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, 9 FEBRUARY 2006

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HOUSE OF REPRESENTATIVES

STANDING COMMITTEE ON INDUSTRY AND RESOURCES

Thursday, 9 February 2006

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 Martin Ferguson, Mr Haase, Mr Hatton, Mr Katter, Mr Prosser and Mr Tollner

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 11.39 am

GOLDSWORTHY, Dr Michael Philip, Chief Executive Officer, Silex Systems Ltd

WILKS, Mr Christopher David, Director, Silex Systems Ltd

CHAIR—I am pleased to open the 12th public hearing by the House of Representatives Standing Committee on Industry and Resources for its inquiry into the development of the non-fossil fuel energy industry in Australia. The committee has commenced its 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 honourable Ian Macfarlane, on 15 March 2005.

I am pleased to welcome representatives from Silex Systems Ltd to the hearings today. Thank you for making your time available to appear before the committee. I understand that you wish to give a presentation. Although the committee does not require you to give evidence under oath, I should advise you that these hearings are formal proceedings of the parliament and I remind you that giving 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 that all evidence be given in public. However, at any stage you may request that evidence be given in private and the committee will consider your request. Please proceed with your presentation.

Dr Goldsworthy—Thank you very much for the opportunity to come and talk to you today about the nuclear power industry and in particular the uranium enrichment industry. I am the CEO of Silex. Before we go into the nuclear industry, I would like to introduce you briefly to Silex the company.

A PowerPoint presentation was then given—

Dr Goldsworthy—Our mission is to become a world leader in isotopically enriched materials; in particular, uranium and silicon. We have a unique technology based on lasers that we use for this. I will talk about that a little more shortly. Secondly, we want to become a world leader in advanced semiconductor materials. We have some very exciting projects going on here in Australia and in Silicon Valley in Palo Alto. We are developing optical silicon interconnects for the next generation microprocessor chips and also next generation silicon-on-insulator and high-k materials. It is very exciting work, but today we are focusing on the nuclear industry.

We are a publicly listed company and were founded in 1988. We have a market cap of around $400 million. We have about 5,000 eager shareholders. I will not go through our history—if anyone is interested, our website contains all our history. We have about 40 employees. We are a small company, but we are talented—we have quite a few PhDs and engineers. At the current time, several of our technologies are nearing commercialisation phase. That is the case with uranium enrichment. We are about to scale up to what we call a test loop and thereafter towards commercialisation. At present, we are looking for a new partner for that project.

Briefly, our activities can be broken into two divisions. SILEX technology is the technology that the company was founded on. SILEX stands for 'separation of isotopes by laser excitation'. Well after I formulated that name I found out that 'silex' also means 'silicon' in French. Just about all our other activities have something to do with silicon, so there is a nice synergy there. Uranium enrichment technology was the initial focus of our SILEX laser enrichment technology. That fits into the nuclear industry at the front end—the fuel cycle. Today, the uranium enrichment industry is worth $US5,000 million—$US5 billion.

Our second activity is silicon enrichment at Lucas Heights for the semiconductor wafer industry. This is also measured in the billions of dollars. Our target market is about $1 billion. We are also undertaking work on carbon and oxygen enrichment, which is very important for medical isotope production. These markets are smaller. We have some effort going on there as well. So that is our SILEX technology, our core technology.

We have since invested in two subsidiaries, one in Palo Alto in California, started by a brilliant young Australian scientist from Adelaide. He is developing some revolutionary optical silicon technologies that I referred to a moment ago. They can be broken up into two sections—the optical silicon and the advanced electronic materials. These markets are also significant. The future of the semiconductor industry, the microprocessor industry, and indeed the continuance of Moore’s Law, depends on these types of materials being developed in the next five years. If these types of materials are not developed, then Moore’s Law will come to an end. We also have a subsidiary in Adelaide working on some unique USB based electronics technology. This technology also has a considerable market. So you can see we have some very interesting technologies.

Before we go into our activities in uranium enrichment, I would like to give you my cut on where we are today with energy. Global electricity demand is set to double by 2030—that is an amazing number—driven by the industrial modernisation of China and India. The vast majority of this growth is going to be supplied by coal. It is well established that coal is driving up atmospheric CO_2 levels. Core samples have been taken deep below glacial masses, under the polar caps. Around 1850, before the industrial age, CO_2 concentrations were 280 parts per million. A few years ago, these levels had risen to 370 parts per million.

When we first met our chairman this morning, he commented that in Western Australia they do not believe in global warming because they have had some pretty rough weather. I am here to tell you that no-one can argue with these numbers. These numbers are scientific fact, and we have already embedded a legacy into our climate. Carbon dioxide is driving up global climate change. The greenhouse effect is real. The first thing that greenhouse gases do is to load extra energy into the atmosphere, and this can manifest as a cooling event or a warming event. The gradients of energy are much larger. That is why you see more extreme weather as the planet warms. It is not necessarily going to get uniformly warmer—it will get more extreme.

So global climate change is already embedded and it will only get worse. On top of that, world oil and gas reserves are depleting and fossil fuel costs are rising accordingly. So our energy consumption habits are unsustainable. We must develop alternatives immediately. They are not just my views—they are the views of many analysts, supported by scientific evidence that is covered in many books out there, some of which I am showing now. All these books give a very detailed account of the scientific evidence for greenhouse gas and of the issues, and all uniformly come to the same conclusions.

There is a wide consensus, again, on what the potential solutions are. Firstly, and obviously, we can decrease fossil fuel consumption and CO_2 levels, and there are numerous ways to do that. Secondly, we can increase reliance on nuclear power. This is probably the more controversial path, but that is what we are here to talk about today. Thirdly, we could increase reliance on renewable energies such as wind and solar. There is a big question as to whether renewables can provide baseload grid electricity. There is a big difference between providing peak power and baseload grid power, and I personally do not believe that wind and solar can provide baseload grid electricity.

Next, we can accelerate the hydrogen economy, but there is no point making hydrogen from fossil fuels. Fossil fuel use will need to be scaled back. If we are going to produce hydrogen and use hydrogen to replace oil and gas, we have to use nuclear power—again, baseload grid electricity. There are many who say that the hydrogen economy will not work. I believe that the technology will fall into place when it is time. Last, but not least, we have to improve energy efficiency across the board. We believe that an integrated mix of nuclear, renewables, hydrogen and energy efficiency measures is required and is inevitable.

