HOUSE OF COMMONS
CHAMBRE DES COMMUNES
CANADA

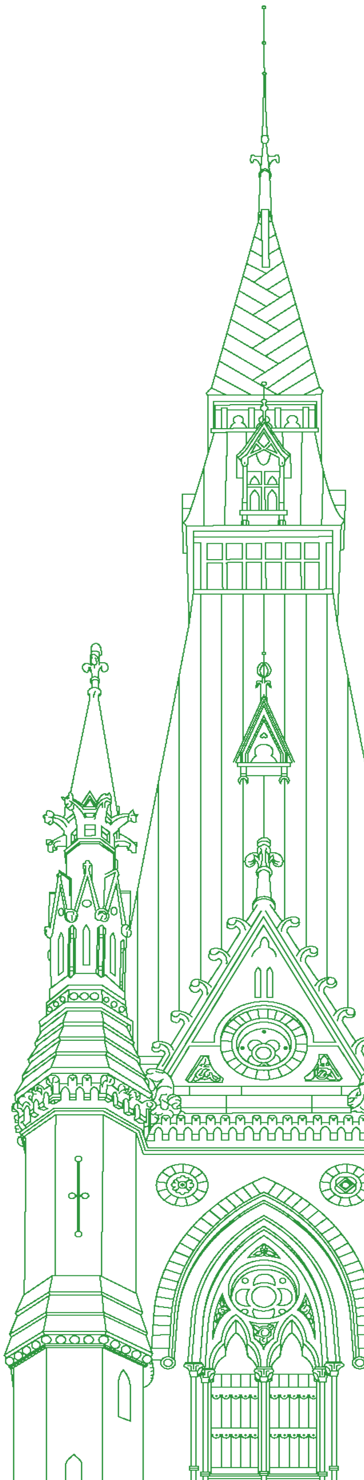
44th PARLIAMENT, 1st SESSION

Standing Committee on Industry and Technology

EVIDENCE

NUMBER 013

Friday, March 25, 2022



Chair: Mr. Joël Lightbound

Standing Committee on Industry and Technology

Friday, March 25, 2022

● (1305)

[*Translation*]

The Chair (Mr. Joël Lightbound (Louis-Hébert, Lib.)): Good afternoon. It is my pleasure to see you again, virtually this time.

I call the meeting to order.

Welcome to the twelfth meeting of the House of Commons Standing Committee on Industry and Technology.

Pursuant to Standing Order 108(2) and the motion adopted by the committee on Wednesday, January 26, 2022, the committee is meeting to study quantum computing.

Today's meeting is taking place in a hybrid format, pursuant to the House order of November 25, 2021. Members may attend in person or by Zoom. Those who are attending in person in Ottawa know the public health rules in place, so I expect that they will behave accordingly.

We have two groups of witnesses with us today to begin our study of quantum computing.

In the first hour we will hear from Nipun Vats, Assistant Deputy Minister, Science and Research Sector, at the Department of Industry, and Geneviève Tanguay, Vice-President, Emerging Technologies, at the National Research Council of Canada.

Before moving on to questions, I am going to let the witnesses make their presentations for a few minutes on the subject under consideration today.

Thank you for being here with us.

Mr. Vats, I give you the floor for six minutes.

[*English*]

Dr. Nipun Vats (Assistant Deputy Minister, Science and Research Sector, Department of Industry): Thank you, Mr. Chair.

My name is Nipun Vats. As was mentioned, I'm the assistant deputy minister of the science and research sector at ISED. In this role, I'm responsible for policy and programs related to federal funding of post-secondary research, and for fostering connections between research and its downstream economic and societal benefits.

It's in this context that my group is responsible for coordinating the national quantum strategy that was announced by the government in the 2021 federal budget.

[*Translation*]

I'd like to start off by providing a brief overview of quantum in Canada, before moving to discuss quantum computing.

Canada is a leader in quantum science. This has been made possible by patient, long-term investment in basic and applied research. This has helped Canadian talent lead the development of new innovations in quantum science and technology.

[*English*]

In this sense, Canada's success in quantum S and T is akin to the Canadian experience with artificial intelligence—although, in general, quantum science is a broader field and at an earlier stage of development in a number of key areas of application.

Over time, we have sought to amplify these strengths with strategic, larger scale investments in research.

In total, over the past 10 years, the federal government has invested just over $1 billion in our quantum ecosystem. This includes both funding for investigator-led projects as well as initiatives such as the Canada first research excellence fund, which has provided large-scale funding to Canadian institutions to achieve world-class status in quantum and in other domains.

[*Translation*]

Today, Canada has a growing ecosystem with centres of quantum expertise in universities across the country, companies that have pioneered world firsts, and healthy Canadian private sector investment, including foreign-sourced venture capital.

While Canada's quantum ecosystem extends from coast to coast, there are four major centres of quantum expertise across the country, mostly clustered around universities.

[*English*]

The Toronto-Waterloo region has strengths in quantum information, communications and sensors, with a range of commercialization accelerators and incubators, and also boasts companies such as Xanadu and Ranovus. There's also the Institute for Quantum Computing, housed at the University of Waterloo. It is the largest institution of its kind in the world.

The greater Montreal, Sherbrooke and Quebec City corridor is anchored by work in quantum hardware and devices. Companies engaged in this ecosystem include IBM, Anyon Systems and SBQuantum.

The Calgary-Edmonton corridor has expertise in nanotechnology and enabling technologies, and Alberta is building a provincial quantum network, Quantum Alberta, to encourage and accelerate the commercialization of quantum technologies.

In the greater Vancouver region, the focus includes quantum materials, algorithms and hardware development. Quantum BC plays a key role in convening provincial stakeholders. One local B.C. company, D-Wave, was an early leader globally in quantum computing and has made significant strides recently in terms of investment and commercialization of its technologies.

[*Translation*]

There is a lot of complementarity in the strengths of these hubs and a range of collaborations between academic researchers, startups and larger, more established companies, and government labs. This positions Canada's quantum ecosystem well for future success.

Canada has strengths in many different areas, and we are particularly known for our work in quantum computing, quantum communications and post-quantum cryptography. From the previous examples, you can see computers figure prominently in Canada's quantum landscape.

[*English*]

One important element that I haven't mentioned yet is that Canadian quantum talent is recognized and sought all over the world. This is why focusing on the talent pipeline will help us leverage quantum's enormous potential for commercialization but also provide direct benefits to Canadians.

[*Translation*]

At this stage in the development of the quantum ecosystem, the next step is to build up our effort strategically to help Canadian researchers and companies seize opportunities as they arise.

Due to the complexity of quantum technologies, they cannot be developed in any single country. As such, international collaboration is also very important. Canadian researchers and companies have been very active in these collaborations. To date, these collaborations have occurred mainly at the researcher level, but they could also benefit from greater coordination.

Given this context, in Budget 2021, the Government of Canada announced the development of a national quantum strategy – and a commitment of $360 million over seven years, starting in 2021-22, as a next step to build out Canada's quantum ecosystem and ensure that Canadian scientists and entrepreneurs are prepared for the quantum era.

[*English*]

The overarching goals of the strategy are to amplify Canada's significant strength in quantum research, grow our quantum-ready technologies in companies and talent, and solidify Canada's global leadership in this domain.

The budget announcement and investment are about doubling down in those areas and those strengths in ways that are more strategic, and foster better connections between our centres of expertise across the country, all while recognizing Canada's expertise and potential economic benefits from these technologies.

[*Translation*]

In order to develop the national quantum strategy, Innovation, Science and Economic Development Canada held consultations in 2021, and recently published a "What We Heard" report, which highlights the importance of international collaboration, foreign talent and investment, and exporting to international markets to support the growth of our quantum market.

It also notes that for Canada to remain a leader in quantum, collaboration between academia, industry, and government, both domestically and internationally, is required.

● (1310)

[*English*]

Informed by these and other consultations, investments under the strategy have already started to move forward under each pillar. For example, NSERC, the National Sciences and Engineering Research Council, has recently launched and announced a number of programs related to training and research, and has a number of collaborations with the European Commission and the U.S. National Science Foundation. As my colleague will likely get into, the National Research Council has also launched calls in a number of areas.

In parallel, the government is developing a national quantum strategy document that will help further focus current and future investments to position Canada to lead in key areas of strength and opportunity in quantum technology over the coming years.

Mr. Chair, I was mindful of time. You suggested six minutes, and the next part of what I was going to say is on quantum computing. I know that in your second hour, you have some leading experts in quantum computing who probably could speak to that far better than I could, so if you want to move on to the next set of remarks, I would be happy to stop here and open it up for questions.

The Chair: Thank you very much, Mr. Vats. We will do that. Perhaps it will come up in the questioning later on.

[*Translation*]

I will now give the floor to Ms. Tanguay.

Dr. Geneviève Tanguay (Vice-President, Emerging Technologies, National Research Council of Canada): Thank you, Mr. Chair, for the invitation to speak with you today about the National Research Council of Canada as part of your study of quantum computing

I would like to begin by acknowledging that the National Research Council's facilities are on the traditional unceded territories of many First Nations, Inuit, and Métis People. I would also like to add that I am currently located on customary territory of the Huron-Wendat nation. We recognize our privilege to be able to conduct research and drive innovation on these lands and pay respect to the peoples who were here before us.

My name is Dr. Geneviève Tanguay and I am the Vice-President of the Emerging Technologies division at the NRC. In this capacity, I am responsible for several research centres including Advanced Electronics and Photonics, Herzberg Astronomy and Astrophysics, Metrology, Nanotechnology, and Security and Disruptive Technologies.

With a doctorate in Parasitology, I have worked for various institutions such as Universities Canada, the Natural Sciences and Engineering Research Council of Canada, and the Centre Québécois de valorisation des biotechnologies. Much of my work has been dedicated to promoting technology and innovation transfer in the biotechnology sector. From 2007 to 2011, I held the position of Assistant Deputy Minister for research, innovation and science and society with the Government of Québec. I then served as Vice-Rector, Research, at the Université de Montréal, before joining the NRC in my current position.

[*English*]

As you may know, the NRC is Canada's federal research and development organization with a national footprint that includes laboratories in 22 locations spread across every province of the country.

[*Translation*]

In addition to doing their own cutting edge research, our scientists, engineers and business experts partner with universities, colleges and Canadian industry to help take research and technologies from the lab to the marketplace.

We serve a unique role connecting the diverse parts of Canada's research ecosystem, responding to public policy priorities and creating opportunities that benefit Canadians.

Over the past five years, we have implemented a plan to revitalize and sustain the NRC's role at the forefront of research and innovation. This has resulted in the creation of 9 Collaboration Centres with universities and other partners in areas such as quantum photonics, ocean technologies, green energy, AI and cybersecurity.

In addition, we are pursuing research excellence through support for exploratory work and leadership in select disruptive technologies, ensuring a more diverse workforce, revitalizing our NRC research environment, and aligning with industrial priorities in key innovation clusters.

