A Strategic Plan for the Deployment of Small Modular Reactors

Prepared by the Governments of Ontario, New Brunswick, Alberta and Saskatchewan

Ontario

New Nouveau Brunswick

Alberta

Saskatchewan

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SMR STRATEGIC PLANNING – EXECUTIVE SUMMARY

The governments of Ontario, New Brunswick, Saskatchewan and Alberta share a vision for a strong and growing economy and a clean energy future for Canada.

Leading organizations like the Intergovernmental Panel on Climate Change and the International Energy Agency, agree that technology and innovation can be a catalyst in the transition to a lower carbon economy. Small modular reactors (SMRs) are the next evolution in nuclear innovation and technology.

This Strategic Plan is a path forward for the advancement of SMRs and the opportunity they bring as a source of safe and reliable, zero-emissions energy to power our communities, while meeting the demands of a growing economy and population. SMRs can improve our quality of life, drive economic growth and prosperity, and help Canada and the world meet its climate goals.

Since December 2019, Ontario, New Brunswick and Saskatchewan have been working together to advance SMRs in Canada and welcomed Alberta aboard in April 2021. This Strategic Plan is the final deliverable under the inter-provincial Memorandum of Understanding (MOU), but it is only the beginning as the provinces work together to take the next steps to advance SMR innovation in Canada.

The plan builds on the SMR Feasibility Study released by the provincial power utilities in April 2021 by identifying key actions that provinces can take to enable a decision on whether to proceed with SMRs. Following a decision to proceed, it outlines further actions to support the deployment of SMRs.

The provinces have identified the following five priority areas for SMR development and deployment:

Technology readiness: Canada's early adoption of SMRs would position the nation as a world-leader in new nuclear innovation and a global SMR technology hub. Canada could realize a significant share of the SMR market, creating new economic and job growth through three streams of SMR development:

- **Stream 1** – a grid-scale SMR project of 300 megawatts (MW) constructed at the Darlington nuclear site in Ontario by 2028. Subsequent units in Saskatchewan would follow, with the first SMR projected to be in service in 2034.

- **Stream 2** – two fourth-generation, advanced SMRs that would be developed in New Brunswick. ARC Clean Energy is targeting to be fully operational at the Point Lepreau nuclear site by 2029, and Moltex Energy will have both its spent fuel recovery system and reactor in operation by the early 2030s, also at the Point Lepreau site.

- **Stream 3** – a new class of micro-SMRs designed primarily to replace the use of diesel in remote communities and mines. A five-MW gas-cooled demonstration project is under way at Chalk River, Ontario, with plans to be in service by 2026.

Regulatory framework: Canada is a leader in nuclear regulations that protect the health and safety of the public and the environment. The Canadian Nuclear Safety Commission (CNSC) will be responsible for licensing SMRs over their full life cycle, from site preparation and construction to operation and the eventual decommissioning of the plant at the end of its life.

This regulatory process also includes the management and disposal of all forms of nuclear waste. Canada's robust regulatory process and focus on safety is a key advantage in providing SMR leadership on the world stage. Some regulatory changes and clarity will be necessary to streamline the federal regulatory and licensing process for SMR projects recognizing SMR technologies are of lower risk and feature enhanced safety characteristics compared to traditional large-scale nuclear projects.

Further, regulatory changes and clarity will be required to ensure reasonable costs and timelines for approvals for investors and operators.

Economics and financing: The SMRs being proposed under the three streams identified by the provinces have the potential to create thousands of jobs and billions of dollars in economic benefits. To achieve these outcomes, SMR technologies are expected to require significant upfront financial investments given the high cost to develop and deploy a first-of-a-kind design.

Federal and provincial governments have a key role to play in sharing the financial risk in order to lay the foundation for SMR development in Canada and the world. Federal investment and financial risk-sharing is required to support the extensive planning work that will deliver on SMRs – from technology selection and impact assessments to site licences culminating in construction licences.

The MOU signatory provinces are looking to the federal government for assurance that it will allocate financial support for the SMR project proposals outlined in this Strategic Plan. A federal funding commitment is critical for the provinces to continue advancing SMR development and deployment, and for SMRs to play a key role in meeting Canada's emission reduction targets.

The economic benefits of SMRs span across Canada. For instance, the growth of SMRs in Canada and around the world will drive increased uranium demand, providing new opportunities for uranium produced in Saskatchewan and potentially Alberta, and increased utilization of refinery and conversion facilities in Ontario.

Nuclear waste management: The Nuclear Waste Management Organization (NWMO), is a federally mandated, industry-led organization responsible for the long-term management of used fuel waste, including fuel waste from advanced reactors and SMRs.

The NWMO is in the process of identifying a willing host community suitable for a Deep Geologic Repository (DGR) for the permanent storage and management of Canada's used fuel waste. Twenty-two communities initially expressed interest in being considered for the DGR site and participated in the NWMO's site selection process. Through technical site evaluations and ongoing social engagement, two potential sites in Ontario are still being considered, with safety assessments and community engagement ongoing. The NWMO is planning to select a single preferred site in 2023, with DGR operations expected to begin between 2040 and 2045.

Through 2021, the federal government has been reviewing and modernizing Canada's Policy Framework for Radioactive Waste to ensure that Canada has strong radioactive waste policies in place that continue to meet international best practices, are based on the best available science, and reflect the values and principles of Canadians. The federal policy review also includes the development of a new Integrated Strategy for Waste Management (i.e., low and intermediate-level waste and used fuel) from existing reactors and future waste streams from new technologies.

The MOU provinces look forward to working with the federal government on the final policy framework and integrated strategy, including ensuring radioactive waste repositories are available for smaller SMR operators, including in Saskatchewan and Alberta. The MOU provinces are closely monitoring the federal government's public and Indigenous engagement on this review.

Indigenous and public engagement: Under the terms of the interprovincial SMR MOU, the provincial governments have committed to working co-operatively to inform the public about the economic and environmental benefits of nuclear energy and SMRs. As part of Canada's SMR Roadmap and Action Plan, all four provinces have highlighted the vital role that Indigenous and public engagement has and will continue to play in SMR development.

Collaboration among the four provinces will enhance and strengthen commitments to create opportunities for Indigenous communities to participate in SMR projects. These opportunities could include employment, skills development, investments, supplier arrangements and other means to share the benefits of the projects.

The governments of Ontario, New Brunswick, Saskatchewan and Alberta will build trust and dialogue with the public related to SMRs. Public engagement topics could include developing a greater understanding of the traditional role that nuclear has played and continues to play as a cost-effective and clean source of energy with significant economic and societal benefits. Given nuclear power generation is new for Saskatchewan and Alberta, engagement will be particularly important to raise awareness and exchange information and viewpoints.

Several decisions are required before governments and power utilities can advance SMRs in Canada. Provincial power utilities will complete detailed planning work with SMR technology developers to enable provincial decision-making on proceeding with SMR projects. This work will include technical aspects along with:

- Completing detailed design, planning, preparation and licensing with SMR technology developers to meet targeted deployment timelines;
- Refining project costs and schedule estimates of the selected SMR technologies; and
- Confirming the economic opportunities the selected technologies would provide for Canadian suppliers.

Provincial governments will carefully consider project risks versus benefits, including:

- Impacts on electricity systems;
- Impacts on electricity ratepayers;
- Emissions reductions;
- Potential for Indigenous partnerships; and
- Enhanced economic activity through the:
  - Potential of the selected technology to provide benefits for Canadian suppliers;
  - Potential for innovation and enhancing research capabilities;
  - Potential for global export; and
  - Potential for export of clean electricity to markets in nearby provinces and the United States (U.S.).

The MOU provinces will continue to seek opportunities for collaboration on SMR advancement with the federal government to ensure the necessary financial, regulatory and policy supports are in place to support continued SMR development.

This Strategic Plan supports the conversations taking place about the role that SMRs could play in our country and across the globe. The governments of Ontario, New Brunswick, Saskatchewan and Alberta look forward to engaging with Indigenous communities, the public, research and academia, government partners and the nuclear industry to exchange information and share perspectives that will inform the future of SMRs in Canada.

1. INTRODUCTION AND NEED FOR ACTION

Small modular reactors (SMRs) present an exciting opportunity for the provinces of Ontario, Saskatchewan, New Brunswick and Alberta to be at the forefront of nuclear innovation, clean energy and emerging markets for SMRs across Canada and around the world.

SMRs are nuclear reactors that operate at a significantly smaller size than conventional reactors. Their modularity means that the manufacturing of major components can be completed in a factory setting and transported via truck, rail or ship to their point of use, with the ability to add reactor modules incrementally as demand for energy increases. This has several advantages, including the standardization of design and components which reduces production timelines and decreases capital costs. Additionally, productivity and efficiency can be gained as the production of successive components and modules continue over time. This means that like all nuclear reactors, SMRs are a source of clean energy; however, their scalability and modular design provides several opportunities that traditional large-scale nuclear power plants cannot offer, such as lower construction costs and the ability to supply power to smaller electricity grids and remote locations.

In addition to providing clean baseload energy, some SMR technologies have increased load-following capabilities to provide electricity system operators with more flexibility in incorporating additional intermittent renewable energy sources to an electricity grid. Some can be complemented by thermal storage solutions, which store energy during periods of abundant renewable energy and can generate electricity when renewable energy is more scarce.

Beyond power production, SMRs can provide opportunities such as district heating, desalination and high-quality steam for heavy industrial applications and hydrogen production.

Several Canadian provinces recognize the opportunities SMRs present and have partnered to explore the potential to meet common priorities, such as addressing climate change, meeting new electricity demand, economic development and innovation, and opportunities for economic participation by Indigenous communities. The governments of Ontario, New Brunswick and Saskatchewan signed an interprovincial SMR Memorandum of Understanding (MOU) in December 2019, with the addition of Alberta in April 2021. The MOU outlines several commitments for the provinces, including collaborating on SMR development and deployment (see appendix for a full list of commitments).

In February 2020, provincial leaders from the MOU signatory provinces met with nuclear industry leaders to reinforce their commitment to the development of SMR technology and discuss steps for moving forward on the MOU commitments.

In April 2021, the provinces released a report prepared by Ontario Power Generation (OPG), Bruce Power, New Brunswick Power (NB Power) and SaskPower titled, Feasibility of SMR

Development and Deployment in Canada (SMR Feasibility Study). The report provides a feasibility assessment of SMR development and deployment, as well as the companies' business cases for SMR implementation.

The power companies assessed that SMRs have the potential to be an economically competitive source of energy. However, that will depend on other low-carbon alternatives available to each jurisdiction. As provinces reduce reliance on fossil fuels in electricity generation, an optimum energy supply mix will need to be achieved, with nuclear playing a potentially larger role in the future.

Since SMRs cover a wide range of power levels, designs, technological readiness levels and end-user applications, the power companies developed three streams of SMR project proposals. As such, the SMR project proposals that were assessed in the SMR Feasibility Study are:

Stream 1 – a grid-scale SMR project of 300 MW constructed at the Darlington site in Ontario by 2028, followed by up to four subsequent units in Saskatchewan between 2034 and 2042.

Stream 2 – two advanced SMR technologies being developed in New Brunswick for deployment at the Point Lepreau Nuclear Generating Station site, with subsequent potential deployment in other regions of Canada and abroad. These advanced SMR designs are complementary to the designs in Stream 1. ARC Clean Energy is targeting to be fully operational by 2029, and Moltex Energy will have both its spent fuel recovery system and reactor in operation by the early 2030s.

Stream 3 – a new class of micro-SMRs designed primarily to replace diesel use in remote communities and mines. OPG has partnered with Ultra Safe Nuclear Corporation (USNC) and Bruce Power has partnered with Westinghouse Electric Company to advance these micro-SMR designs and pursue deployment of demonstration units in Canada in the mid-2020s.

The SMR Feasibility Study concluded that these SMR project proposals are commercially and technically feasible. However, it noted that additional factors, such as support from federal and provincial governments and the nuclear industry, are important in helping advance this new technology.

2. PROVINCIAL INTERESTS IN SMRS

SMRs have the potential to address many common priorities for the MOU signatory provinces, as well as Canada as a whole. These include:

Climate Change

SMRs are non-emitting sources of reliable energy that have the potential to replace fossil fueled electricity, such as coal-fired power on provincial energy grids and diesel power in remote locations. They also reduce the need for natural gas generation as a transition fuel to decarbonization. SMRs can complement intermittent renewable energy sources in the on-grid context, as well as produce high-quality steam and reduce emissions from industrial processes.

In 2020, more than 80 per cent of the electricity consumed in New Brunswick was supplied from clean and non-emitting sources, which includes approximately 36 per cent nuclear. New Brunswick is also highly interconnected with the Atlantic provinces, Quebec, northern Maine and New England. Work is underway in the Atlantic region to study expanding these interconnections to allow for more sources of clean energy to flow throughout the region. SMRs are a potential source of clean energy that could help meet regional clean electricity needs.

In Ontario, over 90 per cent of the electricity consumed is supplied from clean and non-emitting sources, with nuclear representing about 60 per cent. Nuclear energy played a key role in Ontario's phase out of coal-fired generation by 2014, which was the single largest greenhouse gas emissions reduction on the continent. SMRs are a potential source of baseload energy to meet future electricity demand and reduce reliance on natural gas fired generation.

In Saskatchewan, 76 per cent of SaskPower's electricity was generated from coal and natural gas in 2021. The remaining 24 per cent came from renewables (hydro, wind, solar, biomass). SMRs are a potential source of baseload energy to reduce greenhouse gas emissions, meet future electricity demand and support the increasing role of renewables in Saskatchewan's electricity generation.

