITER objective is relatively close to current results, compared to the progress already made. In fact, progress in fusion has outstripped Moore’s Law, the famous rapid growth rate of the semiconductor industry. ITER only needs the equivalent of the improvement from a Pentium to a Pentium 4.

The next step in fusion energy is the International Thermonuclear Experimental Reactor—ITER. In Latin ITER means ‘the way’. ITER is a 500 megawatt fusion experiment designed to explore the burning plasma regime, where the energetic products of reaction self-heat the plasma. Put in perspective, one of Australia’s largest coal fired power stations, Eraring, has four 660 megawatt generators. ITER is hence comparable in size to a medium-sized coal fired power plant. The plasma will sit in a cylindrical tank 60 metres high. Inside, the entire vessel will be cryogenically cooled to permit operation of the superconducting magnetic field coils. At the plasma core, the central ion temperature will approach 100 million degrees centigrade, nearly seven times hotter than the core of the sun. At 837 cubic metres, the plasma volume approaches the volume of an Olympic-sized swimming pool. Finally, nearly 70 megawatts of externally injected heating will be used, which equates to about a million light globes. It is difficult to see, but at the base of that figure on slide 9 there is actually a person, for reference.

The ITER project has three principal objectives. Programmatically, ITER will demonstrate fusion energy for peaceful purposes. Indeed, ITER is a preprototype power plant and the last large-scale fusion energy experiment en route to power production. Physics objectives include an exploration of the burning plasma regime, where the products of reaction self-heat the plasma. Whilst we understand the principles of magnetic confinement and are confident that ITER will meet its objectives, there are unresolved physics issues which will affect the design and performance of the power plant. This research also has an impact on other laboratory and natural plasmas.

ITER will demonstrate the integration of technologies and address the crucial materials issue. The first wall in ITER has to withstand massive heat flux and neutron damage. Over the lifetime of a power plant, every single atom in the first wall will be displaced over 100 times by a high energy impact event. This is a research field in which Australia has ripe expertise upon which to build.

ITER is also a growing consortium of nations and alliances, comprising the European Union, the US, Russia, China, South Korea and Japan. Indeed, on Tuesday this week India became the seventh full ITER partner. Brazil has expressed interest as a minor partner, and negotiations have commenced. The ITER partners are anxious to formalise the ITER legal entity and commence construction in Cadarache in the south of France. Once the ITER legal entity is formalised and contracts are awarded, additional minor partners will only be able to enter the ITER project under the terms of that legal identity, with diminished benefit to the minor partners. Hence, this window of opportunity is quickly closing.

Barring the international space station, ITER is also the world’s largest science project. The construction and 10-year operation costs are respectively, in Australian dollars, $10 billion and $6 billion. Over 80 per cent of these construction costs will be ploughed directly back into industry. Whilst the costs of research seem high, in other developed nations such as the US they represent approximately one per cent of the energy consumption bill. Finally, to give a sense of international perspective and importance, ITER is ranked as the highest funding priority by the world’s largest physical sciences research body, the US Department of Energy.

The ITER experiment will start to produce results in 10 years, enabling the construction of a demonstration reactor—DEMO—in 2025. In turn, this will allow the first commercial power plant in 2050. By 2060 we envisage 10 plants operating and by the beginning of the 22nd century about 1,000—this is roughly 20 per cent of global electricity. Whilst these time scales might seem long to us, they are in fact short in energy research and development terms. Assuming carbon sequestration can be made to work, it will likely be 100 years before hundreds of coal fired power stations in China are replaced. Development and significant deployment of the production and distribution structure for the hydrogen economy will take decades. On this note, we note that the hydrogen economy will double CO_2 emissions unless a greenhouse friendly base load power supply is used.

Australia has an impressive history of fusion research. Indeed an Australian, Sir Mark Oliphant, discovered the fusion process in 1934 via the same reactions that will be exploited in a fusion power plant. In 1946 a graduate of the University of Sydney, Peter Thoneman, pioneered early fusion research in the UK. In 1958 Sir Mark Oliphant commenced plasma physics research at the ANU. Since 1964 fusion research in Australia has grown across multiple institutions and made important contributions to the world fusion program. One of these, the spherical tokamak, now one of the world's leading confinement configurations, was pioneered by Flinders University and ANSTO. To preserve and grow the fusion program, fusion science needs to be a national research priority. That it is not a research priority is inconsistent with the research orientation of nearly every other advanced nation on earth.

