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Chair

Mr. James Maloney

Standing Committee on Natural Resources

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● (0845)

[*English*]

The Vice-Chair (Mr. John Barlow (Foothills, CPC)): Good morning, everyone. Welcome.

Before we get to the witnesses, Mr. Strahl, you had something you wanted to bring up.

Mr. Mark Strahl (Chilliwack—Hope, CPC): Thank you, Mr. Chair.

First, I'm sure that our regular chair is listening from home. I understand that he's not well, so we send him our best wishes.

I had a motion on notice that I wanted to move at this time just because of the time-sensitive nature of it. I hope it won't take long, so that we can quickly move to our witnesses. I don't know if we need to have it distributed before.

The motion states:

> That the Committee invite the Honourable James Carr, the Minister of Natural Resources, to testify about the Supplementary Estimates (B) on or before December 6, 2016.

Obviously, we are running up against a deadline. That's why I wanted to move it today. We don't have committee business scheduled. We would like to hear him talk about those estimates, and I would welcome unanimous support for that motion from this committee.

The Vice-Chair (Mr. John Barlow): Is there any discussion? All in favour?

(Motion agreed to)

The Vice-Chair (Mr. John Barlow): Thank you very much.

We'll go on to our witnesses. I want to welcome Ms. O'Connell and Mr. Bratina for filling in today. Welcome. This committee can be trying at times. As you see, Mr. Maloney couldn't take it any more. His back gave out from trying to carry this group. I thank you very much for filling in today and being part of the meeting.

Thank you very much to our witnesses. We have two people here this morning: Jerry Hopwood from the University Network of Excellence in Nuclear Engineering, and Glenn Harvel from the University of Ontario Institute of Technology.

Each of you will have 10 minutes to give your presentation, and then we'll move on to questions from the committee.

We'll start with you, Mr. Hopwood.

Mr. Jerry Hopwood (President, University Network of Excellence in Nuclear Engineering): Thanks very much.

My name is Jerry Hopwood. I'm here today in two ways, one is as a long-serving nuclear energy professional and also currently as the president of the University Network of Excellence in Nuclear Engineering. It's a long title so we call it UNENE for short.

My own career in nuclear power technology started in the U.K. after which I moved to Canada to join Atomic Energy of Canada Limited, which was more than 35 years ago. I've been in nuclear power reactor design and development, safety assessments and regulatory affairs, and project development for building CANDU nuclear reactors here and around the world.

Ultimately, I served as vice-president of reactor and product development for AECL. After a stint in a similar role with the successor engineering organization, Candu Energy, after AECL's engineering group was reorganized, I left there at the end of 2015, and I have recently taken on the position of president of UNENE.

To introduce you to UNENE, it's a not-for-profit organization with a membership composed of the main nuclear power technology organizations in Canada, the Canadian nuclear universities, and government organizations, so it is a three-way partnership. UNENE’s goals are to foster the development of professionals in nuclear technology by providing post-graduate continuing education for professionals early in their careers, typically to provide a master's program in nuclear engineering or diploma programs in nuclear engineering; by carrying out university research in a coordinated way to support industry needs while building the capabilities of highly qualified personnel at the doctorate and post-doctorate level; and finally, by doing all this UNENE establishes a thriving network of university experts who can provide credible advice to industry, government, and civil society.

To this end, UNENE organizes the master's of engineering and diploma programs in nuclear engineering, whereby several of the Canadian nuclear universities offer courses that contribute to a UNENE degree. The courses are primarily arranged around weekends and one-week intensive courses so that young professionals can complete this education while they're in the early stages of their careers. UNENE also sponsors and organizes a group of university industrial research chairs in nuclear technology topics. UNENE also assembles and approves a series of co-operative research and development projects at member universities. Those are selected based on value to industry and value to Canada.

UNENE organizes this work by funding from industry. In most cases that funding is matched or supported by funding through NSERC, so the Government of Canada provides co-funding based on industry support because the work is of value to industry and based on government support because the work adds a value to the nation.

I should note that Glenn here is a colleague not only at the University of Ontario Institute of Technology but also as part of the UNENE organization. I'm sure he'll have comments to make as well.

That's the background to myself and why I'm here. UNENE is certainly a stakeholder in nuclear research and development and has an interest and a responsibility to the nuclear industry. We're part of the supply chain, if you like, because we supply professionals and highly qualified personnel. In terms of my comments with regard to the committee's questions I thought I would provide a little bit of background as I see it, then summarize the picture that UNENE sees as it goes about its work, and then maybe make a few comments on any individual questions, if I have time.

First of all, I would say that it's important that nuclear power technology offers a very unique baseload, low or zero, GHG energy source. It's an essential component of a response to climate change and dealing with the reduction in greenhouse gases that we are all looking for.

● (0850)

Following COP21 in Paris last year, the recognition of the reality of taking action against climate change became much more widely accepted, much more widely acted upon. Yesterday I saw that Canada is announcing plans to reduce coal power in the country, which would be part of that response.

Today nuclear power plants already supply about 11% of the world's electricity and about 18% of Canada's electricity. Moreover, nuclear power supplies about one-third of the world's greenhouse-gas-free electricity. Hydro power is the largest component, and of course hydro power is a large component in Canada. Nuclear power, however, is the next-largest source of greenhouse-gas-free electricity.

Nuclear technology is not just about the power industry. It underpins amazing advances that have taken place in the last generation in the health and medical sectors. Canada has been a leader in this, and Canada's isotope production, among other things, is part of the advancement in medical technology that touches everybody. I've also been a recipient of Canada's technetium isotope diagnostic techniques, so I'm very glad that Canada is such a leader. It has affected my life as well. It's not just about power. It's also about medicine. It's also about the environment.

Canada's nuclear industry has a strong history. I'm sure you've heard this very many times. There are decades of research and development, and decades of industrial success in Canada's nuclear industry. Examples include the development of the CANDU reactor and other reactors; advancements in nuclear regulation; underpinning R and D undertaken at Canada's national laboratories and universities, which is an important factor for UNENE; and the supply chains for equipment, engineering, and project management.

As I travel around the world as part of my job, I find that Canada is highly respected around the world, and Canadian industry and Canadian regulation is highly respected around the world. People view Canada as a leader in nuclear technology.

CANDU is the foundation for this. It's the reactor technology we have in Canada. Certainly a lot of UNENE's work is relative to CANDU technology. Yet as we look ahead, we can see that at the same time as there is somewhat of a rebirth of CANDU, as the reactors at Darlington and Bruce become refurbished for another 30 years of life, there is also an interest in going beyond CANDU to other reactor designs in Canada and worldwide.

There's also an interest in using CANDU as a recycling process to take on fuel that has been used in other reactors and use it one more time so as to take more energy out before the fuel is used up. There are ways in which our traditional CANDU industry can expand, and UNENE would see that university R and D is one of the starting points, one of the early steps that can happen in any broadening of our nuclear industry.

With that background, UNENE would see that it has a responsibility. Our industry is here to stay, both in nuclear medicine and in nuclear power.

I'm sure you are aware that the Government of Ontario and Bruce Power have signed an agreement that sets the Bruce nuclear units running until the year 2063. That's certainly beyond my lifetime. It's beyond the working lifetime of the new grads UNENE is training, so UNENE will have to be here for another generation in order to see that the power plants now running in Ontario and elsewhere are able to operate for the future. Nuclear is here to stay, and UNENE has a responsibility in that. That's important to us. We need to be aware of our responsibility.

● (0855)

Nuclear technology provides important benefits to Canadian society. Its greenhouse-gas-free electricity in Ontario provides 60% of Ontario's electricity. It is the main reason why Ontario was able to get off coal some years ago. Ontario has had a very good experience in providing a clean and green electricity supply.

Nuclear technology is also a very good source of exports and potential exports for this country. We've had a very cyclic nuclear industry, but I was involved in preparing the projects in Romania and China, where CANDU reactors are being built and operated very successfully. We see our ability to export our products in that way as a tremendous asset for Canadian technology.

The other thing I would say is that, looking historically, nuclear power is still within an early stage of development. That may seem strange when you consider that Canada has been involved in nuclear technology for all of the years since the Second World War. However, there is still a great deal of development in order to improve it, make it more beneficial, and make it more widely applicable, so I believe we're far from reaching the end of the development stage in nuclear power and in nuclear medicine technology.

As an R and D organization, UNENE sees that as very encouraging. We look to continue the relationship we have with the Government of Canada—which is supporting UNENE, and we appreciate that—and to combine that work with industry so that we have valuable R and D and valuable professional development, both for industry and for Canada.