Australia—if I can just get on my soapbox for a moment—has vast coal reserves. We are becoming known as a major global polluter. We need to develop clean coal technologies urgently. We also have vast uranium reserves, but developing them has been held back by political interference in one form or another. Our view is that we need to develop our uranium reserves urgently. The rest of the world certainly needs our uranium. Regarding renewables and hydrogen, we have had some response but we believe we could do a lot more here. We need to accelerate development of renewables—particularly hydrogen. Hydrogen, I believe, is the future replacement for fossil fuels in transportation.

In conclusion, we have a golden opportunity here in Australia to make some major inroads into these three areas, but I believe we will need a bipartisan energy strategy for there to be a coherent and forceful approach. A unique opportunity for political leadership exists, and I wish the committee all its best in its deliberations and its findings. Hopefully, we can make some progress in this direction.

I turn to the global nuclear power industry. Nuclear power currently accounts for about 17 per cent of the world's electricity supply. It has fallen in the last two decades as there has been a hiatus in the take-up of nuclear power. There are about 440 reactors operating around the world; another 70 or so are being planned or built. This is expected to accelerate dramatically as nuclear power development in Asia accelerates. The big drawcard from an environmental point of view for nuclear power is that it has no greenhouse gas emissions and therefore will not impact the global climate. Apart from that, I believe that on economic grounds nuclear power is a legitimate and much needed electricity source.

Governments and utilities around the world are reassessing the nuclear power option and public opinion is changing. At the end of last week I was coming back from Asia through Singapore airport and found in the current edition of *Newsweek* another big story on nuclear power: 'The return of nuclear power—is an oil-hungry world ready?' This is a very topical issue now. Even in Australia we have noticed a lot more public debate, even at government level, on the future of nuclear power.

Before we go into the uranium enrichment industry from a technical point of view, I would like to touch on the three big issues for nuclear power. These issues have been discussed in relation to Silex by some of our critics. Firstly, uranium enrichment and non-proliferation is a big public issue; secondly, nuclear power reactor safety is also a big issue; thirdly, there is nuclear waste remediation. I will come to non-proliferation in a moment.

Nuclear power reactor safety has been the top priority of the industry ever since it was deployed commercially. The industry has employed world's best practice and has made risk analysis a complete science from which many other industries have benefited. The current fleet of nuclear reactors has been improved steadily and is now operating very reliably and efficiently. There is no long-term safety issue with the current fleet.

Third and fourth generation reactors are being developed. Some third generation reactors have already been built in Japan. These reactors have process-inherent safety features. If the reactor core has an excursion—if it misbehaves—automatically the reactor goes into a failsafe mode, natural forces take over and human intervention is cut out. These reactors are failsafe and human proof. Three Mile Island happened because they mismanaged the remedial process. The actual excursion could have been corrected if they had followed a different procedure.

Fourth generation reactors, which are being developed now—they have not been commercially deployed—go one step further. They are built so that inherently the fuel is configured so that an excursion—an event of misbehaviour in the reactor—cannot even occur in the first place. They shut down before the excursion manifests. Examples are the pebble bed reactor being developed in China and South Africa with some German interests, and the modular high temperature gas cooled reactor being developed by General Atomics in the USA. These reactors will become the future reactor of choice. Reactor safety, I believe, is now not a technical issue. There is a public perception issue, and the industry has to educate the public and governments alike.

Nuclear waste remediation is a very topical subject. Again, the technology has matured for nuclear waste remediation. There are two methods that I know of—borosilicate glass, which is the method that overseas countries are looking at, and a brilliant Australian invention called synroc. You might have heard of synroc—it is being developed by ANSTO. Currently, borosilicate glass is being used in several countries and is going to be used in the US in the future. These technologies involve the permanent immobilisation of the high-level waste inside a solid matrix. The borosilicate glass or the synroc is melted and becomes a slurry. The waste is powdered and mixed all the way through, like salt in a cake mix. This material is then cooled under high pressure. It becomes extremely hard and impervious to water. These bricks of waste matrix are then encased for safe measure. The plan is to place them in deep geological burial grounds.

Successful demonstrations have already been concluded in Sweden. They have a fully operational pilot waste disposal system. There is a very large development in Yucca Mountain in Utah in the United States, which has suffered from lack of government support in the past but is gaining momentum now. I believe that the nuclear waste issue is again not a technical issue; it is political and public issue—the 'not in my backyard' syndrome. Again, the industry needs to educate the public and governments alike.

Turning now to enrichment, our area of activity, the big issue here is non-proliferation. You would all appreciate that if you keep enriching uranium past commercial reactor grade eventually you will reach weapons grade uranium. This is a very significant international issue, especially in the light of activities in Iran and North Korea. There is a big question about who should have access to uranium enrichment technology. We will not go down that path in today's discussion, but I will mention that since 9/11 the world has made some major efforts, led by the US government. The US government has initiated what we call the proliferation security initiative, the PSI. The US State Department website is full of information on PSI. Australia is part of PSI, and many countries are taking part. This will effectively limit access to enrichment technology to current legitimate users of commercial nuclear power.

As far as SILEX is concerned, I would like to make a few points about proliferation. Firstly, laser technology—our technology—is far more complex and sophisticated than gas centrifuge technology. I can put my hand on my heart and tell you today that if a clandestine or renegade government wants to build a bomb they, for forever and a day, will go for centrifuge or plutonium. They will not go for SILEX because it is too complex and too sophisticated. Economically, SILEX is superior, but proliferators are not interested in economics; they are interested in getting the weapons material. This has been proven in the past—proliferators have not bothered with lasers; they have always gone for centrifuges. That is what is going to happen in the future.

So, firstly, we have a clear advantage compared to centrifuge technology in terms of proliferation. I have been working on this technology for 15 years and we still have a way to go, and that is with the support of the US. Australia and the US are the best equipped nations to safeguard the SILEX technology. Australia has a proven track record for the strongest non-proliferation policies. We manage our uranium resource very rigorously through the Safeguards Office. We log all our uranium and it is always destined for peaceful purposes. We have a world-class reputation on non-proliferation. We are also a signatory to the IAEA non-proliferation treaty and we have a bilateral treaty regime in place for anyone we deal with regarding uranium or SILEX technology.

