



HOUSE OF COMMONS
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CANADA

SMALL MODULAR NUCLEAR REACTORS

**Report of the Standing Committee on Science
and Research**

Honourable Kirsty Duncan, Chair

**FEBRUARY 2023
44th PARLIAMENT, 1st SESSION**

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**Hon. Kirsty Duncan
Chair**

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44th PARLIAMENT, 1st SESSION

NOTICE TO READER

Reports from committees presented to the House of Commons

Presenting a report to the House is the way a committee makes public its findings and recommendations on a particular topic. Substantive reports on a subject-matter study usually contain a synopsis of the testimony heard, the recommendations made by the committee, as well as the reasons for those recommendations.

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THE STANDING COMMITTEE ON SCIENCE AND RESEARCH

has the honour to present its

THIRD REPORT

Pursuant to its mandate under Standing Order 108(3)(i), the committee has studied small modular nuclear reactors and has agreed to report the following:

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SUMMARY

Small modular reactors (SMRs) are nuclear fission reactors that are smaller and less powerful than traditional reactors, with components that are built in a factory and transported on site for assembly. SMRs produce 10 to 300 megawatts of electricity (MWe). Reactors that produce 10 MWe or less are called microreactors.

While many SMR projects are being developed around the world, only a few have been built so far. Proponents of SMRs say the technology could support the transition to net-zero. SMRs could also provide electricity to remote mines and communities. Opponents of SMRs, meanwhile, say that SMR timelines are not adequate to address net-zero targets and raise concerns about waste and limited economic demand.

Several SMR projects are in the planning stages across Canada. Alberta, New Brunswick, Ontario and Saskatchewan jointly released a *Strategic Plan for the Deployment of Small Modular Reactors* in March 2022. The federal government also signaled its support for SMR development with its release of Canada’s SMR Action Plan in December 2020.

The House of Commons Standing Committee on Science and Research (the Committee) decided to undertake a study of SMRs to “better understand this emerging technology and how it can benefit both the environment and economy in Canadian society.”¹

In the course of its study, the Committee heard testimony on various aspects of SMR development in Canada, concentrating on the science and research aspects. The Committee also heard testimony on climate and the environment, the economic impact of SMR projects and community engagement.

Based on the testimony it heard, the Committee made eight recommendations to government.

1 House of Commons, Standing Committee on Science and Research (SRSR), [*Minutes of Proceedings*](#), 1 February 2022.

LIST OF RECOMMENDATIONS

As a result of their deliberations committees may make recommendations which they include in their reports for the consideration of the House of Commons or the Government. Recommendations related to this study are listed below.

Recommendation 1

That the Government of Canada continue to support small modular reactor projects by sharing their development phase costs. 13

Recommendation 2

That the Government of Canada undertake transparent, independent scientific reviews as part of the decision-making for any funding towards small modular reactor research and development. 14

Recommendation 3

That the Government of Canada work with international and scientific partners to examine nuclear waste reprocessing and its implications for waste management and proliferation vulnerability..... 16

Recommendation 4

That the Government of Canada implement a comprehensive research and development plan on small modular reactors that would bridge government, private industry and academia. 18

Recommendation 5

That the Government of Canada consider including nuclear technology and small modular reactors in green energy and net-zero programs like the Green Bond Framework..... 22

Recommendation 6

That the Government of Canada develop a pan-Canadian strategy, in partnership with provinces, territories and Indigenous governing bodies, for developing a workforce to research, create, establish, operate and maintain small modular reactors. 33

Recommendation 7

That the Government of Canada require the participation of Indigenous communities in decision-making on small modular reactors, including site selection and project management. 36

Recommendation 8

That the Government of Canada review its approach to consulting the public and Indigenous communities on small modular reactor development projects..... 36



A STUDY OF SMALL MODULAR NUCLEAR REACTORS

INTRODUCTION

On 1 February 2022, the House of Commons Standing Committee on Science and Research (the Committee) decided to undertake a study of small modular nuclear reactors (SMRs) to “better understand this emerging technology and how it can benefit both the environment and economy in Canadian society.”¹ The Committee decided that the study would include, but would not be limited to, examining the following:

- a) the impacts of SMRs on climate change;
- b) the contributions of SMRs to Canadian science, research and innovation;
- c) the impacts of SMRs on Canadian-based manufacturing and on the resilience of domestic supply chains across Canada; and
- d) the opportunities created by SMRs to export this technology globally to new and existing markets.²

In the course of its study, the Committee held four meetings between 2 June and 26 September 2022. It heard 29 witnesses and received 29 briefs. The Committee would like to thank all of the individuals and organizations that took the time to participate in this study by appearing or submitting a brief.

The evidence compiled by the Committee resulted in recommendations for the Government of Canada on small modular reactors.

BACKGROUND

Small modular reactors (SMRs) are nuclear fission reactors that are smaller and less powerful than traditional reactors, with components that are built in a factory and

1 House of Commons, Standing Committee on Science and Research (SRSR), *Minutes of Proceedings*, 1 February 2022.

2 Ibid.



transported on site for assembly.³ SMRs produce 10 to 300 megawatts of electricity (MWe). Reactors that produce 10 MWe or less are called microreactors.⁴

More than 70 SMR projects are being developed around the world, using different technologies.⁵ To date, only two SMRs are in operation: the two KLT-40S reactors at the Akademik Lomonosov floating nuclear power plant in Russia have been in operation since 2020 and the HTR-PM reactor built at the Shidao Bay nuclear power plant in China was connected to the grid in December 2021.⁶

Many of those projects use light-water technology that is common in conventional reactors, but SMRs can “vary significantly in size, design features and cooling types.”⁷ The Canadian Nuclear Safety Commission (CNSC) gives the following examples of SMR technologies:

- integral pressurized water reactors;
- molten salt reactors;
- high-temperature gas reactors;
- liquid metal cooled reactors; and
- solid state or heat pipe reactors.⁸

SMRs are expected to have several advantages over traditional reactors. SMRs are smaller and have simpler designs, and their components are easier to manufacture,

3 Canadian Nuclear Safety Commission (CNSC), [Small modular reactors](#).

4 Organisation for Economic Co-operation and Development (OECD), [Small Modular Reactors: Challenges and Opportunities](#), Nuclear Technology Development and Economics 2021, 2021, p. 15.

5 International Atomic Energy Agency (IAEA), [Advances in Small Modular Reactor Technology Developments—A Supplement to: IAEA Advanced Reactors Information System \(ARIS\), 2020 Edition](#), September 2020, p. 1.

6 OECD, [Small Modular Reactors: Challenges and Opportunities](#), Nuclear Technology Development and Economics 2021, 2021, p. 16; and China National Nuclear Corporation, [World's first HTR-PM nuclear power plant connected to grid](#), News release, 20 December 2021.

7 CNSC, [Small modular reactors](#).

8 Ibid.

transport and install.⁹ In addition, SMRs could also support the decarbonization of the energy sector.

Canada was the world's third largest producer of uranium in 2021, with 13% of global uranium production taking place in Saskatchewan in 2019.¹⁰ Incidentally, 75% of this uranium is exported. The nuclear industry contributes \$17 billion to the Canadian economy and generates 76,000 jobs, including 33,000 direct jobs.

In Canada, nuclear energy accounted for 15% of electricity generation in 2019.¹¹ There are 19 CANDU nuclear reactors in four nuclear power stations: Bruce, Pickering and Darlington in Ontario, and Point Lepreau in New Brunswick. There are also four research reactors in Canada.¹²

Nuclear energy largely falls under federal jurisdiction. The federal government is responsible for research and development and for regulating nuclear materials and activities in Canada.¹³

Parliament has established a framework for nuclear energy through various legislation:

- *Nuclear Safety and Control Act*;¹⁴
- *Nuclear Energy Act*;¹⁵
- *Nuclear Fuel Waste Act*;¹⁶ and
- *Nuclear Liability and Compensation Act*.¹⁷

9 OECD, *Small Modular Reactors: Challenges and Opportunities*, Nuclear Technology Development and Economics 2021, 2021, p. 19.

10 The data in this section is taken from Natural Resources Canada, *Nuclear in Canada*, 2020; and The World Nuclear Association, *Uranium Production Figures, 2012-2021*, updated July 2022.

11 Canada Energy Regulator, *Market Snapshot: The Potential Role of Nuclear in Canada's Energy Future*, 6 July 2022.

12 CNSC, *Research reactors*; and Saskatchewan Research Council, *SLOWPOKE-2*.

13 Government of Canada, *Nuclear Energy*.

14 *Nuclear Safety and Control Act*, S.C. 1997, c. 9.

15 *Nuclear Energy Act*, R.S.C. 1985, c. A-16.

16 *Nuclear Fuel Waste Act*, S.C. 2002, c. 23.

17 *Nuclear Liability and Compensation Act*, S.C. 2015, c. 4, s. 120.



However, it is up to the provinces to decide whether or not to build electricity generating facilities, including nuclear plants, within their borders.¹⁸

In recent years, a number of parliamentary committees have released reports on nuclear energy.¹⁹

SMR Development Projects in Canada

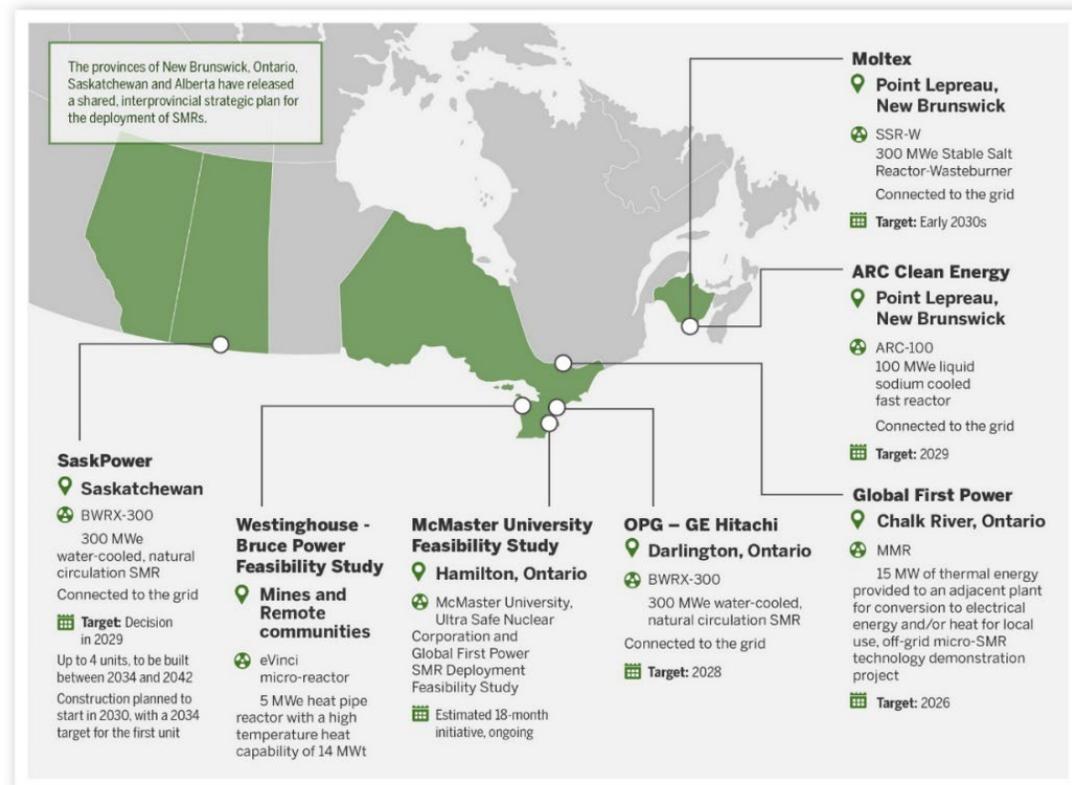
Since 2018, initiatives have been launched at the provincial and federal levels to support SMR development in Canada (Figure 1).