● (0900)

The Vice-Chair (Mr. John Barlow): Thank you, Mr. Hopwood. I appreciate that.

Now we'll move on to Mr. Harvel for 10 minutes.

Professor Glenn Harvel (Associate Dean, Faculty of Energy Systems and Nuclear Science, University of Ontario Institute of Technology): Good morning. Thank you very much for inviting me. I'm very happy to be here. It's the first time I've been in front of such a committee.

I worked in the nuclear industry for 11 years as an engineer and also as a manager, mostly supporting the CANDU product, and then later the smaller reactor technology, such as MAPLE and NRU. I have some knowledge of that aspect of the work cycle.

I then went to the University of Ontario Institute of Technology for 10 years as a professor in research. If you ask a professor to come before a committee about R and D funding, of course they're going to say they want more money. That kind of goes without saying.

I find that in Canada, we cover the entire spectrum of the nuclear industry, right from digging it up out of the ground, and milling it and mining it, to the work that Cameco does, to the designing of nuclear power plants and facilities, processing the construction, operations, maintenance, and decommissioning. We have it all.

In the beginning, in the 1950s and 1960s, that was great and wonderful. We had strong support for that. Nowadays, it's too much. There's so much scope to it, it's hard to fund every single piece of it. The R and D funding at the university level ends up being spread out, trying to cover every bit of area. We end up with marginal improvements in each area, as opposed to significant advancements in maybe some key focus areas. That may be something worth considering, to see where would we like to focus the research at the university level, so that we can start making the major significant advances that we would like to make.

One of the advantages that we have is in our personnel. Our university, alone, has produced over 500 nuclear engineering undergraduates in the past 10 years, which is a significant increase in the workforce. That said, that means the oldest of them is about 10 years active in the service. We have many people who are very close to retiring, and we are at risk of losing that knowledge skill set.

We need the programs at the graduate level, the UNENE programs that Jerry Hopwood talked about, and perhaps some other R and D focused programs at universities, to strengthen the skill set of our core workforce to maintain the strength that Canada currently has. We need to maintain those strengths, not only for our own industry but because this is a major exportable skill set.

If you look at the United Arab Emirates, they're hiring Canadians to help construct a nuclear power plant designed by Korea that doesn't use Canadian technology. Why are they using Canadians? Because they like working with Canadians. They're good people to work with. They have the skill set and knowledge to be able to work on almost any reactor design around the world. They're very good at project management, very good at construction work. This is a skill set we need to maintain in our country, because we can export it around the world and have a strong economic impact to our country.

The other aspect that we should consider developing, at least to some extent, is the nature of the social licence in dealing with the public. In the nuclear industry, we've had pretty much a hands-off affair. We've developed the programs to educate the public through the regulator. Each utility has its own responsible areas for their information centres, and we have programs in high schools to help with the education.

However, by and large, we are not making major efforts at explaining this technology to Canadians. Therefore, they still don't necessarily understand it. If you don't understand the technology, then it's hard to make informed decisions about what the risks are and whether or not we should be proceeding with new builds, etc. We always run into this resistance. That is another area where I'd like to see some focus or effort going forward.

In terms of supporting the current CANDU fleet, the main focus is on finding ways to do it safer, faster, and cheaper. We don't have to sit there and design a new CANDU 6. We already have one of the best machines in the world. We know how to build it. We know how to run it. It works very well in New Brunswick. It works very well in China, in Argentina, in Romania. Countries that do not have strong nuclear backgrounds can run this machine and run it very well. The technology is good, but we need to find ways to make it cheaper to build, make the maintenance cheaper to do, and get the costs down, so it can be even more economical, especially going forward.

● (0905)

With respect to new designs, such as the supercritical water reactors or small modular reactors, basically, I believe we need to focus on one. Canada needs to decide what it is it wants to do.

Do you want to develop a supercritical water reactor? Then we should put money into it and focus on that one design and not worry about the rest. If you want to go toward a small modular reactor, then that's where we should be concentrating the funds. If we try to do it all, what will end up happening is that other countries will develop that technology before we will, and we will end up in a support role as opposed to a lead role.

Anyway, I have answers to your questions, but I think it's better if I let you ask the questions, and I'll do my best to answer them.

Thank you.

The Vice-Chair (Mr. John Barlow): Thank you very much, Mr. Harvel. You're the first witness we've ever had to finish well under time. I wish we had a prize for that, but we don't.

That gives us more time for questions, and we'll start with Mr. Tan, who's furiously preparing his research, for seven minutes.

Mr. Geng Tan (Don Valley North, Lib.): Thank you, Chair.

Thank you both for coming, especially UNENE. I know UNENE very well. I know it's very successful in education and in the research field of our Canadian nuclear industry, as well as supporting other nuclear sectors. I used to have a few co-workers who actually earned their master's of engineering through UNENE.

In September, our government, and more precisely SNC-Lavalin and Candu Energy, signed an agreement-in-principle with the China National Nuclear Corporation to develop markets and build the advanced fuel CANDU reactor. They are also going to form two design centres, one in Canada and one in China.

What are the technical details of this agreement? How is it going to benefit Canada? I know it's going to create jobs or a market internationally, but how is it going to benefit Canadians here at home?

Mr. Jerry Hopwood: Of course, I can't comment on the details of the agreement. It's not something I'm fully aware of, although in my previous life I had some knowledge of it.

I would comment on two or three different aspects. One is that Canada's nuclear technology, which the country paid for in research and development, led to the development of the CANDU reactor, and a lot of that technology has been shared with others around the world during previous projects. So China, for example, does have a technology transfer agreement from the previous projects of 20 years ago, in building two CANDUs in China.

Canada and China may be considered to be two countries that share some nuclear technology. Canada has a tremendous amount of development. China is also extremely highly active in developing nuclear technology of different kinds. From a technology point of view, there's a benefit in sharing; that is to say, China will have access to the technology that we have and we will have access to the technology that China has.

From the point of view of projects, any further projects to build CANDUs will have some benefit to Canada. Certainly, if a project is built in China, I would expect the Chinese government would intend that a lot of the supply chain would be provided from China, but some of the supply chain would come from Canada, and some of the engineering would come from Canada. There would be an exports and jobs benefit from this agreement.

Finally, this will encourage the potential for CANDU exports to third countries as well. The more CANDU projects proceed, the easier it is to go ahead with other projects elsewhere, in terms of desirability and financing.

Prof. Glenn Harvel: I was part of the trade mission to China in April, and at that time there were several Chinese universities that were very interested in the Canadian technology. We're currently having very preliminary discussions about memorandums of understanding between our university and the Chinese universities, mostly in the area of student exchange.

The interest here is that possibly Canadian students will be able to go to China as part of what we're talking about here, and that will grow their ability to work overseas and work in more international markets.

● (0910)

Mr. Geng Tan: I see that you both just mentioned that our CANDU technology or CANDU reactors perform quite well internationally, either in Qinshan III or in others, in Romania or Argentina.

That sale was done many years ago, so within that span of 20 years, why have there been no new builds or new CANDU reactors sold to other countries? Is it just mainly our Canadian researchers who are highly respected or regarded internationally, and our technology covers the whole spectrum of nuclear technology in this area?

I don't know what the reason is behind that. Why? We have good technology, but we don't have the market.

Mr. Jerry Hopwood: I have one or two comments.

One is that the nuclear power building industry has been very cyclical, and the last two decades have been a low part of that cycle. CANDU went through a good period of building in the 1990s to the 2000s, and then subsequent to that, there has been a slackening in sales of nuclear reactors all over the world with a couple of exceptions. The exceptions are China, India, and, to a lesser extent, Russia.

Those are countries that build reactors as much as possible based on their own domestic supply chain. Although India is importing designs, it's trying to have the maximum amount of work done on reactors within India. China has been a very strong proponent of nuclear power and is building literally dozens of nuclear power plants today. That's a tremendous market, but it is dominated by Chinese industries and organizations.

Canada, as a middle power, doesn't have the kind of market power that some of our neighbours to the south, the U.S., or countries like France, which have a very monolithic nuclear industry, have had in making sales. I'm not sure whether that's a good thing or a bad thing; it's a fact of life.

I believe that the likely future of nuclear sales around the world is that they will increase a great deal. The response to climate change is one driver, but the recognition of the reliability and the maturity these days of nuclear power will be another driver.

The Vice-Chair (Mr. John Barlow): Thank you, Mr. Hopwood.

Thanks, Mr. Tan.

Now we'll go to Mr. Strahl for seven minutes, please.

Mr. Mark Strahl: Thank you, Mr. Chair.

Thank you to our witnesses.