Large industrial facilities are Alberta's largest source of emissions, and SMRs have the potential to provide emissions-free, high-quality steam to industrial facilities like those in the oil sands. Alberta's electricity system is also rapidly decarbonizing, going from the majority of electricity being supplied by coal as recently as 2017 to the last coal unit expected to be converted to natural gas by the end of 2023. Natural gas is an essential part of Alberta's generation mix, but SMRs may present an opportunity for electricity decarbonization over the longer term.

Regional Energy Demand

SMRs are a clean source of energy to meet new electricity demand on provincial grids to support growing economies, energy demands and electrification of industrial facilities, electrification of transportation and household heating, and hydrogen production. They have the potential to support adopting more intermittent renewable energy as we discover more about their load-following capabilities. Additionally, SMRs can be a clean energy option for new or expanding industrial operations (e.g., mining, oil sands production, energy-intensive manufacturing).

Economic Development

Canada is home to a world-class nuclear industry and supply chain. SMRs represent an opportunity to continue growing our nuclear industry and supply chain by creating highly skilled jobs and providing opportunities and partnerships with Indigenous communities. In the longer-term, SMRs could provide opportunities to export Canadian services and expertise around the world.

Canada's supply chain is strong and ready to support the advancement of SMR development and deployment across the country and abroad. Developing a new generation of technology that meets Canadian needs for clean energy would enable Canada's nuclear supply chain to continue growing and innovating.

Research and Innovation

The MOU signatory provinces are proud to be home to cutting-edge nuclear research and innovation. SMRs are the next generation of nuclear technology, which can support and enhance the progressive research underway in Canada's universities and research centres.

3. KEY CONSIDERATIONS FOR SMR DEPLOYMENT

3.1. Technological Readiness

Canada is in a global race with other major nuclear nations that are also seeking to capitalize on the SMR opportunity. Early-mover advantage is critical if Canada is to become a global SMR technology hub and capture a significant share of the supply chain opportunities, increased jobs and economic benefits. Successful demonstration and deployment of SMRs in the near-term is key to securing Canada's early-mover advantage. This will also contribute towards Canada's emissions reduction targets, help develop its strategic industrial sectors and provide opportunities for remote communities.

Although the MOU signatory provinces recognize the benefits of leading SMR development within their respective provinces, there are also economic and environmental benefits for all provinces and territories if Canada is successful. The three proposed SMR project streams and associated technologies are important for further research and development, as they all may have valuable applications nationally and internationally.

SMRs cover a wide range of power levels, designs, technological readiness levels and end-user applications. To meet Canada's broad needs, three streams of SMR projects are being proposed.

Stream 1: On-Grid SMR Deployment in Ontario and Saskatchewan

Stream 1 proposes a grid-scale SMR project of 300 MW constructed at the Darlington site in Ontario by 2028. This would be followed by up to four subsequent units in Saskatchewan, with the first unit in service in 2034.

The shovel-ready status of the Darlington site makes it a vital strategic asset, providing an opportunity to select an SMR technology developer for subsequent deployment.

In 2020, OPG concluded a due diligence process on several SMR technologies to advance the development of an SMR in Ontario that would pave the way for potential deployment in other jurisdictions. OPG selected three SMR technology developers to undergo detailed evaluation. Throughout 2021, a short-list of SMR technology developers underwent an in-depth technical, regulatory and economic assessment of risks, benefits and opportunities.

In December 2021, OPG announced GE-Hitachi as the preferred technology developer for the Darlington SMR project[1]. OPG will work with GE-Hitachi on design, planning, preparation and licensing of GE-Hitachi's BWRX-300 reactor for deployment at Darlington.

SaskPower was closely involved with OPG's detailed assessment of the three short-listed SMR technologies. SaskPower expects to announce a decision in early 2022 on whether to align with OPG's SMR vendor selection and advance with licensing and impact assessment work based on the deployment of the same SMR technology in Saskatchewan.

Stream 2: On-Grid SMR Deployment in New Brunswick

Stream 2 proposes two advanced designs being developed in New Brunswick for deployment at the Point Lepreau Nuclear Generating Station site, with subsequent potential deployment of multiple units at this site, as well as in other regions of Canada and abroad. These advanced SMR designs are complementary to the designs in Stream 1. ARC Clean Energy is targeting to be fully operational by 2029, and Moltex Energy will have both its spent fuel recovery system and reactor in operation by the early 2030s.

[1] https://www.opg.com/media_releases/opg-advances-clean-energy-generation-project/

In addition to participating in the development of the federal government's SMR Roadmap in 2018, the Government of New Brunswick provided $10 million in funding, which was matched by two advanced SMR developers: Moltex Energy and ARC Clean Energy[2]. These vendors were selected following a due diligence process conducted by NB Power prior to 2018. The companies are developing delivery capability in New Brunswick with the promise of local economic development. These designs are expected to result in new, lower-cost units that recycle nuclear waste, have more inherent safety attributes, can support the addition of more intermittent renewable energy and are attractive for global deployment.

Supply chain assessment studies by both vendors have shown that between 50 to 60 per cent of the components could be manufactured in New Brunswick, and this figure could be increased with some capability development. Many of the remaining components could be supplied within the rest of Canada[3]. This high percentage is possible due to the simplicity of the designs.

ARC Clean Energy has begun Phase 2 of the Canadian Nuclear Safety Commission's (CNSC's) pre-licensing Vendor Design Review (VDR) process, and Moltex has completed Phase 1 and is preparing for Phase 2. Access to funding is critical to enable the vendors to unlock private sector funding and allow further progress in advancing their designs towards the construction of demonstration units.

On February 10, 2021, the Government of New Brunswick announced an additional $20 million in funding to ARC Clean Energy, with the company providing $30 million in matching funds to progress through Phase 2 of the VDR[4].

On March 18, 2021, the federal government announced $50.5 million dollars in funding for Moltex Energy, with matching funds that will also be used to progress through Phase 2 of the VDR[5]. Federal funding was provided through the Strategic Innovation Fund (SIF) and the Atlantic Canada Opportunities Agency (ACOA). On March 30, 2021, OPG's Centre for Canadian Nuclear Sustainability (CCNS) announced it will provide $1 million in funding to assist Moltex in advancing the development of its used fuel recycling work[6].

The demonstration of both reactors at Point Lepreau represents the potential for national and international deployment. With a successful ARC-100 commercial demonstration, additional units in New Brunswick will be considered. ARC Canada's technology may also be beneficial for use for the later units planned in other provinces, as well as for the oil and gas industry as a pathway to

[2] Small Modular Reactors in New Brunswick, accessed November 23, 2021, https://smrnb.ca/whats-happening-in-new-brunswick/
[3] Reactivating the Underutilized New Brunswick Supply Chain, accessed November 23, 2021, https://cme-mec.ca/wp-content/uploads/2020/12/CME-ARC-Canada-SC-Event-24112020.pdf
[4] New Brunswick announces funds for SMR development, February 11, 2021, https://www.world-nuclear-news.org/Articles/New-Brunswick-announces-funds-for-SMR-development
[5] Moltex receives $50.5M from Government of Canada for small modular reactor, March 18, 2021, https://www.moltexenergy.com/moltex-receives-50-5m-from-government-of-canada-for-small-modular-reactor/.
[6] OPG collaborating with Moltex to study clean energy solutions, March 30, 2021, https://www.opg.com/media_releases/opg-collaborating-with-moltex-to-study-clean-energy-solutions/

reduce its carbon footprint. Its size and high temperature output is well-suited for combined use in heavy industry, hydrogen, synthetic (clean) fuels production and desalination, and coupled with its proliferation resistance it is also a strong fit for existing and emerging nuclear nations. This represents a significant opportunity to reduce the carbon emission footprint in heavy industry and the transportation sectors.

For Moltex, this could mean the potential for more units in other provinces and countries with established nuclear programs and used fuel stockpiles. The ability to load follow renewables makes the Moltex design particularly suitable for siting in locations with both used fuel and renewable energy programs such as the United States, the United Kingdom and parts of Europe. Moreover, the high temperature output allows these reactors to provide clean energy for off-grid applications such as heating and industrial processes - offering additional pathways to net zero, in addition to electrification.

The ability to provide variable output allows for good integration with power from renewable energy forms, and their high temperature output allows these reactors to provide energy for other critical sectors that can offer additional pathways to net zero, in addition to electrification.

Stream 3: Micro-SMR Deployment

Stream 3 proposes a new class of micro-SMRs designed primarily to replace diesel use in industrial, remote community and other commercial applications.

A five-MW gas-cooled reactor demonstration project by Global First Power (GFP) – the Micro Modular Reactor (MMR™) – is underway at the Chalk River site in Ontario. It is expected to be in service by 2026. Through GFP, OPG partnered with USNC for this demonstration project on the basis of shared investment from OPG and USNC, as well as expected funding from the federal government[7].

This project is not intended to be commercially economical for the first-of-a kind demonstration unit, but analysis shows that future two-unit 10-MW plants will be economically competitive with diesel power in remote locations and will provide the opportunity for returns to cover demonstration project costs. GFP estimates that one MMR™ could replace 200 million litres of diesel at a mining site over 20 years[8].

Bruce Power and its partners at the Nuclear Innovation Institute have also been exploring opportunities for micro-SMRs under Stream 3 with the Westinghouse Canada eVinci™ micro reactor.

7 Global First Power, Ultra Safe Nuclear Corp. and OPG form joint venture on MMR at Chalk River, June 9, 2020, https://www.opg.com/media_release/gfp-usnc-and-opg-form-joint-venture-on-mmr-at-chalk-river/

8 Global First Power, Micro Modular Reactor Project at Chalk River, Community Telephone Town Hall, November 16, 2021, http://www.gfpcleanenergy.com/Content/documents/GFP_Transcript_EN.pdf

In October 2020, Bruce Power and Westinghouse announced an agreement to pursue applications of the eVinci™ micro reactor within Canada to provide a reliable source of carbon-free energy[9]. Together, Bruce Power and Westinghouse are investigating the feasibility of deploying the eVinci™ micro reactor to industrial, remote community and other commercial applications. Westinghouse is targeting the mid-2020s for first deployment in Canada.

Westinghouse estimates that a single eVinci™ micro reactor at a mining site, with diesel back-up, could reduce carbon emissions by about 90 per cent[10].

Opportunities for Fuel Supply and Recycling

All of the SMR designs under consideration require different forms of fuel that are not currently manufactured in Canada. For example, they may require low-enriched uranium, fuel salts or reprocessing of used fuel from CANDU or other reactors. In some cases, the fuel can be procured from an existing global supply, some forms of fuel have limited global supply, whereas other forms of fuel are still under development. The deployment of SMRs in Canada represents opportunities for fuel fabrication and other supporting capabilities to be developed across the country. Canada has already demonstrated its ability to develop the knowledge and expertise for a robust nuclear fuel supply chain to support the CANDU fleet, and this provides a solid foundation to pursue new technologies. In addition, as Canada gains a more varied nuclear fleet and research reactors, SMRs present many interesting opportunities for fuel recycling and minimizing nuclear waste in the future.

3.2. Regulatory Framework

Canada is fortunate to have a world-leading regulator in the CNSC, which is responsible for licensing all aspects of a nuclear power reactor project over its full lifecycle. The CNSC regulates everything from site preparation and construction to operation and the eventual decommissioning of the plant at the end of its life, including the management and disposal of all forms of nuclear waste.

In addition, the CNSC and nuclear industry rely on comprehensive technical standards set by the Canadian Standards Association. This includes standards for management systems, nuclear components, and environmental and waste management throughout the lifecycle of nuclear operations.

[9] Bruce Power and Westinghouse collaborate to advance application of eVinciTM battery technology to support Canada's Net Zero initiative, October 9, 2020, https://www.brucepower.com/2020/10/09/bruce-power-and-westinghouse-collaborate-to-advance-application-of-evincitm-battery-technology-to-support-canadas-net-zero-initiative/

[10] Westinghouse – Bruce Power, Executive Summary of the eVinci™ Micro-Reactor Deployment in Mining and Remote Canadian Communities Feasibility Study, accessed November 23, 2021, https://www.brucepower.com/wp-content/uploads/2021/10/210283A_WestinghouseBPMicroReactor_ExecutiveSummary_R000.pdf

A review or assessment of environmental impacts and associated mitigation measures is required before CNSC grants approval for a project to proceed with site preparation. The CNSC's consideration of all licence applications includes a public hearing process involving input from Indigenous communities, the public and interested stakeholders.

For SMRs that generate more than 200 MW of thermal energy at a new nuclear site or 900 MW at an existing nuclear site, the Impact Assessment Agency of Canada will lead an Impact Assessment process, which is a comprehensive review of social, Indigenous and economic impacts in addition to environmental impacts. In addition, the federal *Impact Assessment Act* gives discretionary authority to the Minister of Environment and Climate Change to designate any SMR project (i.e., regardless of size) for the Impact Assessment process if the Minister is of the opinion that the potential adverse impacts or public concerns regarding the project warrant such a designation.

One of Canada's key advantages in the effort to become a world leader in SMR development is a regulatory process that is more safety goal-oriented, commensurate with the risks of a nuclear reactor design, rather than being rule-based.

The CNSC has also put in place an optional pre-licensing assessment process known as the Vendor Design Review (VDR) to provide early regulatory feedback to developers of innovative nuclear reactors such as SMRs. The VDR process does not include any formal approvals. Instead it is intended to:

- Identify and address regulatory issues early enough so that delays in licensing and facility construction can be minimized;
- Enable higher quality licence applications; and
- Potentially result in an efficient and effective licensing process.