18 Government of Canada, [Nuclear Energy](#).

19 House of Commons, Standing Committee on Environment and Sustainable Development, [Canada and Radioactive Waste Management: Important Decisions for the Future](#), Fourth report, September 2022; House of Commons, Standing Committee on Natural Resources, [The Nuclear Sector at a Crossroads: Fostering Innovation and Energy Security for Canada and the World](#), Fifth report, June 2017.

Figure 1: Small Modular Reactor Development Projects in Canada

SMR Projects in Canada



Source: Based on information provided by witnesses.

At the provincial level, the Premiers of Saskatchewan, Ontario and New Brunswick signed a Memorandum of Understanding in December 2019, with Alberta joining in April 2021.²⁰ As part of this agreement, the provinces said they were willing to build SMRs in their jurisdictions and have committed to cooperating to that end.

In April 2021, energy operators in Ontario, New Brunswick and Saskatchewan released a feasibility report on SMRs.²¹ The report provides an economic and technological feasibility assessment of SMR development in each of the three provinces.

20 [Collaboration Memorandum of Understanding](#), 1 December 2019.

21 Ontario, [Small modular reactor feasibility report](#), 25 June 2021.



In March 2022, Alberta, New Brunswick, Ontario and Saskatchewan released a strategic plan for the deployment of small modular reactors.²² According to this document, the provinces will focus on five priorities: technology readiness; regulatory framework; economics and financing; nuclear waste management; and Indigenous and public engagement.

The plan mentions several SMR projects:

- the construction of one 300 MWe SMR at the Darlington station in Ontario by 2028, and several SMRs in Saskatchewan after 2034;
- the development of two 4th-generation SMRs²³ at the Point Lepreau plant in New Brunswick in the early 2030s; and
- one 5 MWe microreactor demonstration project in Chalk River, Ontario, by 2026.

In November 2018, the federal government demonstrated its support for SMRs with Natural Resources Canada (NRCan) engaging in collaboration with representatives from provincial and territorial governments, and utilities and industry partners in the development and release of Canada’s SMR Roadmap.²⁴

Most recently, in December 2020, the federal government launched the Canadian SMR Action Plan.²⁵ This action plan brings together more than 100 participating organizations, including federal government agencies, provincial and territorial governments, Indigenous organizations, municipalities, private and public companies, universities, civil society groups, industry associations and unions. These organizations have all made commitments under the Action Plan.

In Budget 2022, the Government of Canada announced funding for SMRs of \$120.6 million over five years, starting in 2022–2023, and \$0.5 million ongoing, as follows:

22 Ontario, [A strategic plan for the deployment of small modular reactors](#), 28 March 2022.

23 4th-generation SMRs are models that are not based on light water reactor technology, but instead use technologies that are more recent or in development. See: OECD, [Small Modular Reactors: Challenges and Opportunities](#), Nuclear Technology Development and Economics 2021, 2021, p. 16.

24 Canadian Small Modular Reactor Roadmap Steering Committee, [A Call to Action: A Canadian Roadmap for Small Modular Reactors](#), 2018.

25 Government of Canada, [Canada’s Small Modular Reactor Action Plan](#), 2020.

- \$69.9 million for Natural Resources Canada to undertake research to minimize waste generated from these reactors; support the creation of a fuel supply chain; strengthen international nuclear cooperation agreements; and enhance domestic safety and security policies and practices; and
- \$50.7 million, and \$0.5 million ongoing, for the Canadian Nuclear Safety Commission to build the capacity to regulate small modular reactors and work with international partners on global regulatory harmonization.²⁶

In the course of its study, the Committee heard testimony on various aspects of SMR development in Canada, concentrating on the science and research aspects. The Committee also heard testimony on climate and the environment; the economic impact of SMR projects and community engagement.

SCIENCE AND RESEARCH

Technological Maturity of SMRs

Witnesses informed the committee about the progress and technological maturity of SMR projects.

Potential projects in Canada involve the development and deployment of new models of reactors that will need to be successful before regular production can ultimately begin. This first phase is crucial, and several witnesses mentioned the importance of federal government support during this stage of development.²⁷

Regarding the safety of future reactors, several witnesses said that SMRs are designed with passive or intrinsic safety features, in other words, they do not require human intervention, making them easier to operate and reducing the risk of accident.²⁸

26 Government of Canada, *A Plan to Grow Our Economy and Make Life More Affordable*, p. 113.

27 SRSR, *Evidence*, 2 June 2022, 2025 (Michael Rencheck, President and Chief Executive Officer, Bruce Power); SRSR, *Evidence*, 2 June 2022, 2035 (Troy King, Acting President and Chief Executive Officer, SaskPower); SRSR, *Evidence*, 2 June 2022, 2040 (Francis Bradley, President and Chief Executive Officer, Electricity Canada); and SRSR, *Evidence*, 9 June 2022, 1835 (Joseph McBrearty, President and Chief Executive Officer, Canadian Nuclear Laboratories).

28 SRSR, *Evidence*, 2 June 2022, 1840 (Kirk Atkinson, Associate Professor and Director, Centre for Small Modular Reactors, Ontario Tech University); and SRSR, *Evidence*, 9 June 2022, 1910 (Joseph McBrearty).



It was also noted that some of the projects being developed in Canada rely in part on existing technologies in traditional nuclear reactors.²⁹ According to some witnesses, this is advantageous in that the SMR models are based on a solid foundation of research and proven technologies.³⁰ Caroline Ducros, Director General of Advanced Reactor Technologies at the CNSC, testified that:

[T]he CNSC has extensive ties with Canadian academia on the science and research needed to support safety cases for CANDU reactors and other nuclear facilities. That approach is being leveraged for SMRs. Our budget 2022 funding will enable us to support independent third-party research on key SMR-related priority areas.³¹

However, in a brief submitted to the Committee, the Coalition for Responsible Energy Development in New Brunswick advised against investing millions of dollars more into researching technologies that have previously been explored, such as small liquid sodium reactors and molten salt reactors, both researched in the U.S. starting in the 1950s.³²

The fact that SMRs in Canada are still at the design stage was also discussed. According to Susan O'Donnell with the Coalition for Responsible Energy Development in New Brunswick, the reactors planned for New Brunswick have never been successfully marketed because of unresolved technical problems.³³ M. V. Ramana, a professor at the University of British Columbia's School of Public Policy and Global Affairs, appearing as an individual, explained that the research and development to come up with a safe, operational model would require a major investment. He was doubtful that the market is prepared to make such investments that could run between US\$1 billion and US\$2 billion.³⁴ Witnesses questioned the wisdom of public investment to support the research and development activities of private players in this field.³⁵ This argument also

29 SRSR, [Evidence](#), 2 June 2022, 1925 (Rory O'Sullivan, Chief Executive Officer, North America, Moltex Energy).

30 SRSR, [Evidence](#), 2 June 2022, 1840 (Kirk Atkinson).

31 SRSR, [Evidence](#), 26 September 2022, 1835 (Caroline Ducros, Director General, Advanced Reactor Technologies, Canadian Nuclear Safety Commission).

32 Coalition for Responsible Energy Development in New Brunswick, [Submission to the House of Commons Science and Research Committee Study of SMRs](#), 13 June 2022, p. 3.

33 SRSR, [Evidence](#), 9 June 2022, 1840 (Susan O'Donnell, Adjunct Research Professor, Coalition for Responsible Energy Development in New-Brunswick).

34 SRSR, [Evidence](#), 16 June 2022, 2020 (M. V. Ramana, Professor, School of Public Policy and Global Affairs, University of British Columbia, As an Individual).

35 SRSR, [Evidence](#), 9 June 2022, 1840 (Susan O'Donnell).

comes up in three briefs submitted to the committee.³⁶ A further four briefs recommended that the Government of Canada stop investing in research and development into small modular reactors at all.³⁷

John Gorman, President and Chief Executive Officer of the Canadian Nuclear Association, refuted the idea that small modular reactors are an “expensive science experiment,” saying that, just over 20 years ago, solar energy was called an “expensive science experiment.”³⁸ Francis Bradley, on behalf of Electricity Canada, said “[SMRs] are not mature technologies today, but if we said that we shouldn’t pursue technology until it’s mature, we wouldn’t have the amount of wind and solar that’s coming on board today.”³⁹ Further, Amy Gottschling, Vice-President of Science, Technology and Commercial Oversight at Atomic Energy of Canada Limited, testified that “the foundational sciences of SMR technologies are not new. Universities and research laboratories around the world have been researching, developing and demonstrating these technologies for decades.”⁴⁰

Therefore, the Committee recommends:

Recommendation 1

That the Government of Canada continue to support small modular reactor projects by sharing their development phase costs.

36 Anne Lindsey, [Brief](#), Brief submitted to the House of Commons Standing Committee on Science and Research, July 2022, p. 1; New Brunswick Anti-Shale Gas Alliance Inc., [Brief](#), Brief submitted to the House of Commons Standing Committee on Science and Research, 14 June 2022, p. 2; and RAVEN, [Brief](#), Brief submitted to the House of Commons Standing Committee on Science and Research, 14 June 2022, p. 3.

37 Patricia A. Donahue, [Brief](#), Brief submitted to the House of Commons Standing Committee on Science and Research, June 2022, p. 1; Elaine Hughes, [Brief](#), Brief submitted to the House of Commons Standing Committee on Science and Research, June 2022, p. 1; Doug Swain, [Submission to the House of Commons Science and Research Committee Study of SMRs](#), 15 June 2022, p. 1; and Ontario Clean Air Alliance, [Why Small Modular Nuclear Reactors \(SMRs\) should not receive federal funds earmarked for climate action](#), Brief submitted to the House of Commons Standing Committee on Science and Research, 15 June 2022, p. 3.

38 SRSR, [Evidence](#), 2 June 2022, 1900 (John Gorman, President and Chief Executive Officer, Canadian Nuclear Association).

39 SRSR, [Evidence](#), 2 June 2022, 2110 (Francis Bradley).

40 SRSR, [Evidence](#), 26 September 2022, 1830 (Amy Gottschling, Vice-President, Science, Technology and Commercial Oversight, Atomic Energy of Canada Limited).



Science-Based Decisions

Some witnesses wondered about the role of science in the government’s decision-making process when it comes to SMRs.⁴¹ In a brief to the committee, the Passamaquoddy Recognition Group Inc. wrote that “We currently believe that [Small Modular Nuclear Reactor] funding applications do not receive adequate scientific review, or that the scientific review is not appropriately considered by the funders.”⁴² In that light, Susan O’Donnell suggested that all the funding for net-zero technology research be moved to the Natural Sciences and Engineering Research Council of Canada.⁴³ Another witness, Jeremy Rayner, a professor appearing as an individual, opposed that idea, saying that important questions about SMRs actually fall within the purview of the social sciences and the humanities.⁴⁴ Meanwhile, Caroline Ducros with the CNSC testified that “[w]e review the technologies that come to us to ensure that, whatever we recommend to the commission, we have used a scientific basis and had a robust review of full and complete information.”⁴⁵

Therefore, the Committee recommends:

Recommendation 2

That the Government of Canada undertake transparent, independent scientific reviews as part of the decision-making for any funding towards small modular reactor research and development.

Waste Reprocessing

Rory O’Sullivan, Chief Executive Officer, North America, of Moltex Energy—currently undertaking an SMR project in Point Lepreau, New Brunswick—spoke of the possibility of using spent fuel from Canada’s CANDU nuclear reactors to power Moltex reactors, which run on reprocessed fuel.⁴⁶

41 SRSR, [Evidence](#), 9 June 2022, 1840 (Susan O’Donnell); and SRSR, [Evidence](#), 9 June 2022, 1940 (Gordon Edwards, President, Canadian Coalition for Nuclear Responsibility).