Mr. Harvel, you mentioned the social licence. Coming from British Columbia, I think it's more a lack of awareness of nuclear technology. If you ask most of my constituents what they think of when they think of nuclear they would probably list *The Simpsons* and then go down to some of the more unfortunate incidents that have happened across the last number of decades with nuclear accidents. I think that's the challenge the industry faces.

The industry was mentioned this weekend. There was a release of Canada's mid-century, long-term, low greenhouse-gas development strategy, a very catchy title. It didn't mention the oil and gas sector at all, but it did mention nuclear energy. We had talked in previous meetings about how this had not even come up as a clean technology, so that's positive for nuclear development. We heard in our mining study, which we just finished up, about small modular reactors.

You mentioned it in your presentation, but how close are we to actually having that technology commercialized and available? If we're 20 years off from that—or 10 or five, I don't know—I think we need to have an honest discussion, and government needs to be honest. If they're going to promote this as a way to get remote communities off diesel-generated power or to power large industrial development in remote regions, but it's not actually commercially available and it's a theoretical thing that maybe some day someone can come up with, that's disingenuous and doesn't serve the discussion well on greenhouse gas emissions.

Can you give me your best guess, or your best idea as to how far away Canada or the world is from actually having something in the window that can be utilized in the Canadian setting?

● (0915)

Prof. Glenn Harvel: For a small modular reactor...?

Mr. Mark Strahl: Yes.

Prof. Glenn Harvel: It's a very good question because it's almost impossible to answer. The problem is that all of the companies that are doing this are keeping their cards very close to their chests. For several years now I've been going to conferences and I see wonderful three-dimensional graphics that my students could do in a day. That's all they want to show you. They do not want to show you the actual cost. That's what it's going to come down to. Can they be built? Yes. I have no problem believing that they can actually be constructed. I do believe that, technically, they will work and function. It comes down to what the capital cost is going to be, and more importantly, how much staff we would need to operate one of these units, because that's going to affect the capital costs and the profitability of them. That's what we need to start getting the focus on. If we can get them to focus on what that cost will be, then we can answer that question as to how close it is.

New Scale is one of the leads in the United States. It's quite likely that they're targeting the aircraft carrier market with their design. Therefore, they're probably quite well advanced, but again, they don't want to tell anybody just how far advanced.

In Canada, probably the most lead-interesting unit will be Terrestrial Energy's molten salt concept. They're putting a huge amount of effort into it, and they certainly have some very intriguing, new ideas on how it can be used and implemented, which are quite fascinating. But, again, what's the cost going to be, etc.?

I think they could get a design completed maybe within five years and get some nice cost figures, but we're not going to have one ready for construction before 10 years, in my opinion, based upon what I see right now. It gets back to what I meant with focus. Now we have a lot of NRCan money being spent towards the supercritical water reactor. If that money was converted and redirected to SMRs, maybe we can actually push that along a bit. But we have to pick an SMR design. I think there are something like 30 options out there in the world right now, and that's somewhat ridiculous. We have to pick one.

Mr. Mark Strahl: You also mentioned that relative to some other technologies, the economics of nuclear energy is a higher cost option, and it's obviously low-emitting. Where would the targets be to reduce that. Obviously, people want to maintain safety; they want to maintain reliability. Along the supply chain, if you will, where should the targeting be to look for those cost savings?

Mr. Jerry Hopwood: I'll take a shortcut on this. The most significant way to reduce costs would be in replication. The reason that nuclear plants have been expensive and have run over budget, which is perhaps even more of a concern because it leads to uncertainty in the minds of those who are investing in it, is that we keep building first-of-a-kind. We've had numerous examples around the world where new technologies are being developed that look very attractive, and will be very attractive, but that first-of-a-kind build runs into trouble. It's only later that the technology becomes well settled and people are building repeat plants. That has actually been the case in CANDU, where the CANDU 6 units built in the second generation around the world in the 1980s and 1990s benefited from being effectively a replication-type plant. I think that's one benefit, but that means there needs to be a sustained commitment to ordering that may be a worldwide agreement.

Glenn, do you want to comment?

● (0920)

Prof. Glenn Harvel: I agree with your comment. When you look at the Darlington refurbishment, the fourth unit to the refurbishment is going to go very well because they will have learned everything from the first unit. We have to keep in mind that first unit may be delayed, it may have some issues associated with it, because it's the first time that group of people are trying to do that. This is where I believe some R and D—

The Vice-Chair (Mr. John Barlow): Sorry, Mr. Harvel, I'm going to have to cut you off there at seven minutes. Maybe Mr. Cannings will leave you a chance to finish your response.

Mr. Cannings, you have seven minutes.

Mr. Richard Cannings (South Okanagan—West Kootenay, NDP): Yes, keep going.

Voices: Oh, oh!

Prof. Glenn Harvel: Okay.

There's some good R and D that could be done in universities in the mechatronics and robotics areas, where we could start developing tools to shorten the human time involved in some of this work. That also helps with the repeatability of it, because now you have a device that's actually going to do the job the same way every single time it's used. That is the area where I think we can start putting some R and D effort in at the university level to start developing these techniques.

Mr. Jerry Hopwood: If you don't mind, I'll add another point to this question of cost to follow up on what Glenn mentioned with regard to how to develop a small modular reactor type or how to deploy small modular reactors.

I think one of the other areas where cost has been affected is the changing in of requirements during a project. The nuclear industry fell afoul of this in its earlier years. These days, we know a great deal more about how to regulate and how to ensure safety, in our view as industry practitioners. We feel that safety requirements can be settled in advance of a project so that the person who is building it knows exactly what to do. It's a bit like building a house and discovering that your electrical code has changed halfway through the construction. That's really hard to deal with. If we can eliminate this, that would be very good.

From the small modular reactor point of view, I would very much emphasize that there are many ways to build a small modular reactor. Several have already been done successfully. The key is to know what requirements they would have to meet in places such as a remote community or a northern community, or even in a small-town setting. Setting those requirements early, whether it be for the operational, as you say, for remote operation, or for the expectations for local habitation around a reactor, will enable the designers to get on with the job of finalizing it.

Those are just two ways to address it.

Mr. Richard Cannings: To get back to you, Mr. Harvel, you talked about focus and about choosing between a supercritical water reactor or SMRs. From your comments, I got the impression you would favour SMRs. You said there were 30 kinds. From your own personal view, is there one that we should be concentrating on?

Prof. Glenn Harvel: They're all fascinating from a professor's point of view, which is “fund them all, please”, but that's impractical.

Voices: Oh, oh!

Prof. Glenn Harvel: The SCWR technology can probably go to a low funding level because it is still a technology that is going to be 15 or 20 years away with what's happening there. There's still a lot of debate about how exactly you make that device work.

In the SMRs at the moment, I would either concentrate on Terrestrial Energy's technology, because it's going to be strongly Canadian and very interesting and unique, or collaborate with one of the integral PWRs like NuScale, or something along those lines, and concentrate just there.

The advantage of the NuScale type is going to be that it has a lot of basis from the submarine technologies, so we know that scale is very likely to work. Molten salt is a little riskier, but then there's a lot more potential for Canadian intellectual property in that reactor.

Mr. Richard Cannings: On the other areas of focus, you were talking about improving on the CANDU model and making it safer, faster, and cheaper. We talked a bit about how to reduce costs. Can both of you perhaps comment on how we can make them safer and faster?

• (0925)

Prof. Glenn Harvel: It's all about the day-to-day work we have to do. If we have to sit there and change a seal on a pump, etc., or we have to change a pressure tube or some other component.... It's the maintenance work. A lot of that maintenance work is still done in a very time-consuming manner. Doing the development so that we can do that work faster, with machines, turning it more into an nth-of-a-kind approach so that it's being repeated constantly, and shortening the amount of time it takes people to [*Technical difficulty—Editor*].

All of those aspects would be important to this.

Mr. Richard Cannings: Thanks.

I'm still trying to figure out what the heck happened with our sound there.

Voices: Oh, oh!

Mr. Richard Cannings: Perhaps I could get, with whatever time is left....

The Vice-Chair (Mr. John Barlow): I'll give you a little extra. You have two minutes.

Mr. Richard Cannings: Perhaps both of you could comment on the waste management aspects of nuclear energy and where we are in Canada, how we compare with the rest of the world, and how much that is going to cost us.

Mr. Jerry Hopwood: I'll make a few comments to kick it off.

I think Canada has had a decades-long program looking into the management of the most serious nuclear waste—that is the used nuclear fuel—and has been managing its nuclear waste all this time.