[*English*]

Now I will focus in on the NRC's effort in quantum research. Through our collaborative science, technology and innovation program we aim to bring together the best minds from academia, industry and government to deliver game-changing scientific discoveries and technological breakthroughs across the innovation continuum. These cross-sector, collaborative challenge programs address current and emerging government priorities to be achieved over a seven-year time frame. Of our many challenge programs, two of the most recent ones to emerge focus on quantum. They are the Internet of things quantum sensors challenge program and the applied quantum computing challenge program.

Launched in 2021, the goal of the Internet of things quantum sensors program is to enable the development of revolutionary sensors that harness the extreme sensitivity of quantum systems to provide enhanced precision, sensitivity, rates and range of measurable phenomena. The ambition is that this new generation of sensor systems performing beyond the limits of classical physics may be engineered and commercialized for applications that benefit Canadians. To date, we have 47 agreements under development with many industry partners. The main areas of focus for this challenge are quantum photonics, chip-based quantum systems and quantum metrology.

NRC's most recent challenge program, which will be launching in 2022-23, will be concentrating on applied quantum computing. The goal of the challenge will be to support commercial and government innovations in quantum algorithms and applied quantum computing. The program is being developed in alignment with the development of the Government of Canada's national quantum strategy that Nipun just spoke about. It will support quantum initiatives across the Government of Canada by working with federal departments, agencies and Crown corporations to explore applications of quantum computing for public service operations and program delivery. The anticipated areas of focus are quantum algorithms, quantum simulations, and models and architecture.

● (1315)

[*Translation*]

We are also addressing quantum communication in a third Challenge program, which deals with high-speed secure networks. The objective is to develop and deploy quantum communication, including quantum key distribution and quantum satellite communication.

By hosting these challenges, we hope to support Canada's ambition to grow quantum-ready technologies, companies and talent; and solidify Canada's global leadership in this area.

Thank you for your time. I will be pleased to answer any questions.

The Chair: Thank you, Ms. Tanguay.

We will begin our first round of questions.

Ms. Gray, you have the floor for six minutes.

[*English*]

Mrs. Tracy Gray (Kelowna—Lake Country, CPC): Thank you, Mr. Chair, and thank you to the witnesses for being here today.

I'll start my questions with Dr. Vats. I understand THAT in budget 2021 the government intended to develop the national quantum strategy. What is the date that strategy will be launched?

Dr. Nipun Vats: Thank you for the question.

I guess there are two parts to that answer. One, when it comes to the investments relating to the strategy, those are already being announced. The kind of programmatic elements that will drive the objectives of the strategy have already been announced, to some extent.

For example, I believe last week the Natural Sciences and Engineering Research Council announced an investment of about $138 million out of the national quantum strategy for a range of programming under the alliance program, which is focused on larger-scale research and collaboration amongst centres of research and industry, as well as funding for specific training programs under NSERC's CREATE program.

The actual strategy document that will inform the rounds of investment around those programs, but that could also provide a bit of a longer-term direction with respect to quantum in Canada, is currently under development. There's no definitive date for an announcement of the strategy document as of yet.

Mrs. Tracy Gray: Great. Thank you.

Do you know if the funding that was announced, as you mentioned, was allocated through budget 2021? Was that new spending, or did the money come from somewhere else?

Dr. Nipun Vats: The amount that I mentioned from NSERC was from the budget 2021 investment, yes, as is some of the funding that's going towards the NRC challenge programs that Dr. Tanguay mentioned.

● (1320)

Mrs. Tracy Gray: Okay.

Since we're still at the beginning stages of developing the strategies, as you mentioned, how was this funding determined to fit into the strategy, since the strategy isn't developed yet, and where did this funding suggestion come from?

Dr. Nipun Vats: Well, there's a fairly long history, to this point, with respect to the development of the strategy. Prior to budget 2021, there was an extended consultation amongst the research and industrial community in the quantum ecosystem to develop some recommendations on the types of investments that would be required to take the quantum sector in Canada forward. The programmatic elements that were identified under budget 2021 were really informed by that input that was provided by the Canadian quantum community.

Now, the programs themselves have a certain degree of flexibility in terms of how the funding could be focused. The idea is that investments are starting under those buckets, informed by that long consultation process, but we would be able to refine that as we move forward, as informed by the strategy document.

Mrs. Tracy Gray: Okay. Thank you.

Would that have been from those round tables that were held last year? Is that sort of where that flowed out of?

Dr. Nipun Vats: The government's consultations were the round tables last year. There was actually a community-driven consultation process that was conducted even prior to the budget investment. There was a lot of stakeholder input even before the budget. Then, to better focus our thinking with respect to the programs and the longer-term plan, the government conducted a series of round tables over last summer.

Mrs. Tracy Gray: Great. Thank you.

Doctor, are you able to table with the committee the target metrics and the dates to meet those targets from the announcement of the strategy on March 15, just recently, to the date when the strategy will be launched? Are you able to table those metrics and what the dates are as you're developing your strategy?

Dr. Nipun Vats: Well, I'm not sure exactly what pieces. I mean, with respect to the programs, there are definitive timelines in terms of what's been launched, when applications will be due and when decisions will be taken. The strategy as a policy document is something that I don't have a definitive time for, but with respect to the program pieces that have been announced, I think there would be no problem in providing that to the committee.

Mrs. Tracy Gray: Great. Thank you very much.

Has the minister directed you or your department to work with your provincial counterparts in ensuring that the quantum strategy also considers post-secondary training in this field?

Dr. Nipun Vats: I would say that generally we have been working very closely with provincial governments on the quantum strategy writ large. As I mentioned in my initial remarks, there is a lot going on in a lot of different parts of the country. When it comes to the governments, particularly in those provinces with a large concentration of effort in quantum, that being B.C., Alberta, Ontario and Quebec, we have been working very closely with those governments to make sure that what we're doing is complementing what they're doing.

On the training side, that's been one component that's been discussed amongst many. It has been part of those discussions.

Mrs. Tracy Gray: Great, thank you very much.

I have one other quick question. Has the minister directed you or your department to ensure that security and privacy are a pillar of the future national quantum strategy?

Dr. Nipun Vats: Yes, that has come up. In the consultations we had last summer, there was a framing document that talked about the importance of security. In fact, one of the round tables was focused on security issues.

With respect to the programs that are rolling out, there are security provisions embedded within those programs, specifically the alliance program at NSERC that I mentioned. The NRC also has security due diligence built into its program suite. Both in terms of policy and programmatic measures, security is clearly an important issue in this space, so it is integrated into the approach.

The Chair: Thank you, MP Gray, and Mr. Vats.

I'll now turn to MP Dong for six minutes.

Mr. Han Dong (Don Valley North, Lib.): Thank you very much, Chair.

First of all, I want to thank Dr. Vats and Dr. Tanguay for their time in coming to the committee. Also, I don't think I ever had a chance to thank my colleagues on the committee for supporting this very interesting study.

I'm pleased to hear that Canada has a national quantum strategy coupled with $360 million over seven years. However, comparing that with other large competitors in this technology, I see that China is investing $15.3 billion in this research over five years, the United States $1.27 billion, and I think Russia $691 million over five years.

Through consultation and feedback from the industry, is the support from the government, and also its strategy, adequate in the research field of quantum technology?

● (1325)

Dr. Nipun Vats: Maybe I can give my comments, and then, Mr. Chair, if my colleague Geneviève has anything to add, maybe she could do so as well.

The quantum strategy is built on top of a number of investments that were ongoing. I mentioned the billion dollars over the last 10 years. A number of those investments continue through things like these large-scale institutional research investments through the Canada first research excellence fund. Another round of that program has been launched, and we could expect further investment in quantum.

The quantum strategy funding is really focused on some of the key pieces that are needed to accelerate the development beyond the foundational funding, which is already quite significant with respect to quantum—things like making sure that we have very strong training programs in the country to create the pipeline of talent we need, or enabling institutions and companies to scale up their R and D, because with some of these quantum technologies, proof of principle on a small scale is nowhere near the same thing as trying to build something on a commercial scale. Those are the types of investments that this additional funding is focused on.

If you were to ask the research community if the funding is sufficient, I expect that the answer you would get is that it is probably not enough, but we're trying to be very focused in trying to address the gaps that we think really need to be addressed at this point in time to make sure that we can continue to be competitive internationally with respect to quantum.

Mr. Han Dong: I'm not suggesting that we need to compete with those giant countries. We're a middle-power country, but, thinking about nuclear technology, Canada has a very unique advantage, whether in heavy water or the uranium that we use.

Going forward, do you think that the Canadian quantum computing industry will gain that unique competitive advantage over the research happening in other countries?

Dr. Nipun Vats: That's our hope, and our intent is certainly to make sure that we're capturing those benefits for Canada. You need a very strong foundation to make sure that you continue to attract economic investment in emerging technology fields. We've been very good at investing—

Mr. Han Dong: I have a very important question that I want to get in.

Dr. Nipun Vats: Oh, sure.

Mr. Han Dong: I understand where you're coming from.

We can't talk about commercialization of quantum computing without talking about semiconductors. In his state of the union address President Biden mentioned that Ohio, with the help of Intel, is going to have a mega-site for semiconductor production. We all know that it's a national security issue, a national economy issue.

Has your department or anyone from the government reached out to Intel to say, "Hey, look north. We have great use for these future semiconductors," and perhaps boost our semiconductor manufacturing capacity that way?

Dr. Nipun Vats: With respect to that question, I think my colleague, Dr. Tanguay, might actually be better positioned to respond because the NRC has a fairly important role with respect to semiconductor fabrication.

If I may, Mr. Chair, if it's okay to turn to Dr. Tanguay, I think you may get a better answer.

The Chair: Yes, of course.

Madame Tanguay.

[*Translation*]

Dr. Geneviève Tanguay: Thank you.

[*English*]

Yes, we do have a facility within the NRC that does provide semiconductors to industry. We also have a facility that's working on quantum artifacts. For example, we're working with quantum dot lasers, quantum sensors, quantum repeaters and gates just to name a few of the applications that we have.

I know you also just mentioned critical minerals. Critical minerals are also very important for the type of semiconductors that we make, which are compound semiconductors. We use helium, graphite, tungsten, indium, gallium, germanium, chromium, aluminum and nickel. A panoply of critical minerals are being used for the semiconductors and this is very important.

● (1330)

Mr. Han Dong: I'm talking about semiconductor manufacturing capacity in Canada. Right now if you look around, there isn't anything sizable to support the future economy.

The Chair: Make it a brief answer, Madam Tanguay, if you wish.

[*Translation*]

Dr. Geneviève Tanguay: We hope to attract foreign investment specifically to support our efforts in relation to compound semiconductors, such as those I have described.

[*English*]

Mr. Han Dong: Thank you.

[*Translation*]

The Chair: Thank you, Mr. Dong.

I will turn the floor over to Mr. Lemire.