42 Passamaquoddy Recognition Group Inc., [Brief](#), Brief submitted to the House of Commons Standing Committee on Science and Research, 23 August 2022.

43 SRSR, [Evidence](#), 9 June 2022, 1905 (Susan O’Donnell).

44 SRSR, [Evidence](#), 9 June 2022, 2035 (Jeremy Rayner, Professor, As an Individual).

45 SRSR, [Evidence](#), 26 September 2022, 1900 (Caroline Ducros).

46 SRSR, [Evidence](#), 2 June 2022, 1845 (Rory O’Sullivan).

In regard to nuclear waste reprocessing, including the Moltex technology, several witnesses expressed concerns related to nuclear non-proliferation and the risk of reprocessing in nuclear weapons technology.⁴⁷ This sentiment was also expressed in six briefs submitted to the committee.⁴⁸ On this subject, André Bernier, Director General, Electricity Resources Branch with the Department of Natural Resources testified that:

[O]ne of the main sensitivities when we get into reprocessing, especially if it involves the movement of nuclear waste across borders, is the risk of proliferation. We know that SMRs in general are using a different kind of fuel and producing a different kind of waste than CANDU reactors, so by no means is it an insurmountable obstacle, but it is a very different set of considerations than our current equilibrium, where we have natural uranium being used in country and not reprocessed.⁴⁹

In regard to Canada's international obligations related to nuclear non-proliferation, the CNSC testified that:

Canada is a signatory to the treaty on non-proliferation. This requires us to forbid developing or acquiring nuclear weapons, and it also obligates Canada to accept safeguards verification from the International Atomic Energy Agency. It also requires us to implement export control to ensure that any nuclear transfers don't contribute to other nations' nuclear programs. From an SMR perspective, the proponents will need to demonstrate that they meet CNSC's requirements in this respect.⁵⁰

In a private correspondence to the committee, Moltex Energy states that their proposals are in accordance with Canada's international obligations.⁵¹ They affirm that the waste reprocessing used for their project will not be able to produce weapons grade material and that for the output of this process to be used for other purposes, a conventional

47 SRSR, *Evidence*, 9 June 2022, 1905 (Susan O'Donnell); and SRSR, *Evidence*, 9 June 2022, 1940 (Gordon Edwards).

48 Anne Lindsey, *Brief*, Brief submitted to the House of Commons Standing Committee on Science and Research, July 2022; Anthony Reddin, *Brief for Committee study on SMRs*, Brief submitted to the House of Commons Standing Committee on Science and Research, 15 June 2022; Rural Action and Voices for the Environment (RAVEN), *Brief*, Brief submitted to the House of Commons Standing Committee on Science and Research, 14 June 2022; Passamaquoddy Recognition Group Inc., *Brief*, Brief submitted to the House of Commons Standing Committee on Science and Research, 23 August 2022; Sarah Gabrielle Baron, *Brief*, Brief submitted to the House of Commons Standing Committee on Science and Research, 2022; and Frank N. von Hippel, *Re: Request for a proliferation assessment of a Canadian-government-funded proposal to separate plutonium from CANDU spent fuel*, 24 November 2021.

49 SRSR, *Evidence*, 26 September 2022, 1920 (André Bernier, Director General, Electricity Resources Branch, Department of Natural Resources).

50 SRSR, *Evidence*, 26 September 2022, 1915 (Caroline Ducros).

51 Moltex Clean Energy, *Moltex response to open letter to Prime Minister Justin Trudeau regarding proliferation concerns*, 28 May 2021.



reprocessing facility would be required, in breach of Canadian and international regulations.⁵² This was countered by another private correspondence to the committee by Frank N. von Hippel, who stated that pure plutonium could be extracted from the product in a low-cost laboratory “hot cell” and subject to proliferation.⁵³

Several witnesses also spoke to the fact that nuclear waste reprocessing still leaves waste materials that must be safely stored, as well as producing new liquid waste.⁵⁴ Other witnesses pointed out that nuclear waste reprocessing is a proven process already in use in other countries.⁵⁵

Therefore, the Committee recommends:

Recommendation 3

That the Government of Canada work with international and scientific partners to examine nuclear waste reprocessing and its implications for waste management and proliferation vulnerability.

Other Scientific Spinoffs and Areas of Targeted Research

The witnesses shed light on potential spinoffs and applications from the research into SMRs. SMRs generate heat, which could be used in a series of other applications. Among those, witnesses cited agriculture, building heating, marine transport, the production of hydrogen for fuelling vehicles or storing surplus energy, or even desalinating water.⁵⁶ Some SMRs could also be used to produce isotopes.⁵⁷ However, International Physicians for the Prevention of Nuclear War Canada noted in its brief that the production of

52 Ibid.

53 Frank N. von Hippel, *Re: Request for a proliferation assessment of a Canadian-government-funded proposal to separate plutonium from CANDU spent fuel*, 24 November 2021.

54 SRSR, *Evidence*, 9 June 2022, 1900 (Susan O’Donnell); SRSR, *Evidence*, 16 June 2022, 2025 (M. V. Ramana); and Sarah Gabrielle Baron, *Brief*, Brief submitted to the House of Commons Standing Committee on Science and Research, 2022.

55 SRSR, *Evidence*, 2 June 2022, 2010 (Brett Plummer, Chief Nuclear Officer and Vice-President Nuclear, New Brunswick Power Corporation); and SRSR, *Evidence*, 2 June 2022, 2015 (Michael Rencheck).

56 SRSR, *Evidence*, 9 June 2022, 1835 (Joseph McBrearty); SRSR, *Evidence*, 16 June 2022, 1830 (David Novog, Professor, As an Individual); and SRSR, *Evidence*, 26 September 2022, 1915 (Amy Gottschling).

57 SRSR, *Evidence*, 9 June 2022, 2000 (Edouard Saab, President, Westinghouse Electric Canada).

isotopes for medical purposes can be done at other facilities such as cyclotrons or accelerators.⁵⁸

According to the testimony heard at committee, several areas of research connected to the development of SMRs are especially important or promising. Several witnesses mentioned research into advanced fuels.⁵⁹ Other witnesses talked about energy recovery and storage.⁶⁰ Among other areas where more research is needed to support the development of SMRs, several witnesses mentioned advanced modularization or advanced manufacturing technology.⁶¹ McMaster University asked the federal government for support for “increased availability of neutrons for neutron beam research and irradiations.”⁶²

Role of Canadian Nuclear Laboratories and Academia

According to the presentation by Joseph McBrearty, President and CEO, the Canadian Nuclear Laboratories (CNL) is “technology agnostic. [Its] role is to leverage our scientific capabilities to prove or disprove theories and to inform the regulatory process.”⁶³ Joseph McBrearty said that “as a national nuclear laboratory, [CNL] bridge[s] the gap between the academic world and the industry”⁶⁴ by taking academic ideas and putting them to the test at the facilities in Chalk River. In 2018, CNL launched its small modular reactor siting program.⁶⁵ Through that program, Global First Power has proposed building a microreactor at the Chalk River site. CNL is also behind the “Canadian nuclear research initiative,” a cost-sharing program to leverage CNL’s extensive resources to make them more accessible to SMR vendors.⁶⁶

58 International Physicians for the Prevention of Nuclear War Canada, *What does the medical profession say?: A Challenge to Physicians*, Brief submitted to the House of Commons Standing Committee on Science and Research, July 2022, p. 5.

59 SRSR, *Evidence*, 2 June 2022, 2020 (Michael Rencheck); SRSR, *Evidence*, 2 June 2022, 2025 (Brett Plummer); and SRSR, *Evidence*, 2 June 2022, 2125 (Jos Diening, Managing Director, Global First Power).

60 SRSR, *Evidence*, 16 June 2022, 1855 (Dave Tucker, Assistant Vice-President, Nuclear Research, McMaster University); and SRSR, *Evidence*, 16 June 2022, 1855 (David Novog).

61 SRSR, *Evidence*, 2 June 2022, 2025 (Brett Plummer); SRSR, *Evidence*, 2 June 2022, 2125 (Francis Bradley); SRSR, *Evidence*, 2 June 2022, 2125 (Troy King); and SRSR, *Evidence*, 2 June 2022, 2130 (Jos Diening).

62 SRSR, *Evidence*, 16 June 2022, 1835 (Dave Tucker).

63 SRSR, *Evidence*, 9 June 2022, 1835 (Joseph McBrearty).

64 *Ibid.*, 1855.

65 *Ibid.*, 1835.

66 *Ibid.*



Atomic Energy of Canada Limited (AECL), through oversight of the CNL, also highlights their “ability to create a nexus where academia, government and private industry can align to ensure safe and expeditious deployment of nuclear technologies.”⁶⁷

Research projects have been initiated at several universities and organizations. For example:

- McMaster University launched a feasibility study on the implementation of a microreactor in partnership with Global First Power and Ultra Safe Nuclear;⁶⁸
- X-energy and Ontario Power Generation (OPG) announced a partnership in July 2022 to explore the potential of deploying SMRs in industrial sites;⁶⁹ and
- Westinghouse and Bruce Power launched an SMR feasibility study for mines and remote communities.⁷⁰

Dave Tucker, Assistant Vice-President of Nuclear Research at McMaster University and David Novog, a professor appearing as an individual, further recommended the creation of a coordinated national program to link universities, governments and private companies together to facilitate shared objectives.⁷¹

Therefore, the Committee recommends:

Recommendation 4

That the Government of Canada implement a comprehensive research and development plan on small modular reactors that would bridge government, private industry and academia.

67 SRSR, [Evidence](#), 26 September 2022, 1830 (Amy Gottschling).

68 SRSR, [Evidence](#), 16 June 2022, 1835 (Dave Tucker).

69 X-energy Canada, [X-energy Canada Submission to the Small Modular Reactor Study of the Canadian House of Commons Standing Committee on Science and Research](#), 6 October 2022.

70 Westinghouse-Bruce Power, [Executive Summary of the eVinci Micro-Reactor Deployment in Mining and Remote Canadian Communities Feasibility Study](#).

71 SRSR, [Evidence](#), 16 June 2022, 1835 (Dave Tucker); and SRSR, [Evidence](#), 16 June 2022, 1855 (David Novog).

ENVIRONMENTAL CONSIDERATIONS

Much of the testimony heard by the Committee focused on environmental issues with respect to climate change, nuclear waste management and regulations.

Climate Change

The potential role of SMRs in fighting climate change and supporting Canada’s energy transition made up the bulk of the testimony heard by the Committee.

Several witnesses emphasized that nuclear power is a very low greenhouse gas emitting source of energy: the Committee was told that nuclear reactors already contribute to zero-emissions electricity generation in Canada, particularly in Ontario where approximately 60% of electricity is nuclear generated.⁷² Some witnesses proposed including nuclear technology and SMRs in the Green Bond Framework.⁷³ In this light, nuclear in general and SMRs in particular could play a role in the pursuit of Canada’s climate goals and the transition to net-zero.

On the one hand, SMRs could help replace higher greenhouse gas emitting energy sources. Several witnesses pointed to diesel generators used in Northern, remote and rural communities, which in some cases could be replaced by SMRs.⁷⁴ Witnesses noted the importance of consulting with Indigenous communities regarding SMRs and energy decision-making.⁷⁵

On the other hand, as part of the energy transition, many experts expect to see a significant increase in electricity demand in Canada in the coming years due to the

72 SRSR, [Evidence](#), 2 June 2022, 1840 (Kirk Atkinson); SRSR, [Evidence](#), 2 June 2022, 1850 (John Gorman); SRSR, [Evidence](#), 2 June 2022, 1935 (Michael Rencheck); SRSR, [Evidence](#), 9 June 2022, 2040 (Robert Walker, National Director, Canadian Nuclear Workers Council); and SRSR, [Evidence](#), 9 June 2022, 1830 (Christopher Keefer, President, Canadians for Nuclear Energy).