Canada, like some of the other early nuclear countries, started in the 1940s, in wartime, so we have a legacy of waste that was not particularly well documented and disposed of in the early days. That's been a difficult and troublesome topic in terms of cleanup of places like Chalk River.

As far as the nuclear fuel is concerned, I think that engineers would believe that it's quite understandable and feasible that we know how to store the waste underground in deep geological repositories. From a technical point of view, we look at the numbers and we would say that the risks to our lives are extremely low from those kinds of depositories and we know how to do it. The key is the social licence, because only when people will accept a waste depository in their neighbourhood can it go ahead. It seems to me that the NWMO is pursuing that in a very careful and well-thought-out way and is engaging with people in a way that I hope will succeed in building and creating that social licence, so I think that's actually the key.

The cost of waste management and treatment as a portion of the cost of electricity from nuclear power is very tiny. It's an extremely small fraction of the total cost of the electricity that's being produced, so I don't feel concerned over the total cost as it will arise over the years, knowing that the nuclear utilities are supposed to put money into a waste fund that will fund that work.

I think the key is the social licence.

The Vice-Chair (Mr. John Barlow): Thank you, Mr. Hopwood.

Thank you, Mr. Cannings.

Now we go to Ms. O'Connell for seven minutes.

Go ahead, please.

Ms. Jennifer O'Connell (Pickering—Uxbridge, Lib.): Thank you, Mr. Chair.

Thank you, both, for being here.

By way of background, since I'm a visitor to this committee, I represent Pickering—Uxbridge, and previously I was on council for 10 years as city councillor, regional councillor, and then deputy mayor. Given that I represented Durham region, and we host Darlington and Pickering, obviously I find this very important.

Mr. Hopwood, you touched on something, but unfortunately I feel that we really need to discuss this more given Pickering's situation, and that is decommissioning. Are we prepared with the engineers and the people to actually go through this process of decommissioning for Pickering, which will take place soon?

Mr. Jerry Hopwood: It is coming up and it's going to happen, so we should be prepared for it.

I will make two comments. One is that OPG is already engaged, as it happens, with UNENE in researching techniques to dismantle and decommission the Pickering unit, so it is taking action and it's being proactive about it.

I would also comment that Canada has a fantastic opportunity, because Canada has a series of prototype reactors that were shut down, some many years ago. NPD, which is up in Rolphton in the Ottawa Valley, and Douglas Point, which is at Bruce, and Gentilly-1, which is near Trois-Rivières, all operated as prototypes. They have been shut down for some years, which has allowed time for the decay of some of the radioactivity that might be in existence. As prototypes—and I believe they're owned by Canada—these are test beds that should be used as a way of gaining experience so that the decommissioning of Pickering can gain from knowledge arising from the decommissioning and the dismantling of those units. I believe NPD will be dismantled as part of the mandate of the new company operating Chalk River.

• (0930)

Ms. Jennifer O'Connell: Thank you. I would think that if you're going to sell CANDU around the world, you have to sell how you're going to decommission as well, and Pickering is a perfect example. We're one of the oldest in the world, including Canada obviously.

I'm glad you both raised social licence. I've lived in Pickering my entire life. I know what it's like to live in a nuclear community. But I also know the changes that have happened over the years. When I was in elementary school, we had emergency drills for a nuclear accident—in elementary school, not in high school, because I guess you're on your own in high school. KI pills were recently distributed, but that was as a result of a regional motion that we actually moved when I was still on council. They don't do emergency drills in schools anymore.

OPG recently did a study in Pickering, asking people if they were prepared; what would you do in the event of a nuclear accident? It was terrifyingly low. People had no idea where to pick their kids up, where to go, what to do, how much time you have, what routes to take, all of that.

What role do you think your institutions—I know you focus on engineering and science, but part of the social licence, I think, is that everything is done in these silos. You talk about the science, but then it's somebody else's responsibility to do the emergency planning and then somebody else's responsibility for land-use planning in and around nuclear sites.

What roles do you think you have, in terms of building up that social licence? They're actually talking about it. I feel like sometimes people don't want to talk about emergency plans because it makes people think, why do we need an emergency plan? But not having that conversation, perhaps, leads to what you both talked about in terms of not understanding.

Prof. Glenn Harvel: At the university we've already started to try to work toward dealing with this. We started off in an easy way. We deal with the students first. We have forums and debates to get them introduced and excited about it. We've created a new course on nuclear security, and we have plans to bring emergency planning courses into the programs for the graduate-level students. That's one aspect that we're able to do.

The other aspect that the university is quite willing to do is to act as a host for any type of forum or meeting for discussions that the OPG, the CNSC, or the government wishes to have. We've already done that, where the CNSC has come in and opened up what they call a “regulator 101” type of meeting. We're already doing that part of it now.

What we need to do is get back to engaging the public directly at the university level, and start to engage them more with the teachers getting back into the classrooms and local community groups. That's the role that I believe the university can play.

Ms. Jennifer O'Connell: Thank you.

I touched on this a little bit in my statements in the last question: land-use planning. I find this is an interesting one that is not really touched upon, so I'm wondering if you could talk about this at all.

Again in Pickering, not only do we host the nuclear facility but we were selected by the province as one of their places to grow, which meant intensifying our downtown, increasing our population. Our nuclear facility is extremely close to our downtown and the rationale, when residents raised concerns about intensification in this area, was, “Well, it's decommissioning”. Then the province talks about extending the licence, and we say, “But what about that land-use planning rationale?”

Again, it's these silos, right? When you're talking about social licence and talking about getting the public involved, I was on council for 10 years, as I said, and we didn't have the universities, we didn't have the scientists, necessarily, at the table. Is there an opportunity, when you look at planning, because you really can't build nuclear facilities without truly understanding what that neighbourhood's going to look like in 10, 15, 20, or 30 years?

● (0935)

Prof. Glenn Harvel: I agree. Just invite us and we'll come. We talk about that in my class when we're talking about the design of a nuclear power plant and understanding how to site a plant, where to site it, and everything.

One of the interesting questions I raise, if you look at Pickering specifically, was that when they first started building the plant there, there was no city.

Ms. Jennifer O'Connell: Right.

Prof. Glenn Harvel: It was the countryside. Now a city has developed around it and that's changed the whole nature of the relationship between the plant and the city.

Ms. Jennifer O'Connell: Absolutely.

Prof. Glenn Harvel: This is something we are teaching the students, that when they're doing the design work they have to think about this and they have to plan for this. It's not necessarily a site for 150 years if this is going to change the community.

We will gladly come to any council or committee. We've done a few. It's been getting better in the past few years, but it has only been in the past five or six years that the university has been invited.

The Vice-Chair (Mr. John Barlow): Thank you, Ms. O'Connell.

Thanks, Mr. Harvel.

We have just under 10 minutes left. We don't have quite enough time to go through a second round, but if everybody wants, we could maybe have two or three minutes as a round, if everyone is fine with that.

Ms. Stubbs for a couple of minutes, then.

Mrs. Shannon Stubbs (Lakeland, CPC): Thank you, Mr. Chair.

Thanks to the witnesses for being here.

To the member from Pickering, I hope you'll be able to participate in future discussions on this committee. Some of the issues you discussed haven't come up before, and I think you bring an interesting angle to our discussions here.

Mr. Hopwood, I know you've commented previously on your concerns around the ability and rate of moving from R and D to commercialization within Canada, so I just wanted to welcome you to expand on that in terms of what you see as the major barriers, and also if, other than direct funding, you have any advice in terms of policy tools, fiscal measures, frameworks, or approaches that government could take to enhance that process. I would welcome both of your comments on that front.

Mr. Jerry Hopwood: Sure. It's a subject close to my heart, but I'll try to keep it short if I can.

We've seen a great deal of R and D in Canada that has not always resulted in achieved results in terms of new power plants built or new research results, so R and D is an unpredictable business. It makes sense—perhaps both of us being from the university side now would see it this way—to start small and to do R and D in an exploratory way if you have a lot of unknowns, and then build that program outward, but not to try to jump into a huge program.

I think that one of the challenges facing Canada in terms of R and D in the nuclear area is going to be that we cannot do it all by ourselves. It would be very foolish for a middle power like Canada to try to achieve what was amazingly achieved with CANDU, which we did all by ourselves. Today, I don't think that's going to be possible.

Glenn mentioned that there are 30 SMR designs out there. None of them is uniquely Canadian. All of them have some relevance to Canada and have an international domain. Therefore, my plea would be that as a country and as industrial members we team up, participate, partner with, and co-operate with agencies and international organizations overseas because that will vastly multiply the amount of intellectual gain we get from our R and D. That would be one way we could move forward.