The benefits to Australia through growing an ITER engaged fusion research program are multifold. Fusion energy promises an abundant supply of energy. Combined with the translation to electric transportation, it offers Australia and the world energy independence from oil and an end to the geopolitical instability brought by concentrations of oil. While the overall goal is farsighted, with horizons of 20 to 40 years, economic pay-offs will commence immediately. Nearly 80 per cent of the construction costs of ITER will be delivered straight to industry through industrial contracts.

Most importantly, we have essential resources which will be in demand for the construction of fusion machines. We can increase our benefit from these if we actively work to value add, rather than selling them in their raw state. Australia has world significant resources in lithium, vanadium, tantalum, titanium, zirconium and niobium, all of which will play a part in this energy future. Research findings will bring scientific and industrial benefits immediately, which will impact not only on fusion research but on other forms of energy production and on raising essential skill levels in this future field of technology. Australian graduates are highly sought by the world's large fusion laboratories. Hence, a domestic fusion program is essential, to preserve and grow existing competence. Fusion energy is a near-zero greenhouse gas emitter which provides base load energy generation. As such, it is also a responsible investment course to counter the real threat of global warming. Finally, ITER, by definition, is an international research project and so builds upon and fosters international research links. Through ITER, we would be able to build Australia's scientific credibility and consolidate Australia's position within the IAEA as the most advanced nation in atomic energy in our region.

The next figure shows Australia's past and projected electricity generation capacity as appearing in the federal government's energy white paper. Over a 40-year time span, the relative components of each energy sector remain more or less unchanged. Renewable energy contributes to about eight per cent of total supply. Fusion energy offers future base load power generation. It has an energy density sufficiently high to power modern civilisation and industry, as well as providing power grid stability. Magnetic confinement has the following three additional benefits: zero nuclear proliferation, very low-level radioactive waste and a universal abundance of fuel.

In closing, we support the development of alternative energies but, as part of that strategy, we need solid base load generation which has low greenhouse gas emissions. In the long term, the prime candidate for this role is fusion. A responsible low CO_2 emission energy future requires investment in a blend of nuclear and renewable power technologies. Fusion provides not only an endless source of energy for our civilisation but an endless range of opportunities for Australian science and industry, if we embrace its opportunities early enough to remain competitive. The ITER project offers a path forward to access these opportunities. The window of opportunity to maximise Australia’s competitive advantage is, however, closing as I speak. For this reason alone, involvement in the ITER project needs to be urgently addressed by the Commonwealth.

In summary, the Australian ITER Forum has a vision for the future which promotes sustainable and responsible economic growth and fosters creation of a fusion energy industry through research. We have two recommendations for the committee to consider: firstly, that Australia negotiates a subscription to ITER as a matter of urgency and, secondly, that a national or international research centre be established to consolidate Australia’s research efforts in fusion related research. Ladies and gentlemen, thank you very much for your attention.

CHAIR—Thank you for that. What sorts of dollars are attached to the subscription you just referred to?

Dr Hole—The full subscription component, as stipulated by the ITER partners, is 10 per cent. However, Brazil is discussing with the ITER partners the possibility of engaging with ITER while subscribing a significantly lower fraction than 10 per cent—perhaps something in the order of one per cent.

Dr Blackwell—Or perhaps even less.

Dr Hole—In fact, Brazil is now discussing with the ITER partners the possibility of joining ITER with the supply of niobium at reduced rates forming part of the subscription component to ITER. So, if you use one per cent as a figure of estimate, I guess one per cent of $6 billion in construction is about $60 million. If you spread that over 10 years, you are looking at something of the order of $6 million, possibly less, depending upon the engagement with the ITER partners and the offsets, perhaps, through mineral resources.

Mr HATTON—That was a fabulous presentation. Thank you very much. The time frame is a bit long for us. We think we will probably be finished with the committee by then, unfortunately—we would like to be around to finally get that commercialised. This is a tremendous rate of growth—your argument that it has outstripped Moore’s law. How much could it be sped up, or do you think it is pretty much within the framework that it will take until 2050 to go commercial?