In relation to the SILEX technology, we have a special government-to-government agreement between Australia and the US for cooperation on the SILEX technology. This took two years to negotiate in 1998 and 1999. It came into force in 2000. This treaty, specifically to deal with cooperation on developing SILEX technology, contains the regulatory procedures and the safeguard procedures to which we, and any companies in America that we deal with, have to adhere.

So this is a very comprehensive process to safeguard our technology. I believe that we are the most heavily regulated company in Australia, and so we should be because we have this significant technology. We have been housed inside the secure area of Lucas Heights ever since this project started in 1990 and we have been very effectively safeguarded for 15 years. I know that what our technology is doing is still being guessed at in the highest levels of the uranium enrichment industry. There has been a very effective process of safeguards. I can assure you that the SILEX technology is not adding to the threat or the risk of nuclear proliferation in the world today or in the future.

Now I would like to turn to the uranium enrichment business. It forms a key step in making fuel for nuclear reactors. The first step on the top line here, ‘Uranium mining and milling’, is where Australia is active today. We have the largest uranium reserves in the world but we only mine it and mill it, then we sell it. The steps after that are ‘Uranium conversion to UF_6’ and ‘Uranium enrichment’, upgrading the lesser isotope, the more active isotope, from a natural assay of 0.7 per cent to three to five per cent. You need the extra concentration of the active isotope to make this fuel work in a nuclear reactor. That is process of enrichment. It is very difficult. We are dealing with matter at the atomic, molecular level. That is why any enrichment technology takes a while to industrialise and get up and running commercially. Once the material is enriched, it goes into a fuel fabrication plant and it is made into pellets. The pellets go into tubes and bundles and these fuel bundles are what go into a nuclear reactor producing the heat. The heat makes the steam, drives the turbine and gives us the electricity.

On the next slide we are looking at the nuclear fuel industry and the basic economics of those steps. Nuclear fuel costs are around 30 per cent of the total costs of nuclear power. Here is a breakdown of those steps that we just went through in the fuel cycle. Uranium ore accounts for about 35 per cent of the costs of the fuel. Uranium conversion is a small step—that is, converting the oxide to the fluoride—but necessary because all of today’s enrichment technology uses uranium hexafluoride. This accounts for about five per cent of the costs. The pivotal step is uranium enrichment, which accounts for about 40 per cent of the cost of the fuel, and fuel fabrication around 20 per cent. These numbers bob around a bit as the market price for uranium changes. We have seen a dramatic increase in uranium prices over the last two to three years—they have tripled, essentially. So these numbers have changed during the last three years.

Another interesting impact of increasing uranium prices is that, as uranium goes up, demand on enrichment services increases. By increasing the level of enrichment to produce lower tails assay, this also decreases the amount of ore consumed. So you can extract more from the same kilogram of uranium by increasing the enrichment and throw away less. This has an impact on increasing uranium prices and an increase in enrichment services. Turning that around, if you can develop an enrichment technology which is cost-effective enough, then you could go around the world and re-enrich the tails, or the waste stream, which have not been stripped as much and produce more natural uranium. There will be some uranium-235 left in it; it is a question of how much you leave in it. If you keep enriching you extract more of the active isotope. The bottom line here is that uranium enrichment is key to nuclear fuel economics.

Looking at the uranium enrichment market, today we have about 40-odd million units of enrichment—they are called separative work units, a technical definition. A new report, just released by the World Nuclear Association, has updated these numbers. The outlook is now brighter than it was three years ago. The trend is for growth in the reference case—the pink case. In the upper case, there is strong growth and in the lower case we would see some reactors shut down over the next 20 years.

Mr TOLLNER—What are SWUs?

Dr Goldsworthy—They are the separative work units. That is how we measure enrichment. It is a toll service. Uranium comes into an enrichment plant and it is worked on. This is the separative work that is done by the machinery. The product then goes out and tails—is taken away. It is a toll service and it is measured in separative work units. A separative work unit today is worth about $US115. This translates to the next graph we are showing, where we have the value of the enrichment market today and up to 2030.

Again, there are the three scenarios. I have taken the numbers from the last slide, multiplied by today's price of uranium, and added three per cent inflation—and we get the numbers for the market into the future. Today, the uranium enrichment market is worth about $5 billion. In 2015 it will be worth about $10 billion in the reference case and in 2025 it will be worth about $17 billion in the reference case. Many analysts say that we are heading for the upper case.

If we translate that to the Australian situation, where we do not enrich uranium—we let everyone else make this money at our expense—in 2015, if we assume we are providing about one-third of the world's uranium, the value of enrichment that we could achieve by enriching here in Australia is about $US3 billion a year. By 2025, if we enriched that one-third share here in Australia instead of sending it overseas, that number increases to about $US6 billion or $A8 billion. That is the lost opportunity to Australia from not enriching here in Australia.

Mr ADAMS—How much? Did you have a figure?

Dr Goldsworthy—$8 billion.

CHAIR—$A8 billion?

Dr Goldsworthy—Yes.

Mr KATTER—Does that include the value of mined ore as well?

Dr Goldsworthy—No. This is only the value of the enrichment—the added value of enriching. The value of the ore is worth about that much again. We are making that money, but—

Mr KATTER—How could you know that it would be that in 20 years?

Dr Goldsworthy—In 2025, in one year, we will miss out on $US6 billion, because we do not enrich the uranium here.

Mr KATTER—And that is not including the ore?

Dr Goldsworthy—No, that is just enrichment. That is the added value.

Mr TOLLNER—And that is based on the current projections of the ore we will be exporting by then?

Dr Goldsworthy—Yes. That is based on the World Nuclear Association projections.

Mr TOLLNER—What are we missing out on now?

Dr Goldsworthy—We are probably providing around 10 to 20 per cent depending on the year. So 10 per cent to 20 per cent of $5 billion is up to $1 billion a year in today's market.

Mr TOLLNER—When you say that we are missing out on that, who is ‘we’?