I would echo Glenn's comments that at some point you have to focus and agree that you pick something. It may not be the best. We all remember the stories of the VCRs, that Betamax was the best tape but it wasn't the one everyone chose. That's okay, because sometimes you pick something that works and you go with it. I think waiting around to find the best possible option isn't necessarily a good way.

● (0940)

The Vice-Chair (Mr. John Barlow): Thank you, Mr. Hopwood.

Now, we'll go to Mr. Serré for three minutes.

Mr. Marc Serré (Nickel Belt, Lib.): Thank you, Mr. Chair.

Thank you to the witnesses for your presentations.

In the little time I have, I have two questions. First, can you provide to the clerk further evidence or suggestions when you talk about picking a lane on the R and D? I always say this, “pick a lane”, and I agree with you that we should be deciding whether it's a water reactor or a small modular reactor. If you could provide more information to the clerk, that would be really helpful so that we could share that in our report.

My other question is on the indigenous file. I wanted to get your opinion on this. With uranium mining, we have very good impact benefit agreements, and there's a good relationship happening with indigenous people, but when we look at social licence.... Mr. Strahl earlier commented that our public education is with *The Simpsons*. Maybe some of the indigenous communities don't watch *The Simpsons*, which might be a good thing.

What has the nuclear industry done, and what should it do to engage our first nation communities in the nuclear industry outside of the uranium mines?

Prof. Glenn Harvel: The only one that I know of was an attempt by a mining group to put a small modular reactor in the Arctic for mining support. They had approached the indigenous communities of the north, and they got a rather lukewarm response to that. They were quite happy with the fact that they would not have to pay $20 a litre for diesel, but they were still quite concerned about the nuclear aspect, and we didn't have a chance to follow up and have a good discussion on what the risks were.

One of the things that you can do.... Dan Meneley is a colleague of mine, and he has been chasing this idea. The American military is looking at ways to use nuclear power to generate fuels like aviation fuels and kerosene fuels, which you could do in the north with an SMR and then use that to fuel the native communities. The indigenous groups could run that business. That becomes an interesting option for them, but that would require some R and D. That's all I have.

Mr. Jerry Hopwood: I have just a very brief comment that the NWMO in Ontario is being engaged quite extensively with indigenous groups in siting waste depositories. I've heard debates and discussion, which I think have been constructive. Whether it's going to achieve its ends is another question, but at least there's a respectfulness and a recognition by the industry that it has to reach out.

The Vice-Chair (Mr. John Barlow): Thank you, Mr. Hopwood.

We'll finish up with Mr. Cannings for a couple of minutes, please.

Mr. Richard Cannings: Just quickly, if both of you could comment, and this might go a bit beyond the academic realm. Considering the big upfront costs of nuclear and the decreasing costs in other energy sectors' renewables, I wondered if you could comment on the challenges facing the nuclear industry when moving into new provinces. For instance, Ontario seems to be on board, but other provinces are picking other routes, and a lot of that choice is based on costs. Could you comment on that?

Mr. Jerry Hopwood: I think it's very timely, given the circumstances of the move to phase out coal. I think that if we only look at cost, first of all, then we're missing part of the dimension. Nuclear is a base load of power supply. It runs best when it's running full out all the time. It provides the constant, very reliable electricity that we're getting in our room right now. Other greenhouse-gas-free sources, such as wind and solar, are intermittent and provide very valuable power, but have a very different characteristic from base load.

Independent agents—and I used the International Energy Agency as an example—say you need both, and that trying to rely on one or the other is not the right approach.

I grew up in an era where the central planning of electricity supply was the norm, and people tried to get a balance between different types of electrical supply because that gave you the most reliable system. We're moving away from that for many good reasons, but the idea that you may need more than one type of electrical supply is still there. Based on that, I think there would be merit in a debate or a discussion between the nuclear industry and Saskatchewan, Alberta, and even Nova Scotia.

● (0945)

The Vice-Chair (Mr. John Barlow): Thank you, Mr. Hopwood. I'm sorry I have to cut off there. That's our time.

Thank you very much, Mr. Harvel and Mr. Hopwood, for being here with us today. Your testimony was very educational.

We'll take a two-minute break as our next witnesses get set up, and then we'll get going with our second group.

● (0945)

(Pause)

● (0950)

The Vice-Chair (Mr. John Barlow): Thank you, everybody, for being here today.

I understand we have a little change to our witness list. Mr. Heysel is a bit delayed with a flight, but we have Andrea Armstrong and Karin Stephenson from McMaster University. We have Jean Koclas from l'École Polytechnique de Montréal, and we have Éric Turcotte, on video conference, from l'Université de Sherbrooke.

Thank you very much for being here. You will be given 10 minutes each for your testimony. Then there will be questions from our committee.

We'll leave McMaster for last, just in case Mr. Heysel is able to make it in time.

Perhaps we'll start with you, Mr. Turcotte, for 10 minutes, please.

[*Translation*]

Dr. Eric Turcotte (Associate Professor, Department of Nuclear Medicine and Radiation Biology, Université de Sherbrooke): Good morning, everyone. Thank you very much for the invitation to appear before the committee.

I am here as a representative of nuclear medicine specialists. I am an associate professor of nuclear medicine at the Université de Sherbrooke. I am also the clinical head of the Molecular Imaging Centre of Sherbrooke. Finally, I hold a licence for producing medical research isotopes, as well as a licence for producing private isotopes. In short, I am a professor in nuclear medicine, as well as a user and producer of medical isotopes. I am involved in all the stages of the isotope-use system.

In 2009, I was a member of the Expert Review Panel on Medical Isotope Production, which was created at the request of Minister Raitt of the Canadian government. That panel considered plans for developing isotopes in Canada. I am also part of a research group on the use of cyclotrons as a way of replacing nuclear reactors in the production of technetium.

Between 2009 and today—so since my last appearance before this parliamentary committee—a number of events have occurred. I would like to summarize them very quickly to establish context.

From 2009 to 2016, the National Research Universal, or NRU, reactor resumed its activities, much to the relief of all. Its presence helped put an end to the isotope crisis we experienced in 2009. Afterwards, a number of international committees were created to manage the supply. Those committees did excellent work to standardize production and the supply chains, as well as to ensure that no shortages would occur in the future.

Changes to nuclear reactors have been made slowly. Let's remember that reactors must shift from using highly enriched uranium to low enriched uranium. For some reactors, the change has already been made. The same will have to be done for other reactors, since the United States will no longer provide highly enriched uranium.

The Canadian government has made investments in developing alternatives for the production of medical isotopes without the use of nuclear reactors. Among those solutions are projects carried out using linear accelerators and cyclotrons. I expect those technologies to become operational by the spring and summer of 2018.

I also want to remind you that many changes have occurred among isotope providers in Canada. The radiopharmacies of Lantheus Medical Imaging were sold to Isologic. That group is now the primary provider of isotopes in Canada. In addition, the NRU reactor was shut down in October 2016. It will have to remain dormant until March 2018.

I will speak on my behalf, and probably on behalf of a number of individuals involved in the medical field, when it comes to medical aspects. We do not anticipate a lack of medical isotopes over the short term given the striking and organized coordination of various nuclear reactors around the world. Unfortunately, that by no means makes us immune to a major failure. Such a failure could occur at any time and would destabilize the supply chain.

I would like to highlight a reality specific to Canada. Although we think that the supply should remain stable, we are headed toward another problem, that of supply costs and isotope use. With the shutdown of the NRU reactor, isotopes are no longer abundant. A few nuclear reactors are responsible for world production, and that is why there is no longer much surplus. In addition, the reactors that were heavily subsidized, such as the NRU one, are withdrawing from the market. As a result, the path is much clearer for smaller reactors to recover the full cost of isotope production in order to be profitable. We really expect that to lead to a cost increase.

We should add the drop in the production efficiency of low enriched uranium, and that means that the technology creates additional costs. Moreover, the withdrawal of Canadian distributors, following the creation of mega groups, could greatly encourage the appearance of monopolies in the supply of isotopes in Canada.

So we see that all the ingredients are there to increase the cost of isotopes in Canada. Some could drive up the costs by 10$ or 20$ per patient. Individually speaking, those amounts may seem trivial, but when we multiply them by the hundreds of thousands of procedures done annually, they turn into millions of dollars. Canada's health system cannot absorb such a rapid increase.

I yield the floor to you.

● (0955)

[*English*]

The Vice-Chair (Mr. John Barlow): Thank you very much.

We'll now go to Monsieur Koclas for 10 minutes.

