

Written Submission for the Pre-Budget Consultations in Advance of the 2024 Federal Budget

By: D-Wave Systems Inc.

List of Recommendations

- **Recommendation 1:** That the Government of Canada create a Canadian “quantum sandbox” to develop and test near-term quantum applications as part of the implementation of the National Quantum Strategy.
- **Recommendation 2:** That the Government of Canada invest in a government-funded National Quantum Training Program.
- **Recommendation 3:** That the Government of Canada expand the National Quantum Advisory Panel to include greater industry representation.
- **Recommendation 4:** That the Government of Canada conduct an objective assessment of the technology readiness of the different quantum systems and qubit architectures.

July 28, 2023

Honourable Chrystia Freeland, P.C., M.P.
Deputy Prime Minister and Minister of Finance
Finance Canada
90 Elgin Street
Ottawa, ON K1A 0G5

RE: *Pre-Budget Consultations 2024*

Dear Minister Freeland,

On behalf of D-Wave Systems Inc. (D-Wave), I appreciate the opportunity to participate in Finance Canada's pre-budget consultations.

D-Wave was founded in 1999 and is the world's first quantum computing company. Based near Vancouver, the company is a global leader in the development and delivery of quantum computing systems and software, and its mission is to unlock the power of quantum computing to solve the world's most challenging and important problems. D-Wave's R&D efforts at our Quantum Center of Excellence have developed the world's first commercial quantum computing system and four subsequent generations of quantum computers. We continue to be a leader in the development and delivery of quantum computing systems and are the only company building both annealing and gate-model quantum computers. We are also a full stack provider, which means our technology, products and services include hardware, software, cloud access and more. Our platform-agnostic and full-stack approaches allow us to provide a broad industry perspective. Our systems are currently being used by customers including Google, NASA, Lockheed Martin, Volkswagen, and the Los Alamos National Laboratory, among others. At home in B.C., D-Wave's customers include Pattison Food Group who use a quantum application daily for their food delivery service.

D-Wave remains a leader in the development and delivery of quantum solutions. Its technology follows a platform-agnostic and full-stack approach, making it accessible to a wide range of industries. Quantum computing has applications in various fields, including pharmaceutical research, logistics, and scheduling for large retail chains. Quantum solutions offer faster, more efficient problem-solving methods that reduce labour-intensive processes.

The next federal budget provides an important opportunity to invest in and advance the development of quantum technologies and solutions and provide funding for proper implementation of the National Quantum Strategy. In that spirit, D-Wave submits the following four recommendations for consideration as part of Finance Canada's budget deliberations.

Recommendation 1: That the Government of Canada create a Canadian “quantum sandbox” to develop and test near-term quantum applications as part of the implementation of the National Quantum Strategy.

D-Wave continues to recommend the Government of Canada further its investment in the long-term growth of the country’s technology and innovation industry by creating a “quantum sandbox” program in Canada. This would be a powerful program for commercialization.

A sandbox program offers a holistic approach, to promoting the growth of the quantum industry by supporting collaboration, attracting talent, and fostering innovation. A focus on the development and commercialization of quantum technology through application development will accelerate Canada’s innovation role in harnessing quantum technologies to solve complex problems of both national and global importance.

A “sandbox” would provide for enhanced collaboration between government, industry, and research universities, and would expedite development and innovation, and use of quantum technologies. A sandbox program would offer a space where government and the private sector can submit problems that allow sandbox participants to identify solutions by utilizing quantum technologies. The aim of such a program would be to have applications developed and deployed within a short period of time. In the [United Kingdom](#) there is a focus of application development in a 18-month or less timeframe. In the [United States](#), Congress is reviewing legislation to create a sandbox with a 24-month or less timeline, with a program focus of facilitating rapid usage of quantum technology to solve real-world problems such as emergency response, sustainability, supply chain, etc. Such a program in Canada should be inclusive of all quantum computing technologies including quantum annealing, quantum gate-model, and quantum-hybrid applications.

Recommendation 2: That the Government of Canada invest in a government-funded National Quantum Training Program.

D-Wave continues to recommend that the Government of Canada create a government-funded National Quantum Training Program to further promote upskilling in the quantum industry. The retention and development of a strong quantum workforce with skills from a variety of sciences and backgrounds are required to grow Canada’s quantum technologies, companies, and talent.

Through a National Quantum Training Program, the workforce talent could be upskilled in a wide variety of quantum and quantum-hybrid technology systems. This program should be open to students, researchers, government officials, and commercial industry, allowing Canadian companies to participate by sending employees to be upskilled. Additionally, the training program could be offered virtually to provide access to hundreds of people across the country. A program like this has already been initiated in British Columbia, focusing on training students in algorithm development. The program, a collaboration between D-Wave and the Quantum Algorithm Institute, is aimed at [accelerating a quantum ready workforce](#). To expand the reach of this program, it should receive matching funding from the Government of Canada. Moreover, the training program should extend beyond students at academic institutions to include commercial and government up-skilling. Those working on solving optimization problems or who have algorithm development on classical computers alone could easily take industry

quantum training programs to expand their skills and accelerate the ability to create a quantum-ready workforce. Implementing such a program would position Canada as a global leader in quantum talent development and accelerate a quantum-fluent workforce.