While Canada's existing regulatory framework is capable of handling SMRs, there are still some regulatory and procedural changes needed to recognize the lower inherent risk and enhanced safety of SMRs.

As SMR projects will be smaller and less complex than existing nuclear projects, regulatory clarity remains a critical consideration for investors and operators. With a smaller output and the corresponding smaller revenue stream, it is essential that the regulatory processes apply a risk-informed and graded approach to acknowledge the unique features of SMR designs with respect to safety and environmental impacts. Similarly, the resources needed (i.e. cost, timelines) for a licence applicant to move through regulatory decision-making and approvals should be commensurate with the level of risk.

For example, to deploy an SMR as the power source for a remote mine, the cost and time to secure approval for the SMR cannot be longer and more complex than securing approval for the

mine itself. Similarly, long-term supply and investment decisions by electric utilities to maintain reliability must have some level of confidence that the regulatory process will not delay projects. This would create an impediment to considering this clean energy option rather than choosing a higher-emitting incumbent energy source, such as diesel for remote locations or natural gas in other areas.

Once a reactor is licensed and operational, the licensing of subsequent units should be significantly more efficient provided there are no design changes. This will provide investors and operators the licensing confidence necessary to move forward with a "fleet" approach (i.e., deploying the same technology in multiple jurisdictions), which can enhance the business case for SMRs.

The provinces encourage the CNSC and federal government to continue discussions with the nuclear industry and stakeholders in Canada, as well as other international regulators, to ensure Canada's regulatory framework can fully support the deployment of SMRs.

A streamlined federal regulatory and licensing framework for nuclear projects that recognizes the enhanced safety and security features of SMRs, while avoiding unduly burdening project developers, will play a critical role in ensuring that the proposed projects under the three SMR streams can meet their respective deployment timelines, without compromising safety and security.

Stream 1

Ontario is home to the only shovel-ready, licensed site for a nuclear new-build project in Canada – the Darlington nuclear site. In November 2020, the Government of Ontario supported OPG's announcement to undertake planning and preparation activities in order to host an SMR at the Darlington site by the end of decade.

The Darlington site has already completed an environmental assessment and obtained a Site Preparation Licence for a new-build project from the CNSC in 2012. In October 2021, the CNSC renewed OPG's existing Site Preparation Licence for a further ten years (i.e., through to 2031)[11].

By the end of 2022, OPG will work with GE-Hitachi to submit an application to the CNSC for a Licence to Construct the BWRX-300 reactor at the Darlington site. OPG would then require a Licence to Operate from the CNSC before it can be placed into service, which is currently targeted for 2028.

[11] CNSC renews Ontario Power Generation's site preparation licence for its Darlington New Nuclear Project, Government of Canada, October 12, 2021, https://www.canada.ca/en/nuclear-safety-commission/news/2021/10/cnsc-renews-ontario-power-generations-site-preparation-licence-for-its-darlington-new-nuclear-project.html

GE-Hitachi has been undergoing Phase 2 of the CNSC's VDR process. The work taking place under the VDR process, as well as compliance with the environmental assessment requirements at Darlington, are important aspects of the regulatory process for the Darlington SMR project.

SaskPower is advancing with site selection and the development of licensing and impact assessment plans in 2022. The risk for this project is partially mitigated by closely following progress in Ontario for the first-of-a-kind unit and benefiting from any lessons learned. SaskPower is planning to locate the first two SMRs on one site, which will reduce long-term licensing costs. SaskPower will take regulatory criteria for site selection and community input from engagement into consideration during the site selection process. SaskPower will also take technical and operating requirements into consideration, such as existing and future transmission/distribution infrastructure. The Government of Saskatchewan will bring forward additional socioeconomic and regional drivers into SaskPower's site selection process.

SaskPower is advancing with a project plan that includes a seven-year planning phase, leading to a construction decision in 2030 following the successful completion of the first-of-a-kind project. The construction phase is approximately four years, which would result in commissioning the first plant in 2034.

Saskatchewan currently works closely with the CNSC and the Impact Assessment Agency of Canada on regulatory oversight for uranium mines. This experience is expected to be beneficial in providing the foundation for regulatory oversight and an efficient regulatory process for SMRs in Saskatchewan. With the potential for future uranium mining in Alberta, Saskatchewan's expertise in the area will also be invaluable given the ongoing collaboration between the two provinces. At the same time, Saskatchewan and Alberta will be reaching out to other provinces to learn more about and be able to adopt best-practices for regulating nuclear reactors.

Stream 2

ARC has begun design activities for VDR-2. In concert with NB Power, they are also progressing on fuel procurement activities and discussions with the NWMO on long-term waste disposal strategies. They are supporting NB Power in site evaluation and preparation activities, as well as First Nations engagement, economic opportunities and public engagement. CNSC VDR Phase 2 is expected to be complete in the fall of 2023, which is around the same time NB Power expects to be in a position to submit an initial application for the licence to prepare the site. The potential for ARC to provide the electricity and heat source for the production of hydrogen and other synthetic (clean) fuels is also being actively explored as a means of further reducing the carbon footprint in the industrial and transportation sectors.

Moltex has completed VDR Phase 1 and is undergoing preparation activities for VDR Phase 2. They are completing the conceptual design stage and getting ready to begin preliminary design for the SSR-W. Research and development work is progressing for the WAste to Stable Salt (WATSS) fuel recycling facility in parallel with the conceptual design. In concert with NB Power, discussions are underway with NWMO on long-term waste disposal strategies, as well as

discussions with the International Atomic Energy Agency (IAEA) on non-proliferation safeguard strategies. Moltex is supporting NB Power with site evaluation and preparation activities, as well as First Nations engagement, economic opportunities and public engagement.

NB Power continues to engage with First Nations, with discussions on economic opportunities, environmental studies and the incorporation of Indigenous traditional knowledge studies as part of the site evaluation. NB Power is progressing site evaluation studies and activities associated with prerequisites needed for the application of the licence to prepare the site.

CNSC VDR Phase 2 allows preliminary feedback from CNSC staff to be incorporated and addressed up-front, leading to reduced regulatory uncertainty during the Site Preparation Licence application review and approval.

NB Power is providing support to the vendors in navigating the CNSC regulatory regime. The Government of New Brunswick is committed to continuing to work with the federal government to ensure adequate funding and support for Stream 2 Advanced SMR development and demonstration projects in New Brunswick.

Stream 3

In 2018, Canadian Nuclear Laboratories (CNL) issued an invitation to SMR developers for the siting of SMR demonstration reactors at a CNL-managed site. The reactor design for the GFP demonstration project (USNC MMR™) proposed for development at CNL's Chalk River site in Ontario is currently undergoing the VDR process and an environmental assessment as part of the GFP's Site Preparation Licence application.

If the GFP demonstration project receives an approved environmental assessment and a Site Preparation Licence, it will also require a Licence to Construct and a Licence to Operate from the CNSC before it can be built and operated. This project's operation is targeted for 2026.

Westinghouse Electric Company is also targeting the mid-2020s for eVinci™ micro reactor deployment. Together, Bruce Power and Westinghouse are investigating the feasibility of deploying the eVinci™ micro reactor to industrial, remote community and other commercial applications.

Westinghouse will also engage the CNSC, through the VDR process, to agree on an approach to licensing the eVinci™ micro reactor that will take into account the appropriate scaling of a reactor project of the size and risk profile of the eVinci™ micro reactor, as well as its unique deployment and operating features.

Other vendors participating in CNL's invitation for SMR demonstration projects at earlier stages of review include U-Battery, Starcore and Terrestrial Energy. These technologies are also undergoing the CNSC's VDR process.

3.3. Economics and Financing

The development and deployment of SMRs has the potential to create thousands of jobs and billions of dollars in economic benefits as outlined in the SMR Feasibility Study.

Stream 1 will create the following economic benefits for Canada from a single unit in Ontario and four units in Saskatchewan over their lifetime[12]:

- Average annual employment (direct, indirect and induced) of:
  - 1,528 jobs during project development
  - 12,455 jobs during manufacturing and construction
  - 1,469 jobs during operations and
  - 1,193 jobs during decommissioning
- $17 billion positive impact on GDP (i.e., direct, indirect and induced); and
- $5.4 billion in increased government revenue.

Stream 2 can create the following economic benefits for Canada for demonstration units in New Brunswick[13]:

- Average of 1,458 direct and indirect jobs per year;
- $2.15 billion positive impact on GDP (i.e., direct and indirect); and
- $198 million in increased government revenue.

With the opportunity to expand this through a fleet of Canadian and globally exported units to 2060 of:

- Average of 17,900 direct and indirect jobs per year;
- $59 billion positive impact on GDP (i.e., direct and indirect); and
- $5.2 billion in increased government revenue.

[12] A New Power: Economic Impacts of Small Modular Nuclear Reactors in Electricity Grids, Conference Board of Canada, March 2021, https://www.conferenceboard.ca/e-library/abstract.aspx?did=10881

[13] small reactors, big opportunities – Investing in Small Modular Reactor (SMR) technology is a made in New Brunswick contribution to the low carbon economy. https://www.nbpower.com/en/about-us/in-the-community/point-lepreau-nuclear-generating-station

Stream 3 can create the following economic benefits for Canada from a four-unit commercial deployment (20 MW), for example, at a mining site over its operating life[14]:

- Average annual employment (i.e., direct, indirect and induced) of:
  - 240 jobs during project development
  - 638 jobs during manufacturing and construction
  - 282 jobs during operations and
  - 180 jobs during decommissioning

- $900 million positive impact on GDP (i.e., direct, indirect and induced); and

- $320 million in increased government revenue.

Developing a new generation of technology that meets pan-Canadian needs for clean energy, while bringing benefits to Canada's economy over the long-term, requires significant upfront financial investments.

First-of-a-kind SMR projects are expected to carry risk and face high costs. These projects face significant one-time costs, such as initial research and development, as well as design and engineering work to support regulatory and licensing approvals for new SMR technologies. In addition, first-of-a-kind SMR projects are expected to face higher financing costs as they are perceived to carry higher risk with regards to construction and operation.

The federal and provincial governments have a key role to play in cost-recovery and risk-sharing mechanisms to support the completion of development work for these proposed first-of-a-kind SMR projects, as well as their construction and operation, if approved. Successful deployment of the first-of-a-kind SMRs will lay the foundation for a robust SMR industry in Canada and enable future SMR projects to proceed more efficiently.

In Saskatchewan, SaskPower has drafted a plan and budget for the seven-year planning phase that will deliver SMR technology selection (together with OPG), an approved impact assessment and site licence, as well as development of a construction licence application. At the same time, Saskatchewan will pursue post-secondary research and training capacity development, as well as supply chain development. Most importantly, Indigenous and stakeholder engagement will take place during this time. The plan and budget rely on shared funding by the provincial and federal governments.

The growth of SMRs in Canada and around the world will drive an increased demand for uranium, providing new opportunities for uranium produced in Saskatchewan and potentially Alberta, and increased utilization of refinery and conversion facilities in Ontario. In the short-term, Saskatchewan has sufficient uranium to supply planned Canadian SMRs, while increased mining activities are feasible depending on uranium pricing in the long term.

[14] "Emerging Frontiers: Economic Impacts of Very Small Nuclear Reactors in Remote Off-Grid Mining" Conference Board of Canada, October 28, 2020

3.4. Nuclear Waste Management

Under the Government of Canada's Radioactive Waste Policy Framework, Canadian nuclear waste producers and owners are responsible for the funding, organization and safe management of radioactive nuclear wastes. The NWMO, as mandated through the federal *Nuclear Fuel Waste Act,* is a not-for-profit organization established by Canada's nuclear electricity producers. The founding members – OPG, NB Power, Hydro Quebec and Atomic Energy of Canada Limited – are mandated to fund the NWMO's operations.

All used fuel from nuclear power plants in Canada is held onsite at interim storage facilities and falls under the responsibility of the nuclear power plant operator. For some research reactors in Canada, their used nuclear fuel is shipped back to the fuel's originator (e.g., US Department of Energy or Atomic Energy of Canada Limited). Today, used nuclear fuel is safely managed in facilities licensed for interim storage, located at nuclear reactor sites in Ontario, Quebec, and New Brunswick, and at Atomic Energy of Canada Limited's sites in Manitoba and Chalk River Laboratories in Ontario.

The NWMO is undertaking a site selection process to identify a willing host community for a used fuel Deep Geologic Repository (DGR) for the permanent storage and management of Canada's used fuel waste. Twenty-two communities initially expressed interest in being considered for the DGR site and participated in the NWMO's site selection process. The NWMO has gradually narrowed its focus to fewer areas through technical site evaluations and social engagement to assess safety and the potential to build supportive and resilient partnerships. Two potential siting areas in Ontario are still under consideration, with assessments and community engagement currently underway[15]. The NWMO is planning to select a single preferred site in 2023, at which point detailed site characterization will take place. DGR operations are expected to begin between 2040 and 2045.

The NWMO has acknowledged that in addition to Canada's current inventory of used nuclear fuel, it will be responsible for the long-term management of nuclear fuel waste from advanced reactors and SMRs, under a funding arrangement to be developed with the owners of the SMRs.

The Government of Canada is reviewing and modernizing Canada's Policy Framework for Radioactive Waste to ensure that it continues to meet international best practices, is based on the best available science, and reflects the values and principles of Canadians. The federal policy review also includes the development of a new Integrated Strategy for Radioactive Waste (i.e., low and intermediate-level waste, and used fuel) from existing reactors and future waste streams from new technologies.