Dr. Jean Koclas (Professor, Nuclear Engineering Institute, Engineering Physics Department, École Polytechnique de Montréal): Thank you, Mr. Chair.

Even though I could give my talk in French, I think I will give it in English for the benefit of most of the people here.

I am currently a professor of nuclear engineering at École Polytechnique in Montreal. I have been there for almost 25 years. Previously, I worked for 10 years at Hydro-Québec, doing nuclear safety analysis and reactor control system analysis. Before that, I worked for almost two years at the AECL laboratories in Chalk River, so I have quite a good view of what is going on in this industry.

The nuclear industry is a very large and very complex industry in Canada. We have this idea that it's about reactors, but there are many companies that are providing both services and goods of extremely high quality to the industry because of its specific requirements. This particular industry in Canada has always been based on the CANDU system. The CANDU reactor is a very complex reactor.

● (1000)

If you ask any person working in a CANDU plant, when they compare a CANDU plant to other types of plants that are commercially viable on this planet, they will always tell you that the CANDU reactor is a complex reactor. It has many systems and subsystems, much more so than other plants. It is because of this complexity that, if our CANDU plants are to stay competitive on a global scale, we must absolutely rely on top-notch R and D at many levels.

If I concentrate on the Chalk River laboratories, I have grave concerns about the future of our industry if the NRU reactor is closed down in the short term and is not replaced by an equivalent reactor to do specific research. First, one thing that distinguishes CANDUs all over the world is the fact that it must be refurbished or retubed every 20 to 25 years of operation, which means that these reactors have to be stopped for a year or two, three years sometimes, to refurbish and to replace the pressure tubes.

Other technologies do not have this. This is one aspect. The other aspect is the fuel development itself. The only place in Canada where advanced materials for the future of the CANDU reactor can be studied with confidence is when we have a high neutron flux in a high volume, not in a very small location but in a very large core area where conditions resemble what we have in nuclear power plants. You need this type of facility to conduct such research.

You also need a larger research reactor to accommodate actual fuel from CANDU reactors. In the absence of a large research reactor in our country, we will have to send fuel designs outside of the country. It should be clear to anyone that the facilities outside this country do not provide what is required to restore fuel in the complete fuel bundle of a CANDU reactor; they can only provide small parts.

It means that in the medium to long term, the Canadian way of dealing with nuclear power plants will simply get off the grid in global terms. We will not be able to go from generation II reactors, which we have now, to generation III, and even less so, for generation IV.

Therefore, please consider giving Canada a replacement to the NRU, or at least, let us try to keep NRU working for a longer time, which I perceive as an administrative constraint, rather than a purely technical constraint on the life of the NRU reactor.

This is one subject that I have close to my heart. I think the Chalk River laboratories will continue to do very good work in many areas. The word "laboratories" clearly states that there are many labs at the Chalk River facility, but it is vital for the country, if we are to keep the CANDU system alive, not only in Canada but abroad, that we should make all efforts possible to keep NRU and/or replace NRU itself.

This is one point. The other point is that I want to make people aware of how fragile this system is. In Quebec, we had a fully working CANDU reactor. It was going to be refurbished and the Quebec government, with a single signature, was able to completely shut this plant down, so we do not have nuclear power in Quebec anymore.

● (1005)

I'm not talking in a disgruntled fashion. I just want to make people aware that because of increasing cost differentials between the production of nuclear energy and the production of a softer or easier way of producing power, such as shale gas at very low prices, that puts a lot of pressure on keeping the nuclear industry alive, whether it's here or abroad.

The Vice-Chair (Mr. John Barlow): Sorry, Mr. Koclas. Thank you very much. We have to move on to the next witnesses and perhaps you'll be able to answer a bit more with some of the questions.

I see that Mr. Heysel's made it.

Thank you very much for being here. The timing was perfect. You have 10 minutes for your presentation.

Mr. Christopher Heysel (Director, Nuclear Operations and Facilities, McMaster Nuclear Reactor, McMaster University): Good morning, Mr. Chairman and members of the committee. My name is Chris Heysel. I'm the director of nuclear operations and facilities at McMaster University.

First, let me take the opportunity to thank the committee for the opportunity to address you this morning.

Prior to coming to McMaster, I spent 14 years working at the national research universal reactor, or NRU, at Chalk River, and served as the engineering manager for the facility before coming to McMaster.

McMaster is a medium-sized, research-intensive university, located in Hamilton, Ontario. It is home to an extensive array of nuclear research facilities, including the McMaster nuclear reactor, a five-megawatt research reactor. Once the NRU is permanently shut down in March 2018, McMaster's nuclear reactor will be the most powerful research reactor in Canada.

Nuclear research reactors are important because they produce neutrons. Neutrons are important because they are used by hundreds of Canadian researchers to solve research problems in all five of Canada's science and technology priority areas. Neutrons are used in environmental and agricultural research to improve Canadians' understanding of plant nutrition as we work toward global food security in an era of climate change. They are used to analyze the flow of pollutants in our ecosystems and to understand the impacts of these pollutants on Canada's lakes, streams, and aquatic life. Researchers are also using neutrons to examine how radiation exposure affects organisms at the cellular level.

In the natural resources and energy sectors, neutrons are used to identify deposits of resources, including gold and uranium, and they are used to determine the composition and geological age of Canada's landmasses. In fact, tens of thousands of assays are conducted at McMaster's nuclear reactor every year, in support of Canada's mining industry. Neutrons are used to create the nuclear gauges used in the oil and gas sector to characterize underground wells and pipes, and to detect leaks in these systems. As well, emerging small modular reactor technologies have tremendous potential to power resource extraction equipment at remote sites and provide energy for our remote communities in northern Canada.

In the health and life sciences sector, Canada has a long and proud history of using neutron-based medical isotopes to diagnose and treat disease. Research into new medical isotopes and new pharmaceuticals using these medical isotopes is ongoing throughout Canada. Researchers at McMaster are also developing neutron-based techniques for diagnosing heavy metal poisoning in occupationally exposed workers.

Neutrons are especially important for research into materials sciences because they penetrate deep into materials and provide information about interior structures of matter at the atomic level. This is important for developing advanced materials for clean energy technologies, high-efficiency engines, and information technology hardware.

Neutrons are routinely used to detect flaws in parts for the aerospace industry, to ensure the safety of Canada's air transportation industry. Researchers are also examining the effects of cosmic radiation on aerospace components toward designing the next generation of satellites, space telescopes, and interplanetary space probes.

Neutrons are important. Research reactors are important. Maintaining Canada's small fleet of nuclear research reactors, which includes several SLOWPOKEs and the significantly higher-powered McMaster nuclear reactor, is critically important, especially post-2018. Without research reactors to serve as sources of neutrons, none of the above-mentioned research can be performed.

The McMaster nuclear reactor also plays an important role in education, especially through our outreach program. Thousands of high school students, university students, science camp participants, and everyday Canadians visit McMaster's nuclear reactor every year to learn about nuclear energy and nuclear research in Canada.

● (1010)

McMaster has an extensive suite of nuclear facilities that complement its research reactor, including a 24,000 square-foot nuclear laboratory facility and a new cyclotron facility that produces the medical isotope fluorine-18, which is used for cancer diagnosis.

Our new, industrial-size, post-irradiation examination hot cell facility allows researchers to safely handle and test highly radioactive materials, such as components from Canada's nuclear power plants. This enables scientists to ensure the safety of Canada's existing nuclear fleet, while developing appropriate materials for use in next-generation technologies. Our expansive suite of nuclear facilities, infrastructure, skills, and equipment has earned McMaster the title of “Canada's nuclear university”.

I'll speak more specifically to the questions posed by the committee. The main challenge facing nuclear energy development in Canada today is the impending closure of the NRU reactor, with no clear plan to relocate the vital research being done at this facility. The McMaster nuclear reactor is the only facility in Canada capable of supporting this work. While we are working toward expanding our capacity to accommodate researchers from NRU, we can't do so without support.

The McMaster nuclear reactor is the only self-funded research reactor in the world. It receives no direct funding from the university or from any level of government, federal or provincial. We attempted to secure funding to expand our research capacity through the Canada Foundation for Innovation's major science initiatives program. However, the MSI committee ruled that it was not even able to consider our application on the grounds that neutron-based research activities remain a responsibility of the federal government through NRCan.

The future of nuclear research, development, and technology in Canada is very precarious. When NRU closes, a community of approximately 250 Canadian neutron beam researchers will be displaced. These scientists may well relocate to foreign countries to access neutron sources or change their research areas entirely.