Dr Hole—Professor Goldstein, who is a director of Princeton Plasma Physics Laboratories, was asked the same question when he was out here recently. His answer was that fast-tracking the ITER program is really a matter of political will. ITER is an expensive experiment, and getting it to the point where it is at present required a great deal of negotiation between the various international partners. Being able to bring it to fruition is in part an issue of political will. The opportunities for fast-tracking are certainly there, I guess, but it is in part a political issue.

Prof. O'Connor—The track to ITER and the total expenditure were established many years back. If that expenditure had been placed in the path at the time, we would be there now, so, yes, it is a rate of expend. The difference between fusion and fission was that fission had other imperatives, great investments were made in it and it was developed rapidly. Fusion could still achieve the same rapid growth if there were an increased rate of spend. So ,yes, there is a capacity to increase the rate.

Just to come back to a point raised earlier, you were talking about the duration—not seeing this to fruition. That may be the case, but many of the benefits will flow almost immediately. The first wall is one of the most hostile environments you can find. Research into that area will immediately have impact on aerospace, coal fired power stations and solar powered stations. So we have the potential that, while we are pursuing this long-term goal, we will get very immediate pay-offs.

Mr HATTON—That is interesting. While fusion has always been the fundamental grail, we could have been there if there had been that will and capacity?

Prof. O'Connor—Yes.

Dr Hole—That is true.

Mr HATTON—So it was not the scientific problems that were the fundamental keys; it was lack of desire to drive towards it. I had always understood that it was not possible, simply because there were too many scientific problems to overcome.

Dr Hole—The real barrier is political will. There are science issues that from time to time perturb the ITER design—that occurred a number of years ago with respect to turbulence; that was a science issue that modified the ITER design—but the primary hurdle to bringing fusion to fruition as a commercial power plant option has been political will.

Mr HATTON—To get to the demo phase, I imagine the areas you are probably most interested in, given what you have presented, are the metallurgical problems in the first wall and the fact that withstanding the neutron damage and the rest of it has not been done before, except on a smaller scale. Even though this is a new area, does Australia have a base load capacity of expertise in the area that can be drawn on?

Prof. O'Connor—The first wall is a very hostile environment, as you say—100 displacements per atom. It is actually an expansion on what we know, because within a nuclear reactor the same sorts of displacements are occurring, so we are building on a body of knowledge. We are not coming from zero. There is already a standby first wall, which is perhaps not perfect, but they will certainly use it. We have the capacity in Australia to explore new areas.

One that we are particularly interested in is a class of alloys called MAX alloys. These satisfy the requirement of low-neutron activation, which is ideal. They have some great properties. They are only about 10 years old as a class of material, so there is a lot that we do not know about them, but what we do already know indicates that they are a very promising line for research. They may not be the ultimate end point, but we need to invest in research in this area to see what it leads to in terms of even richer forms of alloys that may be the first wall. To go with what we have at present is a make-do effort. Australia has the material science expertise to make a contribution. We have made a contribution in the past in terms of radiation damage and iron surface interaction. Australia has had a strong history in that area.

Mr HATTON—Most of that has come from ANSTO, I imagine?

Prof. O'Connor—There has been a strong collection from there, but even at my university, the University of Newcastle, we have a unit which is plasma-wall interaction basically—it is low-energy ion bombardment of solids. The ANU has experience in this area. They are looking not just at fusion itself but at the fundamentals of the bombardment of solids by high-energy ions. So the broader range of radiation interaction with materials has been studied in a number of different places—it is also being studied presently at the University of Melbourne. So we have that spread around a number of places.

Mr HATTON—Australia has been slow off the mark in investing in a range of scientific programs, including a number of telescope programs over time—we eventually got in just at the last bit. What has happened? How many steps has the government taken? Has it shown any likelihood that it will grasp this opportunity before it goes?