SMRs present a new paradigm in Canada of smaller entities deploying one or more small power reactors, whereas historical experience in Canada was large provincial and federal crown entities building large centralized power reactors and large nuclear research sites. Therefore, the MOU

[15] NWMO Study Areas, accessed December 16, 2021, https://www.nwmo.ca/en/Site-selection/Study-Areas

provinces are closely monitoring the federal government's public and Indigenous engagement on this radioactive waste review, and look forward to working with the federal government on the final policy framework and Integrated Strategy for Radioactive Waste to ensure it supports deployment of SMRs and micro-SMRs by all potential operators across Canada.

3.5. Indigenous and Public Engagement

Under the terms of the interprovincial SMR MOU, the provincial governments have committed to working co-operatively to inform Indigenous communities and the public about the economic and environmental benefits of nuclear energy and SMRs. This work will build upon ongoing efforts that each province has taken independently and within other SMR projects and forums.

For instance, all four provinces contributed to the Canadian Roadmap for SMRs as members of the SMR Roadmap Steering Committee and through participation in the SMR Roadmap Working Groups, including the Indigenous and Public Engagement Working Group. Following up on the recommendations of the Roadmap, each province contributed a chapter to Canada's SMR Action Plan, individually highlighting the vital role that Indigenous and public engagement will have in SMR development and deployment.

Indigenous Inclusion

Building and maintaining relationships with Indigenous communities is an important and ongoing aspect of current and proposed nuclear initiatives in the four provinces.

Each provincial government has made its own commitment to build and strengthen positive relationships with Indigenous communities as SMR activities are in the early stages of development. The provinces have worked to foster meaningful relationships with Indigenous communities in the development of energy and resource projects and can build upon those experiences to engage on SMRs.

Collaboration amongst the MOU signatory provinces will enhance and strengthen commitments to creating opportunities for Indigenous communities to participate in SMR projects. These opportunities could include employment, skills development, investments, supplier arrangements and other mechanisms to share in project benefits.

The provincial governments acknowledge that ongoing Indigenous engagement is additional to obligations under the Duty to Consult as part of the environmental and regulatory review processes. This Strategic Plan is intended to contribute to the conversation on the topic of SMR deployment and, as such, the provinces are enthusiastic about continuing to hear Indigenous views and ideas related to SMR deployment.

In June and July 2021, the North Shore Micmac District Council (NSMDC) hosted a series of workshops to inform their strategic plan to support the development of SMRs in New Brunswick,

including enabling opportunities for local First Nation communities. The workshops featured presentations from Moltex Energy, ARC Clean Energy, NB Power, First Nations Power Authority (FNPA) and supply-chain representatives[16].

In September 2021, SaskPower partnered with FNPA to facilitate public engagement sessions with interested Indigenous Peoples and communities. These sessions focused on the future of Saskatchewan's power system and supply options, including SMRs[17].

Public Engagement

The governments of Ontario, New Brunswick, Saskatchewan and Alberta are tasked with building trust and dialogue with the public on the topic of SMRs. Public engagement on the topic of SMRs could include developing a greater understanding of the traditional role that nuclear has played and continues to play as a cost-effective and clean source of energy with significant economic and societal benefits. For example, nuclear energy currently provides about 60 per cent of Ontario's electricity needs and about 36 per cent of New Brunswick's electricity needs – the single largest source of non-emitting generation in each province. The Canadian nuclear industry supports a total of 76,000 jobs and adds $17 billion per year in GDP, including from nuclear operations and uranium mining and processing[18]. Nuclear power and research reactors are also a key source of medical isotopes produced across Canada, which are used to diagnose and treat life-threatening diseases as well as sterilize medical equipment around the world.

Stakeholders in Saskatchewan and Alberta do not have much experience with nuclear reactors for power generation and will naturally have additional comments, concerns and questions about using nuclear technology in their jurisdictions. Meaningful engagement in these western provinces will be particularly important for education and awareness, and public acceptance of SMRs.

Further, the provincial governments look to establish transparent and ongoing discussions with communities, industry, labour organizations and educational institutions in order to build trust and establish meaningful relationships. Each of these groups brings unique perspectives and priorities for the future of the energy sector and role of nuclear.

Public engagement is also essential in ensuring that the SMR workforce continues to be inclusive of women, youth, racialized and Indigenous communities. A number of programs are already in place in Ontario, New Brunswick and Saskatchewan by nuclear sector companies to attract a diversity of future workers and leaders on nuclear projects, with the potential to do so in Alberta when private sector SMR projects are proposed. Working together means that the four provinces

[16] Moltex strengthens MOU with NSMDC, participates in SMR workshop series, June 16, 2021, https://www.moltexenergy.com/moltex-strengthens-mou-with-nsmdc-participates-in-smr-workshop-series/
[17] SaskPower Partners with First Nations Power Authority to Engage on Future of Supply Options to Achieve Net-Zero by 2050, July 28, 2021, https://www.saskpower.com/about-us/media-information/news-releases/2021/saskpower-partners-with-fnpa-to-engage-on-future-supply-options-to-achieve-net-zero-by-2050
[18] Benefits of Nuclear Energy for Canadians, MZConsulting Inc., October 2019, https://cna.ca/wp-content/uploads/2019/11/MZ-Consulting-Benefits-of-Nuclear-Energy-for-Canadians.pdf

can build upon existing relationships, share information and best-practices and collaborate on new initiatives for public engagement.

4. WORKING COOPERATIVELY WITH THE FEDERAL GOVERNMENT

As highlighted in the interprovincial SMR MOU, working cooperatively with the federal government is key to advancing SMR development and deployment.

Natural Resources Canada (NRCan) has been working with provincial, territorial and industry counterparts in order to advance SMRs as a clean energy option in Canada. The Canadian Roadmap for SMRs, led by NRCan, outlined several recommendations for advancing SMR projects within Canada and included a recommendation to develop an SMR Action Plan.

Canada's SMR Action Plan affirms the federal government's support, in principle, for SMR development and deployment. In this respect, the provinces look forward to working with the federal government to identify funding, risk sharing and financing sources for SMR projects.

In October 2020, then-federal Minister of Innovation, Science and Industry voiced support for SMRs, stating, "the Government of Canada supports the use of this innovative technology to help deliver cleaner energy sources and build on Canada's global leadership in SMRs. By helping to bring these small reactors to market, we are supporting significant environmental and economic benefits, including generating energy with reduced emissions, highly skilled job creation and Canadian intellectual property development."[19]

Federal cost-sharing of first-of-a-kind projects would lead to Canadian job creation and enhanced supply chain development, as well as position Canada with an early mover advantage in the SMR export market.

The benefits would not just be at home, as there are significant global opportunities for decarbonization. Building on the positive impact of CANDU reactors, Canada has the opportunity to help other nations access safe clean nuclear power and support global emissions reduction. Today, CANDU technology is currently producing clean electricity in not only Canada, but South Korea, China, India, Argentina, Romania and Pakistan, helping to avoid emissions from fossil fuel generation. SMR development and deployment represents the next generation of Canada's efforts to export clean reliable electricity across the world.

[19] Government of Canada invests in innovative small modular reactor technology, October 15, 2020, https://www.canada.ca/en/innovation-science-economic-development/news/2020/10/government-of-canada-invests-in-innovative-small-modular-reactor-technology.html

Federal government investment in domestic SMR projects would help Canada keep pace with the national governments of all other leading nuclear nations who are already investing billions of dollars to support early deployment of SMRs and secure a share of the global SMR market. The U.S. government has announced an investment of US$3.2 billion over 7 years to support the deployment of multiple SMR technologies through its Advanced Reactor Demonstration Program (ARDP)[20]. The U.K. government has included SMRs in its plan to achieve net zero carbon emissions and recently announced a US$285 million investment to develop and deploy a domestic SMR[21]. France has committed to invest US$1.16 billion to help deploy its first SMR in France by 2030[22].

In June 2020, OPG, Bruce Power, NB Power and SaskPower submitted a proposal to the federal government outlining Canadian opportunities for the development and deployment of SMRs and requesting funding support for the three streams of SMR projects. The MOU signatory provinces collectively supported the proposal, noting the need for federal financial and policy support to advance SMR development deployment within Canada. The utilities reiterated their funding request to the federal government in February 2021.

The federal government has not responded to the utilities' joint proposal and has not communicated how they intend to financially support the deployment of SMRs. While the provinces continue to make progress on all three streams of SMR deployment, it is necessary that the federal government allocate financial support for the SMR project proposals outlined in the SMR Feasibility Study and this Strategic Plan. It is important for all parties to work together to seize the SMR opportunity for Canada.

Former Natural Resources Canada Minister Seamus O'Regan stated "There's no path to net-zero without nuclear power."[23]Since then, the Prime Minister has committed to a net zero electricity system by 2035[24].

Deployment of SMRs is crucial to realizing these targets. For example, in Ontario, the deployment of SMRs would play a key role in further reducing greenhouse gas emissions from the electricity system by displacing natural gas-fired generation that would otherwise be required to maintain system reliability and meet Ontario's electricity needs. To make this possible, the federal

[20] U.S. Department of Energy Announces $160 Million in First Awards under Advanced Reactor Demonstration Program, U.S. Department of Energy, October 13, 2020, https://www.energy.gov/ne/articles/us-department-energy-announces-160-million-first-awards-under-advanced-reactor

[21] Rolls Royce secures funding for SMR deployment, November 8, 2021, https://www.world-nuclear-news.org/Articles/Rolls-Royce-secures-funding-for-SMR-deployment

[22] France to Build Small Modular Reactors by 2030 in Export Push, BNN Bloomberg, October 21, 2021, https://www.bnnbloomberg.ca/france-to-build-small-nuclear-reactors-by-2030-in-export-push-1.1665031

[23] Chris Hall: There's no path to net-zero without nuclear power, says O'Regan, CBC, September 19, 2020, https://www.cbc.ca/radio/thehouse/chris-hall-there-s-no-path-to-net-zero-without-nuclear-power-says-o-regan-1.5730197

[24]PM Trudeau's pledges at COP26, and how they might affect Canadians, CTV News, November 2, 2021, https://www.ctvnews.ca/politics/pm-trudeau-s-pledges-at-cop26-and-how-they-might-affect-canadians-1.5649657

government needs to engage with the provinces and commit to sharing the costs of this transformation.

As SaskPower works to achieve its goal of net-zero greenhouse gas emissions, there is a strong potential for nuclear power from SMRs to play a significant role. Unlike some other provinces, Saskatchewan lacks the resources and geography for wide-spread hydroelectric power generation. While Saskatchewan is blessed with some of the best conditions for wind and solar generation, these options aren't always available, and so reliable and cost-effective baseload options are required to replace our current reliance on fossil fuels and to support the expansion of these intermittent renewable options. For Saskatchewan's electrical grid to reach net-zero greenhouse gas emissions in the next 15-25 years, significant investment is needed to bring options such as nuclear power from SMRs to commercial operation in Canada as soon as possible.

In addition to power generation, SMRs and micro-SMRs have the potential to play a role in achieving industrial decarbonization, particularly for large industrial emitters such as oil extraction and processing, potash and uranium mining, and manufacturing sectors. Saskatchewan is also evaluating the business case of using SMRs for opportunities such as hydrogen production, electricity exports, district heating, co-generation, and advanced research applications.

The provinces call on the federal government to fully commit to nuclear energy and SMRs as a key tool to help Canada meet its emissions reduction targets. In particular, the provinces urge the federal government to allow SMR projects to access all federal funding programs and incentives designed to accelerate the development and deployment of clean energy technologies, including those that are currently limited to renewable energy sources such as wind and solar.

Canada's national nuclear laboratories have a vital role to play in advancing SMRs, with the infrastructure and expertise to continue SMR and nuclear innovation research and development. Additionally, as nuclear waste regulations fall within the responsibility of the federal government, ensuring the continued development of a robust nuclear waste framework is essential to instilling confidence that spent fuel and nuclear byproducts are handled in a safe and responsible manner, and that any fuel recycling follows a cohesive national strategy.

While Canada has a well-developed science and technology capability for CANDU technology across industry, academia and national labs, SMR technologies will require new innovations and research capabilities. As Saskatchewan and Alberta are new to nuclear power, they will require increased science and technology investment, capabilities and resources to generate highly qualified people and relevant research to support their new nuclear industry. It is expected that post-secondary capacity building and investment will be an important baseline component for SMRs in Saskatchewan, with future SMRs in Alberta to potentially follow. Ontario's mature nuclear supply chain companies would also benefit from access to federal funding and investment programs that support re-tooling and re-skilling required to serve the domestic and global SMR market.

In order to make the licensing process more cost effective and streamlined, the CNSC is developing a risk-based and graded approach for its licensing framework. It is equally important for policy makers to apply a similar approach to ensure insurance and liability are affordable for SMR vendors and utilities.

Finally, the provinces call upon the federal government to ensure that other regulatory frameworks, such as impact assessment, support the advancement of SMRs in Canada and recognize their unique features compared to larger traditional nuclear power plants.

5. PROVINCIAL STRATEGIES FOR SMR DEPLOYMENT

5.1. Actions to Enable Provincial Decision-Making

In order to support provincial decision-making, further work is required by the utilities to advance and finalize their project proposals, including:

- Completing detailed design, planning, preparation and licensing with SMR technology developers to meet targeted deployment timelines;
- Refining project costs and schedule estimates of the selected SMR technologies;
- Confirming the economic opportunities the selected technologies would provide for Canadian suppliers;
- Engaging with the federal government on funding and other supports;
- Advancing public awareness and engagement; and
- Advancing Indigenous consultation and partnerships.