Mr. Sébastien Lemire (Abitibi—Témiscamingue, BQ): Thank you, Mr. Chair.

My first question relates to an article I have read from the AVEQ, the Association des véhicules électriques du Québec. According to a Korean study the article talks about, quantum could allow electric vehicles to be charged at home in three minutes rather than ten hours, while quick charging could be reduced to nine seconds rather than 30 minutes.

I would like to put my question to Mr. Vats from the Department of Industry in particular.

Does going green, by shifting to batteries and the electrical network, have a significant place in the national quantum strategy? Is it a priority at the Department of Industry?

[*English*]

Dr. Nipun Vats: I would say with respect to the quantum strategy specifically, quantum materials are an important part of the quantum ecosystem. We have centres of expertise across the country that are focused on quantum materials, and quantum materials can be applied to a range of different things whether it's quantum computing or advanced solar cell technologies or batteries. Through these investments, that is one of the channels that could be pursued by companies or researchers.

For the department as a whole, I can't speak for all aspects of the department, but it's pretty clear that battery technologies and green vehicles are a pretty high priority, as we have seen even on the industrial scale through a recent announcement of a large facility in Ontario. Both from a research perspective and from an industrial perspective I would say that battery technologies and next-generation battery technologies are going to continue to be a priority for the department.

[*Translation*]

Mr. Sébastien Lemire: Other announcements were made before the federal government's national quantum strategy was announced. I am still wondering how the National Defence quantum science and technology strategy fits into the national quantum strategy.

[*English*]

Dr. Nipun Vats: There are clearly some specific defence-focused priorities that the Department of Defence would have with respect to quantum technologies.

I would say that the programs we have launched under the national quantum strategy actually enable collaboration with the Department of Defence so that we can leverage what they are doing and more strongly connect what they are doing with the academic research community and with industry to make sure that as our defence establishment is looking to develop needed quantum technologies in Canada, they are better linked to the research community and to companies so that you can be pulling those technologies to market.

With respect to the longer term, we have been working very closely with Defence and other departments to make sure that as the national quantum strategy comes together, it is an integrated initiative so that it brings together all of these different pieces where specific departments may have specific interests with respect to quantum to make sure that we are all speaking with one voice and, therefore, can better leverage the capabilities of the government to support Canadian research and industry in this area.

[*Translation*]

Mr. Sébastien Lemire: I note that this is an emerging field and that it may expand considerably over the next few years.

At page 6 of the document, where summaries of the comments made by the people consulted are presented, the following conclusion is stated: "The overall amount of [National Quantum Strategy] funding may be insufficient to achieve our goals, especially as other countries have promised to invest more."

What are the possible impacts of the research? How far can we go in this field?

● (1335)

[*English*]

Dr. Nipun Vats: That's a very difficult question to answer in the sense that it will really be up to the researchers and the companies to determine how far they can go in terms of these new innovations.

I would say that one of the things that we're trying to do through this strategy is to work smarter to better connect what we already have in the country that's funded through a fairly strong base of basic research funding to better enable our centres of quantum expertise to work together, to better connect what our start-up companies are doing to capabilities that are resident in institutions across the country, and to be more deliberate in how we pursue international collaboration.

It's really hard for me to say how far we can go. Over time, it's clear that we'll need more investment in this space, both [*Technical difficulty—Editor*] private sector and government investment.

One of the advantages we have as a country when we go internationally and talk about quantum research and quantum R and D is that we tend to appreciate collaboration across disciplines more than other countries sometimes do. We're small enough that we can have a very strong collaborative relationship between companies and the basic research sector, and that can take you pretty far in a space like this.

I can't speak to the specific technology outcomes, but I can certainly say that we're trying to incent more of the kind of collaboration that can catalyze some of these innovations here at home.

[*Translation*]

Mr. Sébastien Lemire: I look forward to seeing where you go and what recommendations will be made.

I think I won't have time to ask my question about intellectual property, am I right, Mr. Chair?

The Chair: You will get another turn shortly, Mr. Lemire.

Mr. Sébastien Lemire: Thank you.

The Chair: Mr. Masse, you have the floor for six minutes.

[*English*]

Mr. Brian Masse (Windsor West, NDP): Thank you, Mr. Chair.

Thank you to both of our guests for being here today.

My first question is on facial recognition. I'll allow both of you to get in on this.

With the way that research is being done right now, is there any commitment to or thought about how that can be applied to not just the private sector, but also the public sector, say, the border and other types of government services that are provided? I'm curious as to whether there is even direction for that or whether that has happened. As we look at research and more grants and development, I wonder whether this is coming back to the public sector in any aspect with the direction.

Facial recognition is one that I'm a bit interested in, having toured some of the sites, even 15 years ago, that were doing the initial work on that. The advances been unbelievable. We vote now in the House of Commons through facial recognition on our hand-held devices.

I'll turn it over, but I'd love to hear from both of our guests here today.

Dr. Nipun Vats: When it comes to technologies like facial recognition, which is largely based on machine learning and artificial intelligence-based advances that have happened in the last number of years, there are relationships to quantum technology with respect to machine learning. However, more generally, when it comes to AI, there has been a fairly big investment in Canada over the last 10 years with respect to doubling down on the fact that we have very strong.... Some of the pioneers of that kind of research are here in Canada.

Through investments such as the pan-Canadian artificial intelligence strategy, which was renewed in budget 2021, we're trying to invest in the researchers and in training the people who can implement those kinds of technologies. We're also investing in understanding the societal impacts of these technologies. The flip side of the efficiencies that can be gained through facial recognition is the potential impacts on bias, security and privacy that you need to be very mindful of. Those are things that we're funding on the research side.

With respect to the specific application of those technologies for government, our Treasury Board Secretariat has been trying to develop some guiding principles. These could guide how you do things like use those technologies for autonomous decision-making in a way that respects some of these values that we all share around making sure that people's privacy is protected, and making sure that we try to eliminate bias if we're going to try to use mechanistic kinds of tools to try to identify how to take decisions, and so on.

There is work going on in that space, although it isn't something that my department is.... We are implicated through privacy legislation and other things, but it's largely directed out of our Treasury Board Secretariat.

● (1340)

[*Translation*]

Dr. Geneviève Tanguay: I don't have much to add, apart from the fact that at present, there are numerous groups examining the ethics of quantum technologies, and also the ethics of artificial intelligence, a technology that is widely used in the field of facial recognition.

[*English*]

Mr. Brian Masse: Thank you very much for that. That's one of the interesting aspects. People are going to see this in more of a direct correlation to their life and that's how they might get more interested, even into the quantum element. It's kind of like explaining to people what a spectrum auction is. It gets very sleepy for some people very quickly, no offence.

I want to ask, though, about how we keep our Canadian researchers and our ground game here, if we're going to lose people internationally. I'm just curious about that aspect. In my region, I've seen tool and die or mould making, for example, where there was an attempt to kind of poach some of our best people, and it has been a challenge to keep the younger people, and so forth.

I wonder if you both have some thoughts on how we can best do that and continue to punch above our weight.

Dr. Nipun Vats: Thank you for that question as well. It's one that we think a lot about, because our ability to actually seize the benefits of these technologies over time really relies on having that pipeline of talent. Having the researchers here means you can train students. It means that companies are interested in setting their home bases here in Canada, because the natural resource in these emerging technology areas is people. If you have that pipeline of people, that really drives your success.

A lot of these things we're doing through these large investments in research are really also with a mind towards what the downstream benefits will be just by creating that pipeline: the research funding, funding for training for students and post-doctoral fellows, and then connecting those companies in our eco-system to that pool of talent so that they have a place to go that they can plug into as they complete their education. These are all really important pieces that we need to stay on. It's a constant effort.

When you talk to people around the world, they recognize Canadian talent in this space. Anywhere you go, any of the top institutions in the world, they will say, oh yes, they have students who were at Sherbrooke, or at Waterloo or wherever. I think some of that is good, that we're actually learning more by having Canadians go abroad, but we want to bring them back too. That's a critical piece of the puzzle for sure.

[*Translation*]

The Chair: Thank you, Mr. Vats.

I now turn the floor over to Mr. Lewis for five minutes.

[*English*]

Mr. Chris Lewis (Essex, CPC): Thank you, Mr. Chair. Thank you for the excellent dialogue here so far today.

To be honest, when I was invited to come here on behalf of MP Gérard Deltell, I didn't quite know what quantum computing was all about. Because of that, I really dove into it with both feet, so to speak. Then I realized just how close it was to international trade. I could probably go on for an hour, but I have only five minutes. I'm going to get right down to it.

Dr. Vats, you mentioned that quantum computing cannot be developed in any single country. I found that really remarkable. My riding of Essex is right next to Mr. Masse's riding of Windsor West. There are a lot of international travellers every single day.

I have a concern with regard to Huawei. For a moment, let's just imagine that Huawei was allowed in Canada and wasn't allowed in the United States. If we have autonomous vehicles that cross our bridge each and every single day, what would look like? What is the government doing to ensure that crossing the border is going to be free and clear with whatever way both countries go?

● (1345)

Dr. Nipun Vats: The most important thing in these collaborations from that security perspective is that we make sure that we're engaging with our trusted partners in a way that we can actually have interoperability. At earlier stages of research, it's less of a contentious issue because the research is very fundamental in nature and maybe doesn't have as much of a technological implication. However, as you get further downstream, you need to think about how you're going to make sure that the technology you're developing will be able to plug into supply chains internationally.

This is something that's being discussed in terms of standards, in terms of whether we have appropriate security understandings with our allies when it comes to some of these more sensitive security technologies. A lot of those types of things are ones that we're also trying to do in parallel with these investments through the strategy, to make sure we're strengthening those—

Mr. Chris Lewis: I'm so sorry to cut you off, Doctor.

With regard to allies, are we suggesting then that China is our ally?

Dr. Nipun Vats: No. I'm sorry, I was talking about the Canada-U.S. border.

Mr. Chris Lewis: Okay, fair enough.

I was speaking specifically to Huawei. Do you have any thoughts on that front?

Dr. Nipun Vats: I'll give you an example. In the alliance program, which is one of the key delivery vehicles for the quantum strategy when it comes to research, there are some research security provisions that are built into that which basically require that we understand, where there are industrial partners involved, whether those partners meet the international norms in terms of transparency, openness, state control and other factors. We're actually reviewing these things when research polls are brought forward through that program.

Mr. Chris Lewis: Thank you very much, Doctor. I'm going to move off that.

On international trade, then, in regard to CUSMA and CETA, and looking ahead to our trade agreement with the U.K., will quantum computing be a part of those agreements, if it's not already? Number one, do we need to amend those agreements at all in regard to quantum computing?

Dr. Nipun Vats: Well, I'm not an international trade expert, I have to admit.

I would say that there are typically provisions in those agreements with respect to trade in goods, services and procurement. As well, there are provisions related to national security. I think all would be relevant to quantum.