Dr Hole—We have presented the case for Australian involvement in ITER and expansion of the fusion energy program to the Department of Industry, Tourism and Resources, the Department of Education, Science and Training and the Department of the Environment and Heritage—and we have briefed the Department of Foreign Affairs and Trade. To date, those meetings have been quite productive. I guess the central issue that those departments felt was that they were unclear about the mechanisms of engagement. In terms of what we are doing to try and engage Australia in the ITER project, we have put forward an international science linkages proposal to invite the ITER partners to Australia to discuss a possible engagement in ITER and formulate a research policy. That invitation was sent to all of the ITER negotiators at the time. Russia, the European Union and Japan replied positively to say they were interested in attending and we had expressions of interest from the other ITER partners. One of the questions they had was about whether or not these are government-to-government negotiations, because ITER is a project that is driven at the very highest levels of government overseas. We are a research community and there was a question as to whether or not the right interaction was between our research community and government. An Australian response to ITER really needs to be from the whole of government.

Mr HATTON—And we have not had that yet?

Prof. O'Connor—Can I add that there is no clear mechanism whereby we would fund a subscription. One might consider, say, NCRIS, but NCRIS is not quite in the same class. So one of the difficulties is to identify the mechanism, and this is really where the government needs to take a lead. We cannot identify any pot of money that would normally be used for this subscription, but there is an opportunity there. We can identify funds for recommendation 2, which is to bring together an international centre—and that is under the ambit of the ARC—but on the first recommendation we see an impasse and we are looking to the government for guidance.

Mr HATTON—But also if the government did not want to do an up-front 10 per cent of costs—if they wanted to do what Brazil is doing—if we have four per cent of the world's lithium, as compared to 40 per cent of the world's uranium, and if we have niobium and tantalum, we could do an in kind deal with that as well, couldn't we?

Dr Hole—We certainly could, but that would require negotiation between government and the ITER negotiators. It is something we would like to bring to the attention of government, but we feel that that level of interaction really needs to come clearly from government.

Mr ADAMS—With the politics of oil in the world and the politics of the present energy and nuclear fuel—energy from that source—I would have thought the United States of America and a few others would be very keen on this project and would pursue it really strongly. Is that the case?

Dr Hole—That is the case. In fact, the reason the Department of Energy, which is the world's largest physical science research body, has given it the highest priority is that the US President instructed it to do so—to give it the highest priority. So they are taking it very seriously.

Prof. O'Connor—And they are funding ITER.

Mr ADAMS—That is good. I do not know why we are dragging the chain to get in there. As you said, John, there are some pretty good spin-offs from it. Do we mine this stuff already in other processes or do we need new mines to get it out?

Dr Hole—Interestingly, one mine in Western Australia already produces 60 per cent of the world's lithium in a mineral form. Several of those mines, at least for fusion fuels, are already in place.

Mr ADAMS—What forms other than metal does lithium come in?

Prof. O'Connor—It is also extractable from brine; there are brine sources as well.

Mr ADAMS—From brine?

Prof. O'Connor—Lithium brine—extreme salt solutions.

Mr ADAMS—So we need new money made available to this, in that sense?

Prof. O'Connor—The issue would be that, if a subscription were put forward, that money would flow back to Australia. So the demand would be there for lithium or titanium or whatever they want and that money would come back via subscription.

Mr ADAMS—Is the process that our departments do not understand it—or is it too big for them? Is there anyone in there who has a grasp of it?

Dr Hole—The departments have become aware of the situation and, to their credit, they are beginning to address it. Part of the problem is that fusion does not clearly fit under the auspices of any one government department. Elements of the policy fall under the Department of Industry, Tourism and Resources, elements fall under DEST, elements fall under DEH, and there is even a Foreign Affairs component. So it really needs a whole-of-government response.

Mr ADAMS—So basically no one department can put together a submission to the cabinet?

Prof. O'Connor—Not at this stage.

Mr ADAMS—I understand that. Thank you.

Mr HAASE—It is a remarkable concept. I am no scientist, but that impresses me no end. As you would be aware, we have looked at energy issues in the past. I, for one, have looked in some depth at renewable energy in the form of tidal power, and I suffer the derision of all of my colleagues because of that.

CHAIR—With some exceptions.

Mr HAASE—With some exceptions, of course—

Mr HATTON—Anyone else proposing, it would have been all right.