Provincial decision-making on SMR project proposals will require careful consideration of project risks versus benefits. Proposals will only proceed where certain benefits can be demonstrated. These include:

- **Expected benefits for electricity systems and ratepayers:** evaluating the impact of SMRs on electricity system reliability, transmission system requirements and electricity rates;

- **Emissions reductions**: evaluating SMRs as a cost-effective source of emission reductions compared to other energy sources, while taking into consideration each province's different mix of energy sources for electricity generation and related greenhouse gas emissions;

- **Enhanced economic activity**: assessing GDP and job creation from SMR deployment within respective provinces and across Canada, including undertaking any additional economic assessments that may be required and building on work that was started as part of the SMR Feasibility Study. This includes establishing the potential of the selected technology to provide benefits for Canadian companies in the nuclear and non-nuclear supply chains (including potential for fuel fabrication);

- **Potential for Indigenous partnerships:** creating opportunities for Indigenous communities to participate in SMR projects. These opportunities could include employment, skills development, investments, supplier arrangements and other mechanisms to share in project benefits;

- **Potential for innovation and enhancing research capabilities:** alignment of existing and future federal and provincial nuclear research to ensure capacity to support SMR development and deployment in Canada in the most effective and efficient way possible;

- **Potential for global export**: an uptake of SMRs will mean opportunities for Canada and certain provinces to increase uranium exports (Saskatchewan and potentially Alberta); advanced nuclear fuel fabrication opportunities (Ontario, Saskatchewan and potentially Alberta); provide leadership in nuclear research, development and innovation for manufacturing and export of SMRs; lead fleet deployment of grid connected SMRs; and lead the deployment of micro-SMRs for remote communities; and

- **Export of carbon-free electricity**: The MOU signatory provinces are well positioned geographically and have existing infrastructure to benefit from the potential for export of clean electricity to nearby provincial and U.S. markets.

SMR project proponents should demonstrate that strategies are in place to manage key projects risks, which can significantly impact cost and schedule (e.g., SMR design completion, licensing risks, fuel qualification and availability). Project proponents and provincial/federal governments will collaborate to identify early indications of public acceptance and build relationships with Indigenous communities, which are also important to the successful execution of SMR projects.

In Saskatchewan, the provincial government will need to make the decision to include nuclear as a new source of energy for electricity generation, as well as a decision on whether, how and when to take advantage of the economic growth opportunities SMRs and micro-SMRs can bring to the province. The government will develop a comprehensive business case assessing costs and benefits of nuclear power compared with alternative zero-emissions baseload generation options available in the early 2030s, as well as an economic impact analysis that evaluates the impact of

SMRs on nuclear and non-nuclear supply chains, opportunities related to SMR manufacturing and uranium value add activities, innovation, research and development, and electricity export potential.

Given it would be the private sector in Alberta that would need to pursue SMRs in a competitive marketplace, either for electricity generation or industrial applications, decision making in Alberta will be fundamentally different – with the private sector ultimately making the decision whether to invest in SMRs after weighing the relative merits. However, Alberta's close engagement with New Brunswick, Ontario and Saskatchewan will be invaluable in furthering Alberta's understanding of the technology and ability to provide relevant information to interested stakeholders.

5.2. Actions to Follow a Provincial Decision to Proceed

Ontario, New Brunswick and Saskatchewan

When provincial governments decide to proceed with an SMR project, there will be a need to establish policy and regulatory frameworks to support cost recovery, project oversight and readiness of the nuclear supply chain to ensure successful execution.

With previous experience in developing nuclear projects, the Ontario and New Brunswick governments will be well-positioned to share information and guidance with the Saskatchewan and Alberta governments on policy development and regulatory frameworks related to nuclear topics, such as project economics and oversight, supply chain support, and public and Indigenous engagement.

Alberta

With all electricity generation and industrial facilities in the province being private investments within a competitive market, many of the policy tools listed for the other provinces would not be applicable to Alberta. Engagement with the other provinces will better position Alberta to tailor an approach more compatible with a competitive market where government does not endorse one project over another as a matter of policy.

The initial focus for Alberta is the need to establish policy and clarity on regulatory frameworks prior to any decision by the private sector to invest in an SMR. No private developer will pursue an SMR investment as long as it is unclear how the federal regulatory responsibility for nuclear reactors will interact with areas of provincial regulatory responsibility, particularly in instances where a federally regulated SMR is to be part of an otherwise provincially regulated facility. Alberta's immediate plans for this work is outlined in more detail in the appendix.

All Signatory Provinces

Provincial policy tools that could support cost recovery for SMR projects while encouraging private investment could include:

- Power Purchase Agreement (PPA);
- Electricity rate regulation (i.e., rate-regulated asset);
- Provincial government funding; and
- Working collaboratively with the federal government and power utilities on additional tools to support first-of-a-kind SMR development costs and support other regional opportunities (e.g., transmission grid extensions, clean energy grants for fossil fuel phase out).

In November 2021, the Ontario government made a regulatory amendment to rate-regulate the Darlington SMR project under the oversight of Ontario's independent energy regulator, the Ontario Energy Board (OEB)[25]. This allows OPG to recover prudently incurred costs from electricity ratepayers for the development, construction and operation of the project.

In addition, provincial governments can work with power companies to implement appropriate oversight mechanisms to ensure that SMR projects are carried out in alignment with government policy priorities and include robust financial assurances and management systems to complete the projects within approved budgets and schedules.

Provincial policy tools could further support SMR development and deployment through:

- The areas listed in 5.1 where government policy and regulations are required (e.g., fuel fabrication, research and development grants, strategic partnerships and collaborations with SMR technology developers and/or federal research and development organizations, education and skills training);
- Exploring micro-SMRs for independent electricity or heat generation opportunities in future mines or for hydrogen production; and
- Enabling Indigenous partnerships at the forefront of SMR development and deployment.

A critical success factor for the deployment of SMRs in Canada is a strong domestic supply chain. This includes Canadian small and medium-sized nuclear suppliers, uranium mining and world-leading nuclear research. The flexibility and experience of these suppliers will be valuable to SMR

[25] O. Reg. 739/21: PAYMENTS UNDER SECTION 78.1 OF THE ACT, November 5, 2021, https://www.ontario.ca/laws/regulation/r21739

deployment and complement the capabilities of Canada's manufacturing and engineering companies. The provinces will work together with power utilities and selected SMR technology developers to engage suppliers and leverage skilled workforces to ensure readiness to support SMR projects.

The provinces will also work together and collectively engage with the federal government to ensure readiness of the nuclear supply chain to support SMR deployment, with a focus on:

- Availability of skilled labour and supply chain capacity;
- Enhanced innovation capabilities including leveraging laboratories, research centres and educational institutions; and
- Development of innovative advanced manufacturing techniques to reduce SMR costs.

Universities and research centres will play a role in this interprovincial strategy. They are already leading the way on SMR research. From technical studies and materials testing to understanding the social aspects of new nuclear, the academic community is training the next generation of nuclear workers and leaders. In order to harness these efforts, provincial governments can focus on convening the academic and research communities with a goal to coordinating initiatives, fostering collaboration and collectively engaging with the public.

Economic development as a result of SMR deployment is one of the key provincial interests. The provinces are interested in the longer-term opportunities to export SMR-related Canadian products, services and expertise around the world. As such, the provinces will consider how to collaborate with the federal government to pursue international markets for SMRs, including nuclear cooperation agreements (where necessary) and export development support for Canadian companies.

In Ontario, OPG estimates that 70 to 80 per cent or more of the necessary components and materials for its proposed SMR at the Darlington site will be sourced in Ontario, thanks to the strong existing Ontario and Canada-based nuclear supply chain.[26]

In New Brunswick, initial assessments by ARC Clean Energy and Moltex Energy suggest a significant portion of their supply chain could be obtained by sources within the province. Specifically, 50 per cent of reactor components can be manufactured in New Brunswick, with that number increasing to over 75 per cent if investment is made in capability development[27]. Work to date includes the initial supply chain needs and economic impact assessments and individual engagement with potential local supply chain firms. Much of the supply chain work is expected to be done in collaboration with Canadian Manufactures and Exporters (CFM) as well as Opportunities New Brunswick (ONB).

[26] https://www.opg.com/media_releases/opg-advances-clean-energy-generation-project/
[27] Reactivating the Underutilized New Brunswick Supply Chain, accessed November 23, 2021, https://cme-mec.ca/wp-content/uploads/2020/12/CME-ARC-Canada-SC-Event-24112020.pdf

In conjunction with selection of an SMR technology, Saskatchewan will commence supply chain research to confirm what portions of the nuclear and non-nuclear supply chains can be sourced in Saskatchewan for the units that could be deployed in Saskatchewan. While the uranium can be sourced from Saskatchewan, this research may also look into opportunities for fuel fabrication and Indigenous participation opportunities throughout the supply chain.

6. NEXT STEPS

As the world transitions to a low carbon economy, SMRs are uniquely positioned to support decarbonization of energy use, including from heavy emitting industrial facilities and processes, transportation and buildings. SMRs can replace fossil fuels while simultaneously supporting the expansion of renewable energy. Beyond power production, SMRs have the potential to provide district heating, desalination and emissions-free high quality steam and hydrogen to reduce emissions from industrial processes. SMRs are also an exciting opportunity for Canada to be a world leader in nuclear innovation, clean energy and to capitalize on emerging world-wide markets for SMRs.

Canada has a world-class nuclear industry and supply chain that could support emerging SMRs, creating highly skilled jobs, new partnerships including those with Indigenous communities, and new opportunities to export Canadian knowledge and expertise around the world. As the next-generation of nuclear technology, SMRs are supported by cutting-edge nuclear research and innovation across Canada's universities and research centres. SMRs are a unique opportunity to expand Canada's research and innovation capabilities.

Since December 2019, the MOU signatory provinces have been working collaboratively to advance SMR development and deployment. This Strategic Plan – the final deliverable of the interprovincial SMR MOU – represents a step in our journey towards making SMRs a reality in Canada.

Ontario, New Brunswick, Saskatchewan and Alberta are working together to leverage each province's experiences and expertise to advance SMR development and deployment in Canada. Together, the four provinces have outlined several actions required to enable provincial decision-making on whether or not to move forward with specific SMR projects, and the actions required if a decision to proceed is made.

The MOU signatory provinces will continue to engage and are interested in hearing the diverse perspectives and priorities of Indigenous communities, the public, research and academia, and the nuclear industry, on the role of nuclear energy and SMRs in Canada's clean energy future.

Our combined interests in SMRs – emission reductions, regional energy demands, economic development, and research and innovation – brought Ontario, New Brunswick, Saskatchewan and Alberta together. It is by working together, including with the federal government, and our partners and stakeholders, that we may realize the potential of SMRs for current and future generations of Canadians.

7. APPENDICES

7.1 Interprovincial SMR Memorandum of Understanding (MOU)

1. To work co-operatively to advance the development and deployment of SMRs to address the needs of New Brunswick, Ontario, Saskatchewan and Alberta with regards to addressing climate change, regional energy demand, economic development, and research and innovation opportunities;

2. To work co-operatively to address key issues for SMR deployment including technological readiness, regulatory frameworks, economics and financing, nuclear waste management, and public and Indigenous engagement;

3. To work co-operatively to positively influence the Federal government to provide a clear unambiguous statement that nuclear energy is a clean technology and is required as part of the climate change solution;

4. To work co-operatively to positively influence the Federal government to provide support for SMRs identified in the Canadian SMR Roadmap and as requested by the CEOs of Ontario Power Generation (OPG), Bruce Power, New Brunswick Power Corporation (NB Power) and SaskPower;

5. To work co-operatively to positively influence the Federal government to make changes as necessary to facilitate the introduction of SMRs;

6. To work co-operatively to inform the public about the economic and environmental benefits of nuclear energy and SMRs; and

7. To work co-operatively to engage with other interested provinces and territories to explore the potential for SMR deployment in their jurisdictions.

Additionally, the MOU outlines three key deliverables for the provinces' energy ministers:

1. Hold a meeting in the January-March 2020 timeframe ("Winter Meeting") to discuss strategies that will best advance the development and deployment of SMRs, including engagement with the nuclear regulator, nuclear operators, supply chain companies, academic and research experts, technology vendors and the Federal government;

2. Informed by the Winter Meeting and in cooperation with the respective CEOs of OPG, Bruce Power, NB Power and SaskPower, prepare a feasibility report, including a business case for the development and deployment of SMRs in their jurisdictions; and

3. Develop a strategic plan for deployment of SMRs, including market opportunities across Canada and globally, based on the outcomes of the Winter Meeting, and report back to their respective Premiers on next steps.

7.2. Ontario – Taking the next steps on nuclear innovation

Overview of Nuclear Energy in Ontario

Ontario has been at the heart of Canada's nuclear industry for over 75 years, starting with the country's first nuclear laboratories established in 1944 in Chalk River.

Ontario is the birthplace of Canada's own reactor technology – the CANadian Deuterium Uranium (CANDU) reactor. In 1962, the first ever CANDU prototype reactor went into service in Rolphton, Ontario. Today, there are 18 operational CANDU reactor units in Ontario spread across three sites (i.e., Darlington, Pickering and Bruce) for a combined capacity of about 13,000 megawatts.