Dr Goldsworthy—The Australian economy. We are selling uranium ore to the overseas countries and they are making this money by doing the enrichment.

Mr TOLLNER—Where does the government factor into that?

Dr Goldsworthy—At the present time, government policy does not permit uranium enrichment in Australia.

Mr TOLLNER—That is right, but in other countries? Where is the incentive for governments to say, ‘We’ll do it in Australia’?

Dr Goldsworthy—Economic incentive.

Mr TOLLNER—We raise revenues and royalties on uranium mining. Is there any plan that government could be raising that from nuclear?

Dr Goldsworthy—Our plan is to take this technology to America and have a royalty stream back to us. Our preference would be to do it here and make all the money, but I do not think that is going to happen in my lifetime. So we are going to have a relationship with an American company or two—hopefully in the near future—and have a royalty stream coming back to Australia on our technology. That is our wish.

Mr Wilks—The benefit of that for the Australian economy is less than if we had a plant and added the value here.

Dr Goldsworthy—I would now like to talk about the supply and demand balance now. In the top section of the graph, you can see the colour red. Those three sources of enrichment are only short term. They are going to go away soon. Areva, the French government consortium, has a very large gas defusion plant, as does USEC, the DOE spinout in America. These plants were built in the 1950s and 1960s. They are first generation technology—they are old—and both these companies have stated their urgency to get rid of these plants as soon as possible.

In the case of the gas diffusion plant in America—in Paducah, Kentucky—to give you an idea of how inefficient this technology is, the one plant in Paducah, Kentucky consumes one-half of one per cent of all electricity generated in the United States. It is incredibly inefficient, and it is leaking CFCs more than any other industrial plant in the world. It has a special dispensatory licence to still operate with CFCs. They cannot replumb it for the new coolants. It is the world’s largest CFC polluter. So there are many reasons why these plants have to be shut down. USEC also obtains half of its supply from Russian HEU material—highly enriched uranium. This is the warhead material that has been blended back down to reactor grade and sold on the American market by USEC. More than 10,000 Russian nuclear warheads have been converted to electricity through this path. That too will go away soon. These three suppliers have to look at new capacity.

In the green section you can see centrifuge suppliers. There are four, and two are active today: Urenco and Tenex. Urenco is a tripartite European organisation; Tenex is the Russian centrifuge organisation. These two companies currently provide about 43 per cent of today's supply, and there are a few other small players. So today we have a balance between supply and demand, but only because of those old diffusion plants still operating.

Mr TOLLNER—What does MSWU stand for?

Dr Goldsworthy—Million units of enrichment. We measure the enrichment service in things called separative work units. They cost about $US115 each. It is very technical to explain what a separative work unit is, but it is a toll service. It takes into account all their operating costs and capital costs.

Mr KATTER—What are GD, HEU and C?

Dr Goldsworthy—That is gas diffusion technology, and C is centrifuge. There is an index at the bottom of the table. Gas diffusion is where they fit in the technology regime. These are the types of technologies that are available today. There is a balance between supply and demand. If you go to 2010, the situation is already looking quite interesting. Areva and USEC want to close those diffusion plants as soon as possible. They would like to close them tomorrow if they could. So there is a question mark on whether those plants will operate. If there is no other supply, then they will have to. They will be forced to keep them open, and they do not make money on that technology now.

Urenco will increase its share a little in 2010. Areva, USEC and a new organisation in America, NEF—National Enrichment Facility—plan to build new centrifuge plants in that time frame. This factors in a contribution from partially complete plants by those three players: Areva in France, USEC and NEF in the USA. Based on their representations of how much capacity they will have, there is a supply deficit of up to 13 million SWU—not counting the diffusion plants. So if there is no other supply, it will force Areva and USEC to keep the diffusion plants open past 2010. I am trying to also impress upon you the misnomer that there is an overcapacity. It is only by default. There really is not an overcapacity. They need to shut those plants down quickly.

There is a marked supply deficit in 2010. In 2015 the situation gets even more interesting. The Russian HEU material will have gone; the diffusion plants will have gone; Urenco will have increased its supply from centrifuge; Tenex, Areva, the French—the centrifuge plant will be operating at full capacity, 7.5 million units. USEC will operate its first commercial plant at full capacity, 3.5 million units, and NEF in the US will also have three million units operating. If you add all of them up, and the market expectations, you see another supply deficit of 27 per cent or 15 million units. It takes 10 years to build any of these plants, and it will take us 10 years to get to a commercial position. So we need to look this far out. Already you can see a very big supply deficit emerging over the next 10 years. This is the industry. People who say there is an overcapacity are kidding themselves.

Let us compare the three technologies: the two operating and ours. On the right-hand side you can see gas diffusion. It is a very old process. It essentially uses brute force—compressing the gas against a porous membrane. It is very simplistic, very crude. The enrichment factor is very low. The middle line shows it at 1.004. Each time it goes through a diffusion machine, it is only 1.004 times more enriched than what went in. It is very low enrichment and very inefficient.

Diffusion plants are massive—50 or 70 acres each. The costs are operating costs, electricity consumption particularly, and it is $100 a unit. It still provides a large share of the market. Centrifuge was also invented in the 1940s, during the war effort. Centrifugal force is again a very simple mechanical approach.

Mr MARTIN FERGUSON—The issue is that they are very energy demanding processes.

Mr Goldsworthy—With diffusion it is horrendous. The biggest issue with centrifuge is the capital costs. Also, these plants are tens of acres each. The capital costs are extremely high. The amount of energy required is also high but much less than for diffusion.

Mr MARTIN FERGUSON—Okay.

Mr Goldsworthy—The enrichment factor for centrifuge is much better at 1.25, and the costs are much lower. Forty per cent of today's market is called the 'second generation technology'. Our technology, SILEX, is laser based. We are not using a mechanical approach. The laser is tuned to one isotope and excites it. It is quantum physics. It is very discrete. We get the energy in very efficiently, so you expect higher efficiency and lower costs. We know the enrichment efficiency. We measured that in a program we finished last year. I am not allowed to tell you the exact number because it is classified. I am allowed to tell you it falls between two and 20—so you are guaranteed it is a lot better than centrifuge already, and it should be as it is a laser process. The costs are accordingly much lower.