Mr HAASE—Thank you, colleagues. Among the questions that come to mind is one about the ratio of construction costs to energy output. I would like you to comment on that. You mentioned the possibility of putting a deal together where we participate in kind, so to speak—but immediately I think we are not in a state-owned situation in this nation. The materials that we are speaking of are owned by private shareholders and there would have to be some new style of thinking—some new model—to go further in that pursuit. Finally, I am wondering whether you might cite some existing example of a strategy like this and the international consequences of international cooperation in the development of new things. There is a space station that comes to mind; but, to my knowledge, Australia has no involvement with that. I am wondering whether you could give us an example so that we could perhaps imagine the cooperation required to achieve that and how it might be replicated. There is a fair load for you.

Dr Hole—Perhaps if I could answer your first question which I think demands some indication of what the costs of electricity per construction costs are. This topic has been actively modelled by researchers overseas—and this data is taken from the United Kingdom Atomic Energy Authority. You can see from this slide a combination of internal costs—which are the costs of constructing, fuelling, operating and disposing of a power plant—and the external costs, which are the estimated impact costs to the environment and public and worker health. If you look at the first plot, which shows internal costs, you can see that they are across a range of different technologies. The important point to note is that the internal costs of fusion are comparable to those of fission. These are projected costs for when a fusion power plant does come on line—and coal for that matter.

If you look at the external costs, fusion is very attractive. It has a similar impact to wind—and, of course, perhaps the largest single most expensive cost is coal. So, in answer to the first question about whether fusion energy will be economically competitive, the answer is yes.

Prof. O'Connor—In your question about whether there are other models, I think there are a range of other models. I think you mentioned astronomy earlier, and we are part of international consortia there. But I also understand that Australia subscribed just recently to an international tourism agency to promote tourism as well. So there are other models whereby subscriptions to international bodies gain access to increased exposure or increased output. So I think we can certainly identify models that would be comparable to this, but unfortunately this does not fall within the one category. For instance, astronomy really tends to fall into research, which is DEST, and tourism falls into another single category. The fact that this is across several is the complication.

Dr Blackwell—It is a much bigger project than anything else. Energy is by far the biggest economic sector. If we do not do something about it, it will have dire consequences for the world, one way or another. You could even put it on a scale with the industrial revolution—realising that we have to do something about the future of the earth, the temperature and future energy sources.

Mr ADAMS—But isn't this a globalised approach as well?

Dr Blackwell—It is very—

Mr ADAMS—Getting this together is a sort of new world, with what we are doing with universities coming together from one country to another and that sort of thing, isn't it?

Prof. O'Connor—This has the leading countries there. There is Russia, China, Japan, the USA and Europe.

Dr Blackwell—Over 30 leading countries, not including Australia.

Mr HATTON—In your slides—and you have repeated it in your evidence—you say that this has the highest priority in the world, because, you said, George W Bush had made it so. He had decreed that that was what he wanted done. How well informed was he?

Prof. O'Connor—He was not the first person to push it. In fact, the original contract for ITER was signed by Ronald Reagan, I believe, with Gorbachev. So it has not been just George W Bush; it has been Ronald Reagan, Bill Clinton and George W Bush. So it has actually had a history of getting very high-level support.

Mr HAASE—Okay. So you would be familiar with the SKA project—the square kilometre array telescope affair?

Dr Blackwell—Yes.

Mr HAASE—That is on shaky ground as far as full Australian participation—finding funds and so forth—isn't it? Do you see any comparisons?

Dr Blackwell—It is pure science, whereas this is a big economic imperative.

Prof. O'Connor—It is very hard to compare this to something that is purely a research project. This has a large research component, which we would certainly like to encourage, but the square kilometre array project is a discovery project, where we are out there looking for new knowledge purely to inform us about where we are in the universe; this is about making sure that we can continue to exist in our universe.

Mr HAASE—That is a fair comment. Finally, what do you know about the source of the West Australian lithium? What do you know about the company and the location? I am not aware of it, and I thought I was the member for mining.

CHAIR—It is a Sons of Gwalia mine.

Mr HAASE—It is yours—that is why I do not know about it. Thanks very much.

Mr KATTER—Where did you source your costings for cost per unit from?

Dr Blackwell—They are taken from research colleagues in the United Kingdom.

Mr KATTER—Is there a document?

Dr Blackwell—Yes. We can certainly provide you with the peer review publication afterwards.

Dr Hole—I have it here, actually.

Mr KATTER—If I could have a copy of that, I would be very appreciative.

Mr HAASE—I would be interested in that.