73 SRSR, [Evidence](#), 2 June 2022, 1935 (Michael Rencheck); and SRSR, [Evidence](#), 9 June 2022, 1830 (Christopher Keefer).

74 For example: SRSR, [Evidence](#), 2 June 2022, 1835 (John Gorman); and SRSR, [Evidence](#), 2 June 2022, 2040 (Francis Bradley).

75 SRSR, [Evidence](#), 16 June 2022, 1850 (Ken Hartwick, President and Chief Executive Officer, Ontario Power Generation Inc.); SRSR, [Evidence](#), 2 June 2022, 2035 (Troy King); SRSR, [Evidence](#), 26 September 2022, 1910 (André Bernier); SRSR, [Evidence](#), 2 June 2022, 1910 (John Gorman); SRSR, [Evidence](#), 9 June 2022, 1910 (Joseph McBrearty); SRSR, [Evidence](#), 2 June 2022, 2050 (Jos Diening); and SRSR, [Evidence](#), 9 June 2022, 2040 (Jeremy Rayner); and SRSR, [Evidence](#), 16 June 2022, 1940 (Dazawray Landrie-Parker, Director, Nuclear Sector, Creative Fire).



electrification of transportation and industry and growing demand for electric vehicles.⁷⁶ Mr. Bradley estimates that electricity generation needs could increase two to three times by 2050.⁷⁷ SMRs could help meet this additional demand.⁷⁸

More specifically, many witnesses identified SMR technology as a stable baseload clean energy to support intermittent renewables such as wind and solar, and move Canada toward decarbonization goals.⁷⁹ According to several witnesses, all forms of non-emitting energy would be needed in order to meet Canada's climate change goals.⁸⁰ For example, John Gorman, President and Chief Executive Officer of the Canadian Nuclear Association shared that, "This is a math problem. It's not a theology problem. We have to get away from picking a favourite technology and realize that we need everything at our disposal in order to meet this challenge."⁸¹

Witnesses also emphasized the need to tailor the non-emitting energy configuration of each province and territory based on their individual geography, noting that some provinces and regions lacked sufficient natural resources to support certain non-emitting technologies, including hydroelectricity, wind and solar.⁸²

However, the Committee also heard opposing evidence.

Evelyn Gigantes, appearing as an individual, said that renewable energy sources such as wind, solar, geothermal and hydro can adequately address clean energy needs without the support of nuclear energy. She cited research that promoted methods for achieving

76 SRSR, [Evidence](#), 2 June 2022, 1835 (John Gorman); SRSR, [Evidence](#), 2 June 2022, 1950 (Michael Rencheck); SRSR, [Evidence](#), 9 June 2022, 2105 (Jeremy Rayner); and SRSR, [Evidence](#), 26 September 2022, 1845 (André Bernier).

77 SRSR, [Evidence](#), 2 June 2022, 2040 (Francis Bradley).

78 Ibid.

79 For example: SRSR, [Evidence](#), 2 June 2022, 1955 (Michael Rencheck); SRSR, [Evidence](#), 2 June 2022, 2040 (Francis Bradley); SRSR, [Evidence](#), 2 June 2022, 2120 (Jos Diening); SRSR, [Evidence](#), 16 June 2022, 1840 (Ken Hartwick); X-energy Canada, [X-energy Canada Submission to the Small Modular Reactor Study of the Canadian House of Commons Standing Committee on Science and Research](#), 6 October 2022; and International Union of Operating Engineers, [Submission to SRSR Study on Small Modular Nuclear Reactors](#), 2022.

80 SRSR, [Evidence](#), 2 June 2022, 1855 (John Gorman); SRSR, [Evidence](#), 2 June 2022, 1950 (Michael Rencheck); SRSR, [Evidence](#), 16 June 2022, 1840 (Ken Hartwick); and SRSR, [Evidence](#), 2 June 2022, 2110 (Francis Bradley).

81 SRSR, [Evidence](#), 2 June 2022, 1855 (John Gorman).

82 SRSR, [Evidence](#), 9 June 2022, 1845 (Christopher Keefer); SRSR, [Evidence](#), 2 June 2022, 2055 (Troy King); SRSR, [Evidence](#), 2 June 2022, 2040 (Francis Bradley); SRSR, [Evidence](#), 16 June 2022, 1910 (Ken Hartwick) and Brahm Neufeld, [Brief](#), Brief submitted to the House of Commons Standing Committee on Science and Research, 2022.

net-zero emissions goals without SMR and nuclear technology, including batteries and electric storage technologies, increasing renewable energy diversity, improvements in energy efficiency, interprovincial transmission, and policies such as demand flexibility.⁸³ Other witnesses supported these arguments.⁸⁴

Some witnesses also felt that SMRs would not be ready in time to make a meaningful contribution to Canada's climate change commitments.⁸⁵ This concern was also cited in several briefs submitted to the Committee.⁸⁶

Alternatively, other witnesses spoke both to projections that could see SMR technologies deployed by the late 2020s and fully commercialized by the mid-2030s,⁸⁷ and the need to look beyond 2030 to future energy goals and long-term solutions to Canada's energy needs.⁸⁸ According to Natural Resources Canada:

There's no disagreement. This is not something that will make a material difference before the end of the decade. It's not something where we expect SMRs to contribute on a large scale to the achievement of the 2030 goal. Even by 2035, it's likely that we'll see a very small number of SMRs deployed in Canada, but beyond that point, as we look toward what we expect to be a very significant expansion of the electricity system in Canada but also globally to meet the needs of a decarbonized economy, that's where

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- 83 SRSR, [Evidence](#), 9 June 2022, 2030 (Evelyn Gigantes, As an Individual); Amory B. Lovins and M. V. Ramana, Yale Environment 360, [Three Myths About Renewable Energy and the Grid, Debunked](#), 9 December 2021; and Stephen Thomas and Tom Green, [Shifting Power: Zero-Emissions Electricity Across Canada by 2035](#), Report, David Suzuki Foundation, May 2022.
- 84 International Physicians for the Prevention of Nuclear War Canada, [What does the medical profession say?: A Challenge to Physicians](#), Brief submitted to the House of Commons Standing Committee on Science and Research, July 2022; Council of Canadians, [Brief](#), Brief submitted to the House of Commons Standing Committee on Science and Research, 13 June 2022; Sustainable Energy Group, [Brief](#), Brief submitted to the House of Commons Standing Committee on Science and Research, 15 June 2022; Peterborough Pollinators, [Brief](#), Brief submitted to the House of Commons Standing Committee on Science and Research, 2022.
- 85 SRSR, [Evidence](#), 9 June 2022, 1840 (Susan O'Donnell); SRSR, [Evidence](#), 16 June 2022, 1935 (M. V. Ramana); SRSR, [Evidence](#), 16 June 2022, 1945 (Ginette Charbonneau, physicist and spokesperson, Ralliement contre la pollution radioactive); and SRSR, [Evidence](#), 9 June 2022, 1940 (Gordon Edwards).
- 86 For example: Rural Action and Voices for the Environment, [Brief](#), Brief submitted to the House of Commons Standing Committee on Science and Research, 14 June 2022; New Brunswick Anti-Shale Gas Alliance Inc., [Brief](#), Brief submitted to the House of Commons Standing Committee on Science and Research, 14 June 2022; and Council of Canadians, [Brief](#), Brief submitted to the House of Commons Standing Committee on Science and Research, 13 June 2022.
- 87 SRSR, [Evidence](#), 16 June 2022, 1920 (David Novog); and SRSR, [Evidence](#), 9 June 2022, 2020 (Edouard Saab).
- 88 SRSR, [Evidence](#), 2 June 2022, 1910 (John Gorman).



there could be a very significant role for SMRs, and Canada as a leader in terms of demonstrating this technology.⁸⁹

However, several witnesses stated in their testimonies that money invested in SMRs would be more effective at reducing carbon emissions if invested in other renewable technologies. M. V. Ramana said that there's an "economic opportunity cost," as "[m]oney that is invested in SMRs would save far more carbon dioxide if it were invested in renewables and associated technologies."⁹⁰ This was an opinion that was also cited in several briefs submitted to the Committee.⁹¹

Therefore, the Committee recommends:

Recommendation 5

That the Government of Canada consider including nuclear technology and small modular reactors in green energy and net-zero programs like the Green Bond Framework.

Nuclear Waste Management

Many witnesses commented on the issue of nuclear waste generated by SMRs.

Kirk Atkinson, Associate Professor and Director, Centre for Small Modular Reactors, Ontario Tech University, told the Committee that "SMRs, like all nuclear reactors, will produce a small amount of radioactive waste per energy emitted."⁹² However, he said Canada can draw on decades of expertise in the storage of nuclear waste.⁹³

John Gorman added that "Canada has an exceptional track record that is respected internationally for the way it manages the entire cycle of every bit of waste it produces. I'm not aware of any fatality from handling the waste here in Canada or, indeed, around

89 SRSR, [Evidence](#), 26 September 2022, 1900 (André Bernier).

90 SRSR, [Evidence](#), 16 June 2022, 1935 (M. V. Ramana); and SRSR, [Evidence](#), 16 June 2022, 1945 (Ginette Charbonneau).

91 For example: Elaine Hughes, [Brief](#), Brief submitted to the House of Commons Standing Committee on Science and Research, June 2022; International Physicians for the Prevention of Nuclear War Canada, [What does the medical profession say?: A Challenge to Physicians](#), Brief submitted to the House of Commons Standing Committee on Science and Research, July 2022; Tom McLean, [Brief](#), Brief submitted to the House of Commons Standing Committee on Science and Research, 15 June 2022; and Passamaquoddy Recognition Group Inc., [Brief](#), Brief submitted to the House of Commons Standing Committee on Science and Research, 23 August 2022.

92 SRSR, [Evidence](#), 2 June 2022, 1840 (Kirk Atkinson).

93 Ibid.

the world.”⁹⁴ Kirk Atkinson said that “[b]eing an early adopter of SMRs, Canada is in an ideal position to become a world leader in developing lucrative new and novel technologies for the management of SMR wastes.”⁹⁵

Several witnesses, however, testified that SMRs may actually produce larger amounts of high-level nuclear waste than larger reactors, including citing a recent research study out of Stanford University.⁹⁶ Gordon Edwards, President of the Canadian Coalition for Nuclear Responsibility, recommended an independent scientific investigation of the volume and characteristics of radioactive waste that will be generated by SMRs.⁹⁷ Jeremy Rayner mentioned that SMR waste will be spread among a larger number of smaller sites, and will need to be transported to a waste repository, in comparison to larger reactors that have historically stored waste on-site.⁹⁸

Some witnesses also testified to gaps in Canada’s nuclear waste management policies related to, for example, SMR waste storage, post-fission intermediate-level waste and independent nuclear waste management.⁹⁹ Ginette Charbonneau, physicist and spokesperson for Ralliement contre la pollution radioactive, said “[n]o waste management strategy for small modular reactors emerged from the consultation conducted by the Nuclear Waste Management Organization” because the waste from SMRs is not well characterized.¹⁰⁰

94 SRSR, [Evidence](#), 2 June 2022, 1855 (John Gorman).

95 SRSR, [Evidence](#), 2 June 2022, 1840 (Kirk Atkinson).

96 SRSR, [Evidence](#), 9 June 2022, 1935 (Evelyn Gigantes); SRSR, [Evidence](#), 9 June 2022, 1940 (Gordon Edwards); SRSR, [Evidence](#), 16 June 2022, 1945 (Ginette Charbonneau); SRSR, [Evidence](#), 16 June 2022, 2020 (M. V. Ramana); and Lindsay M. Krall, Allison M. Macfarlane and Rodney C. Ewing, “[Nuclear waste from small modular reactors](#),” *Proceedings of the National Academy of Sciences (PNAS)*, Vol. 119, No. 23, 31 May 2022.