Ontario is home to majority of Canada's nuclear industry which now includes more than 200 companies, contributes about $17 billion to Canada's GDP and supports around 76,000 jobs, mostly in communities in Ontario. Ontario's nuclear technology and services are exported globally.

Nuclear energy is the backbone of Ontario's clean energy system. Nuclear generation is reliable, cost-effective, greenhouse gas emission-free and currently provides about 60% of Ontario's annual energy needs. Nuclear is expected to remain the single largest source of generation in Ontario over the long term.

Ontario's current nuclear reactors are designed to provide electricity generation for about 25 to 30 years. Ontario is moving forward with a $26 billion program to refurbish ten nuclear units at Darlington (four units) and Bruce (six units) which will secure a long-term supply of reliable and cost-effective baseload power for decades to come. All ten units are planned to be refurbished by 2033.

The Pickering nuclear station, Ontario's first commercial nuclear power plant, is not planned to undergo refurbishment and will be shut down and decommissioned at the end of its safe operating life.

The CNSC has presently authorized OPG to operate Pickering until 2024, followed by activities to prepare the station for decommissioning. In August 2020, Ontario announced its approval for OPG to proceed with plans to operate Pickering units 1 and 4 to 2024 and Pickering units 5 to 8 to 2025, subject to approval by the CNSC. Operating Pickering until 2025 will provide a reliable and cost-effective source of power while Darlington and initial Bruce units are undergoing refurbishment.

Key Accomplishments

Ontario's nuclear power plants have operated for 50 years with an excellent safety record because of the high priority set for nuclear safety and security by both Ontario's nuclear operators and federal and provincial governments. Despite the challenges of the unprecedented

COVID-19 pandemic, Ontario's nuclear power plants have continued normal operations, thanks to the proactive measures put in place by the nuclear operators – OPG and Bruce Power.

In 2020, the CNSC once again confirmed that all of Ontario's nuclear power plants continued to operate safely and in accordance with CNSC expectations. Recent international reviews conducted by the International Atomic Energy Agency (IAEA), the World Association of Nuclear Operators (WANO) and Institute of Nuclear Power Operations (INPO) have also concluded that our nuclear power plants are operating safely and are among the top performing nuclear stations in the world.

On September 15, 2020, Darlington Unit 1 surpassed the previous world record for continuous operation of a nuclear reactor, at 963 consecutive days. The unit went on to set a new world record at 1,106 days of continuous operation before being taken offline for a planned maintenance outage on February 5, 2021.

Ontario's nuclear refurbishment program remains on track as well, despite the COVID-19 pandemic.

In June 2020, OPG successfully completed the first Darlington refurbishment (i.e., Unit 2), on budget, in the midst of the first wave of the pandemic. In September 2020, OPG commenced the second Darlington refurbishment – Unit 3 – after putting in place mitigation measures to address COVID-19. Unit 3 refurbishment remains on track to be completed within budget and on schedule. OPG has incorporated more than 4,000 lessons learned from Unit 2 refurbishment into the planning and execution of Unit 3 and subsequent unit refurbishments to ensure continued project success. Overall, the $12.8 billion project is on track to be completed on budget by 2026.

Bruce Power is currently proceeding with the first of six Bruce refurbishments – Unit 6 – which are part of a $13 billion life-extension program. Unit 6 refurbishment commenced in January 2020 and remains on track to be completed within budget and on schedule despite the challenges of the COVID-19 pandemic, thanks to the proactive efforts of Bruce Power and its refurbishment partners. Bruce Power and OPG are also collaborating extensively and sharing lessons learned in order to ensure that their refurbishment projects remain on time and on budget.

Ontario's refurbishment program is playing a key role in supporting Ontario's post-COVID economic recovery. Darlington refurbishment is expected to contribute $90 billion to Ontario's GDP and increase employment by an average of 14,200 jobs annually across the province. Bruce refurbishment is expected to increase employment by up to 22,000 jobs annually and generate up to $4 billion in annual economic benefits in communities throughout the province.

In April 2020, Bruce Power launched the Re-tooling and Economic Recovery Council with its supply chain partners, to develop strategies for contributing to Ontario's economic recovery from the COVID-19 pandemic by leveraging its refurbishment program, medical isotopes and other innovation initiatives.

Bruce Power also carries out innovation initiatives through the Ontario Nuclear Innovation Institute's Bruce Power Centre for Next Generation Nuclear Technology. Jointly established by Bruce Power and Cameco Corporation in August 2020, the Centre focuses on next generation nuclear technologies by advancing the existing expertise of suppliers, regulators and operators to support future economic, environmental and export opportunities for Ontario, Saskatchewan and beyond. Innovations in nuclear energy will help support new technologies like SMRs, cancer-fighting isotopes and hydrogen development by using infrastructure investments that drive the economy now and power the world of the future.

In July 2020, OPG launched a Decommissioning Centre of Excellence in Pickering, known as the Centre for Canadian Nuclear Sustainability (CCNS). CCNS is bringing together organizations and industry partners in Canada and from across the world to explore innovation in nuclear decommissioning by leveraging Ontario's industrial know-how and its skilled trades. CCNS will play a key role in supporting OPG as it proceeds with its planning and preparation for the decommissioning of Pickering station after it is shut down.

Leadership in Medical Isotopes

In addition to the role of nuclear in providing 60 per cent of the electricity that Ontarians rely on every day, Ontario is proud of its role in producing life-saving medical isotopes. Ontario's nuclear reactors transform chemical elements, such as cobalt, into isotopes that can diagnose and treat life-threatening diseases. These isotopes can also sterilize medical equipment such as hospital gowns, gloves, masks, implantable devices and syringes, as well as some food products.

Since the 1940s, Canada and Ontario have been global leaders in producing essential medical isotopes, used every day to save lives. In fact, Saskatchewan, Ontario and Natural Resources Canada (NRCan) collaborated together to perform the world's first cancer treatments with radiation (in London, Ontario on October 27, 1951; and in Saskatoon, Saskatchewan on November 8, 1951), marking an important milestone for the fight against cancer. Further, Cobalt-60, used for cancer radiation and medical device sterilization was originally produced in the National Research Experimental (NRX) reactor at Chalk River Laboratories in Ontario.

For over six-decades, High Specific Activity (HSA) Cobalt-60 was produced in the National Research Universal (NRU) reactor in Chalk River, Ontario, supplying a majority of the world's demand of this vital medical isotope. HSA Cobalt-60 is used in 10 million cancer therapy treatments each year and to sterilize more than 40 per cent of all single-use medical devices produced around the world. Until the reactors end of life in 2018, the NRU produced Cobalt-60 along with Molybdenum-99, Iodine-131, Iodine-125, Xenon-133, and Iridium-192 – all essential isotopes used in variety of applications including medical device sterilization, diagnostic imaging, cancer treatment, insect sterilization, food irradiation, and research and development.

When the NRU reached its end of life in 2018, Ontario's nuclear operators stepped up to ensure that Canada remains a world leader in medical isotope production. In 2018, Bruce Power and

Nordion entered into an agreement to secure the long-term supply of Cobalt-60, including HSA Cobalt-60 through to 2064. Currently 70 per cent of the world's Cobalt-60 is produced in Ontario's nuclear power reactors. Additional medical isotopes are currently produced in Ontario by Bruce Power, OPG, and at McMaster University.

Ontario's World-Class Nuclear Supply Chain and Research Centres

Ontario has been committed to nuclear energy and the success of our world-class nuclear industry for over 75 years. Ontario's decision to deploy nuclear power as part of its electricity supply mix in partnership with the federal government was instrumental in the establishment of Ontario's nuclear supply chain. Today, our robust domestic supply chain consists of more than 200 companies and is made up of a diverse mix of small, medium and large enterprises. The nuclear supply chain companies are involved in fuel production, engineering and design, manufacturing, services, operations and maintenance, decommissioning and waste management. Ontario's nuclear supply chain provides services for nuclear power stations within Canada and around the world.

Ontario has made investments and long-term commitments to nuclear power. The refurbishments at Darlington and Bruce Nuclear Generating Stations have enabled the nuclear supply chain to retool, expand it capabilities, and advance innovation.

The vitality and innovation of Ontario's nuclear supply chain was demonstrated during the COVID-19 pandemic response. Several of Ontario's nuclear supply chain companies retooled and repurposed their manufacturing capabilities to produce medical devices and other equipment such as ventilator components and face shields.

Ontario's nuclear supply chain is well positioned to support SMR development and deployment. In fact, the flexibility, experience, and knowledge that our supply chain possesses will be essential to Ontario and Canada's successful development and deployment of SMRs.

Our universities and research centres are also essential to successful development and deployment of SMRs. With decades of experience in nuclear education and research, Ontario's institutions are making essential contributions to the advancement of SMR technology. Our academic community is actively engaged in a broad range of SMR research and initiatives. For instance, Ontario's academic community is:

- Preparing our future SMR workforce by developing education streams and training programs focused on SMRs and conducting fundamental research that advances our understanding of SMR principles;

- Establishing virtual and simulation SMR testing facilities and test loops;

- Looking beyond the technical aspects of SMRs to understand economic viability and social acceptance issues;

- Developing relationships and partnerships with government, SMR technology developers, utilities and regulators to ensure that research activities and programs align with the future needs of the industry; and

- Engaging with the public and Indigenous communities to grow awareness and support for the role SMRs could play in climate change and sustainability.

The nuclear industry in Ontario has a proud history of promoting and enhancing skilled trades and economic development for local communities. Ontario's nuclear operators, OPG and Bruce Power, are working together under a collaboration agreement to coordinate their approaches to skilled trades planning and training. Together, they have several initiatives aimed at ensuring the continued availability of skilled trades and enhancing opportunities for Indigenous communities. For instance, OPG's Indigenous Opportunities in Nuclear program seeks to recruit qualified workers from Indigenous communities to work within the nuclear sector. While Bruce Power's Skilled Trades and Training Secretariat aims to maximize training programs and capitalize on local assets to increase the supply of skilled trades locally.

Further, the aforementioned Ontario Nuclear Innovation Institute was established by Bruce Power and the County of Bruce in order to bring together technological leaders to share collective expertise and knowledge, while identifying opportunities to advance nuclear applications and technologies, as well as people skills through training.

Ontario's nuclear supply chain, represented by the Organization of Canadian Nuclear Industries is also working to promote and enhance skilled trades, economic development and opportunities for Indigenous communities. For instance:

- The Skilled Trades Employment Pathway (STEP) is an outreach, talent acquisition, and industry educational training program with a target audience of underemployed groups within the ages of 15-30 in the Durham Region; and

- The First Nation, Metis, Inuit (FNMI) Engagement Action Plan focuses on education and employment opportunities for Indigenous youth in Ontario's nuclear sector.

Ontario is Leading the Way on SMR Development

The Ontario government recognized the potential of SMRs at a very early stage and as such, has been monitoring developments in the SMR market for several years and exploring the potential benefits for Ontario.

In 2016, the Ontario government released a feasibility study on SMRs for deployment at remote mines in Ontario, recognizing their potential to replace diesel power. The report concluded that SMR technologies are feasible for remote mining applications in Ontario and could provide lower energy costs and emissions compared to diesel power.

In 2018, the Ontario government participated in the development of a Canadian Roadmap for Small Modular Reactors alongside the federal government, interested provinces and territories, and utilities. Ontario participated as a member of the SMR Roadmap Steering Committee and in the SMR Roadmap Working Groups (i.e., Public and Indigenous Engagement, Technology, Economics and Finance, Waste, and Regulatory Readiness).

In 2020, the Ontario government was eager to contribute to Canada's SMR Action Plan, which follows up on the recommendations outlined in the Canadian Roadmap for SMRs. The Ontario government contributed a chapter to the SMR Action Plan, highlighting our ongoing commitment to SMR development and deployment, as well as the tangible actions we are taking to address the recommendations outlined in the Canadian Roadmap for SMRs.

SMR Project Proposals in Ontario – Darlington and Chalk River

OPG is currently undergoing detailed planning and preparation work with GE-Hitachi to enable a final government decision on the Darlington SMR project by the end of 2024. During the 2022-2024 period OPG is expected to undertake several key planning and preparation activities such as:

- Negotiating contracts with the technology developer and key project suppliers;
- Submitting a Construction Licence application to the CNSC;
- Continuing to refine the project budget and schedule; and
- Seeking government approval to proceed to construction following receipt of Construction Licence from the CNSC.

Key considerations for Ontario government decision-making on the project include ratepayer cost and benefits, greenhouse gas emissions reduction, job creation, economic growth as well as maximizing opportunities for Ontario's nuclear supply chain and 'made-in-Ontario' innovation through pan-Canadian collaboration.

In November 2021, the Ontario government made a regulatory amendment to rate-regulate the Darlington SMR project under the oversight of Ontario's independent energy regulator, the Ontario Energy Board. This allows OPG to recover prudently incurred costs for the development, construction, and operation of the project.

Additionally, government decision-making will consider OPG's ability to deliver the project on time and on budget as well as measures in place, including government oversight, to minimize and mitigate risks for Ontario and its ratepayers.

As the ministry responsible for Ontario's energy policy and the representative of OPG's sole shareholder (the Ontario government), the Ministry of Energy will be responsible for coordinating government decision-making and approvals for the Darlington SMR project.

OPG is also partnering with Ultra Safe Nuclear Corporation (USNC) under the Global First Power (GFP) joint venture to develop and deploy an off-grid micro-SMR technology demonstration project by 2026. GFP is engaging with Canadian Nuclear Laboratories (CNL) to site the project at Atomic Energy of Canada Limited's (AECL) federally-owned Chalk River Laboratories in Ontario, operated by CNL.