It is the only third generation laser technology surviving today. Billions of dollars have been spent around the world, by the Americans, the Japanese, the British, the French, the Germans and the South Africans. All these countries have had national efforts to build laser enrichment technologies and they have all failed. Ours is the last surviving technology. Half of them failed because of economic issues. Economically, it was not better than centrifuge. The other half, roughly, failed because of technical issues—the laser processes, the laser equipment or the separator equipment was not achievable. Our approach is completely different to what anyone else has done in the world. As it is today, we are the lone surviving laser process and we have a very good chance to have it commercially developed.

Mr TOLLNER—Where is the other 15 per cent of the market now?

Mr Goldsworthy—This is the Russian HEU material. You will see the note at the bottom. That is the Russian material.

Mr KATTER—What does enrichment efficiency mean? It seems to me that you use more energy in your process.

Mr Goldsworthy—No. You put natural uranium into the front end of an enrichment machine and you get enriched uranium out. This number shown is the factor by how much it is enriched. If you have a number one, you are not enriching. If you are just above one, each time you put it through a gas diffusion unit, you are enriching it very slightly. The bigger the number, the more efficient it is. The enrichment is much higher. Our number is much larger than for centrifuge. Our efficiency is much higher. The key features of our technology are that we have very low energy requirements compared to those other technologies and much lower capital costs. It is a

UF_6 based process, so there is no change in the material required. We slip straight into the existing industry. Some of the laser processes that were proposed did not use UF_6 and that was an added cost to them.

We have viable engineering concepts and the laser technology can be industrialised. A couple of the laser technology processes that were developed overseas failed because the lasers could not be industrialised. The pulse energies, the peak powers, were too much for any known optical material—the lenses and the mirrors and things. Some of those issues killed other processes. Our process does not have those issues. SILEX technology has a clear commercial advantage over centrifuge as well and, as I said, it is the only third generation technology under development today.

Mr TOLLNER—Is there any waste arising from that process?

Mr Goldsworthy—The waste from uranium enrichment is the tails. This has less radioactivity than the natural uranium because it has been stripped.

Mr TOLLNER—Is it classed as low level or intermediate level?

Dr Goldsworthy—It has less than the natural level of uranium.

Mr KATTER—So tailings are less radioactive—is that what you are saying?

Dr Goldsworthy—That is right, because the process of enrichment takes the more active species into a smaller product stream and concentrates it. So, in what is remaining, the majority of the material has less of the active species in it.

Mr KATTER—There are huge tailings dumps at Mary Kathleen and Radium Hill et cetera. Can they be reprocessed through your—

Dr Goldsworthy—Are you talking about ore tailings now? You are talking about overburden and—

Mr KATTER—Yes, because you have—

Dr Goldsworthy—This is the ore that has been taken from the mine—the good stuff. It still has to go through this enrichment process. From that enrichment process you get a depleted stream and an enriched stream. The enriched stream is what goes into the reactor.

Mr KATTER—Yes, but if your efficiencies are what you are making them out to be then those tailings, which still contain some U235, would suddenly become economically viable—that is, if these figures that you are putting on the board are correct.

Dr Goldsworthy—A big drawcard with some of the companies we are talking about is that our process is looking so efficient that we might be able to re-enrich a lot of the stockpiled tails from the last 30 or 40 years of enrichment that are still sitting there. These have only been stripped from 0.7 per cent to 0.4 per cent or 0.35 per cent. They have had only half of the good stuff taken out because uranium was so cheap. Now that uranium is becoming more expensive and our technology means it is half the cost to enrich, you might have a secondary source of uranium. We could go and re-enrich the tails back up to natural uranium or continue. So there is a real dynamic between enrichment and uranium.

Mr KATTER—And the cut-off ore left behind in those old mines could now be economically viable to mine?

Dr Goldsworthy—No, I do not think that is the case. You are talking about dirt compared to uranium ore.

Mr KATTER—No—

Dr Goldsworthy—The mine tailings are basically dirt.

Mr KATTER—There is what they call a cut-off point. You go beyond a certain percentage and then you cannot go further. But there is still ore there.

Dr Goldsworthy—What will drive that is the price of uranium ore itself, not enrichment.

CHAIR—We will have to let Michael finish his presentation otherwise we are going to run out of time.

Dr Goldsworthy—I have a brief history which I might leave for you to look through at your leisure. We started in the early nineties on the SILEX technology. By the mid-1990s the process we have today—the SILEX process—emerged. In 1996 we formed a relationship with USEC, which lasted about 6½ years. The classification of the technology came through in 2001 from the Australian and US governments, but we have operated as if classified since 1990. In 2003 our partner, USEC, withdrew from the project because they had all sorts of issues with the DoE on their gas diffusion plants, their waste remediation and, ultimately, the Russian HEU agreement. They had to drop us because they had to take up the American centrifuge program. That is what they are developing today. They could not afford to run us in parallel with American centrifuge. They left us in 2003. We continued solo. We finished the program and today we are looking for a new partner on the back of the results we have achieved in our new program.

Mr ADAMS—Where does your capital come from? Who funds you?

Dr Goldsworthy—We have funded ourselves since USEC withdrew.

Mr Wilks—We are a public company so we have had access to the market.

Mr KATTER—With adequate funding, how many years away from being economically viable are you?

Dr Goldsworthy—At pilot level, producing commercial material, it will probably be about six or seven years. At full industrial level it will be 10 years.

Mr KATTER—And that is adequate funding?

Dr Goldsworthy—Yes.

Mr ADAMS—How much do you want?

Dr Goldsworthy—We are in negotiations now with several companies in North America. We have a plan, a budget and a schedule. It is all mapped out. But we have not disclosed the details yet until we have finished the negotiations.

Mr ADAMS—What is your share price?

Dr Goldsworthy—Our market cap is about $400 million.

CHAIR—Can we finish the presentation and then go to questions.

Dr Goldsworthy—The status of the project today is that we have finished what we call the 'direct measurement program'. That was in the middle of last year. We have had classified due diligence evaluations completed by three overseas companies. They were completed last month. As a result of the evaluations they did on our technology they were suitably impressed and we are now in negotiations with those North American companies. A decision on a commercialisation partner is expected at the end of this quarter. We are fairly close to announcing something. We remain quietly optimistic about the commercialisation prospects for our technology.