97 SRSR, [Evidence](#), 9 June 2022, 1940 (Gordon Edwards).

98 SRSR, [Evidence](#), 9 June 2022, 2110 (Jeremy Rayner).

99 SRSR, [Evidence](#), 9 June 2022, 2000 (Gordon Edwards); SRSR, [Evidence](#), 16 June 2022, 2025 (Ginette Charbonneau); and SRSR, [Evidence](#), 9 June 2022, 2130 (Jeremy Rayner).

100 SRSR, [Evidence](#), 16 June 2022, 2025 (Ginette Charbonneau).



As noted above, several witnesses also raised concerns about managing waste from reprocessing spent fuel, which is being considered in the development of some SMRs.¹⁰¹

Lastly, witnesses suggested creating a nuclear waste management agency, independent from the nuclear industry.¹⁰²

An official with Natural Resources Canada said:

[T]he government is evaluating Canada’s current radioactive waste policy, and we are developing a comprehensive new policy that further provides Canadians with confidence in the long-term management of all of Canada’s radioactive waste, including any waste from future technologies such as SMRs. Results from that engagement are being analyzed, and we plan to release the policy before the end of the year.¹⁰³

Caroline Ducros with the CNSC said that waste is included in the CNSC’s review of licence applications: “With any application that comes to us, the licensing has to have a path for where the waste will end up, and that waste has to end up in a licensed facility.”¹⁰⁴

The Committee notes that the House of Commons Standing Committee on Environment and Sustainable Development tabled a report in September 2022 entitled *Canada and Radioactive Waste Management: Important Decisions for the Future*.¹⁰⁵ The second recommendation in this report is on SMRs:

The [Standing] Committee [on Environment and Sustainable Development] recommends that any research and development work related to small modular reactor (SMR) technology rigorously document and categorize in their analyses the radioactive waste that will be generated, and that a plan be developed to manage this waste as part

101 For example: SRSR, [Evidence](#), 9 June 2022, 1900 (Susan O’Donnell); SRSR, [Evidence](#), 9 June 2022, 2005 (Gordon Edwards), Sarah Gabrielle Baron, [Brief](#), Brief submitted to the House of Commons Standing Committee on Science and Research, 2022; Sustainable Energy Group, [Brief](#), Brief submitted to the House of Commons Standing Committee on Science and Research, 15 June 2022; and Rural Action and Voices for the Environment (RAVEN), [Brief](#), Brief submitted to the House of Commons Standing Committee on Science and Research, 14 June 2022.

102 SRSR, [Evidence](#), 9 June 2022, 2005 (Gordon Edwards); and SRSR, [Evidence](#), 9 June 2022, 2130 (Jeremy Rayner).

103 SRSR, [Evidence](#), 26 September 2022, 1840 (André Bernier).

104 SRSR, [Evidence](#), 26 September 2022, 1920 (Caroline Ducros).

105 House of Commons, Standing Committee on Environment and Sustainable Development, [Canada and Radioactive Waste Management: Important Decisions for the Future](#), Fourth report, September 2022.

of Canada’s Policy for Radioactive Waste Management and Decommissioning.¹⁰⁶

Regulation and Assessment

Witnesses highlighted an important federal role in the environmental assessment process and regulation of SMRs.¹⁰⁷ André Bernier from Natural Resources Canada said that “[p]rotecting the health and safety of Canadians and the environment always has been, and always will be, the Government of Canada’s top priority regarding nuclear energy.”¹⁰⁸

Several witnesses spoke to the record of protection and robust regulatory system supported by the Canadian Nuclear Safety Commission (CNSC),¹⁰⁹ and the important role of the CNSC in maintaining public confidence in nuclear safety.¹¹⁰ Recent budget allocations to CNSC were also praised by witnesses.¹¹¹

Caroline Ducros provided further details on the CNSC’s role and certification processes for SMRs. She said that SMR technologies are different from CANDU reactor technology, which the CNSC is accustomed to.¹¹² She added that the CNSC has been working to ensure “that our regulatory framework is appropriate for SMRs.”¹¹³

Caroline Ducros said that the CNSC relies on its extensive ties with Canadian academia to study proposed SMR designs and projects. The CNSC also supports “independent third-party research on key SMR-related priority areas.”¹¹⁴

106 Ibid., p. 43.

107 SRSR, [Evidence](#), 16 June 2022, 1850 (Ken Hartwick); SRSR, [Evidence](#), 16 June 2022, 1920 (David Novog); and SRSR, [Evidence](#), 9 June 2022, 2120 (Jeremy Rayner).

108 SRSR, [Evidence](#), 26 September 2022, 1840 (André Bernier).

109 SRSR, [Evidence](#), 9 June 2022, 2110 (Jeremy Rayner); and SRSR, [Evidence](#), 2 June 2022, 1915 (Rory O’Sullivan).

110 SRSR, [Evidence](#), 9 June 2022, 2035 (Jeremy Rayner).

111 SRSR, [Evidence](#), 2 June 2022, 1915 (Michael Rencheck); SRSR, [Evidence](#), 2 June 2022, 2120 (Jos Diening); and SRSR, [Evidence](#), 16 June 2022, 1850 (Ken Hartwick); and SRSR, [Evidence](#), 26 September 2022, 1835 (Caroline Ducros).

112 SRSR, [Evidence](#), 26 September 2022, 1835 (Caroline Ducros).

113 Ibid.

114 Ibid.



As to potential conflicts of interest in nuclear governance, Caroline Ducros said that the CNSC does not “have a mandate as a proponent for any type of technology.”¹¹⁵

Some witnesses also indicated a need for ongoing modernization to allow regulators to keep pace with emerging technology and account for emerging climate change mitigation measures.¹¹⁶ Other witnesses testified to the importance of consistency of SMR regulation across different policies and frameworks, and over time.¹¹⁷

On this point, Caroline Ducros said that the CNSC “is taking a leadership role and working closely with international regulators, notably the U.S., the U.K. and international organizations” to “harmonize requirements and standards, share reviews and streamline licensing processes as much as possible, while maintaining our regulatory sovereignty.”¹¹⁸

The *Impact Assessment Act*, in place since 2019, as supplemented by the *Physical Activities Regulations*, was a frequent topic raised by witnesses.¹¹⁹

Some witnesses testified that the Act would increase project timelines.¹²⁰ Others expressed concern that most SMR projects may not be subject to an impact assessment.¹²¹ The regulations provide an exemption for the construction, operation and decommissioning of one or more new nuclear reactors with a combined thermal capacity of less than 900 megawatts thermal (MWth) within the licensed boundaries of an existing nuclear facility or one or more new reactors with a combined thermal capacity of less than 200 MWth outside the licensed boundaries of an existing nuclear facility. The Minister of the Environment may, however, designate by order projects to be

115 Ibid., 1900.

116 SRSR, [Evidence](#), 2 June 2022, 1950 (Michael Rencheck); SRSR, [Evidence](#), 2 June 2022, 1950 (Brett Plummer); and SRSR, [Evidence](#), 16 June 2022, 1850 (Ken Hartwick).

117 SRSR, [Evidence](#), 2 June 2022, 1845 (Rory O’Sullivan); and SRSR, [Evidence](#), 2 June 2022, 1900 (John Gorman).

118 SRSR, [Evidence](#), 26 September 2022, 1835 (Caroline Ducros).

119 [Impact Assessment Act](#), S.C. 2019, c. 28, s. 1; and [Physical Activities Regulations](#), SOR/2019-285.

120 SRSR, [Evidence](#), 2 June 2022, 1915 (Rory O’Sullivan); SRSR, [Evidence](#), 2 June 2022, 1950 (Brett Plummer); and SRSR, [Evidence](#), 9 June 2022, 2015 (Edouard Saab).

121 SRSR, [Evidence](#), 9 June 2022, 1935 (Evelyn Gigantes); SRSR, [Evidence](#), 9 June 2022, 1940 (Gordon Edwards); and SRSR, [Evidence](#), 16 June 2022, 1945 (Ginette Charbonneau).

subject to the impact assessment process. Several witnesses recommended that each SMR project be subject to an impact assessment.¹²²

Caroline Ducros with the CNSC said that “any project that goes through the CNSC, any licence application that goes through the CNSC, is subject to an environmental projection review under the *Nuclear Safety and Control Act*.”¹²³

ECONOMIC MODEL AND LABOUR NEEDS

Economic Model of SMRs

Witnesses presented the economic model used for the development of SMRs in Canada. Based on that model, small reactors have three primary opportunities in Canada, as previously mentioned: to contribute to satisfying a growing demand for electricity in conjunction with renewable energy sources with variable output; provide energy to remote communities by replacing diesel generators; and provide electricity and heat to mines and off-grid industrial facilities.¹²⁴

According to proponents of SMRs, these new types of reactors have several economic benefits that make them uniquely suited to these markets.

Building traditional nuclear reactors requires substantial investment from the outset, but those costs are offset over-time and through a significant capacity to generate electricity that provides economies of scale, lowering the cost of the electricity generated in cents per kilowatt-hour (¢/kWh).¹²⁵

SMRs have lower electricity generation capacity, but their economic model seeks to reduce the cost of the electricity generated by limiting their construction cost. The simplified design of SMRs, their mass production at dedicated plants, their modular installation directly on site, and the simplicity of their usage should help reduce their

122 For example, Anthony Reddin, [Brief for Committee study on SMRs](#), Brief submitted to the House of Commons Standing Committee on Science and Research, 15 June 2022; and Passamaquoddy Recognition Group Inc., [Brief](#), Brief submitted to the House of Commons Standing Committee on Science and Research, 23 August 2022.

123 SRSR, [Evidence](#), 26 September 2022, 1925 (Caroline Ducros).

124 For example: SRSR, [Evidence](#), 16 June 2022, 1850 (Ken Hartwick); SRSR, [Evidence](#), 2 June 2022, 1835 (John Gorman); and SRSR, [Evidence](#), 2 June 2022, 2050 (Jos Diening).

125 SRSR, [Evidence](#), 9 June 2022, 1850 (Christopher Keefer); and Terrestrial Energy, [Brief](#), Brief submitted to the House of Commons Standing Committee on Science and Research, 18 June 2022, p. 4.



installation and operation costs.¹²⁶ The economies of scale should be achieved by reactor production.¹²⁷ Several witnesses estimated that in these conditions, the cost of electricity generated by SMRs could stabilize around 10¢/kWh.¹²⁸ In comparison, witnesses testified that hydro costs in Ontario are currently 6¢/kWh to 8¢/kWh, nuclear is 9¢/kWh, gas is 14¢/kWh to 15¢/kWh, wind is 15¢/kWh and solar is 49¢/kWh to 50¢/kWh.¹²⁹

However, several other witnesses questioned this economic model. They wondered about the demand for SMRs. According to them, international examples show that the demand for SMRs is limited for the time being.¹³⁰ Furthermore, witnesses cited studies indicating that the level of demand for electricity in Northern, remote and Indigenous communities does not justify the investment required for building SMRs.¹³¹ In regards to the potential deployment of SMRs in Indigenous communities, witnesses also noted the importance of consulting with Indigenous communities regarding SMRs and energy decision-making.¹³² For Gordon Edwards, SMRs are a technology “in search of a market.”¹³³

126 SRSR, [Evidence](#), 2 June 2022, 2005 (Brett Plummer); SRSR, [Evidence](#), 2 June 2022, 2050 (Jos Diening); SRSR, [Evidence](#), 2 June 2022, 2125 (Francis Bradley); and SRSR, [Evidence](#), 2 June 2022, 2125 (Troy King).

127 Terrestrial Energy, [Brief](#), Brief submitted to the House of Commons Standing Committee on Science and Research, 18 June 2022, p. 4.