I don't know whether you would need quantum-specific provisions in an international trade agreement, particularly because this is a space where the technology is still evolving. In general, you want to try to have a framework of general application that will allow Canadian innovations to have access to those markets.

It might be a bit premature to be thinking about the specific tweaks you need to make to international agreements, in that perspective.

Mr. Chris Lewis: Thank you, Doctor.

Mr. Chair, I'm not sure, but am I all done?

The Chair: Yes, you have no time left.

I'll now move to Mr. Erskine-Smith for five minutes.

Mr. Nathaniel Erskine-Smith (Beaches—East York, Lib.): Thanks, Joël.

Thanks for your presentations.

We could have a long conversation about basic research, but I just want to talk about commercialization. In the "What We Heard Report", they note that "Canada has a history of producing excellent research that often does not get commercialized." That doesn't only apply to quantum; that applies across the board, unfortunately.

In the quantum space, we see a few different kinds of investments. We see from the NRC these challenges, obviously identifying mission-driven priorities and saying that any companies can compete for this. But in other contexts, we have large public funding for specific organizations. We saw $40 million, for example, for D-Wave in March 2021.

In the "What We Heard Report", there's an acknowledgement that "there was consensus that government should remain inclusive and not pick winners at this time, as quantum is a developing sector." That seems right. They note that "At some point, Canada will need to make a strategic decision whether to support a few large players or projects, or many small ones."

Given that money is being rolled out the door already as part of the $360 million, what's the answer to that question?

• (1350)

Dr. Nipun Vats: When it comes to quantum computing, we're still at a relatively early stage in many ways. When you talk about the need to not be picking a lane at this point in quantum computing, I think that's probably right.

We have a number of players within Canada that are all pursuing slightly different approaches, and sometimes very different approaches, to achieving the ultimate goal, which is a quantum computer that can correct for errors and that enables you to do some really meaningful real-world types of calculations on it.

It may be the case that one, two or more technologies actually emerge as being the most likely to achieve that goal of what's called "fault tolerant" quantum computing—

Mr. Nathaniel Erskine-Smith: I'm sorry to cut you off, but I have limited time.

I'm less interested in our picking a technological winner, but more interested in the latter point, where the "What We Heard Report" says, "At some point, Canada will need to make a strategic decision whether to support a few large players or projects, or many small ones."

Given that money is rolling out the door, have we arrived at the conclusion? What's the strategic decision?

Dr. Nipun Vats: I guess what I'm saying with respect to quantum computing is that we're still at that early stage. We're not at the point where we'd be in a position to pick winners, because of our small number of investments. The race is still on, and we're still at a fairly early stage in development. I think it would be unfortunate at this point to be closing doors to what look like viable candidates for a quantum computer.

It may be the case, though, as the report says, that we arrive at a point where we have to make some of those decisions, or the markets will dictate or technology will dictate—

Mr. Nathaniel Erskine-Smith: Let me take a step back with a similar problem. The report also acknowledges—and many people, businesses and responses acknowledge—that Canada has a venture capital climate that tends to be highly risk averse, and that we see a lot of basic research that happens in Canada and people leave to find financing elsewhere. Venture capital is more easily found in other countries, potentially.

When you look at the approach of funding by large companies, which may well be at a place where they are more easily able to access capital in the private sector and private markets versus early stage companies exiting from research and trying to commercialize, is that not a space where Canada has a gap there, potentially, and that Canada with public dollars maybe ought to fill?

Dr. Nipun Vats: I think that's true. I think there are programs that are doing that right now. You mentioned the investment in D-Wave. That was done through the strategic innovation fund, which is for those kinds of companies at a certain threshold level.

Mr. Nathaniel Erskine-Smith: Pause there. Is it really for those companies?

D-Wave strikes me as a company that is much more established than what I'm imagining. When you're thinking of the start-up space, where they're exiting the incubators and looking for venture capital in the private market, D-Wave seems a little more advanced than that.

Dr. Nipun Vats: That's true. If we were to walk through that kind of translational space, I think the first barrier is the scientist who is trying to figure out what their product is. There are some questions about whether we actually have the tools we need to help a scientist innovator define the economic opportunity, the product, and then to develop a business that can actually succeed in raising capital. Even before you get to the traditional incubator stage, there is work that could be done there, and there are a number of places that are doing that work.

When you are a small start-up firm, it's partly about the C-suite kind of expertise. It's also partly making sure that you have strong connections to the research base that can help support your innovation and emerging tech area, and we have programs like IRAP at the NRC that actually provide funding and expertise to help those companies.

Then, as you go further downstream, there are some specific things that companies may be looking for. For example, it may be the case that there are common platforms or test beds that could be deployed to help them test some of these technologies, whether they're in sensors or in computing, infrastructure and other things, and looking at ways to support those. Again, they're not necessarily picking winners, but it's to give them a leg up to be able to test. Then as you get further downstream, you get to programs like SIF where people are at a scale where they're bringing in series-B investment and they want some supportive investment. We also have the BDC deep tech venture fund, which is another sort of venture capital vehicle that can provide support in that space.

There are a number of different pieces that already exist in the system. I think one of the things that we're looking at through the quantum strategy is how we tie them together, particularly in an emerging tech area like this, to make sure that our companies can connect all of those tools in an efficient way and that we have a line of sight on how they're progressing so we can help them along.

• (1355)

Mr. Nathaniel Erskine-Smith: And where the gaps are.

Dr. Nipun Vats: And where the gaps are.

Mr. Nathaniel Erskine-Smith: Thanks, Dr. Vats. I really appreciate your contribution.

The Chair: Yes, thank you very much.

We'll now move to Mr. Lemire for two and a half minutes.

[*Translation*]

Mr. Sébastien Lemire: Thank you, Mr. Chair. I would note in passing that you are wearing a very gorgeous tie today.

I am going to continue in the same vein as the questions asked by my colleague, Mr. Erskine-Smith. I would like to address the issue of intellectual property, one that I see as fundamental, especially in an emerging sector.

How is intellectual property dealt with in this sector in Canada?

[*English*]

Dr. Nipun Vats: When it comes to intellectual property that is generated in universities, universities themselves have their own kinds of approaches to management of intellectual property and they have different models. Some are owned by the researcher, some are owned by the institution and licensed to the researcher, and they're looking at ways to maximize the economic potential of the IP that is generated here in Canada.

When it comes to companies, of course, I can't speak to the individual company's decisions here, but a lot of it is dependent on their business strategy. In some cases like in quantum algorithms, it may be that the key is not the IP itself but being the first to seize a space, as is often the case in software. When it comes to some of the hardware innovations, I think IP is a much more important piece of the puzzle. I believe some of the speakers in the second hour will have a pretty good understanding of those issues as well. I know we don't have very much time at the moment.

Our goal always is to try to make sure that, while respecting business decisions, you can maximize the retention of that IP here in Canada, particularly in areas where the federal government is investing. But I think you have to look at it in a context of how companies deploy IP to ensure their future growth as well. So there are strategic decisions that companies need to make with respect to that.

IP is a very deep, as you know, strategic kind of asset that you need to think about.

[*Translation*]

Mr. Sébastien Lemire: You are entirely correct.

In view of the espionage committed by hostile countries, which may even have taken place at the Canadian Space Agency, are we putting sufficient measures in place to protect ourselves?

I would like to get a brief answer.

[*English*]

Dr. Nipun Vats: Very quickly, for both the academic sector and Canadian industry, there's been a lot of effort over the last couple of years to do a lot of outreach and training. For researchers, it's even like, "What could someone want to steal that I have?" It's about whether you have the right protections in terms of cybersecurity.

So there's cybersecurity work, and it's the same thing with companies. Organizations and security agencies are going to companies directly to make sure they are providing them with training and advice to ensure that they have the right kinds of protections in place and to make sure they're minimizing the risks of exfiltration of Canadian innovation. It's a very active area for the federal government right now from both a research and industry perspective.

I think Geneviève has something she wants to add.

[*Translation*]

Mr. Sébastien Lemire: Thank you, Mr. Vats.

[*English*]

The Chair: I'm sorry, Madame Tanguay. I'll have to stop it there if we want to go to our last questioner.

Mr. Masse, you have two and a half minutes.

Mr. Brian Masse: Thank you, Mr. Chair.

I'll let Madame Tanguay go ahead. Monsieur Lemire was actually heading in the direction on cybersecurity that I was going too. I'll let her get her response in.

[*Translation*]

Dr. Geneviève Tanguay: Thank you.

I can tell you that the level of security at the NRC is very high. All employees have to pass a security check. We are pretty strict about this. We have the same requirement for visitors and the companies we work with, because we want to be sure that if we transfer something, it is not going directly to another country. Measures are increasingly being taken by research organizations to guarantee the security of the research being done here.

● (1400)

[*English*]

Mr. Brian Masse: Is there work being done as well with regard to training Canadians, that you know of? I know that Coding for Veterans is a program to go through with regard to getting Canadians into the cybersecurity forum. Is that happening as part of this too?

As we're investing more into this, it's going to be a real challenge. It's also a real opportunity. Coding for Veterans has been very, very successful at this. I'm wondering if you have any thoughts on how we continue to train on the practical job elements that are necessary beyond research and development.

Dr. Nipun Vats: Thanks for the question. Briefly, when it comes to cybersecurity, and quantum is part of that, there was a program launched last year, called the cybersecurity innovation network, that is basically to fund collaborations between universities and industry as well as training programs across the country. Colleges, to some extent, are involved in that as well, I believe. It's to make sure that the research that's being done at universities and the training that's being done at universities actually target the needs of Canadian industry when it comes to cybersecurity.

That's a complement. That's more focused on cybersecurity specifically, but that's a complement to what we're doing here through the strategy. Cybersecurity and quantum are quite strongly linked in some ways. That is an important piece of the puzzle.

[*Translation*]

The Chair: Thank you, Mr. Vats and Ms. Tanguay. That is all the time we have with you. I want to thank you for being here today and starting off the committee's study on quantum computing. Take care of yourselves.

I am going to briefly suspend the meeting to give the witnesses in the second group time to join us.

● (1400)

_____________________(Pause)_____________________

● (1400)

The Chair: The meeting is resumed.

I would like to thank the witnesses in the second group for being here with us.

The witnesses for this second hour are: Alexandre Blais, Professor and Scientific Director of the Quantum Institute at the Université de Sherbrooke; Norbert Lütkenhaus, Executive Director of the Institute for Quantum Computing at the University of Waterloo; and Barry C. Sanders, Professor and Scientific Director of the Institute for Quantum Science and Technology at the University of Calgary.

Thank you all for being here with us on this Friday afternoon.

We will start with you, Mr. Blais. You have the floor for six minutes.

● (1405)

Dr. Alexandre Blais (Professor and Scientific Director, Quantum Institute, Université de Sherbrooke, As an Individual): Thank you, Mr. Chair.

First, I would like to thank you for giving me the opportunity to talk to you today.