The plan for the future is shown here and shows the test loop—the next step—the pilot plant and the commercial plant, ultimately leading to commercial operation. These are a few photos of our existing equipment in Lucas Heights labs. This is what we call the direct measurement test facility. You can see that scale of the equipment is quite significant now. There is a lot of equipment that size in the next room. This is the actual process area, and this shows the other end of the direct measurement facility—there is a lot of diagnostic equipment. We have built all this; this was an empty lab when we started five years ago. This has now produced the results we have shown to the external parties leading to the negotiations.

Mr TOLLNER—Where is the lab?

Dr Goldsworthy—At Lucas Heights.

Mr TOLLNER—I did a tour through there.

Dr Goldsworthy—This is inside the secure area. This is the laser facility for the direct measurement lab. Again, the scale of these lasers is quite impressive. This is the largest laser system, I believe, in the Southern Hemisphere. It is a very powerful laser system; it is incredibly sophisticated laser technology here and is way beyond off-the-shelf laser technology. I also have a few pictures here of a conceptual industrial plant. We have spent two years developing engineering designs for a full-scale SILEX laser plant. This is what it might look like. In the foreground of the lower section we have the laser hall. In the middle section we have the separator facilities and, around the top and the side, we have all the support infrastructure. There is an enormous amount of detail underneath those drawings. There are the nuts and bolts of materials all inside there ready to be cut. The level of design is very impressive already. This is the front and side elevation and this is a close-up of the laser hall in the commercial plant. All these MOPA—master oscillator power amplifier—laser chains, frequency converters, multiplexers et cetera have all been designed. This is the separator hall. Again, there is a lot of design detail inside those machines. That is the presentation. I hope it gives you a bit of a view of the enrichment industry and our activities at Silex. Thank you.

Mr HATTON—Have you had a chance to look at the evidence that has been given to the committee previously?

Dr Goldsworthy—Some of it, yes.

Mr HATTON—As you probably know, some of it casts you as probably the most sinister company in Australia, with secret links to the United States, and that the technology you were developing undercover could, firstly, be gained by terrorists and, secondly, be used by proliferators and that you are virtually a secret society. I, amongst other members of the committee, ask some pretty serious questions of people who put those arguments forward. We have also asked the CSIRO. Would you give a general response to that. I know that in the overview you have given us you have, in part, answered some of those allegations. But, specifically, it might be useful to clarify—and there is an associated question here. Part of the criticism was that the transportability of it—the fact that you have a relatively small process versus either the old gas diffusion or the centrifuge—meant that people could more readily gain access to it and use it.

Mr ADAMS—A suburban garage.

Mr HATTON—I know that you have argued that no-one has done it yet but, once you have actually done it, doesn't it become a different proposition so that there might be a kernel of truth within that? I just want to give you an opportunity to answer the critics on the sinister aspects.

Mr MARTIN FERGUSON—The garage?

Dr Goldsworthy—I will put the slide back up to show what garage we would—

Mr MARTIN FERGUSON—I do not exactly think it would go in Lindsay Fox's garage!

Dr Goldsworthy—That is exactly the point. Our process is much more complex and much more sophisticated than the alternatives. I have already pointed that out. It will not fit in anyone's garage, not even Lindsay Fox's. You can see the scale. This is a smallish commercial plant. I cannot tell you what it represents in numbers, but it is a smallish commercial plant and you cannot have equipment of a lesser size than this. You cannot pick up this stuff and carry it away. It is still very big machinery. The difference between this and centrifuge and diffusion is that diffusion and centrifuge would have 100 of these, not just one. So it is still a very big plant but it is not, as the critics make out, portable.

Mr MARTIN FERGUSON—What is that investment value?

Dr Goldsworthy—I will give a very rough ballpark answer, because it goes to the capacity: roughly half a billion dollars, maybe less.

Mr TOLLNER—What about centrifuge?

Dr Goldsworthy—The same size would be three times that, roughly, in ballpark figures. On the issue of the criticisms we have had, Greenpeace have targeted us several times. Their claims are absolute rubbish—baseless, factless. They have never looked at our website, you would have to say, from some of the claims that they and other people make. We put out a response to Greenpeace's report back in November 2004. I could even table it for the committee. Basically, we answered all the claims they made.

CHAIR—The committee would like you to table that.

Dr Goldsworthy—I will table it. We are not a secret agency. We are a public listed company. We are accountable to our shareholders and to the ASX, and we are accountable to ASIC and to everyone else. We have an open policy, but people have to understand that this is a sensitive technology and we cannot have people trooping through the facilities because they just want to have a look at it. It is a sensitive technology and it has to be safeguarded. But we are not secretive in any way. Claims that we had a secret relationship with ANSTO were absolute rubbish. There were claims that we had a secret relationship with the US and with others. Of course we have relationships with everyone, but they are commercial and at arm's length and they are fully defined and fully legitimate.

Mr HATTON—My second point runs to the question of efficiency. Gas diffusion at 1.04 per cent and centrifuge—a bit of a kick up—at 0.19 per cent. When those enrichment technologies are used, do they have to put the material back through a number of times in order to get it up to that three to five per cent? Given that you cannot tell us what the figure is—and it is two to 20 per cent—if you were to say to that you were able to get 18.73 per cent efficiency out of your process, you would not have to go through that process as much. Is that one of the benefits? Is part of the efficiency in the process that, because you are getting a bigger impact and more throughput, you simply do not have to do it so many times?

Dr Goldsworthy—That is exactly right. Diffusion and centrifuge are huge plants because they have what we call cascades, loops through successive stages of enrichment over and over again. In a diffusion plant, you have to go through 1,500 stages to get it from 0.7 per cent to 4 per cent enrichment. In centrifuge, you have to go through dozens, depending upon the size of the machine—perhaps 100 stages. So it would have to go through 100 machines before it got to the commercial grade. In ours, it is a few steps. I am not allowed to say how many. But we still have a cascade because not only do you enrich but you have to strip out of that tail stream. You do not want to shove that tails stream out the back door until you have extracted the maximum value from it, the cut-off point. So even in a laser process you have a small recycling step, a small cascade, to bump up the economics. But it is nothing like diffusion or centrifuge.