Mr KATTER—Can I just come back to the point that my honourable colleague from Western Australia took up?

CHAIR—Yes.

Mr KATTER—I really have not heard of lithium before, and I was in mining before I went into parliament—is it a molecular compound or an element? How is it found in nature?

Dr Blackwell—It is the lightest metal.

Prof. O'Connor—It is a very light metal. It appears as a silvery coloured metal, but it is very reactive. You will not find it as a material. Lithium batteries are an excellent example, but lithium is very similar in its chemical properties—

Mr KATTER—I represent one of the biggest mining areas on earth, and I am just wondering where we look for this and what formations have it.

Prof. O'Connor—It is very similar to sodium and potassium in terms of its reactivity, but it does appear in a number of different forms. It appears as minerals, but it also appears in saline solutions.

Dr Hole—Interestingly, another application of lithium is towards antidepressants. It is used actively in that.

Dr Blackwell—And in grease.

Mr KATTER—Is it igneous deposits, sedimentary deposits or—

Prof. O'Connor—You will find it in a whole range. Most commonly you will find it in things which were laid down from salt solutions, because it dissolves very readily. It is actually used in something that has reacted—

Mr KATTER—Julia Creek shale oils have very high vanadium content. Should we be having a look there for lithium?

Prof. O'Connor—I would not necessarily expect it to be there, but I am not an expert in this area so I would not—

Mr KATTER—Cut me short if this has already been covered, but does this work like uranium? You bring enough of it together, you get critical mass and we get heat.

Prof. O'Connor—No.

Dr Hole—It works quite differently. The principle is that, unlike fission, in which you bring together a certain amount of radioactive mass and then it reaches a critical state, in order to be able to fuse two isotopes together, you have to lift them to very high energy. In fact, what you have to do is get them sufficiently close to each other that their electrostatic repulsion is overcome by the strong nuclear force and binds the two nuclei together. In the sun, this is done by gravity; on earth, gravity is nowhere near strong enough so we have to do this by an alternative mechanism. We use magnetic lines of force that confine the plasma and are able to lift it to these temperatures to reach ignition.

Prof. O'Connor—You have to heat it to about 100 million degrees Celsius, but what you are using is not lithium but deuterium and tritium, two isotopes of hydrogen. The reason lithium comes in is that tritium does not occur in any great quantity, so you actually generate tritium from lithium. It is a feedstock.

Mr KATTER—How do you get those hydrogen isotopes out of water?

Prof. O'Connor—Deuterium can be removed physically. It is about one part in 6,000 of the hydrogen that is there. In fact, the energy content of the deuterium that is in that jug of water has the energy equivalent to about 800 litres of oil.

Mr ADAMS—So the energy comes from when they finally—

Prof. O'Connor—when they come together. That is right. It is a bit like burning: you bring two things together and they create something new. Here you are bringing two hydrogen isotopes together and producing helium. That gives off energy.

Dr Blackwell—It is not a chain reaction; there is no meltdown.

Mr ADAMS—But how do you get the heat to that level?

Dr Blackwell—You spend about 40 years doing research. Like a microwave oven, radio frequency heating, microwave heating.

Prof. O'Connor—There are a couple of different mechanisms. That is one; another is to inject a large amount at high energy, but all of these are just low-energy inputs to what is a high-energy—

Mr HATTON—Is deuterium extraction similar to an electrolytic process?

Mr KATTER—That is what I am trying to get at.

Prof. O'Connor—There are a couple of different ways of doing it because, in fact, this was done during the Second World War in Norway. That is where their heavy water came from, because deuterium is a constituent of heavy water. It can be done through electrolytic means or it can be done by physical means. There are a couple of different pathways. The easiest way is electrolytically. You pull off the hydrogen and separate it, but there are other pathways which require less energy.

Dr Blackwell—The point is that the fuel is so rich that the throughput of the separation process does not have to be as high as you might think.

CHAIR—There being no further questions, thank you for appearing here today. It was a very interesting presentation, and I thank you for that. Mr Haase has moved that the presentation slides presented by ITER Forum be received as evidence for the committee's inquiry and authorised for publication.

Resolved (on motion by **Mr Adams**):

That this committee authorises publication of the transcript of the evidence given before it at public hearing this day.

Committee adjourned at 12.19 pm