The Canadian industries that rely on this research, including advanced manufacturing and medical sciences, are also in jeopardy. We, at the McMaster nuclear reactor, are working to increase our capacity to support Canada's neutron source researchers and technologies and to minimize the impact of the closing of NRU, but we need your help.

Canada is among the world's leading nations in nuclear research, as described earlier. Canada is also a world leader in the production of medical isotopes. The NRU reactor currently supplies about a dozen different medical isotopes to the world. Indeed, McMaster University's research reactor is the world's largest supplier of the medical isotope iodine-125, which is used to treat prostate cancer. Our staff are proud to produce cancer treatments for over 200 dads a day. The McMaster nuclear reactor's research and development team works with researchers from all across Canada to develop new medical isotopes and technologies. We are also developing our capacity to produce many of the medical isotopes now produced at NRU.

In conclusion, Canada is facing a massive disruption of its neutron-based research in 2018. The McMaster nuclear reactor already plays a large role in Canada's neutron-based research, and that role will only grow going forward, particularly if a reactor core upgrade is explored as a long-term solution to the impending neutron gap.

We are excited to have the opportunity and the privilege to work with some of Canada's leading scientists and engineers as they pursue research that will meet Canada's domestic science and technology priorities and improve the health, environment, and standard of living of all Canadians.

● (1015)

Thank you very much for your time and attention. I would be happy to answer any questions you may have.

The Vice-Chair (Mr. John Barlow): Thank you very much, Mr. Heysel. I appreciate your presentation.

Just as a reminder, there is a headset to your right, underneath or on your desk, for translation if you need it.

Now we'll go to Monsieur Lemieux.

[*Translation*]

Mr. Lemieux, you have seven minutes.

Mr. Denis Lemieux (Chicoutimi—Le Fjord, Lib.): Thank you, Mr. Chair.

I want to thank our three witnesses for their excellent presentations, which were very thought-provoking.

My first question is for Dr. Turcotte.

You are the head of clinical research at the Molecular Imaging Centre of Sherbrooke, one of the most recognized research centres in Canada when it comes to positron emission tomography. Could you tell us more about that research centre and about the work you are doing there?

Dr. Eric Turcotte: I really appreciate your question. There are several aspects to our work. The Molecular Imaging Centre of Sherbrooke was created in 1998, with the installation of a cyclotron, a device that runs on electricity and is used to produce research isotopes.

Afterwards, the centre grew a lot thanks to the hiring of radiophysicians and radiochemists, the team needed to produce isotopes. So the centre shifted from research to clinical use. The isotopes used in animals for scientific research needs will also be used in humans for diagnostic purposes.

Our centre combines two devices for manufacturing isotopes. We use two cyclotrons that provide us with a wide range of isotopes. We have devices to perform imaging of both the animal model and the human model. Those are positron emission tomography devices.

We also have magnetic resonance imaging devices and other high technologies that enable us to perform imaging.

Ours is a unique laboratory that enable us to take an isotope—a radioactive substance—and apply it to a disease.

● (1020)

Mr. Denis Lemieux: Could the Canadian government do more to support your research centre?

Dr. Eric Turcotte: The government has been heavily involved since 2009 in terms of funding programs for the use of accelerators to produce isotopes. The Sherbrooke centre has twice received funding from the Canadian government to find a way to use cyclotrons to produce technetium.

We can produce technetium and we are allowed to use it on humans, but we are still at the research stage. However, when it comes to producing technetium isotopes, we expect that, by March 2018, we will even be able to move on to the commercial stage and then supply other Quebec hospitals with isotopes produced in Sherbrooke.

Mr. Denis Lemieux: That's very interesting.

Other witnesses have told our committee that a lot of improvements have been made, but that those improvements are marginal in the various sectors of nuclear research. So they recommend that the government make research efforts more focused in order to have better results.

I would like to hear what our three witnesses have to say about that. Do you think that nuclear research is too scattered in Canada?

Dr. Eric Turcotte: We do feel that the research is scattered. Unfortunately, the funding is diluted as a result, and that does not foster the installation of high technology in a specific location.

However, the competition created in a number of areas forces us to challenge ourselves. Canada even has the reputation of doing a lot with very little. Sending money to various groups actually helps maintain that type of leadership.

If a decision was made in the nuclear sector to concentrate everything within a single centre, all the other centres would close within one or two years, and that would be catastrophic.

Mr. Denis Lemieux: I would now like to hear what other witnesses have to say about this.

Dr. Jean Koclas: It is a bit difficult for me to answer your question directly.

At the École polytechnique de Montréal, we cannot say that we cover all the disciplines related to nuclear engineering.

However, we have developed software that is now used by the entire CANDU nuclear industry, not only reactors in Canada or those of the now defunct Gentilly-2 nuclear power plant, but by all CANDU reactors, around the world.

That happened because we focused our efforts and received fairly steady funding. Before we were successful, those efforts were put in over at least 25 years, if not 30 years of development. During that time, Atomic Energy of Canada was trying to develop software similar to what we have created.

However, since our software was already accepted by the rest of the nuclear industry, the niche we found has borne fruit thanks to a concentration of individuals who were all working in the same direction. Had some of us worked separately—one on waste disposal, another one on civil engineering of containment venting, and another one on long-term uranium supply—we would not have experienced this development, this success.

I could tell you that, on a large scale, it is necessary to focus....

● (1025)

[*English*]

The Vice-Chair (Mr. John Barlow): Sorry, Mr. Koclas, it's the end of the seven minutes. You may have time to continue with your answer in another question.

Now we go to Mr. Strahl, for seven minutes, please.

Mr. Mark Strahl: Thank you very much, Mr. Chair.

Thank you to our witnesses as well.

We heard in the previous panel about a need to focus our research and development. I think Mr. Lemieux just mentioned that in his question.

My question is for Dr. Turcotte. He's talking about the Sherbrooke cyclotron. We have a world-leading facility as well in British Columbia, the TRIUMF laboratory. We heard from some witnesses today about the need for an NRU replacement, and we've seen that there is a possibility. You talked about the commercialization in 2018 of Tc-99m medical isotopes being created in a non-nuclear facility such as yours.

Given that there is a scarcity of resources, where do you believe the government should be focusing its funding going forward? Is it in the new technologies? Do we need to have both? I don't expect you to be able to say whether the government can afford that, but I imagine it would be very expensive to maintain both at a world-leading capacity.

If you could talk about your perspective on that first, then I'll go to the panel that's here in Ottawa.

[*Translation*]

Dr. Eric Turcotte: Thank you.

As for the production of medical isotopes by a nuclear reactor, the panel of medical experts created in 2009 and I have always felt that this was the secondary mission and not the primary mission of a nuclear reactor. I think we need to properly establish the principle whereby a nuclear reactor is a device used mainly for research. Earlier, Mr. Koclas and other witnesses talked about the role of neutrons that come from those nuclear reactors.

Should the industry stop producing isotopes in nuclear reactors, there would still be other devices, such as cyclotrons and linear accelerators, that are used regularly to produce medical isotopes. It is certain that the production scale is totally different from that of a nuclear reactor. Let's take the example of a cyclotron. The cyclotron production of technetium is done on a provincial scale in Canada. The devices in Sherbrooke could produce enough isotopes to cover a maximum of 50% of the use and needs in Quebec. In comparison with a nuclear reactor, a paltry 20% of the NRU reactor would be used on a global scale.

Medical isotopes can shift toward those new less expensive and in-demand technologies. Should we some day need them, we only have to activate those devices to obtain isotopes. It's as easy as that. By comparison, when nuclear reactors are used, the process has to be started two weeks in advance to produce isotopes.

I feel that the nuclear reactor must be seen as a device for conducting research; that is its main purpose. The production of medical isotopes by a nuclear reactor is a secondary mission. Accelerators could help in that area.

[*English*]

Mr. Mark Strahl: Thank you.

To the panel here, Mr. Koclas and Mr. Heysel—doctors, I'm sure, pardon me—what is the figure talked about in NRU replacement? What is the figure that you understand we're talking about in terms of investment required to refurbish or replace the current NRU, which is scheduled to wind down?

● (1030)

Mr. Christopher Heysel: I think there are a number of numbers out there. It depends on the size and scale and the purpose that the reactor is designed to serve.

We have to remember that there's more than one medical isotope. There are dozens of medical isotopes. Some can be produced on cyclotrons, like the ones at Sherbrooke or McMaster, but some can only be produced at nuclear reactors. On the cost for replacement energy, I've heard hundreds of millions of dollars to a billion dollars. I've looked at the cost to upgrade the McMaster nuclear reactor, and it's closer to $200 million. There's a range of possibilities. It depends on whether you want the Volkswagen or the Cadillac, I guess.