The proposed GFP project includes a nuclear plant that would utilize USNC's Micro Modular Reactor™ technology and provide approximately 15 MW of thermal energy to an adjacent plant for conversion to electrical energy and/or heat for local use. GFP would be the facility's operator.

In 2019, GFP filed an application for a Site Preparation Licence from the Canadian Nuclear Safety Commission and an environmental assessment commenced for the demonstration project. In November 2020, GFP announced that it had signed a Project Host Agreement with CNL. The agreement put in place a framework for cooperation between GFP and CNL with respect to licensing, design, siting and other matters required to advance the project at the Chalk River Laboratories site.

As the GFP project is not intended to serve Ontario's electricity grid, the Ministry of Energy will focus on providing shareholder oversight and approvals, as required, concerning OPG's ongoing participation in the project.

Bruce Power is also supporting the advancement of a micro reactor technology to provide 5 MW of electrical energy for off-grid application at mines and in remote communities. In October 2020, Bruce Power entered into an agreement with Westinghouse Electric Company to pursue applications of Westinghouse's eVinci™ micro reactor within Canada. Together, Bruce Power and Westinghouse are investigating the feasibility of deploying the eVinci™ micro reactor to industrial, remote community and other commercial applications.

7.3. New Brunswick – Leading the Development of New Generation Technology

Nuclear Energy Generation in New Brunswick – Forty Years of Safe/Reliable Operations

Nuclear energy has been a fundamental part of New Brunswick's energy mix for almost four decades and New Brunswick has a history of being a Canadian leader in nuclear energy beginning with the construction of the Point Lepreau Nuclear Generating Station (PLNGS). The construction of PLNGS was completed in 1981, licensed to operate in 1982 and fully operational in 1983.

PLNGS is a 705 MW(electrical) nuclear facility and was the first CANDU-6 reactor to be in operation. It provides non-emitting baseload energy to the electrical grid powering more than 333,000 homes per year. Currently, nuclear energy supplies approximately 36 per cent of the energy consumed in the province and results in a reduction of 4 Mt of Greenhouse Gases (GHG) annually.

New Brunswick is one of only two provinces in Canada with nuclear power operations.

Point Lepreau Key Accomplishments

PLNGS completed its refurbishment to extend the life of the facility for at least another 25 to 30 years and was reconnected to the grid in October of 2012. PLNGS recently completed its scheduled maintenance in November 2021, after 417 consecutive days of being online, the longest streak of continued operation since 1994.

PLNGS is a valuable contributor to the economy, providing more than 2,700 direct and indirect jobs, $287 million in provincial GDP, and $29 million in provincial revenue. Eighty- five per cent of spending by PLNGS occurs within New Brunswick.

In 2020, 80 per cent of in-province electricity came from non-emitting energy sources including wind, hydro, solar and nuclear. This has resulted in the total reduction of over 6 Mt of GHG emissions.

In the 2021 National Inventory Report released by the Federal Government, New Brunswick **"Leads Canada**" in emissions reductions since 2005 with a reduction of 38 per cent, while NB Power has reduced emissions in the electricity sector by 64 per cent since 2005.

Creating a Next Generation SMR Innovation Hub

New Brunswick has long understood the important role that nuclear energy contributes as part of achieving Net Zero and recognizes the role Small Modular Reactors (SMRs), can play as well within the province and potentially beyond.

New Brunswick has a distinct advantage to many other locations for developers of SMRs as the Point Lepreau site was originally designed for multiple units and thus, this well characterized site has ample room for additional nuclear capacity in a region in which the benefits from nuclear power are well understood and accepted.

In 2018, the Government of New Brunswick announced $10 million in funding to promote nuclear innovation in the province. In conjunction with that, agreements were reached with two vendors after an extensive selection process.

MOUs were signed with ARC Clean Energy and Moltex Energy to build first-of-a-kind Generation IV reactors at the PLNGS site. Both vendors provided financial commitments, have opened offices in Saint John, and now have in-province teams assembled and actively working on the designs and the approval process.

In February 2021, the Government of New Brunswick announced an additional $20 million in funding to ARC Clean Energy that will be matched with $30 million in private investment. To further accent the importance of this work, in March 2021, the Federal Government announced $50.5 million in funding for Moltex Energy through the Strategic Innovation Fund (SIF) and Atlantic Canada Opportunities Agency (ACOA), and again these funds will also be matched by private investment.

In addition, ACOA has also provided $5 million in funding to NB Power to prepare the site at the PLNGS for SMRs, and $561,750 to the University of New Brunswick's Centre for Nuclear Energy Research to expand its capacity to support SMR technology.

New Brunswick has also participated in the national SMR Roadmap, which led to the SMR Action Plan, to which the Province submitted input from key organizations like NB Power, ARC Clean Energy, Moltex Energy, University of New Brunswick's Centre for Nuclear Energy Research, Atlantica Centre for Energy, Atlantic Clean Energy Alliance, Saint John Citizen's Coalition for Clean Air and North Shore Micmac District Council (NSMDC).

ARC Clean Energy is developing an advanced Generation IV SMR, the ARC-100, a 100 MW liquid sodium cooled fast reactor which it expects to have completed and operational by 2029. The reactor is unique to most designs globally as it is based on the proven technology of the EBR-II fast-reactor at Argonne National Laboratory in Lemont, Illinois, which ran successfully for 30 years. This successful operation included demonstrating the reactors' inherent safety systems by shutting down without any human intervention after coolant flow was purposely stopped and back-up safety mechanisms were disabled. EBR-II also demonstrated its ability to successfully recycle its own used fuel.

Moltex Energy is developing a 300 MW Stable Salt Reactor-Wasteburner (SSR-W). Moltex Energy is also developing in parallel their 'WAste To Stable Salt' (WATSS) technology to recycle used CANDU fuel. This technology will allow Moltex Energy to recycle the used fuel at PLNGS and use it to fuel their reactors, lowering the overall inventory of nuclear waste that will need long-term

storage. Ontario Power Generation has also provided $1 million in funding to help demonstrate the viability of Moltex's WATSS technology.

Initial assessments by both vendors suggest a significant portion of their supply chain could be obtained by New Brunswick sources, specifically 50 per cent of the reactor components can be manufactured in New Brunswick, with that number increasing to over 75 per cent if investments are made in capability development. Work to date includes reviewing the initial supply chain needs, economic impact assessments, engagement with First Nations and engagement with potential local supply chain providers.

The Department of Natural Resources and Energy Development (DNRED) and NB Power have set goals for both ARC and Moltex to be in operation and plans have been developed to meet these targets.

ARC is targeting to be fully operational at the Point Lepreau site in 2029, and Moltex will have both its spent fuel recovery system and reactor in operation by the early 2030s, also at the Point Lepreau site.

NB Power and DNRED have been working closely with ARC Clean Energy and Moltex Energy as they progress through the Pre-Licensing Vendor Design Review (VDR) process. Both have successfully completed the first phase of the VDR process, ARC has begun Phase 2 and Moltex is preparing to begin Phase 2. A Project Oversight Committee has been established to ensure that key milestones are being met and that the operational units are on track to be deployed at the PLNGS site by the target dates.

The Province has also just provided additional rigour to the SMR file appointing a Nuclear Secretariat in January 2022 and dedicating additional resources to the SMR file, to ensure coordination and acceleration of this critical activity.

The SMR work and investment has also led to the start of new activity at University of New Brunswick's (UNB) Centre for Nuclear Energy Research (CNER). The initial investment provided funding to UNB which has allowed UNB to progress on R&D activities to support the vendors and progress regulatory and licensing requirements necessary to perform work with uranium on-site. It has also allowed UNB to design, construct and operate new equipment at both CNER labs and complementary lab space in the Head Hall Engineering Complex. UNB has also formed a working partnership with CNL. The partnership with the vendors has also led to benefits for the Engineering Department at UNB. This includes the hiring of a new chair in Chemical Engineering, as well as multiple Masters and PhD students working on various research projects on SMRs. Curriculum within the UNB Engineering Department has also been revitalized with a Nuclear option in Chemical Engineering launched in the Fall of 2019, with the first program graduates in May 2021.

In 2016, New Brunswick implemented the Climate Change Action Plan which seeks to further reduce carbon emissions. The Province has set bold emission reduction targets and understands

the critical role nuclear energy and SMRs must play in meeting those targets. Renewables alone are not enough to meet future clean electricity demand. SMRs will help New Brunswick meet its GHG targets by providing clean energy and while the Province continues to expand and support the development of renewables. SMRs can also play a role in reducing the output of the coal-fired Belledune Generating Station (BGS) to meet equivalency targets and potentially replace the electrical generation of BGS at its end of life.

New Brunswick – A Firm Path Forward

The Government of New Brunswick, NB Power, ARC Clean Energy and Moltex Energy continue to work cooperatively to accelerate the activities in New Brunswick. Continuing to drive engagement by formally building the SMR cluster, looking for opportunities to expand the SMR eco-system beyond New Brunswick and ensuring the supply chain is ready for nuclear are key priorities in addition to proving and deploying the technology.

As it relates to the technology specifically:

With respect to the ARC-100 Sodium Fast reactor deployment:

- NB Power will continue the engagement activities with First Nations and the public;
- ARC Clean Energy is pursuing discussions to line up the fuel supply and manufacturing contracts;
- NB Power and ARC Clean Energy will continue to work with NWMO and other organizations to establish the plan for long term management of ARC Clean Energy radioactive waste;
- ARC Clean Energy will complete the Preliminary design and CNSC Vendor Design Review Phase 2;
- NB Power and the provincial government will continue to work with industry partners and other provinces to obtain the remaining Federal funding;
- ARC Clean Energy and NB Power with the support of the provincial government will complete discussions with private investors to form a consortium that will allow for the completion of the design and establish the operating company;
- NB Power will apply for the licence to prepare the site and begin the Environmental Assessment;
- In parallel with progressing with the formal licensing, construction, and training of operating staff, NB Power and ARC Clean Energy will discuss the formation of central fleet services and enter into discussions with various jurisdictions for future ARC Clean Energy units elsewhere in NB, Canada and for export;
- NB Power and ARC Clean Energy will explore the opportunity for ARC fuel recycling; and
- ARC Clean Energy and NB Power continue to explore the opportunity for industrial and off grid applications with the technology being well suited for use in processes for the production of hydrogen, ammonia and synthetic clean fuels.
- New Brunswick Power and ARC Clean Energy have completed a market study of the application of its technology in Alberta, where a significant use of energy is currently consumed in industrial processes in that province, resulting in significant GHG emissions. The

report concluded that the ARC Clean Energy technology produces steam at a high temperature and pressure which make it an ideal solution for industry in the oil sands where a fleet of these units could be deployed resulting in significant benefit.

In parallel, with respect to the Moltex Energy SSR-W and WATSS deployment:

- NB Power will to continue the engagement activities with First Nations and the public;
- Moltex Energy will complete the SSR-W preliminary design and CNSC Vendor Design Review Phase 2;
- NB Power and Moltex Energy will engage in initial discussions with IAEA on safeguards;
- NB Power and Moltex Energy will continue to work with NWMO and other organizations to establish the plan for long term management of Moltex radioactive wastes;
- Moltex Energy will complete the WATSS preliminary design and R&D. NB Power and the provincial government will continue to work with industry partners and the other provinces to obtain the remaining federal funding;
- NB Power and Moltex Energy, with support from the province, will complete discussions with private investors to form a consortium that will allow for the completion of the design and establish the operating company;
- NB Power will apply for the licence to prepare site and begin the Impact Assessment; and
- In parallel with progressing with the formal licensing, construction, and training of operating staff, NB Power and Moltex Energy will discuss the formation of central fleet services and enter into discussions with various jurisdictions for future Moltex Energy units elsewhere in Canada and for export.

First Nations Engagement

NB Power, the Provincial Government and ARC Clean Energy and Moltex Energy are committed to engaging with First Nations on the development and deployment of SMRs in New Brunswick. NB Power has an extensive and very active First Nations and Public engagement program. In addition to a busy program of face to face and virtual meetings and open houses, supporting material is available on https://smrnb.ca/

NB Power has been collaborating with the consultative bodies for all First Nations: Wolasteqey, Mi'gmaq and the Peskotomuhkati through monthly meetings. NB Power also collaborates with the Tribal Councils and Economic Development Officers from all 16 Communities in New Brunswick on economic opportunities such as supply chain, equity, and business development. They are also collaborating on Environmental and Traditional Knowledge Studies.

NB Power is also working with the First Nations to produce an Indigenous Inclusion Guide that contains a vision of 5 key pillars: Leadership, Relationships, People, Economic Development and Environmental Stewardship. The key principles of the vision are: listening with open minds, creating an environment of collaboration, delivering on commitments, and working towards a mutually beneficial future. The vision and its components were created from the

recommendations outlined in the Truth and Reconciliation Commission Report, in particular action 92 related to business and reconciliation.

- Consultative bodies
    - Wolastoqey Nation in New Brunswick (WNNB)
    - Mi'gmawe'l Tplu'taqnn Inc. (MTI)
    - Kopit Lodge
    - Peskotomuhkati Nation at Skutik

- Tribal councils
    - Wolasteqey Tribal Council Incorporate (WTCI)
    - North Shore Micmac District Council Inc.
    - Mawiw Council Inc

7.4. Saskatchewan – A new era of nuclear energy and climate leadership

Saskatchewan's Growth Plan for the Next Decade of Growth (2020-2030) outlines the path to building a stronger Saskatchewan and a better quality of life for residents of the province.