Recommendation 3: That the Government of Canada expand a National Quantum Advisory Panel to include greater industry representation.

D-Wave is supportive of the advisory panel being created as part of the National Quantum Strategy, and we recommend expanding the engagement to include greater industry representation. Currently, the advisory council comprises one industry representative and one academic. The industry representative has a start-up focused on photonic-based qubits but does not have a system available for commercial use today. Representatives on the council should include a variety of different technologies including quantum computing (annealing and gate-model systems) that are inclusive of the different qubit architectures (superconducting, photonic, ion trap, etc.) as well as other quantum technologies. Ensuring the advisory council has a variety of industry engagement from across the technology readiness levels will also ensure the government is engaging with the different technologies appropriately as each of these technologies and qubit architectures are advancing at different paces, and the needs will vary.

An expanded National Quantum Advisory Panel would serve as an important resource for the government to identify workforce development needs, support near-term application development programs, understand the readiness level of the different technologies, and achieve other key policy objectives necessary to ensure the long-term growth of Canada's world-leading quantum technology.

Recommendation 4: That the Government of Canada conduct an objective assessment of the technology readiness of the different quantum systems and qubit architectures.

Confusion around readiness of emerging technology such as quantum, continues as there are mixed messages about capabilities and achievements. In the case of quantum computing technology, there are messages that quantum is available and useful to solve problems today, while others are stating that the technology could be decades away. An objective technology readiness level (TRL) assessment is needed to better understand the state of today's quantum computing technology capabilities. Such an assessment should look at the maturity of quantum systems (annealing and gate systems) as well as review the readiness level of the different qubit architectures (superconducting, ion traps, photonics, atoms, etc.). There is no current global TRL assessment, and the Government of Canada can be a leader in this space.

[TRLs](#) are a type of measurement system used to assess the maturity level of a particular technology, and provide a rating on a scale of 1 to 9. TRL 1 is the lowest rating where basic research is still being conducted, while TRL 9 is the highest rating where there are proven benefits and a strong commercial market. Engagement with the technology can occur across the entire spectrum of readiness levels, but understanding where the technology sits today is necessary for demystifying the technology, and a role for Government.

In June 2021, the National Institute of Standards and Technology ([NIST](#)) in the U.S. while discussing how to better harmonize quantum technology terminology, provided an assessment of quantum technologies (computing as well as other quantum devices) and discussed that full-scale error-corrected gate-model systems were at a TRL-1, meaning they are decades away from being ready for the market. The noisy intermediate-scale quantum (NISQ) gate-based research systems that are available via the cloud were determined to be a TRL-5. Annealing quantum computers that are commercially viable were determined to be a TRL-8. In July 2022, the Forschungszentrum Jülich supercomputing center released their [technology readiness levels for quantum computing](#). Their quantum TRL mirrored the nascent stage of the gate-based systems and the maturity level of annealing quantum computers assessing annealing quantum computers at readiness level if 7-8 and [NISQ systems](#) were determined to have a readiness level of 5. While not providing a specific technology readiness assessment, the [Hague Centre for Strategic Studies](#) in October 2021, showcased that in the field of quantum computing, there is already an annealing quantum computer with a few thousand qubits available for solving optimization, and Boston Consulting Group (BCG) in 2018 discuss the range of gate-based quantum systems having an assessment of TRL-1 to 5 ([Exhibits 6 & 7](#)). BCG highlighted the different qubit architectures in gate-based computing systems as having their own differing TRL level assessment. For example, photonic systems were determined to be a TRL-3 while superconducting gate-based systems were a TRL-5 and trapped ions were at TRL-4. None of these assessments have included application development with quantum-hybrid technology.

The lack of a comprehensive and regularly updated TRL assessment leads to confusion for technology engagement and procurement, and therefore an objective TRL assessment released by the Government of Canada is important. Moreover, such an assessment should be updated every few years to ensure the advancements of the technologies and different modalities is better understood by end users, whether they be government or private sector. As technologies advance along the TRL assessment, they can be identified for engagement within the pillars of the National Quantum Strategy as well as within the sandbox and training programs recommended above.

Conclusion

D-Wave's recommendations will result in a significant boost to quantum commercialization and will accelerate talent development. This approach will also accelerate Canada's global position as a commercial quantum computing innovation leader. Additionally, our recommendations align with, and reflect the findings in the Report of the Standing Committee on Industry and Technology titled "How Can Canada Remain a Leader in the Global Quantum Marathon?". Members of the Industry Committee support quantum innovation and have reiterated their commitment to establishing Canada a world leader in quantum science.