As the Chair has just said, I am the Scientific Director of the Quantum Institute at the Université de Sherbrooke. My research deals with the development of quantum computers, and has led to the creation of four young quantum enterprises led by students.

[*English*]

Despite the ever-increasing power of modern computers, there are some computations of scientific, societal and economic value that are simply impossible to realize. Quantum computers promise to make some of these impossible computations possible. A quantum computer could indeed efficiently complete computations that would take billions of years with today's fastest supercomputers. For some problems, the speed-up offered by quantum computers is more modest. For others, there is no speed-up at all.

Understanding the real-world quantum acceleration that can be expected from future quantum computers remains an open question. We don't know everything yet, and answering this question is made more difficult by the fact that we don't have fully functional quantum computers.

However, fundamental research and technological development towards the realization of these computers is accelerating at a phenomenal pace. In the last few years only, we have already gone from very rudimentary devices to small quantum computers on the cloud. These devices can be used to test new ideas and to develop new applications. The price of entry to contribute to the field is no longer a Ph.D. in physics.

Although the current generation of quantum computers is still too simple to run large-scale computations, quantum advantage has already been demonstrated. In other words, the current generation of quantum computers can compete for some specific tasks with today's most powerful supercomputers.

How long will it be before fully functional quantum computers become available? As already mentioned, fundamental research and technological development are still needed, and it will take time. This is to be expected. Going from transistors to our modern computers took decades.

Because its researchers are responsible for many key discoveries, Canada has a long history of excellence in the field and a solid reputation internationally. This has been made possible thanks to investments from NSERC, CFI, CFREF, CIFAR and others. This has led to a critical mass of researchers with extensive expertise and state-of-the-art research infrastructure. In particular, the CFREF funding in Sherbrooke, Waterloo and UBC gave us the resources, agility and long-term perspective needed to be competitive and has helped grow Canada's presence internationally.

Looking back, one can almost say that Canada's position in quantum research was reached by luck. It is the efforts of individual researchers and institutions using existing competitive programs. At a time when other nations are investing strategically in quantum, for Canada to follow the same approach can only lead to one thing: a smaller role for its researchers and industry on the global stage.

Of course, this is where the national quantum strategy enters and why it is excellent news. To ensure maximum impact of the strategy, there are, in my opinion, a few aspects to consider.

First it is important to acknowledge that, while it is an excellent effort, it is relatively modest compared to other nations'. I'm convinced that it can have a large impact, but it remains important to manage expectations.

Second, I mentioned that Canada's position in quantum was achieved by individual researchers and institutions using existing competitive programs. Of course, the national strategy is only now being deployed, but up until now, the investment appears to follow the same approach of relying on existing programs. There is a danger in this approach. We have limited resources and cannot excel in everything quantum. Choices will have to be made.

Fortunately, quantum science and technology are more than one idea. It is not a winner-takes-all situation. Making choices may mean that we will lose some opportunities, but not that we will lose the race. It's quite the contrary.

What are some of the important actions to take to maximize the national quantum strategy's impact? First, over technology, talent is the real quantum advantage. It is important to attract and train talent at all levels: faculty, postdocs, graduate students and technical staff. Not everybody needs a Ph.D.

At the moment, Canada's biggest export in quantum is probably talent. It is crucial to retain in Canada those who we train. At institut quantique in Sherbrooke this has been on our mind since day one after receiving the CFREF award. We have taken action for our graduate students and postdocs to receive the appropriate training and support to become young entrepreneurs and to create their own quantum startups.

● (1410)

The culmination of this vision was the creation only a few weeks ago by the provincial government of a quantum innovation hub in Sherbrooke with over $450 million in public and private investments. This will continue to grow the quantum ecosystem in Sherbrooke and more generally in Canada. It will help us to retain our talent here but also to become even more attractive internationally for students, companies, and investors. More initiatives like this are needed as well as support for existing initiatives.

Building on existing centres of excellence is also, more generally, an important way for Canada to remain competitive on the global stage. Over the last seven years, the CFREF quantum centres have built unique research capacity, something from which the old Canadian quantum ecosystem has benefited. Continued support for these centres of excellence will help Canada maintain its leadership.

In summary, fundamental research and technological development are needed before quantum computers are available. The timeline isn't certain. The potential is vast, but expectations need to be managed.

To have impact on the global stage, Canada needs a national quantum strategy that is ambitious, agile and makes strategic choices. This is how Canada can remain at the forefront of quantum science and technology, helping drive our country's long-term economic and social prosperity.

Thank you.

[*Translation*]

The Chair: Thank you, Mr. Blais.

[*English*]

I'll now yield the floor to Mr. Lütkenhaus.

Dr. Norbert Lütkenhaus (Executive Director, Institute for Quantum Computing, University of Waterloo, As an Individual): Thank you very much.

Good afternoon. My name is Norbert Lütkenhaus. I'm the executive director of the Institute for Quantum Computing.

I have been working in the field of quantum information since 1993. More specifically, I work in the field of quantum cryptography.

First, let me say a few words about what quantum information is. Alexandre Blais already gave something of the introduction. Of course, the main ingredient is quantum physics, which talks about how the world works on a microscopic scale. Actually, we had the first quantum revolution by understanding these rules and that gave us devices like lasers and transistors, which of course led to computers and so on. These technologies are actually driving today's high-tech industry and you of course know them from your everyday life.

The second quantum revolution is now merging quantum physics with computer science and information theory. The difference is that now we ask questions about whole systems and not just devices.

What are these questions? They are, for example, about how to compute the answer for a mathematical question. It might sometimes sound very abstract, like how can we factor large numbers? We actually found that we have to change our view of what is a hard problem and what is an easy problem. We know some problems that quantum computers can solve efficiently that conventional computers cannot.

Another example for quantum information is actually that we ask questions like, how can we securely communicate over a channel so that an eavesdropper cannot listen to our communications? How can we actually secure our privacy over here? Here again, quantum information gives us the tools at hand to protect this privacy.

This second quantum revolution is asking for systems. The knowledge about these systems and the knowledge of how to build them is what will drive tomorrow's high-tech industry.

Now it is important for me to say something about the time scale. In the end, quantum information is a long-term game, but it has short- and medium-term benefits and even benefits today.

Why is it a long-term game? First, we know quantum computers solve particular tasks like breaking codes or simulating quantum systems. They are really good at that one.

What else can they do? That is really a question for basic research. We really have to find these applications where a quantum computer can help. Any problems that are computationally intensive for conventional computers, maybe because you run out of computational power, is of course fair game to us. We need fundamental research. We need to understand what the advantage would be.

The second thing is, of course, the need to build quantum computers that actually scale up and that we can build into large computers. This is a hard problem, but as Dr. Blais already said, we are making progress. This is therefore a long-term game.

We have made advances as well in the medium term. As we make progress toward building scalable universal quantum computers that can solve all these wonderful things, we are finding out two things. One is that the hardware that they're building is getting better and coming toward the universal quantum computer.

At the same time, as we investigate which problems can be solved by a quantum computer, we realize there are more problems that need smaller quantum computers to actually work and have a crossover. The interesting question is, where does this crossover happen and what will the problems be? That is a field where academia and industry are working today because there will be an extremely high payoff when they find the first crossover problems.

In the short term, quantum communication is actually ready for action. These are things we can build and develop. The quantum-secured communication and the QEYSSat mission by the CSA, which is led out of IQC, are examples of this near-term development.

Now with other things, we have even shorter time scales. These are things that we can do today. That is something to do with the difficulty of building quantum computers. Quantum computers are difficult because just environmental noise can disturb them easily, so we really need to learn how to harness and control it. The interesting thing is if we have a device that is very susceptible to the environment, we then take it, turn it around and use this device as a sensor to measure small variations in electrical gravitation fields. That is the field of quantum sensors, which is something that we already see happening today.

If you think about the benefits for Canada of working in that field, of course it's important for the quantum industry. We know of course that the quantum industry is involved not only in the short term, but also already in the medium- and long-term activity today. It's very important to realize that one. There is a forecast from the Doyletech study that predicts an $8.2-billion year-end turnover and 18,000 highly skilled jobs by 2030.

● (1415)

If you think about that, it means that we need to build the workforce. IQC has been doing that for more than 20 years on all kinds of levels. At the moment, for example, we're training 200 graduate students who are working at Waterloo at the moment, and our graduates are easily taken up by the emerging quantum industry. Our colleagues in Sherbrooke and Calgary are building up these programs as well, so this will be something we do jointly.

The second point is very important. We need to maintain this research continuum. Lots of our focus is based on basic research, and we have this funnel of work built on that. It is really important. Although we look at the short term, for things like quantum centres, they come because we have the bigger effort. Always remember, if you like cherries, you need to plant a cherry tree. You can't grow the cherries directly. There is a whole system that you need.

The third part is asking how we structure it. Shared resources are very useful. In Waterloo, we have the Quantum-Nano Fabrication and Characterization Facility, which helps the incoming quantum industry to lower the initial investment threshold. It becomes a gain, it helps the academic research community and we have these networks and collaborations all over Canada to use it.

Together, the availability of talent, academic excellence and shared resources attract investment for the quantum industry. It may be local start-up companies—we have 14 spin-offs from IQC alone—or faculty interns, post-docs and students, as well as other companies coming from outside.

It will be a pleasure to elaborate more on those points when you have questions about them. I am available for meetings either online or one-to-one in person, once I'm in Ottawa.

Thank you very much.

[*Translation*]

The Chair: Thank you for your testimony.

I now turn the floor over to Mr. Sanders.

[*English*]

Dr. Barry C. Sanders (Professor and Scientific Director, Institute for Quantum Science and Technology, University of Calgary, As an Individual): Thank you very much.

I'm very lucky to go third, because my good friends Alexandre and Norbert did great pitches on quantum and why it's important.

Before I go into my spiel, I'll just mention that we're a close-knit community. I've written papers with both Alexandre and Norbert. I just want to convey to you right off the bat that we're very fortunate in the quantum community because we get along, we all work together and we're not fighting each other. That can be rare in the academic world.

I'm a professor in physics at the University of Calgary, director of the Institute for Quantum Science and Technology at the University of Calgary, and I'm lead investigator of Quantum Alberta, which is a loosely knit community of quantum scientists and technologists across Alberta. That's our vehicle to help us become even stronger in quantum science and technology.

I'm also a scientist with the Creative Destruction Lab, both the quantum stream at the University of Toronto and the prime stream at the University of Calgary. In this role, I mentor and evaluate venture start-ups. That has been extremely helpful because it gives me, as an academic scientist, a very good perspective on what it takes to make successes in the venture world.

In Alberta, our strengths cover the spectrum of the strategic quantum areas that you've been hearing about. We work on quantum sensing, quantum-secured communication, quantum computing and quantum materials. The names change and the number varies, but that's roughly the four areas that we talk about.