Mr HATTON—Do you go any higher than three to five per cent, or is that all you need to do?

Dr Goldsworthy—That is all the reactors need, although it depends on where they put the fuel rods. They have a list of the assays they need for the centre of the core or for the peripheral of the core, which requires more enrichment. So it is between three and five per cent generally.

Mr HATTON—It looks like you have succeeded where others have failed in terms of the laser technology. Some of the criticism has been that this would not work anyway, that the French had already tried it and all the rest of it. I imagine part of what you had to do was to use different wave lengths that had been used previously and more precision—not overload the process, given some of the problems—so that you could look at what went wrong. I imagine that was a step in working through this. Are you absolutely sure that you could go to commercialisation on this now, that you have proven it enough in the developmental stages?

Dr Goldsworthy—We have proven it to a very significant level, but one should never underestimate the effort involved in scaling up to full scale. Our effort now will focus on scaling up from where we are today to full scale. There are two more steps. One is called a test loop. We will build a full scale laser and a full scale separator and we will bring them together and operate them as a closed loop. That will show the technology at full scale on an equipment level. Then the pilot plant will be built with the small cascade and produce the real material. There are still two steps to go. We are very confident that we will get there, but we will have risks and issues to overcome along the way.

Mr HATTON—Given that they are two of the hardest steps, there is always the question of money as well as the technical problems associated with them. But throughout the briefing that you have given us you highlighted technical versus emotive problems—you have called them political problems, but fundamentally they are emotive issues. There is an emotionally based response to this, and it has been that way for three decades. In terms of breaking through, if you are able to go to commercialisation, the political framework that we currently have is being driven by that emotive response to these issues over a lot of time.

You have also pointed out that with not only the work this committee is doing but also what is happening in the rest of the world it seems as though that is changing—in part because of the third and particularly the fourth generation reactors that we have been briefed on. We have also been briefed recently on fusion technology and the possibility that that could be brought in now. Can you give me an idea of the order of magnitude of this? Currently, you are forced to go to the US to get partners. If you could do it here onshore rather than being forced to look at doing it in the US—if there was that change in policy and change in feeling within Australia—how much more money could your company and therefore Australia make?

Dr Goldsworthy—There was a slide I showed earlier on the market outlook. If I remember the number correctly, by 2020 or so that number could be as high as $US6 billion a year just from enrichment if we do our share of the uranium here. That is roughly a third of the world's uranium. If we are producing a third of the world's uranium and we enrich it in Australia then we add another $US6 billion every year by 2020.

Mr Wilks—It is probably worth also saying, though, that that is assuming we are only processing Australia's uranium. If our technology is as efficient as we think it is then and if we are half the price of any other technology—

CHAIR—It might mean that less uranium is purchased.

Mr Wilks—There is that, but there is also the possibility that we could get more of the market. If you have a technology that is half the price of the next best technology, you could have 70 per cent of the market, whether you do it here or offshore.

Mr HATTON—I have a final small technical question. With the advanced semiconductor materials that you are developing—the other part of the business—you have SOI and high-k substrates. Does ‘high-k substrates’ mean ‘high Kelvin substrates’?

Dr Goldsworthy—This is a high-k dielectric. This is to help chips talk to each other, because wire connections are going to have to go. Chip-to-chip communication has to go optical, and that is what high-k material is being developed for. It needs to be a high dielectric material. Silicon-on-insulator materials is a next generation material, an ideal platform for optical functions.

On that issue, I should point out that we also have a silicon enrichment technology. This is absolutely, completely and fundamentally different to the uranium enrichment technology. You cannot use our silicon technology in any way or form to enrich uranium. I want to make that point, because it is another criticism that has been thrown at us—that someone is going to get our silicon technology and enrich uranium. It is absolutely and fundamentally physically impossible.

Mr MARTIN FERGUSON—Regarding silicon technology, there is a world-wide shortage of silicon at the moment, which is a problem for the solar energy industry. What progress have you made in commercially developing this?

Dr Goldsworthy—We have three silicon activities. There is the enriched silicon for enriched silicon epi-wafers—these are very high quality wafers that are being used more and more for high powered chips. We have a pilot plant already operating at Lucas Heights for silicon enrichment. It is a very nice little plant. The trouble is, the market has not drawn that technology along yet—there is a market issue. Then we have optical silicon and silicon on insulated materials. We are well advanced. We are actually talking to commercial parties now about our silicon technologies, so we are not that far off from commercialising those technologies, either.

Mr MARTIN FERGUSON—Would it be commercially viable to do that downstream processing in Australia?

Dr Goldsworthy—I would love to see a silicon fab built in Australia. In fact, one of the parties we are talking to—it is public knowledge that we have a relationship with it—is the Sumitomo Mitsubishi Silicon Corporation, SUMCO. We have tossed around some ideas there, but there is a lot of infrastructure required, a lot of political will required to make it happen and a lot of industrial will required to take that on, because it is a big risk to start setting up a silicon fab industry here in Australia with no track record yet. If we could do what Ireland did, we would be an absolute success story on the silicon side, and I am absolutely for it and we are actively looking into that as we speak.

Mr MARTIN FERGUSON—I have two other related questions. In the current treaty between the US and Australia on this technology, do we receive any financial consideration for that? Secondly, I take it that, given the current political environment in Australia, you would be developing this in the US based on licence, which leads to the royalties, so we keep ownership of the technology.

Dr Goldsworthy—Yes. The business model down the track could evolve in several ways. It could be a licence and royalty flow back where we own the technology, or it could even be that at a certain point we decide to sell the uranium enrichment technology to them and still receive the royalties. We are looking at the different alternatives now and it is too early to say which way it will go, but the main thing we are interested in is obviously to make sure we leverage maximum commercial value in licence fees and royalties in that process.

Mr MARTIN FERGUSON—In the current treaty?

Dr Goldsworthy—The treaty does not involve any money. The treaty is simply to enforce security and safeguards and maintain non-proliferation regimes.