128 SRSR, [Evidence](#), 2 June 2022, 2030 (Brett Plummer); and SRSR, [Evidence](#), 16 June 2022, 1910 (Ken Hartwick).

129 SRSR, [Evidence](#), 9 June 2022, 1850 (Christopher Keefer); and SRSR, [Evidence](#), 16 June 2022, 1910 (Ken Hartwick); and SRSR, [Evidence](#), 2 June 2022, 2025 (Michael Rencheck).

130 SRSR, [Evidence](#), 16 June 2022, 1935 (M. V. Ramana).

131 Ibid., 2010; SRSR, [Evidence](#), 9 June 2022, 1840 (Susan O'Donnell); and RAVEN, [Brief](#), Brief submitted to the House of Commons Standing Committee on Science and Research, 14 June 2022, p. 3.

132 SRSR, [Evidence](#), 16 June 2022, 1850 (Ken Hartwick); SRSR, [Evidence](#), 2 June 2022, 2035 (Troy King); SRSR, [Evidence](#), 26 September 2022, 1910 (André Bernier); SRSR, [Evidence](#), 2 June 2022, 1910 (John Gorman); SRSR, [Evidence](#), 9 June 2022, 1910 (Joseph McBrearty); SRSR, [Evidence](#), 2 June 2022, 2050 (Jos Diening); and SRSR, [Evidence](#), 9 June 2022, 2040 (Jeremy Rayner); and SRSR, [Evidence](#), 16 June 2022, 1940 (Dazawray Landrie-Parker).

133 SRSR, [Evidence](#), 9 June 2022, 1940 (Gordon Edwards).

Several witnesses also questioned the optimistic projections for the cost of electricity generated by SMRs.¹³⁴ According to them, the construction of traditional reactors historically encountered significant delays and cost overruns.¹³⁵ M. V. Ramana told the committee that the construction cost for traditional reactors to date tended to increase over time.¹³⁶ As previously mentioned, the committee’s attention was also drawn to the fact that Northern, remote and Indigenous communities each have specific needs that may not be met by mass-produced SMRs.¹³⁷ Further, Jeremy Rayner referenced research he had previously conducted that identified economic challenges for SMRs in the wide span of designs in development and the “failure of vendors and potential buyers to agree on a small number of potentially promising designs.”¹³⁸

A brief submitted to the Committee by the Sustainable Energy Group further states that economic models to date have not incorporated the financial costs of decommissioning reactors at the end of their lifespan, increasing the overall cost of nuclear.¹³⁹

In these conditions, witnesses questioned the possibility of achieving the economies of scale that would make SMRs competitive.¹⁴⁰

International Market

Witnesses also addressed the issue of the international market. Most of the witnesses heard by the Committee said that, as a pioneer, Canada could achieve success

134 For example: SRSR, *Evidence*, 16 June 2022, 2020 (M. V. Ramana); Coalition for Responsible Energy Development in New Brunswick, *Submission to the House of Commons Science and Research Committee Study of SMRs*, 13 June 2022, p. 2; Council of Canadians, *Brief*, Brief submitted to the House of Commons Standing Committee on Science and Research, June 2022, p. 1; New Brunswick Anti-Shale Gas Alliance Inc., *Brief*, Brief submitted to the House of Commons Standing Committee on Science and Research, 14 June 2022, p. 3; and RAVEN, *Brief*, Brief submitted to the House of Commons Standing Committee on Science and Research, 14 June 2022, p. 3–4.

135 SRSR, *Evidence*, 9 June 2022, 1940 (Gordon Edwards).

136 SRSR, *Evidence*, 16 June 2022, 2005 (M. V. Ramana); and SRSR, *Evidence*, 16 June 2022, 2015 (Dazawray Landrie-Parker).

137 *Ibid.*, 2020.

138 Mariia Iakovleva, Jeremy Rayner and Ken Coates, “Breaking Out of a Niche: Lessons for SMRs from Sustainability Transitions Studies,” *Nuclear Technology*, Vol. 207, No. 9, September 2021, p. 1352.

139 Sustainable Energy Group, *Brief*, Brief submitted to the House of Commons Standing Committee on Science and Research, 15 June 2022.

140 SRSR, *Evidence*, 16 June 2022, 2005 (M. V. Ramana); and RAVEN, *Brief*, Brief submitted to the House of Commons Standing Committee on Science and Research, 14 June 2022, p. 3.



internationally by exporting its expertise.¹⁴¹ This was also cited by two briefs submitted to the Committee.¹⁴² André Bernier testified, for example, that “Canada has the potential to become a leader in the development and deployment of SMR technology and potentially claim a significant share of a projected global market estimated to be \$150 billion a year by 2040.”¹⁴³ The CNSC, meanwhile, testified that Canada could take a leadership role among international regulators in regard to requirements, standards and licensing requirements.¹⁴⁴

Others were more pessimistic, citing the significant number of models under development and international competition as risk factors.¹⁴⁵ M. V. Ramana, in private correspondence with the committee, also shared that the fuel required for certain SMR models under consideration is not currently produced in Canada and would need to be imported from other countries, of which Russia is a primary producer of such fuel.¹⁴⁶

Labour Needs

Job Creation Potential

Several witnesses discussed the job-creating potential of developing SMRs.¹⁴⁷ Rory O’Sullivan said that this is “a huge opportunity.”¹⁴⁸ The development, construction and operation of SMRs will require hiring many skilled workers in a variety of fields.

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- 141 SRSR, [Evidence](#), 2 June 2022, 1835 (John Gorman); SRSR, [Evidence](#), 2 June 2022, 1840 (Kirk Atkinson); SRSR, [Evidence](#), 2 June 2022, 1845 (Rory O’Sullivan); SRSR, [Evidence](#), 2 June 2022, 1940 (Brett Plummer); SRSR, [Evidence](#), 9 June 2022, 1830 (Christopher Keefer); and SRSR, [Evidence](#), 9 June 2022, 1945 (Edouard Saab).
- 142 Organization of Canadian Nuclear Industries, [Brief](#), Brief submitted to the House of Commons Standing Committee on Science and Research, 6 October 2022; and X-energy Canada, [X-energy Canada Submission to the Small Modular Reactor Study of the Canadian House of Commons Standing Committee on Science and Research](#), 6 October 2022.
- 143 SRSR, [Evidence](#), 26 September 2022, 1840 (André Bernier).
- 144 SRSR, [Evidence](#), 26 September 2022, 1835 (Caroline Ducros).
- 145 Chris Corey, [Small Modular Nuclear Reactors Are Mostly Bad Policy](#), Brief submitted to the House of Commons Standing Committee on Science and Research, 13 June 2022, p. 3; and New Brunswick Anti-Shale Gas Alliance Inc., [Brief](#), Brief submitted to the House of Commons Standing Committee on Science and Research, 14 June 2022, p. 4.
- 146 M. V. Ramana, written response to questions, 16 June 2022.
- 147 For example: SRSR, [Evidence](#), 2 June 2022, 1840 (Kirk Atkinson); SRSR, [Evidence](#), 2 June 2022, 2035 (Troy King); SRSR, [Evidence](#), 9 June 2022, 1915 (Joseph McBrearty); SRSR, [Evidence](#), 9 June 2022, 1955 (Edouard Saab); and SRSR, [Evidence](#), 9 June 2022, 2055 (John Root, Executive Director, Sylvia Fedoruk Canadian Centre for Nuclear Innovation Inc.).
- 148 SRSR, [Evidence](#), 2 June 2022, 1845 (Rory O’Sullivan).

According to Joseph McBrearty, SMR development projects will need “not only the scientists and the engineers, but also skilled trades to execute these construction projects, and you’re going to need skilled operators to operate these plants.”¹⁴⁹

The development of SMRs could also have positive spinoffs on employment in other sectors. For Kirk Atkinson, “[i]n Alberta, oil and gas workers can be assured of long-term job security by re-skilling for the SMR-generated process heat economy in hydrogen and alternative fuels.”¹⁵⁰

There was also reference to the possibility of the installation and operation of SMRs creating job opportunities within local communities.¹⁵¹ In addition to these direct jobs, SMRs were presented as an economic development opportunity for the regions concerned.¹⁵²

During his appearance, M. V. Ramana raised concerns about these optimistic predictions. According to him, “[t]he literature is unambiguous that nuclear reactor construction generates comparatively fewer jobs than renewables like solar and wind energy per dollar invested.”¹⁵³ He also said that, even if investment in SMRs generated jobs, the uncertainty of opportunities in this sector casts doubt on the sustainability of these jobs.¹⁵⁴

Other witnesses emphasized that the jobs offered in the nuclear sector are “good jobs.”¹⁵⁵ For Robert Walker, National Director of the Canadian Nuclear Workers’ Council, “[t]hese are skilled jobs with good pay and great working conditions. I believe I can speak with some authority when I say that our nuclear facilities are amongst the safest workplaces anywhere.”¹⁵⁶ One witness noted that the nuclear sector has “the highest union density” in Canada.¹⁵⁷ It was also noted that the nuclear industry is a major employer of Indigenous populations in Canada and that a growing number of women

149 SRSR, [Evidence](#), 9 June 2022, 1915 (Joseph McBrearty).

150 SRSR, [Evidence](#), 2 June 2022, 1840 (Kirk Atkinson).

151 SRSR, [Evidence](#), 2 June 2022, 2120 (Jos Diening).

152 SRSR, [Evidence](#), 9 June 2022, 2020 (Edouard Saab); and International Union of Operating Engineers, [Submission to SRSR Study on Small Modular Nuclear Reactors](#), 2022.

153 SRSR, [Evidence](#), 16 June 2022, 1935 (M. V. Ramana).

154 *Ibid.*, 2010.

155 SRSR, [Evidence](#), 2 June 2022, 1840 (Kirk Atkinson); SRSR, [Evidence](#), 9 June 2022, 1855 (Christopher Keefer); and SRSR, [Evidence](#), 2 June 2022, 2035 (Troy King).

156 SRSR, [Evidence](#), 9 June 2022, 2040 (Robert Walker).

157 SRSR, [Evidence](#), 9 June 2022, 1855 (Christopher Keefer).



are joining the sector.¹⁵⁸ On behalf of the Department of Natural Resources, André Bernier spoke about an upcoming meeting of the SMR Leadership Table to be co-chaired by a member of the Indigenous Advisory Council, partly to ensure that “we’re able to look at potential opportunities for Indigenous communities or development opportunities, including on the skills training side and in terms of potential ownership stakes in any projects.”¹⁵⁹ As in other cases where SMRs were brought up in relation to Indigenous communities, witnesses highlighted the important role of consultation with Indigenous partners.¹⁶⁰

Training and Workforce Development

Witnesses shed light on the need to train workers to meet labour skills in building and operating SMRs.

It was noted that, because of their size and simple design, future SMRs will likely require fewer operators than traditional reactors.¹⁶¹ Similarly, it is also possible that those operators can be trained more quickly.¹⁶²

Nevertheless, several witnesses testified that efforts will be required to ensure labour training in the SMR sector.¹⁶³ Witnesses noted that, in Canada, nuclear expertise is geographically concentrated primarily in Ontario and New Brunswick and to a lesser extent in Quebec. Other provinces, such as Alberta or Saskatchewan, still lack expertise.¹⁶⁴ Dazawray Landrie-Parker, Director of the Nuclear Sector at Creative Fire, made a point of saying that training and mentorship of the Indigenous workforce can take quite a bit of time and “needs to start immediately” and in consultation with Indigenous communities.¹⁶⁵

158 SRSR, [Evidence](#), 9 June 2022, 1910 (Joseph McBrearty); and SRSR, [Evidence](#), 9 June 2022, 2100 (Robert Walker).