Soon I'll be appointed the scientific director of Calgary's Quantum City initiative. That's a partnership between the University of Calgary; the City of Calgary; anchor industry partner Mphasis, an Indian IT company that is setting up its world quantum computing headquarters in Calgary; and the Province of Alberta. Quantum City's focus, which I'll be leading, is about developing Alberta's quantum ecosystem, so it's not just the academic side but really all levels, to make sure that we have a successful quantum ecosystem that meets the expectations and needs of all stakeholders.

Quantum City's priorities include collaborating with quantum scientists and technologists across Canada. I was in discussions with Alexandre Blais and Norbert Lütkenhaus earlier. We're not trying to compete with each other. We want to find ways where we each understand our complementary strengths and can work together to make great success.

We also understand the importance of working internationally, so our priority is also to work internationally. As we've heard in this hour and the previous hour, the resources coming in are not sufficiently large that we could become the world's greatest, so we have to work strategically, cognizant of the security issues, on how to make sure we are working with others to make Canada great in quantum science and technology.

Our own priorities at Quantum City are proof-of-concept and prototype development for quantum components, devices and systems. We are working towards training a quantum workforce. We heard about talent. One of the focuses we have is not on training people in quantum, but training people who don't know quantum to be able to use quantum tools.

Also, our goal in Alberta is to maintain and enlarge our community of world-class researchers in quantum sensing, communication and computing. I think of us as lean and mean. Alberta is a player on the national scene, but we have not had the same investment. We're very happy about that, because other priorities have existed, but now we want to enter the stage at the same level and not compete with the others, but rather, find ways to build on the strengths that have been established across Canada.

I note that we're progressing quickly to establish the world's first professional master's degree in quantum computing. It's software focused, with a plan to admit students in September 2023. We've been doing our industry discovery, and industry in Canada and beyond is showing great enthusiasm for taking on interns and graduates from this degree.

I want to finish by mentioning another point that could be relevant to this committee. I maintain a strong international research and outreach profile. My international activities are very important to me.

I do a lot of outreach in Africa, but I also have strong involvements with China and with India. I'm cognizant of security. Some of the questions that come up, and certainly in the past hour, do overlap sometimes. I'm one of those people where, in talking about security issues and all this kind of stuff, in my international activity, I'm sometimes a topic of conversation. I just want to make sure people are aware of that here.

I maintain the strong international activities, cognizant of geopolitical and all these other security issues. I do so partly because Canada is a great beneficiary of these international links. Many good things do flow to Canada as a consequence, and somehow we need to manage things so that Canada's needs and security are well looked after but we don't cut off contacts with others if we can avoid cutting off those contacts.

● (1420)

Thank you very much.

The Chair: Thank you, Mr. Sanders.

For our first round of questions, we'll start with MP Kram for six minutes.

Mr. Michael Kram (Regina—Wascana, CPC): Thank you very much, Mr. Chair.

Thank you to the witnesses for joining us today on a Friday afternoon.

In the first hour, the committee heard that the federal government was in the process of developing a national quantum strategy. I wonder if each of the witnesses could offer their input as to what they would like to see in the government's national quantum strategy.

Any one of the witnesses may answer, but all of the witnesses would be preferable.

● (1425)

Dr. Barry C. Sanders: Alexandre, you can go first.

Dr. Alexandre Blais: Well, I did address the national quantum strategy in my introduction. I mentioned that being strategic about the use of these funds was important and that making choices is something we have to do. We cannot excel in everything quantum; at some point choices will have to be made. At the moment, the investments through NSERC are tagged "quantum", but NSERC does not make any strategic choices. This is good. It will continue to allow researchers to explore different avenues.

That said, I believe now that making strategic investments that bring together Canada and Canadian researchers around common goals would be a great way to go forward. I think that, if we can define community-based goals around which we can attract enough interest in Canadian researchers, we would have a chance to make research have a large impact.

Dr. Norbert Lütkenhaus: Maybe I can add to this one.

I think there are two aspects. Of course, we need to finance basically the research infrastructure, so what investment is needed so we can build the thing, like our nano facilities that we need?

The second point is, indeed—and I agree here with Dr. Blais—that we need to have projects that really match what the community thinks need to be done. This one needs to be matched, of course, with the need of the government and the industry. At the Institute for Institute for Quantum Computing, we're going by formulating these kinds of projects as lighthouse projects. We really say these stay together, we say these things should be done, and we will start marching on that one.

We think that's a really good discussion as well to have at the national level and, indeed, to think about what are those things that really define what we should be doing. I think that's a very important part of the process. We should not just funding little projects here and there; we need to talk about strategy.

Thank you.

Dr. Barry C. Sanders: Okay, I'll jump in.

I like what I see being rolled out, and my Alberta colleagues like it. The way I perceive the national quantum strategy is that it's different from the AI strategy from Genome Canada. It's really saying that we have existing mechanisms to provide funding and we'll do a quantum bump in funding. It kind of lowers the bar a bit for all kinds of projects. There are big projects like CFI/MSI programs. There's internship through Mitacs, etc. I see this as a great step. We have all these existing mechanisms. This doesn't put us in quantum on the spot saying that we're somehow treated as special.

These different agencies are really experienced in knowing what they're looking for and vetting the proposals. This idea of a quantum bump to every possible funding envelope and having us go through the normal procedure I think is a real strength.

It does matter to us in Alberta a lot because, again, in some ways we're a new kid on the block. How much do we direct our funding towards maintaining existing strengths versus letting up-and-comers step in? I think this is a good way to do it.

Mr. Michael Kram: Professor Blais, you said a couple of times that strategic choices would have to be made. Could you elaborate a little bit on what strategic choices will have to be made for Canada and where we should maybe focus our efforts and what areas might have to be left by the side of the road, so to speak?

[*Translation*]

Dr. Alexandre Blais: The answer I'm going to give is based on an initiative that our neighbours to the south have had in place for several years. Two research funding agencies in the United States, the Army Research Office and the Department of Energy, send challenges out to the community. They are challenges established by actors in the community, to which the community has an opportunity to respond. These challenges must involve multiple research teams across the country, and they also include participants in foreign countries. In fact, my own group receives funding resulting from those initiatives. These challenges, or strategic choices, are the work of the community, which proposes the avenues that it thinks are the most promising. Then, in collaboration with those research funding agencies, the choices are made and funding is granted.

● (1430)

The Chair: Thank you, Mr. Blais.

Mr. Kram, your speaking time is up.

I will now turn the floor over to Viviane Lapointe for six minutes.

Ms. Viviane Lapointe (Sudbury, Lib.): Thank you, Mr. Chair. I would inform you that I will be splitting my time today with my colleague, Mr. Dong.

My question is for Professor Blais.

Can you tell us about the potential use of quantum detection, particularly in mining and medicine? Since I come from Sudbury, I would very much like to know what benefits Canada might derive from quantum information in those sectors.

Dr. Alexandre Blais: Thank you for the question.

A lot has been said today about quantum computers, but, as I mentioned, it is important to understand that quantum information has more than one component. There are several aspects to quantum information. Mr. Lütkenhaus talked about one of them: quantum detectors, which measure the properties of their environment faster and more efficiently than current detectors. There are detectors everywhere around us, including in our smart phones, in our cars, and in the medical imaging equipment used in hospitals. Quantum computing means we can have detectors that are faster and provide better data.

At present, SBQuantum, a company in Sherbrooke, is designing quantum detectors for the mining industry. The first tests are being done now, in collaboration with the NRC. These detectors could be placed on drones and could detect variations in the magnetic field that indicate the presence of deposits. These technologies are much more advanced than quantum computers, in fact.

Quantum detectors could also provide better data, faster, in the medical imaging field. At present, big pieces of equipment are used to do medical imaging, because patients have to go inside the machines. We could imagine much smaller structures, such as helmets equipped with quantum detectors, that could be used to do imaging must faster and more efficiently. Once again, Canadian companies are developing these technologies, and it is even more advanced than quantum computers.

Ms. Viviane Lapointe: Thank you.

[*English*]

Mr. Han Dong: Thank you very much, Viviane, for sharing your time.

Dr. Sanders, Dr. Blais and Dr. Lütkenhaus, thank you so much for coming. If you could see my brain activity, you would see fireworks. I already feel smarter from listening to your presentations.

I just want to follow along what my colleague was asking. The theory of quantum computing is quite fascinating, but I want to hear from you that you are confident that with our current technology the application of the theory is actually possible and we can realize these applications.

Speaking in the context of hearing about the government's investment of $360 million over seven years and then looking at other countries that are investing a lot more, if we have to pick a lane—a certain part of this technology to gain a unique advantage over our competitors in the future—we had better be sure that the lane is not soon going to a very short dead end.

I want to hear your thoughts on this, starting with Dr. Blais.

[*Translation*]

Dr. Alexandre Blais: Thank you. That's a very good question.

At present, there is every indication that we will succeed in creating a quantum computer. All our scientific and technological advances are leading us to that goal. Although it is a hard road and there are still a lot of advances to be made, we are not seeing any major obstacles. In recent years, we have gone from small devices to online devices that we can really make work, but there are still challenges to be overcome and work to be done.

Part of the national quantum strategy funds NSERC, the Natural Sciences and Engineering Research Council of Canada, which enables Canadian researchers to explore all sorts of approaches leading to quantum computers, to help them achieve that goal. I talked about strategic choices earlier. Canada could choose a few possible architectures and invest in those avenues. It is possible for Canada to make that choice without it being at the expense of broader exploration, which is needed, thanks to the investments already announced for NSERC.

● (1435)

[*English*]

Mr. Han Dong: Thank you very much.

Is there any answer from your colleagues?

Dr. Norbert Lütkenhaus: I am happy to offer some thoughts on that. Yes, as Dr. Blais said, we are confident that quantum computing will come, and there are studies as well from the Global Risk Institute that tell you a little bit about what we in the community are thinking and what the timelines are.

It's very important to understand that the benefit from quantum computing/quantum information is not only the quantum computer itself. Already today, the quantum industry's acting on all aspects. If you have a quantum computer, you need to know what to use it for. That is some of what I said about the medium-term benefit, as well as our going and building up the small-scale or noisy quantum computers—or you wonder what they can be doing. There is already today the interaction between industry and academia to figure out what we can use those things for. As well, that is already a small part the industry. It's not only the quantum computer itself.

That is in addition to the spinoffs of technology for centres and so on—

Mr. Han Dong: I'm sorry. On that point, which is a very good one, I previously asked government officials about semiconductors. Semiconductor manufacturing capacity, to me.... Since we have this new technology to get to autonomous vehicles and all that future much more quickly, we need semiconductors to embody this technology.

Is that a field that you think that Canada should move toward to build our own independent semiconductor manufacturing capacity?

The Chair: Answer very briefly, please.

Dr. Norbert Lütkenhaus: Okay.

I'll provide very brief input on that. One thing is that the technology on which quantum computers will be based is not necessarily the same technology on which today's conventional computers are based. When you talk about today's semiconductor industry, that's not necessarily what we need for the quantum computer.

That is my short input.

The Chair: Thank you very much.

We'll now move to MP Lemire for six minutes.