Mr TOLLNER—In your opening comments you said the industry has a role to play in educating the public. I am curious as to what your company is doing in that regard.

Dr Goldsworthy—I am here today. We have a very good website. We are financially supporting the Uranium Information Centre, which is a marvellous educational forum in Australia with very high-quality factual educational material on the nuclear industry. We attend the World Nuclear Association and Nuclear Energy Institute conferences. We do not have an active separate program. We do not go out as an entity and try to educate people—we leave that to the educators—but we support them financially and we partake in things like this when we get the chance.

Mr Wilks—It is probably worth mentioning Ian Hore-Lacy, who is an Australian who has been a major driver of education. You might have met Ian.

Mr MARTIN FERGUSON—Yes, we have.

Dr Goldsworthy—There are very good people who are being funded by companies like us to educate the public, here in Australia and overseas.

Mr TOLLNER—It seems to me that the big problem in the world with the fear of things nuclear has been the secrecy of the whole industry in the past. People are not aware of nuclear issues. It always seems that everybody we get in front of this committee says, ‘We all agree that the public needs to be educated and informed on this issue,’ but when you look at it and say, ‘What are you doing?’ they say: ‘We’re part of the nuclear industry. People are very cynical whenever we advertise something, so we leave it to someone else,’ and nothing ever seems to happen.

Dr Goldsworthy—I think that point is valid and the industry has suffered from not educating the public enough in the past, but that has changed. Secondly, I do not believe it is as bad as people have always made out. There are many different facilities that have public tours. There are these educational bodies that you can download a plethora of material from.

Mr TOLLNER—Certainly, but when you look at what is thrown at you by your opponents, you are massively outgunned in the media and everywhere. Greenpeace set sail on boats to blow up ships.

Dr Goldsworthy—I can tell you now: Greenpeace have not impacted on our share price, and I suppose some people would say all news is good news when you are a listed company. But Greenpeace are not an impact on our company. They and people like them certainly make noise about us, but we are not closed. We are open. We have a good website, we have forums and we report to the ASX. We have to announce things. We have to be open—it is the law of being listed. More generally, there is a much better effort now to educate the public. Alternatively, the issue is also being forced by environmental factors. The nuclear issue is being brought to the table by our fossil fuel, greenhouse gas and global climate change environment issues. They are forcing the issue back on the table.

Mr TOLLNER—On another issue: once the process is done and you have created the fuel rods, how difficult is it to convert those fuel rods to weapons grade material?

Dr Goldsworthy—That is the second-most likely source of proliferation, as I mentioned earlier. There is centrifuge enrichment of uranium and then there is plutonium. Plutonium extraction from used nuclear fuel rods is a proliferation risk, there is no doubt about it. I would like to see all used uranium reprocessed, because that burns the plutonium. It is gone forever. Some countries are adopting reprocessing. That is the ultimate answer to getting rid of plutonium. It is possible to extract the plutonium, but the plutonium that comes out of spent fuel rods in commercial reactors is extremely technically unsuitable for weapons.

Mr TOLLNER—Is that prior to them being spent fuel rods?

Dr Goldsworthy—No, this is after. The plutonium is only created in the reactor. It is part of the process.

Mr TOLLNER—So once you have created a fuel rod, that fuel rod cannot then be taken by some rogue nation and converted to a weapons grade material; it actually has to go through a reactor first and then be used. Is that right?

Dr Goldsworthy—Yes, the plutonium only comes from inside the reactor. A small amount of the uranium gets converted to plutonium, but the issue is that that small amount can be chemically extracted. It has got nothing to do with enrichment; that is uranium only. It can be chemically extracted from spent fuel, but it is very unsuitable. It does not have the right qualities. They had special reactors that bred plutonium. Not any more—they shut them down. It is a different type of reactor.

Mr ADAMS—One of the good things that has happened is that the breeders have gone.

Dr Goldsworthy—That is a different issue.

Mr TOLLNER—In effect, what is used in nuclear bombs has to have gone through a reactor first?

Dr Goldsworthy—Yes, and then you have to process it.

Mr TOLLNER—There are concerns about Australian uranium being used in bombs. But it is not Australian uranium. It actually has to have gone through another country's reactor somewhere.

Dr Goldsworthy—Yes, but we track it all the way to where it sits in high-level waste pools. Under our bilateral agreements, we will not sell to anyone who does not adhere to what we say.

CHAIR—We have run out of time. Are there any more questions on the process?

Mr ADAMS—What was the name of the silicon optical process?

Dr Goldsworthy—Interconnects. Just briefly, silicon cannot emit or absorb light. It has not played a role in the photonics industry—the optical superhighway. Our company in Palo Alto has invented a form of silicon that does emit and absorb light and could revolutionise future generations of semiconductor chips. It is very exciting stuff. There is information on the website on that, if you are interested.

Mr ADAMS—When you do your process and you are upgrading your processing, are you continuing to redo it? I take it it is a bit like you are concentrating it down? Is that how you enrich it?

Mr Wilks—That is what enrichment is.

Mr HATTON—I have just one quick supplementary question, about lend-lease. Given that you are talking about reprocessing to do away with the plutonium, if you develop your enriched uranium in Australia would you look at a process that the Russians used? It is basically a lend-lease thing: 'We will sell you the fuel rods with the material in it, but when those fuel rods are spent we will take it back and do the reprocessing.' This way you have a complete cycle where responsibility is taken by the person who does the enriching.

Dr Goldsworthy—That is a cradle-to-grave lend-lease policy.

Mr HATTON—You also make a lot more money from it.

Dr Goldsworthy—There are well-known proponents of the lend-lease proposal. I would be in favour of it. I do not think it is going to happen in my lifetime, but it would be fantastic to see Australia playing a role in every step of the fuel cycle. Not only that, there is a waste industry out there waiting to happen, of nuclear waste being stored around the world, which amounts to hundreds of billions of dollars. It is waiting for someone to come along and do it. The waste industry itself is a huge economic resource.

CHAIR—Thank you very much for appearing before the committee today. If the committee has any further questions the secretary will contact you, so thank you.

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

That the presentation slides provided by Silex be received as evidence to the committee and authorised for publication.

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

That the response to the Greenpeace claims be received as an exhibit.

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 12.50 pm