159 SRSR, [Evidence](#), 26 September 2022, 1910 (André Bernier).

160 SRSR, [Evidence](#), 26 September 2022, 1910 (André Bernier); SRSR, [Evidence](#), 2 June 2022, 2035 (Troy King); and SRSR, [Evidence](#), 16 June 2022, 1940 (Dazawray Landrie-Parker).

161 SRSR, [Evidence](#), 16 June 2022, 1910 (David Novog); and SRSR, [Evidence](#), 2 June 2022, 2005 (Brett Plummer).

162 SRSR, [Evidence](#), 16 June 2022, 1925 (David Novog).

163 For example: SRSR, [Evidence](#), 2 June 2022, 2100 (Francis Bradley); and SRSR, [Evidence](#), 16 June 2022, 1835 (Dave Tucker).

164 SRSR, [Evidence](#), 2 June 2022, 1920 (Kirk Atkinson).

165 SRSR, [Evidence](#), 16 June 2022, 1940 (Dazawray Landrie-Parker).

In that context, several witnesses brought up the importance of partnerships with universities and the contribution that research and education communities can provide to this sector.¹⁶⁶

Witnesses also recommended investment in technical training for young people in the nuclear sector and the development of a pan-Canadian nuclear workforce strategy.¹⁶⁷

Therefore, the Committee recommends:

Recommendation 6

That the Government of Canada develop a pan-Canadian strategy, in partnership with provinces, territories and Indigenous governing bodies, for developing a workforce to research, create, establish, operate and maintain small modular reactors.

COMMUNITY ENGAGEMENT

Many of the witnesses focused on issues related to the impact of potential SMR development on local communities. Indigenous communities drew particular attention in this regard. Other more general comments focused on the social acceptability of SMR development.

In regard to the potential deployment of SMRs on Indigenous lands, many witnesses spoke to the importance of meaningful partnerships and consultation processes with the Indigenous communities in question.¹⁶⁸ Speaking to this point, John Gorman said, “The nuclear industry takes Indigenous relations and partnerships very, very seriously. A tremendous amount of effort is being based on delivering trusted relationships and partnerships.”¹⁶⁹

The representative from CNSC said that SMRs are being considered for deployment in certain areas of Canada with no history of nuclear power generation. According to her,

166 For example: SRSR, [Evidence](#), 2 June 2022, 2020 (Brett Plummer); SRSR, [Evidence](#), 2 June 2022, 2100 (Francis Bradley); SRSR, [Evidence](#), 9 June 2022, 1925 (Joseph McBrearty); SRSR, [Evidence](#), 16 June 2022, 1830 (David Novog); and SRSR, [Evidence](#), 9 June 2022, 1955 (Edouard Saab).

167 SRSR, [Evidence](#), 9 June 2022, 1900 (Joseph McBrearty); SRSR, [Evidence](#), 2 June 2022, 2035 (Troy King); and SRSR, [Evidence](#), 16 June 2022, 1835 (Dave Tucker).

168 SRSR, [Evidence](#), 2 June 2022, 1845 (Rory O’Sullivan); SRSR, [Evidence](#), 2 June 2022, 1910 (John Gorman); SRSR, [Evidence](#), 2 June 2022, 1935 (Michael Rencheck); SRSR, [Evidence](#), 2 June 2022, 2050 (Jos Dening); SRSR, [Evidence](#), 2 June 2022, 2055 (Troy King); SRSR, [Evidence](#), 9 June 2022, 1925 (Joseph McBrearty); SRSR, [Evidence](#), 16 June 2022, 1850 (Ken Hartwick); and SRSR, [Evidence](#), 9 June 2022, 2040 (Jeremy Rayner).

169 SRSR, [Evidence](#), 2 June 2022, 1910 (John Gorman).



“[t]hat requires early and ongoing engagement by all involved, including the CNSC, to build relationships and trust, especially with Indigenous nations and communities and potential host communities.”¹⁷⁰

On behalf of Natural Resources Canada, André Bernier said that a national Indigenous Advisory Council had been created as part of the SMR action plan.¹⁷¹ The council is composed of members from First Nations, Métis and Inuit communities in Saskatchewan, New Brunswick, Ontario, Alberta and the territories.¹⁷²

Dazawray Landrie-Parker testified not only on the importance of engagement with Indigenous communities and informed consent in relation to SMR projects, but also on the potential for “increased Indigenous energy sovereignty. These communities need to be empowered to own and operate their own energy systems.”¹⁷³ Speaking to this point, Dazawray Landrie-Parker said, “You have to be equal players at the table. You have to be involved in those conversations from the very beginning. That includes defining what those processes look like.”¹⁷⁴

Dazawray Landrie-Parker also highlighted other potential benefits of meaningful Indigenous consultation in the energy sector, including using traditional knowledge to strengthen impact assessments, using local knowledge and lived experience to guide engagement, early training and mentorship of an Indigenous workforce, and including Indigenous-owned businesses in the procurement process.¹⁷⁵

More broadly, multiple other witnesses also mentioned the potential benefits of SMRs for Indigenous communities related to employment, shared ownership and management of projects, and participation in supply chains.¹⁷⁶

While Dazawray Landrie-Parker spoke of support for SMRs in some Indigenous communities she had worked in, Ginette Charbonneau, physicist and spokesperson for

170 SRSR, [Evidence](#), 26 September 2022, 1835 (Caroline Ducros).

171 SRSR, [Evidence](#), 26 September 2022, 1910 (André Bernier).

172 Natural Resources Canada, [Canada Supports Indigenous Advisory Council for SMR Action Plan](#), News release, 15 December 2021.

173 SRSR, [Evidence](#), 16 June 2022, 1940 (Dazawray Landrie-Parker).

174 *Ibid.*, 1955.

175 *Ibid.*

176 SRSR, [Evidence](#), 2 June 2022, 2035 (Troy King); SRSR, [Evidence](#), 9 June 2022, 1910 (Joseph McBrearty); and SRSR, [Evidence](#), 9 June 2022, 1945 (Edouard Saab).

Ralliement contre la pollution radioactive, mentioned opposition to SMRs from “most First Nations” in her testimony.¹⁷⁷

In a brief to the Committee, the Passamaquoddy Recognition Group Inc. (PRGI), a not-for-profit Indigenous-led organization representing the Peskotomuhkati Nation in Canada, shared that their consent was never sought or granted for the development of the Point Lepreau nuclear reactor facility on the shores of the Bay of Fundy.¹⁷⁸ In its brief, PRGI voiced its opposition to SMR projects, including those planned for the Point Lepreau site.

PRGI raised the issue of reconciliation, asking “how will supporting, allowing and advancing [SMRs] on Indigenous territory promote and facilitate reconciliation with Indigenous peoples?”¹⁷⁹

PRGI also criticized the “piecemeal approach” to consultations with Indigenous communities: “Instead of participating in a holistic conversation about nuclear, we are asked to respond to specific projects and are forbidden to draw links between projects because of either the project scope, or the limited mandate of the host of the conversation.”¹⁸⁰ This criticism echoes Jeremy Rayner’s remarks about public engagement. In his view, placing responsibility for engagement on the proponents of nuclear development projects raises a problem:

The problem is that members of the public will want to raise broad questions of public policy and regulation around nuclear issues that are beyond the scope of a project-based assessment and outside the competence of a proponent to address. Examples are general questions about uranium mining or the disposal of nuclear fuel. Simply telling them that they can’t raise such questions at an assessment is not going to help the deployment of SMRs, and I think we need to find some way of including those broader questions in public engagement processes in Canada.¹⁸¹

Several witnesses acknowledged that many Canadians still have concerns about SMRs, and nuclear energy more generally, related to waste, safety and economics.¹⁸²

177 SRSR, [Evidence](#), 16 June 2022, 2000 (Dazawray Landrie-Parker); and SRSR, [Evidence](#), 16 June 2022, 1945 (Ginette Charbonneau).

178 Passamaquoddy Recognition Group Inc., [Brief](#), Brief submitted to the House of Commons Standing Committee on Science and Research, 23 August 2022.

179 Ibid.

180 Ibid.

181 SRSR, [Evidence](#), 9 June 2022, 2035 (Jeremy Rayner).

182 SRSR, [Evidence](#), 2 June 2022, 2040 (Francis Bradley); and SRSR, [Evidence](#), 16 June 2022, 1830 (David Novog).



Dazawray Landrie-Parker spoke of the importance of beginning community engagement with energy literacy that encompasses the positive and negative attributes of different types of energy generation, to enable communities to make informed decisions based on their particular concerns and needs.¹⁸³ On a similar topic, David Novog mentioned the need for “a robust national dialogue on nuclear energy” that includes a fact-based analysis.¹⁸⁴

Therefore, the Committee recommends:

Recommendation 7

That the Government of Canada require the participation of Indigenous communities in decision-making on small modular reactors, including site selection and project management.

Recommendation 8

That the Government of Canada review its approach to consulting the public and Indigenous communities on small modular reactor development projects.

183 SRSR, [Evidence](#), 16 June 2022, 1950 (Dazawray Landrie-Parker).

184 SRSR, [Evidence](#), 16 June 2022, 1830 (David Novog).

APPENDIX A LIST OF WITNESSES

The following table lists the witnesses who appeared before the committee at its meetings related to this report. Transcripts of all public meetings related to this report are available on the committee’s [webpage for this study](#).

Organizations and Individuals	Date	Meeting
Bruce Power Michael Rencheck, President and Chief Executive Officer	2022/06/02	14
Canadian Nuclear Association John Gorman, President and Chief Executive Officer	2022/06/02	14
Electricity Canada Francis Bradley, President and Chief Executive Officer	2022/06/02	14
Global First Power Jos Diening, Managing Director	2022/06/02	14
Moltex Energy Canada Inc. Rory O'Sullivan, Chief Executive Officer, North America	2022/06/02	14
New Brunswick Power Corporation Brett Plummer, Chief Nuclear Officer and Vice-President Nuclear	2022/06/02	14
Ontario Power Generation Inc. Ken Hartwick, President and Chief Executive Officer	2022/06/02	14
Ontario Tech University Kirk Atkinson, Associate Professor and Director, Centre for Small Modular Reactors	2022/06/02	14
SaskPower Troy King, Acting President and Chief Executive Officer	2022/06/02	14
As an individual Evelyn Gigantes Jeremy Rayner, Professor	2022/06/09	15

Organizations and Individuals	Date	Meeting
Canadian Coalition for Nuclear Responsibility Gordon Edwards, President	2022/06/09	15
Canadian Nuclear Laboratories Joseph McBrearty, President and Chief Executive Officer Louis Riccoboni, Vice President, Corporate Affairs	2022/06/09	15
Canadian Nuclear Workers Council Robert Walker, National Director	2022/06/09	15
Canadians for Nuclear Energy Christopher Keefer, President	2022/06/09	15
Coalition for Responsible Energy Development in New-Brunswick Susan O'Donnell, Adjunct Research Professor	2022/06/09	15
Sylvia Fedoruk Canadian Centre for Nuclear Innovation Inc. John Root, Executive Director	2022/06/09	15
Westinghouse Electric Canada Edouard Saab, President	2022/06/09	15
As an individual David Novog, Professor M. V. Ramana, Professor, School of Public Policy and Global Affairs, University of British Columbia	2022/06/16	16
Creative Fire Dazawray Landrie-Parker, Director, Nuclear Sector	2022/06/16	16
McMaster University Dave Tucker, Assistant Vice-President, Nuclear Research	2022/06/16	16
Ontario Power Generation Inc. Ken Hartwick, President and Chief Executive Officer	2022/06/16	16
Ralliement contre la pollution radioactive Ginette Charbonneau, Physicist and Spokesperson	2022/06/16	16
Atomic Energy of Canada Limited Amy Gottschling, Vice-President, Science, Technology and Commercial Oversight	2022/09/26	18

Organizations and Individuals	Date	Meeting
Canadian Nuclear Safety Commission Caroline Ducros, Director General, Advanced Reactor Technologies Brian Torrie, Director General, Directorate of Safety Management	2022/09/26	18
Department of Natural Resources André Bernier, Director General, Electricity Resources Branch Daniel Brady, Deputy Director, Nuclear Science and Technology	2022/09/26	18

APPENDIX B LIST OF BRIEFS

The following is an alphabetical list of organizations and individuals who submitted briefs to the committee related to this report. For more information, please consult the committee's [webpage for this study](#).