[*Translation*]

Mr. Sébastien Lemire: Thank you, Mr. Chair.

Professor Blais, I won't hide the fact that when we began our efforts to inform ourselves about quantum computing, I was a bit outside my comfort zone. I was directed, with great admiration, to the work of the Université de Sherbrooke and what you are doing. Based on your presentation today, you get high praise from me.

I would like to take the opportunity to let you tell us about the present situation. First, you said that the current directions did not necessarily imply a strategic choice, except with respect to national defence and the demands of military defence, as we understood during the first hour of the meeting. I would like you to talk to us about what the government's priorities should be, particularly regarding funding and research, both applied and fundamental.

Dr. Alexandre Blais: Thank you for the comment and question.

I won't go into strategic choices again, since I have already said enough about that, but there are several points that I could make. One issue I would like to go back to is talent, which is essential. There is the technology, which we have talked about, but there have to be people to create it. The number of people we are training is not very high, as compared to what would be needed. In addition, those few people are immediately hired by companies at the international level. I have students who are approached by multiple companies just a year after starting their doctorates, asking what they will be doing once they get their diplomas. We are in a funny situation.

We have to keep these people. To do that, we have to create an ecosystem of enterprises. I am talking about the budding talent we create here and enterprises we attract. To create new talent, I don't believe the best approach is to ask professors to create an enterprise. If a professor creates a company, they create one and it's over. If the professor leaves to devote themself to their enterprise, then we lose an important channel for students.

Encouraging our students to start their own companies is really a winning formula, to my mind. There are probably some components missing for doing that. In Canada, investors are more timid when it comes to investing in initiatives that call for a long-term investment. The first years, the period when students go from university to a company the size of D-Wave, which we talked about, are critical. I think the national strategy has a role to play in that regard.

• (1440)

Mr. Sébastien Lemire: I see the urgency of creating an ecosystem based on collaboration, particularly with academia, but also with SMEs. The government can play a leadership role in this by investing major amounts so that Canada does not lose its competitive advantage.

We can talk about the urgency of establishing a collaboration with the academic community. That has an influence on numerous fields, including artificial intelligence, leading-edge robotics, communication networks, blockchain, and industry 4.0. Unfortunately, we often hear that these companies are sometimes working in a vacuum. That is also the case for the government.

What would you propose to make the collaborations and dialogues more productive?

Dr. Alexandre Blais: At present, the companies working in the quantum field in Canada do participate in worthwhile collaboration with the academic community. That is not the case for all companies, but some of the budding talent companies that have just started up simply have no choice but to work closely with academics. The research they are doing comes out of what is being done in the universities and is really pretty fundamental.

In all honesty, I don't think working in a vacuum is a problem in the quantum field, although it does happen, I agree, in other fields.

Mr. Sébastien Lemire: How can we guarantee growth in the quantum industry?

I often note that the government's strategies amount to putting its money on a horse that is going to give it a good reputation or a good press conference, rather than staying open to a wider group of SMEs and actors who could also become winning horses, not necessarily in the short term, but in the long term.

Dr. Alexandre Blais: I think the innovation zone in quantum sciences and technological applications that has just been announced in Sherbrooke is a good example. It is based on research excellence and local expertise, quantum Sherbrooke in this case, and on investments. These will help students start up their companies and will also encourage companies from outside to come to the Sherbrooke region. The idea is that it will become a much more natural route for our students. Of course, things were extremely difficult for the first student who created an innovative company in Sherbrooke, but they were a little less difficult for the second.

In this ecosystem, we need an assembly of talent to move from quantum science to quantum technology. As well, we have to generate a lot of attraction at the international level. People have to have the feeling that Sherbrooke, in this case, and Canada, more generally, offer them a multitude of possibilities. People have to think that if it should happen not to work out—because young buds are sometimes born and then die—at least three other opportunities are offered to them, because a multitude of other things are going on in that region.

These investments are therefore crucial.

Mr. Sébastien Lemire: I think the chair is going to tell me my time is up. I sometimes overdo things. So I am going to stop here.

Thank you, Mr. Blais.

The Chair: Yes, that's right. Thank you for managing your time, Mr. Lemire.

Mr. Masse, you have the floor for six minutes.

[*English*]

Mr. Brian Masse: Thank you, Mr. Chair, and thank you to our guests.

Mr. Sanders, I noted and I think it might have been you, and I'm hoping it is because I'd like to learn more about this, who mentioned the quantum computing hackathon that was done. I'd like you to expand a little bit on that. I thought that was a rather interesting initiative. I know it's been going on for awhile, but it seems to be really growing. It's for social good and is what it is, so that people understand that.

Was that you who was a guest speaker? I know you weren't involved in organizing it, but maybe you were a guest speaker. Could you maybe elaborate a little bit on that because I see these as exciting opportunities to continue to push cybersecurity and also the good that quantum computing can do.

Dr. Barry C. Sanders: Actually, that will be next week. After this meeting I'm heading to the airport and flying off to Abu Dhabi. There, I'm working with New York University's Abu Dhabi campus, and the idea is to do a hackathon. It's called “Hackathon for Social Good in the Arab World”. I'm going as the quantum computing expert for it.

The hackathon brings in software engineers, computer scientists, people who want to build apps or APIs, just things that can go on your phone. The idea is to do what I think a lot of people at this meeting are caring about: to look at how is quantum computing going to fit into practical applications.

I help a lot in these things. Next week I'm a guest speaker, but also a mentor and enabler. The idea is that we want to take what quantum computing can do today.... And I just want to be a little bit clear here: Quantum computing is a long-term effort, but there's an area called “quantum-inspired computing”, which is where we say, what would a quantum computer be good at, and if we simulate a quantum computer today, could the benefits of the future come around today? Basically, thinking about what a quantum computer will do in the future inspires us to invent new algorithms today, like in optimization areas.

Part of what we're doing next week in Abu Dhabi is that I'll be looking at what the inspiration of quantum computing is doing to drive new algorithms and how to incorporate those new algorithms into apps. Then I'll bring in some of my students from Calgary, and we're doing things like basically flight management. We're working on problems like developing apps so that countries can minimize global temperature rise, and we call that the “objective function”. We're trying to find ways to say, given takeoffs and landings, altitudes, how do we minimize the global temperature rise, and we're doing it all with quantum-inspired computing.

Thanks for asking. That's what I love, and it just turns out that Abu Dhabi is the first place launching a hackathon of that type, so I'm helping them.

● (1445)

Mr. Brian Masse: Thanks for that.

Sorry, I didn't notice the date when it was happening because I just read two articles on it and won't be anywhere near there.

What I found interesting, though, is there is even discussion on stuff like grocery store apps and things of that nature. It's interesting to me because I've been in dialogue with some of the grocery stores because they do have some apps now, and there are some ethical issues with regard to price differences, and it also depends on whether it's a store or it could be the supplier. There are a whole bunch of ethical issues still in there.

For this conference, though, is it mostly young people who will be involved in it? You mentioned you're a mentor. Is there a Canadian component to it, or are you just going there basically on your own? I'm just curious how we fit in this, because I think these things are really exciting because they do provide an opportunity for people to see the practical element of this.

Dr. Barry C. Sanders: There's no official connection between Canada and what's going on in Abu Dhabi. It is a New York University Abu Dhabi campus thing. I'm the lead mentor and pushing it forward, so by my association Canada has a strong presence in this activity.

This is really breaking new ground. As you said, there are grocery apps and all these kinds of things, and we really want to find ways to make quantum computing matter now, and engage the software community. A lot of this is really physicist and computer-scientist driven, but we really want to engage the software community better.

I look at this activity in Abu Dhabi as an experiment on my part. I'm going there and I'll learn a lot. I'm hoping with what I experience there and what successes I see there, I can bring back to Canada and we can start developing a lot more focus on the software side and using quantum inspiration to solve today's problems.

Mr. Brian Masse: Maybe potentially the next time we have you back as a witness it could be related to Canada's having hosted something of this nature, if that's not too ambitious. It would certainly seem that these types of efforts are really worthwhile.

I think we'll follow up as well. That's where I see there being a great role for the universities and the Government of Canada to help sponsor and reverse the potential loss of talent as opposed to our getting a chance to have people come to our community. I have the University of Windsor and St. Clair College in my riding. When we host those events internationally, they're of huge significance to attract future star candidates.

Thanks, Mr. Chair. Those are my questions.

[*Translation*]

The Chair: Thank you, Mr. Masse.

I am now going to turn the floor over to Mr. Généreux for five minutes.

Mr. Bernard Généreux (Montmagny—L'Islet—Kamouraska—Rivière-du-Loup, CPC): Thank you, Mr. Chair.

Mr. Sanders, rather than having an app installed on my phone to vote in the House of Commons, I would like the opportunity to be transported there by my phone and vote there by hologram.

I'm joking, obviously.

I would like to thank the witnesses for being here. What you are teaching us is pretty impressive. In all sincerity, at the start of our study, I felt a bit like Mr. Lemire: I wondered what kind of questions I was going to be able to ask you. As it turns out, I have a million questions to ask you.

Mr. Blais, you talked a lot about training earlier. You said that the Government of Quebec had invested major amounts in addition to the amounts paid by the Government of Canada through the national quantum strategy that is being developed.

When it comes to training, you know that there are the Centres collégiaux de transfert de technologie, the CCTTs, in Quebec. Where I live in La Pocatière, Novika Solutions and OPTECH, which you are certainly familiar with, are part of the CCTTs. I have visited OPTECH's website and I learned that the company was also working on quantum technology.

This is about technical training. Do you know whether the national quantum strategy provides for funds that will be dedicated to technical training?

● (1450)

Dr. Alexandre Blais: I don't know whether that is provided for, but I can say, however, that it is essential.

In my presentation, I mentioned that it wasn't necessary to have a Ph.D. to contribute to this field; far from it. We need specialists in cryogenics and machining. Without them, we will not have quantum computers.

In fact, the Institut quantique employs a number of people from La Pocatière. As I said, there is expertise in Sherbrooke. Sherbrooke's Innovation Zone in Quantum Sciences and Technological Applications will also be working with the Cégep de Sherbrooke on this.

Mr. Bernard Généreux: As I understand it, the government is investing $50 million a year through the NRC, which then has an obligation to put the strategy in place.

Is the NRC or the government itself doing that? Can you give me some information on this point?

Dr. Alexandre Blais: As I understand it, the NRC already offers programs, such as the Discovery Grants Program, the Alliance grants, and the CREATE program, and funds will be devoted to quantum computing through those programs.

Mr. Bernard Généreux: Okay, I understand. So those funds will be added to the funds invested by the Government of Quebec.

[*English*]

Mr. Sanders, do you know if Alberta is doing the same?

Is Ontario, wherever you are, doing the same, Mr. Lütkenhaus?

Dr. Norbert Lütkenhaus: There are initiatives for sure in the NSERC-CREATE training aspects, which is part of the national quantum initiative. That is actually training at the graduate level.