The researchers in Canada flock to nuclear reactors because of the intense neutron fluxes that are available. We're there to produce neutrons, whether they are for research or for producing medical isotopes. We're multi-purpose; therefore, investment in that type of facility benefits Canadians on a number of different levels for the same investment. I believe that nuclear reactors, as well as cyclotrons, need to be part of the mix going forward.

Dr. Jean Koclas: I'm of the opinion that we can leave the production of radioactive isotopes to other means of production. That seems to be the way to go.

I think it would be about a billion dollars to design and build the equivalent of a modern NRU. A research reactor such as the NRU is essential because if you want to refurbish your CANDU in 40 years instead of in 20 years, you need to test material behaviour in accelerated time in a high-flux environment like that provided by the research reactor.

You're not going to have a lot of co-operation from your international competitors to help your technology compete with their own, so you have to do that for just your materials. You also need to study your new fuel behaviour, as well. On a strictly technological basis, a replacement for the NRU, or an extension of its life, is needed.

When I was in front of this panel in 2009, I said that the life of the NRU could be extended way above 2010 or 2012. Nobody believed me, but now we're in 2016, looking at 2018, which is like tomorrow. I think the life of this reactor could be extended to provide the neutron sources that we need in the meantime.

The Vice-Chair (Mr. John Barlow): Thank you, Dr. Koclas. I appreciate your time.

Mr. Cannings, you have seven minutes, please.

Mr. Richard Cannings: Thank you.

Thank you to all the witnesses for being here or speaking here.

I would like to start with Dr. Turcotte.

You talked about the challenges facing Canada and the world in the production of medical isotopes—the rising costs, the coordination needed—and the challenges around production if something shut down. There might be shortages. Could you expand on what you think is the best system or the best program that Canada can move forward with to provide a stable supply of isotopes for our country and, perhaps, for the world, which is a role we used to play?

● (1035)

[*Translation*]

Dr. Eric Turcotte: I will reiterate the recommendation issued in 2009 by the expert panel. It was to build a new nuclear reactor on Canadian soil to replace the NRU reactor. That was the main recommendation of the report. That reactor would be used for research on neutrons and for developing new CANDU reactors, with a secondary mission of manufacturing medical isotopes. It would also be used for numerous research projects. I think that Canada needs a functional nuclear reactor for all those reasons.

More specifically, when it comes to medical isotopes, it is certain that having a reactor on our soil is a guarantee of global supply and renown in the production of isotopes. That would also be added to the participation of other countries and would reduce the global burden of the need to produce isotopes. One country should not be the only producer for the entire world. My dream is for us to have a new nuclear reactor. Without such a reactor, Canada would become a buyer of isotopes just like other countries without a reactor.

Should that happen, we would not be immune to the market. We would have to follow the availability and the cost of obtaining isotopes, and the market could fluctuate based on the stability of nuclear reactors in the world. The mechanics are relatively complex when it comes to the final cost that could lead to, and when it comes to what we would think the final cost may be.

How could replacement technologies be a part of that large supply chain? I think that those other techniques exist to address the shortcomings of nuclear reactors. For example, the nuclear reactor of Petten, in the Netherlands, may have to undergo extensive maintenance, and Canada would experience a shortage of isotopes, let's say of 30%. So we would receive 30% less isotopes.

When it comes to accelerators—as we heard earlier—there is one in British Columbia, one at McMaster University in Ontario and another one in Sherbrooke. Those accelerators could be activated and cover the shortfall of 20% to 30% of isotopes in Canada. Once the Petten nuclear reactor returned to service, the production of cyclotrons could be reduced. So there could be such a dynamic in terms of global supply, where accelerators would cover the shortfall.

[*English*]

Mr. Richard Cannings: Thank you. I'm going to turn to Dr. Heysel.

Could you expand on McMaster's possible role? I know you touched on this, obviously, in your presentation. With NRU closing down, would you like to see McMaster being involved in a nuclear program of research and isotope production in Canada, where McMaster would work with another facility with a nuclear reactor?

Mr. Christopher Heysel: The key to supply chain stability is working with your competitors. Indeed, there are about two other large-scale producers of I-125, which is used all over the planet to treat prostate cancer. We're in regular communication with our competitors to ensure that, at the end of the day, a patient has a treatment available.

With the shutdown of NRU, what we're planning on doing, or what we've been reviewing, is increasing our power and increasing our operating time. That'll allow us to not only produce more isotopes, but it'll also help us sustain a number of the researchers and industries that currently use NRU.

That's a medium-term solution, and a viable solution to keep Canada through a neutron gap until we have another large neutron source. We will look at how we can refurbish our facility to be that large neutron source, but it'll be a wider discussion with a number of parties involved.

● (1040)

Mr. Richard Cannings: Dr. Koclas, you've made a really strong plea to keep NRU going. I was wondering if you could continue on that theme, perhaps talking about the economics of the investment—I think you mentioned a billion dollars to keep it going—over the next couple of generations of CANDU reactors.

The Vice-Chair (Mr. John Barlow): You only have about 30 seconds. I know it's really tough. Maybe Mr. Serré will give you some time.

Dr. Jean Koclas: I don't think we have much of a choice in that. Still, the end user of this specialty is the nuclear industry, the CANDU power industry, which is a very large and a very rich industry, although they claim they're not large and they're not rich.

The Vice-Chair (Mr. John Barlow): I'm sorry, Dr. Koclas, and I apologize, but we're very—

Dr. Jean Koclas: They should provide part of the financing for this.

The Vice-Chair (Mr. John Barlow): We're very tight for time.

Mr. Whalen, are you going to...?

Mr. Marc Serré: I'll share my time with Mr. Whalen.

The Vice-Chair (Mr. John Barlow): Okay. You only have about three minutes.

Mr. Nick Whalen (St. John's East, Lib.): Thank you very much, Mr. Chair.

Dr. Stephenson, thank you very much for coming today. We heard some interesting testimony earlier from Dr. Heysel that your facility operates "break even" through the revenues generated from your commercial operations. As you are manager of commercial operations, I'm going to give you the credit for that.

In that vein, do you see a role for a refurbished, extended, or replaced NRU in the global supply chain to generate revenues sufficient to meet its operating capacity and to be self-sustaining in the way McMaster is?

Dr. Karin Stephenson (Manager, Commercial Operations, McMaster Nuclear Reactor, McMaster University): I think there needs to be some investment in the refurbishment, but I think that even when we wrote our MSI application for CFI, the goal was to become sustainable at some point. I do think there's a trade-off. There will need to be some underlying support for operating costs, because it supports the research community as well. Ultimately, the goal in the long term is for it to be a sustainable entity and to reinvest in the McMaster nuclear reactor.

Mr. Nick Whalen: Do you see a global market for it to participate in to generate those revenues long term?

Dr. Karin Stephenson: I think so, yes. We talked a lot about technetium today, but we haven't talked about all the other medical isotopes that go into nuclear medicine, radiology, and treatment.

A nuclear reactor makes a lot of those other isotopes as well. Those markets are growing, and that's probably what's going to help sustain it long term.

Mr. Nick Whalen: In terms of the neutron shortage that might happen in Canada, where would Canada be acquiring other isotopes for research across the country if the NRU shuts down? What markets will we be looking to? What countries will we be buying the isotopes from?

Dr. Karin Stephenson: South Africa, Belgium, and the Netherlands have the other big research reactors in the world. Russia also has one. The U.S. as well is certainly involved in molybdenum-99, but for those other isotopes, they're all involved in all of them.

Mr. Nick Whalen: Presumably, if we expanded or extended, we would be able to sell into those markets as well with our additional....

Dr. Karin Stephenson: Absolutely, yes.

Mr. Nick Whalen: Thank you.

The Vice-Chair (Mr. John Barlow): You have about one minute or maybe a little less.

Mr. Marc Serré: I'll take 30 seconds, Mr. Chair.

Thank you to the witnesses.

The mandate of the committee is to look at innovation, sustainable solutions, and economic opportunities. I ask the three witnesses to provide to the clerk recommendations on specifically what you would want us to do to increase the number of jobs in Canada in the nuclear and medical industries, specifically looking at the good-paying jobs that we want to increase in the industry here, in the short time that we have.

Thank you, Mr. Chair.

● (1045)

The Vice-Chair (Mr. John Barlow): Thank you, Mr. Serré. I'll leave that with our witnesses.

Please provide that information to the clerk if you are able to do so. Thank you very much to all of you for being here. Again, there was some great information.

Thanks to Mr. Whalen and Ms. O'Connell for filling in today. We hope to see you again.

Enjoy the rest of your day.