Baron, Sarah Gabrielle

Beaudin, David

Beaudin, Mary

Clark, Lauren

Coalition for Responsible Energy Development in New Brunswick

Concerned Citizens of Renfrew County and Area

Corey, Chris

Council of Canadians

Donahue, Patricia

Hughes, Elaine

International Physicians for the Prevention of Nuclear War Canada

International Union of Operating Engineers

Leap4wards

Lindsey, Anne

McLean, Tom

Neufeld, Brahm

New Brunswick Anti-Shale Gas Alliance Inc.

Ontario Clean Air Alliance

Organization of Canadian Nuclear Industries

Passamaquoddy Recognition Group Inc

Peterborough Pollinators

Ramana, M. V.

Reddin, Anthony

Rural Action and Voices for the Environment

Sustainable Energy Group

Swain, Doug

Terrestrial Energy Inc.

Wuest, Lawrence J

X-energy Canada

REQUEST FOR GOVERNMENT RESPONSE

Pursuant to Standing Order 109, the committee requests that the government table a comprehensive response to this Report.

A copy of the relevant *Minutes of Proceedings* (Meetings Nos. [14](#), [15](#), [16](#), [18](#), [23](#) and [26](#)) is tabled.

Respectfully submitted,

Hon. Kirsty Duncan
Chair

NDP Dissenting Report Small Modular Nuclear Reactors

The New Democratic Party of Canada disagrees with recommendations one, four, five, six and seven. It is the NDP's position that Small Modular Nuclear Reactors are not environmentally friendly technology, will not be able to reduce Canada's Greenhouse Gas Emissions within the timeframe set by the Government of Canada, the technology is expensive and has been plagued by cost overruns, and will increase the distribution of highly radioactive nuclear waste across Canada. Rather than spending billions of taxpayers' dollars on this technology, Canada should focus on increasing the amount electricity generated through renewable sources. Wind, solar and hydro-electric technologies are mature, cost effective, efficient and ready to be deployed now.

Small Modular Nuclear Reactors Are Not Environmentally Friendly Technology

While nuclear fission does not release greenhouse gases into the environment it does produce large amounts of highly toxic radioactive waste. In 2006, the United States' National Research Council report Biological Effects of Ionizing Radiation (BEIR) VII concluded that there is likely no safe dose level, and that even low radiation doses have the potential to cause an increase in cancer risk.ⁱ

"Small modular reactors are going to produce more waste per kilowatt hour of electricity being generated, compared to a large reactor," testified Dr. M.V. Ramana. He went on to say, "...these substances are going to be hazardous for hundreds of thousands of years. That's an inherent property of these materials. There's no amount of research that's going to change that property."

No permanent solution to the long-term storage of nuclear waste currently exists in Canada. At this time, spent nuclear fuel bundles are first stored temporarily in water-filled pools where they remain for up to 10-years. They are then moved to reinforced high-density concrete dry-storage containers, which have a lifespan of 50 yearsⁱⁱ.

According to Canada's Nuclear Waste Management Organization, there is an existing inventory of about 3.2 million used nuclear fuel bundles in Canada. At the end of the planned operation of Canada's existing nuclear reactors, the number of used fuel bundles could total about 5.5 million. About 90,000 additional used fuel bundles are generated each year.

As Dr. Ginette Charbonneau testified, Canada needs to "exercise great vigilance regarding the problems of radioactive waste generated by small modular reactors. It is risky to develop the nuclear industry because, as you know, the waste is accumulating more and more, and the costs associated with managing it are becoming absolutely astronomical."

She added, "because the waste from small modular reactors is not well characterized. We don't know what it's going to be. We know that it will have a shorter lifespan and a lower intensity,

but that it will be more complex in terms of intermediate and low-level waste. So it's totally unknown, and we don't know what to do with it.”

The position of Canada’s New Democrats is that it is not prudent to add more highly toxic nuclear waste to this already large pile.

Not reduce GHGs quickly enough

Canada has set a greenhouse gases emissions reduction target of 40 percent below 2005 levels by 2030 and net-zero emissions by 2050. In order to meet this target Canada must be deploying non-GHG emitting energy technology now. Mr. André Bernier, Director General, Electricity Resources Branch, Department of Natural Resources, testified the deployment of small modular nuclear reactors, “is not something that will make a material difference before the end of the decade. It's not something where we expect SMRs to contribute on a large scale to the achievement of the 2030 goal. Even by 2035, it's likely that we'll see a very small number of SMRs deployed in Canada.”

Dr. Ramana told the committee. “The [nuclear] industry has been talking about this for decades at this point. In 2001 the U.S. Department of Energy commissioned a report that looked at different SMR designs. They concluded that one of these could be operational by the end of the decade, which means 2010. It's now 2022. There is not a single SMR design in the U.S. that is ready for commercial use. The leading design, NuScale, when it was established as a company, promised to have its first reactors operational by 2015 to 2016. Now it is talking about 2029 to 2030. I think even that is optimistic.”

A study by the David Suzuki Foundation revealed, “Canada’s electricity system can achieve zero emissions by 2035 primarily through investments in wind, solar, energy storage and interprovincial transmission, complemented by investments in energy efficiency.”ⁱⁱⁱ

While a few small modular nuclear reactors are operating, many are still only at the concept stage and design stage. Waiting decades for this technology to be workable will not help Canada meet its GHG emission targets. Additionally, the billions of taxpayers’ dollars spent trying to make this technology work takes away from the amount of funds which could be used to improve existing renewable energy technologies.

The Technology Is Expensive And Has Been Plagued By Cost Overruns

The nuclear industry argues small modular nuclear reactors are a low-cost solution to Canada’s energy needs, particularly for rural and remote communities. However, Dr. Ramana told the committee, “...the empirical record on nuclear power around the world has been that costs have actually increased, not decreased, with more construction. In both France and the United States, the two countries with the most nuclear plants, the average cost of the nuclear plant increased as more and more plants were built.” Dr. Jeremy Rayner, when asked about development costs of small modular nuclear reactors, testified, “I'm neither an economist nor

do I have access to the information that companies have about costs. In fact, they [the nuclear industry] don't even have very strong information right now until they build one.” Meanwhile the industry, without providing clear evidence, argues that their hopes and assumptions are this time the costs will not be excessive as small modular nuclear reactors will be built in large numbers.

Dr. Gordon Edwards outlined for the committee a brief history of past pushes for nuclear power;

“The first big push came after the 1973 oil embargo when AECL predicted that hundreds of CANDU reactors would be built from coast to coast in Canada. That turned out to be a false alarm.

Hydro-Québec itself envisioned at that time up to 50 new large power reactors along the St. Lawrence River, but none of them were ever built. The only Quebec reactor that was under construction at the time is now shut down permanently.

The second big push came when the 21st century began. There was much fanfare about a global nuclear renaissance whereby thousands of large reactors would be built around the world, but that nuclear revival also turned out to be a bust. Only a handful of new reactors were ever ordered, including one in Finland; one in Flamanville, France; and four in the southern states of Georgia and South Carolina. Those projects all experienced years of delay and massive cost overruns. Two nuclear corporate giants were bankrupted.”

Dr. Ramana provided the committee with a history of other country’s experience with small modular nuclear reactors,

“The Russian design was a so-called floating power plant, where the nuclear reactor was located on a barge. It was meant to serve as a way to electrify remote communities in Russia, which were on the Arctic coast. This was built. It was over a decade late. It was about three times as expensive as the initial cost estimates. That's the primary reason they haven't had any customers. There are many countries that would say that they would like one of these things. Indonesia is one that I mentioned. They said they have large numbers of islands and it would be great to have a floating power plant, but when they see the experience and the cost, they don't really want to go there.

In China's case, they actually built a high-temperature, gas-cooled reactor, which was based on earlier experience in Germany. This reactor, too, was about four years late. The cost was estimated to be 40% higher than the cost of electricity from light-water reactors in China. As a result, the plans they had to build more of these high-temperature gas-cooled reactors are being shelved. They talk about trying to make it larger, so that they can try to reduce the cost through economies of scale, which

basically means that they are no longer talking about small modular reactors, but of large reactors.

In the case of South Korea, its SMART design was licensed for construction in 2012. They looked around South Korea, and not a single utility wanted to build one of these. Therefore, South Korea is looking for export markets. They're talking about Saudi Arabia and Jordan, but none of them have actually bought one so far.”

He also testified, “even doing the R and D required to try to prove that one of these reactors is safe to build is a very expensive proposition. I go back to the example of the NuScale Reactor in the United States. They have spent over \$1 billion U.S. at this point, and their reactor design is nowhere near actual completion or ready to be constructed. Most estimates are that they're going to go to about \$1.5 billion or \$2 billion U.S.”

Dr. Ramana pointed out that these high costs drive customers away from these nuclear reactors,

“because of the adverse economics, there is little demand for SMRs. Russia's KLT-40S design, China's HTR-PM design and South Korea's SMART design, which was licensed for construction about a decade ago, have attracted no customers. In the United States, many utilities have exited the proposed NuScale project due to its high cost.

Although many developing countries claim to be interested in SMRs, none have invested in the construction of one. Good examples are Jordan, Ghana and Indonesia, all of which have been touted as promising markets for SMRs for years, but none of which are buying one.”

A further cost ignored by advocates of small modular nuclear reactors is that of clean-up and decommissioning. Dr. Edwards told the committee, “In Hanford, Washington, for example, and at Sellafield in northern England, the costs of cleanup have amounted to the equivalent of \$100 billion. That's just to deal with the cleanup of that waste. Remember that cleanup doesn't mean that we're eliminating it, simply that we're storing it in a better condition.”

Will Increase The Distribution Of Highly Radioactive Nuclear Waste Across Canada

The nuclear industry argues that to be cost-effective small modular nuclear reactors would have to be built and deployed in large numbers. This would result in potentially hundreds of new nuclear reactors deployed across Canada many in remote locations such as northern communities and mine sites. Each of these facilities would produce highly radioactive waste requiring its collection and transport to either storage or reprocessing locations. Due to the sheer increase in the frequency of radioactive waste being transported the risk of accidents will increase considerably.

The recent massive search in Western Australia for a pea-sized Caesium-137 radioactive capsule should serve as a warning as to the cost for dealing with an accidental release of radioactive waste during transport. Considering the cleanup costs and danger to human and animal life from a single accident when transporting and handling nuclear waste from hundreds of remote locations deploying these reactors as a replacement for diesel electrical generation is not a prudent risk.

Conclusion

In consideration of the factors above the NDP feels Canada would be following a more prudent approach to the expenditure of public funds were it to redirect funding currently provided to the nuclear industry for small modular nuclear reactors towards developing renewable energy technologies.

ⁱ [https://www.osha.gov/ionizing-radiation/health-effects#:~:text=When%20ionizing%20radiation%20interacts%20with,DNA%20\(i.e.%2C%20mutations\).](https://www.osha.gov/ionizing-radiation/health-effects#:~:text=When%20ionizing%20radiation%20interacts%20with,DNA%20(i.e.%2C%20mutations).)

ⁱⁱ <https://www.nwmo.ca/en/Canadas-Plan/Canadas-Used-Nuclear-Fuel/How-Is-It-Stored-Today>

ⁱⁱⁱ <https://davidsuzuki.org/science-learning-centre-article/shifting-power-zero-emissions-electricity-across-canada-by-2035/>