We at the Institute for Quantum Computing have been actually doing training on all levels. We start off with high school students. We have training elements for undergraduate and graduate students. We have trained 200 graduate students.

We have, as well, training like CryptoWorks 21, which is actually a form of this NSERC-CREATE program that we have been doing together, for example, with Calgary, where we do training between disciplines. That is for the important area of cybersecurity and quantum-safe cryptography, where we have classical cryptography—cryptography not working with quantum mechanics at all—and basically cryptographers who work with quantum mechanical means. We bring them together so that both of these communities can come together and know about their respective advantages.

It's very important to make this cross-connection. It's not only about quantum physicists having fun. It is really about bringing the different backgrounds together as well as teaching people outside about what it is that quantum can and cannot do, and how it can be utilized.

These training efforts are very important, and the NSERC-CREATE initiative is one of the tools in this part of the quantum strategy as well.

[*Translation*]

Mr. Bernard Généreux: Thank you for your answer, Mr. Lütkenhaus.

Mr. Blais, you talked about competition earlier. You have partners everywhere in the world. Mr. Sanders referred to New Delhi and New York. You collaborate with partners, but you also have competitors. Who are they?

On a scale of one to ten, where is Canada at present in the global quantum computing industry?

Dr. Alexandre Blais: In fact, there are two different aspects: the academic sector and the industry sector. I want to be sure I am understanding your question correctly. You are talking about the industry, more specifically, is that right?

Mr. Bernard Généreux: Yes.

Dr. Alexandre Blais: For the industry, as Professor Lütkenhaus explained well, quantum computing brought about an initial revolution: microelectronics as we already know it. We are now in the second revolution.

We could say that Canada came out a loser, in a way, in the first revolution. The Apples, IBMs and Intels of this world are not here in Canada; they are south of the border. As a result, the big players that are investing massively in quantum technology today are also located south of the border: Google, IBM, Intel and Amazon.

Mr. Bernard Généreux: IBM is in Bromont too, is that right?

Dr. Alexandre Blais: IBM has a plant in Bromont. It is the only one left in the world. In fact, an IBM quantum computer is going to be installed in Bromont this year.

● (1455)

Mr. Bernard Généreux: Right.

Regarding...

The Chair: Thank you, Mr. Généreux. I'm sorry, but your speaking time is up. That will be for another time.

Mr. Filmore, you have the floor for five minutes.

[*English*]

Mr. Andy Fillmore (Halifax, Lib.): Thanks very much, Mr. Chair; and tremendous thanks to this panel. It's clear that much of the leadership in quantum computing in Canada resides with you and we're very grateful to have you join us today.

I would love nothing more than to crack into an exciting discussion about the details of the work you do in your labs and how quantum computing works and will work. On that note, I just want to say thanks to the committee's analysts. I think it was Sarah and Scott who provided the very helpful working paper that made the concepts of quantum computing accessible to committee members, so thank you to the analysts. However, the committee unfortunately today is more focused on governance and creating the conditions for you to be able to do your work and to get Canada to where it needs to be, rather than on the details.

I want to come back to this question. It has been raised a few times, but it needs to be raised again, about the talent pipeline. The global context of cybersecurity and international security is changing and becoming more complex by the day, and Canada needs to be competitive in these fora.

This is your opportunity to be very specific to the committee about what this national quantum strategy has to do to support the talent pipeline. Does the funding that has already been mentioned cover the cost of recruitment and training, marketing and other things? Is more money needed? Exactly how would you see a strategy like this, a national strategy, being effective in creating a talent pipeline?

I would open that question up to anybody to answer.

Dr. Barry C. Sanders: Maybe I could jump in first. I'll just mention that certainly in Calgary, similar to what's happening in Ontario and Quebec, we're looking for ways to be able to bring in the companies and have the talent. As we've heard, we create talent, the talent leaves Canada and that's a problem.

Where the money and the governance can really help is in co-developing the two. In Alberta, a chief part of the funding we got in the recent Alberta government budget helps us to effectively subsidize talent development so we're able to create these kinds of programs that are addressing what industry needs and these are full cost-recovery degrees. We set up professional degrees and then we go to companies and say we are developing the talent. There will be talent. We tell them that if they set up a base in Calgary, we are putting through talent, and it's effectively zero risk because it's taxpayer dollars that are enabling us to be able to launch this in a managed-risk kind of way.

If we don't do that kind of thing, we create the talent and the establishment of the companies comes later. As my colleagues have said, the students will go out and create the companies, but it's too late; we lose the talent. On the other hand, if we try to bring in companies and we don't have the talent, that's a problem. I see this as a problem, but it's a solvable problem.

I've had discussions with Mitacs, which is an excellent organization, for internships, and so on, but this is a point I keep raising. We need to find a way where we're establishing deep tech talent, we have the dollars to be able to do so, we're simultaneously bringing in companies and we're marrying the two together so that a company setting up at a place is able to have the talent step into it.

The nutshell of what I said is that we need to make talent development and company creation simultaneous. That's a gap in the way we're currently managing our quantum strategy.

Mr. Andy Fillmore: Thank you.

Are there other comments?

Dr. Norbert Lütkenhaus: One thing we really need when we talk about talent is having enough people interested in going into the field. That is something I think we all understand in Canada. We need to play together to really bring more people in. That's why we have this funnel really going from high schools to bring people into STEM and to bring people into our field. This is only one of the aspects.

Now if you think about talent to work as well as to drive the quantum industry, there really are two parts to it. It is one thing to have sufficient funding to hire enough graduate students so that we bring them to that level over here and they can then go into work in the quantum industry. That's really the one thing, and I think that exists as the core part of the quantum initiative as well, to make sure that we can do the research and, in that way, train the academic workforce for companies.

Then another thing is indeed something that we have to figure out. It's something that Barry mentioned about the need to have the professional development. That means people who are not in the main quantum part but would need to know how to work with it. We need to figure out how exactly to make this work. This is not the core academic part, but we need to figure out what instruments we need to actually help support that. I don't have a clear answer to that one, but it's clearly one of the things that we think we need to take care of.

● (1500)

Mr. Andy Fillmore: Thank you.

[*Translation*]

Dr. Alexandre Blais: Mr. Chair, could I make one last comment?

The Chair: Yes, but make it very quick, Mr. Blais.

Dr. Alexandre Blais: Yes, it will be brief.

In addition to the national quantum strategy, Canada could expedite visas granted to students and people who want to train and work in the industry. It is difficult to get visas to the United States at the moment, so Canada could take advantage of that to expedite this here and make Canada even more attractive for these people.

The Chair: Thank you, Mr. Blais.

I will turn the floor over to Mr. Lemire for two minutes.

Mr. Sébastien Lemire: Thank you, Mr. Chair.

Thank you for your flexibility, Mr. Blais. I am going to continue with you.

Should we create a body to develop standards for the industry, which would enable more than one company to produce the same product and take part in the international market?

It would be somewhat like the USB standards for connectors.

Dr. Alexandre Blais: That is part of the discussions, although it is still early to be developing those standards, not for quantum computers, but rather for quantum communication and quantum cryptography. We have to start thinking about it. The NRC can take part in those discussions.

Mr. Sébastien Lemire: I would like you to talk to us about intellectual property. How would you like intellectual property to be treated in Canada? Is the law sufficiently robust or up to date to deal with this issue in the field of quantum computing?

Dr. Alexandre Blais: My answer will be incomplete because, as was mentioned during the previous hour, it really differs from one university to another and takes on a very local character. In this regard, each university's situation is unique.

Mr. Sébastien Lemire: I am very interested in electric and battery-powered cars.

What are the possibilities in that regard? Are you able to initiate a knowledge transfer or knowledge appropriation to contribute to the energy transition and the value chain of batteries? What could you tell us about that?

Dr. Alexandre Blais: I could tell you two things.

First, we need to look at new materials, quantum materials, that would potentially have better properties. Those materials don't exist yet, but we could imagine them. That would be one area to research.

Second, quantum computers could be used to simulate those materials and those processes, to improve batteries. That is something that is under discussion. It is not yet possible to do it using the current generation of quantum computers.

Mr. Sébastien Lemire: I like your answer.

In the meantime, are you afraid that certain materials may become scarce? Obviously, we can think of critical and strategic minerals.

Dr. Alexandre Blais: Very much so. My comments do not answer that important aspect of the question. It would be projecting, but we can hope that this work will one day help us find an alternative approach that does not use rare metals, which are difficult to obtain.

Mr. Sébastien Lemire: Thank you, Mr. Blais. It was a privilege to speak with you.

Dr. Alexandre Blais: And thank you.

The Chair: Thank you.

Mr. Masse will ask the last questions.

You have the floor for two minutes.

[*English*]

Mr. Brian Masse: Thank you, Mr. Chair.

I'll start with Mr. Blais really quickly and go across the board.

This is the first time we've studied the question of quantum computing at the House of Commons. Could you give us some quick advice as to where this committee should go next? If you were to prioritize one or two things, what would they be? What advice could you give us?

I would appreciate that advice.

[*Translation*]

Dr. Alexandre Blais: That's a good question and it is very broad, so I could give several answers.

First, thank you for taking the time to do this study.

I am going to go back to the strategic choices made in the national strategy. In that strategy, we have to make sure not to scatter the dollars all over. We have to make choices, which may be difficult, but which are necessary.

And again, we have to think about talent and visas, as I said earlier. That is something that is completely outside the national strategy but that will have an immediate tangible effect for the entire community.

Thank you. I am sure my colleagues will have something to add.

● (1505)

[*English*]

Dr. Norbert Lütkenhaus: Maybe I can add to that. That is really going in the same direction Dr. Blais said.

The national quantum strategy should be more than funding programs that have “quantum” in their title. The important thing is the coordination between academics, government and industry. We need to have this vehicle that really comes together, makes its focus points and says what it is we should be doing.

Building on the strength that you already have is also what you need to take into account. You need to talk especially about what our national priorities are. For example, cybersecurity and being quantum safe are very important. You need this coordination, and I think that is a very important thing for sure, to make sure that the strategy takes this coordination into account.

Dr. Barry C. Sanders: I have just one comment. That's what the Americans call “soup to nuts”. The soup would be the creation side, the academic. The nuts would be the final beneficiaries, those getting benefit out of it.

I think it's important to keep an eye on and always to keep aware of that full menu, from soup to nuts.

Mr. Brian Masse: Thank you very much.

Thank you, Mr. Chair.

[*Translation*]

The Chair: Thank you, Mr. Masse.

Mr. Sanders, Mr. Lütkenhaus, and Mr. Blais, the committee thanks you enormously for being with us. It has been very enlightening. We still have a long way to go, but it is important to look at quantum computing and all its possibilities. I would like to thank you for the light you have shed and I wish you a very lovely weekend.

I would also like to thank all the committee members, interpreters, clerks, analysts and technical support officers.

Have a good weekend, everyone.

The meeting is adjourned.