To power a growing economy, the Government of Saskatchewan is exploring the development and deployment of small modular reactors (SMRs) to supply safe and reliable, zero-emissions baseload power to residents and businesses of the province. SMRs represent a key technological advancement that could help Saskatchewan and its people grow and prosper while contributing to Canada's efforts to address climate change.

The deployment of 1,200 Megawatts (MW) of nuclear power from SMRs in Saskatchewan between 2034 and 2042 would help achieve net-zero emissions in the provincial electrical grid. Currently 76 per cent of electricity in Saskatchewan is generated from fossil fuels. As a reliable and scalable baseload generation option, SMRs would support the further expansion of clean energy in the province.

The SMR Feasibility Study recently prepared by Saskatchewan's government-owned utility, SaskPower and other utilities in Canada, finds that nuclear power from SMRs has the potential to provide competitively priced baseload electricity in Saskatchewan by the mid-2030s.

The deployment of SMRs to provide reliable baseload power combined with expanded regional transmission capacity could also support the expansion of intermittent renewable electricity from wind and solar.

Certain SMRs being evaluated also have the capacity to efficiently generate heat for industrial processes or hydrogen production.

The development, construction and operation of SMRs could support economic and population growth by generating new economic activity and creating high-skilled jobs in Saskatchewan.

Construction of the first 300 MW of nuclear power from SMRs in Saskatchewan could start as early as 2030 and be operational in 2034 with the potential for construction of another 900 MW of SMR generation in Saskatchewan between 2034 and 2042.

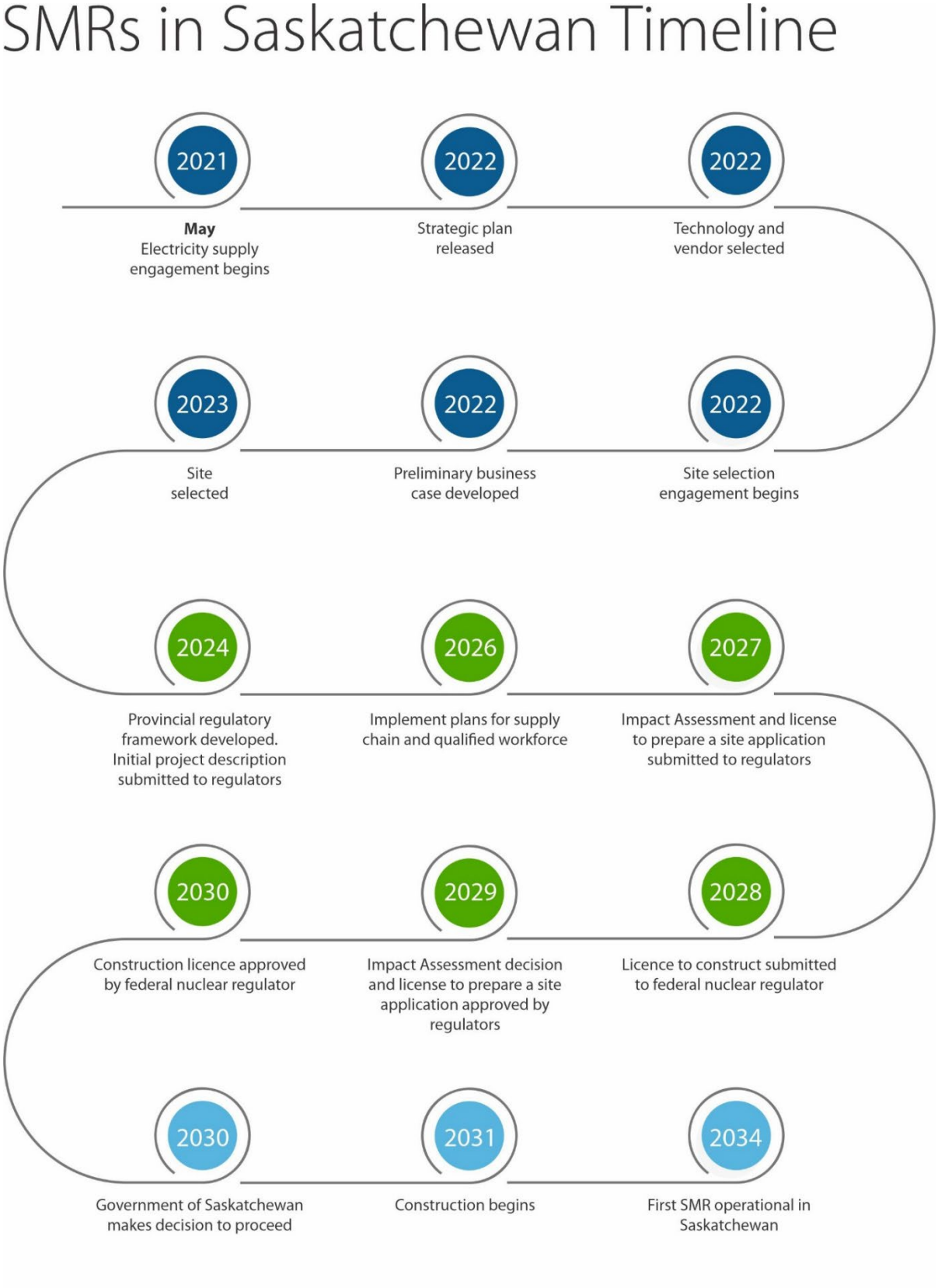
To help inform decision-making on future SMR development and deployment, the Government of Saskatchewan will undertake three phases of work:

- ✓ **Phase 1: Assessment and Planning (2021-2023)**
    - May 2021: Electricity supply engagement begins
    - 2022: Strategic Plan released
    - 2022: Technology and vendor selected
    - 2022: Site selection engagement begins
    - 2022: Preliminary business case developed
    - 2023: Site selected

- ✓ **Phase 2: Planning, Impact Assessment and Licensing (2024-2030)**
    - 2024: Provincial regulatory framework developed. Initial project description submitted to regulators
    - 2026: Implement plans for supply chain and qualified workforce
    - 2027: Impact Assessment and licence to prepare a site application submitted to regulators
    - 2028: Licence to construct submitted to federal nuclear regulator
    - 2029: Impact Assessment decision and licence to prepare a site application approved by regulators
    - 2030: Construction licence approved by federal nuclear regulator

- ✓ **Phase 3: Construction (2030-2042) and Operations (2034-Ongoing)**
    - 2030: Government of Saskatchewan makes decision to proceed
    - 2031: Construction begins
    - 2034: First SMR operational in Saskatchewan

Figure 1. Visual Timeline of SMR Development in Saskatchewan



Phase 1 (2021-2023): Assessment and Planning

Phase 1 includes a preliminary business case for development and deployment of SMRs in Saskatchewan. The government will complete an analysis to evaluate the economic and emissions reduction opportunities of SMRs in Saskatchewan beyond utility scale electricity production. These opportunities could include utilizing SMRs and micro-SMRs for co-generation of industrial heat and clean hydrogen production which could further reduce emissions across the provincial economy. SMRs could also create additional research and innovation opportunities and value-added activities for Saskatchewan uranium. SaskPower continues to assess the cost-competitiveness and benefits of nuclear power compared with alternative zero-emissions baseload generation options.

Phase 1 will include the following steps:

1. **Business Case:** Completing a business case for SMRs and micro-SMRs (e.g. costs, benefits, feasibility, emissions reductions). As part of the development of the business case, Saskatchewan will seek federal investment and evaluate potential financing arrangements.
2. **Technology Selection:** Selecting the SMR technology and vendor for the first and second grid-scale SMRs in the province, providing up to 600 MW of electricity. SaskPower will complete evaluation of selected SMR technologies including potential economic opportunities.
3. **Site Selection:** Recommending a site for an SMR to be constructed and connected to the electrical grid. SMRs need to be located on a site that is supported by the host community and meets all technical and regulatory requirements. The Canadian Nuclear Safety Commission (CNSC) has a detailed list of site selection criteria for new nuclear sites (REGDOC-1.1.1). SaskPower, as a project proponent, is responsible for reviewing and considering these and additional criteria when identifying possible locations for SMRs in the province. Site selection is a mandatory step before beginning the impact assessment and licensing process. SaskPower will perform the impact assessment for two SMRs on the same site, but the decision to construct a second SMR will be made at a later time.
4. **Engagement:** SaskPower will engage broadly with stakeholders, customers, communities and Indigenous rights holders through information sharing and dialogue focused on building awareness and understanding around SMR site selection and the development of nuclear power from SMRs in the province. The Government of Saskatchewan will conduct engagement activities with targeted stakeholders and Indigenous Peoples to explore opportunities for participation in research and development, education and training, policy development and supply chain development.
5. **Supply Chain:** Completing a supply chain study in collaboration with Saskatchewan industries and associations. The SMR supply chain is the network of organizations, people, activities, information and resources involved in supplying nuclear and non-nuclear components from qualified suppliers. A strong Saskatchewan nuclear and non-nuclear supply chain would support SMRs in Canada and internationally and bring economic benefits to Saskatchewan.

6. **Provincial regulatory framework:** Completing analysis of overlaps and gaps in provincial and federal regulations for SMRs. Saskatchewan can build on existing collaboration with federal regulatory authorities, including the CNSC, which has responsibility for uranium mines and mills in the province.
7. **Research and Development:** In collaboration with SaskPower, the selected SMR vendor and academic institutions, the government will investigate research and development (R&D) opportunities associated with SMRs. Building a strong and relevant R&D foundation that compliments national and global SMR activities will enable Saskatchewan to educate, retain, and attract highly qualified people and companies that can support growth in Saskatchewan's nuclear innovation ecosystem.

Key deliverables:

- ✓ SMR business case development.
- ✓ SMR technology and vendor selection.
- ✓ SMR Site selection.
- ✓ Supply chain study completion.
- ✓ Federal investment applications.

Phase 2 (2024-2030): Planning, Impact Assessment and Licensing

Phase 2 will lay the foundation for the deployment of SMRs in Saskatchewan and contribute to the ability to make an informed decision about construction in Phase 3. Phase 2 includes continuing Indigenous and public engagement, completing an impact assessment and approving the site and construction licences for the first grid scale SMR in Saskatchewan.

Phase 2 will include the following steps:

1. **Engagement**: Continuing broad engagement with stakeholders, customers, communities and Indigenous rights holders in Saskatchewan to ensure information related to health, safety and security of persons and the environment, as well as other issues associated with the lifecycle of nuclear facilities, are effectively communicated.
2. **Supply Chain**: Collaborating with suppliers to develop a supply chain for domestic and export markets.
3. **Provincial regulatory framework**: Implementing a regulatory framework that enables a clear, streamlined process for project proponents to develop and deploy SMRs in Saskatchewan.
4. **Research and Development:** Supporting academic institutions with the implementation of research and development capacity. This support could range from enabling conversations to ensuring alignment between different programs to facilitating funding through federal, provincial or private industry grants.

5. **Education and training**: Determine human resource needs for the construction and operations of SMRs, and collaborate with education, training, immigration and labour institutions in Saskatchewan to align programs with anticipated needs.
6. **Impact Assessment and Licensing**: Completing the impact assessment and securing site and construction licences for the first grid scale SMR. Federal and provincial regulators assess the environmental impacts of SMRs, while the CNSC oversees the full lifecycle of nuclear energy and materials.

Key deliverables:

- ✓ Business case review and update to determine if SMRs remain technically and economically feasible.
- ✓ Federal impact assessment decision and approved licences for SMR development.
- ✓ Provincial regulatory frameworks, legislation and regulations developed.
- ✓ SMR supply chain and qualified workforce planning.

Phase 3: Construction (2030 – 2042) and Operations (2034-Ongoing)

The construction and start of operations of the first SMR begins in Phase 3, along with the licensing and construction of additional SMRs.

Phase 3 will include the following steps:

1. **Construction Decision:** The decision whether to proceed with the construction of the first grid scale SMR in Saskatchewan is expected to be made in 2030.
2. **Construction and Commissioning:** The construction and commissioning will target the first grid-scale SMR to be operational in Saskatchewan by 2034.
3. **Decision to Proceed with Additional SMRs:** The decision whether to construct additional grid scale SMRs will be made in the early 2030's.
4. **Commence Work to Locate, Licence and Construct Additional SMRs.**

7.5. Alberta – Engaging with nuclear stakeholders and ensuring regulatory readiness

Alberta Energy

Alberta's Ministry of Energy represents the interests of Albertans as the owners of oil and gas resources in the province and contributes to sustained prosperity by overseeing the responsible resource development and the stewardship of energy and mineral resource systems. The Ministry of Energy manages Alberta's energy resources to ensure they are developed in responsible ways that benefit and bring value to Albertans. The ministry also oversees a reliable and affordable electricity system for Albertans and encourages additional investment that creates jobs and economic prosperity. Sustained prosperity includes having regard for the social, economic and environmental impacts of Alberta's energy development.

The ministry consists of the Department of Energy (i.e. Alberta Energy), the Alberta Energy Regulator, the Alberta Utilities Commission, the Alberta Electric System Operator, the Alberta Petroleum Marketing Commission, the Post-closure Stewardship Fund and the Balancing Pool. Each entity plays an important role in overseeing the orderly development and regulation of Alberta's energy resources.

In terms of the province's approach to electricity, Alberta has a unique energy-only market designed to encourage efficiencies through competition in the electricity generation sector. Electricity generation in the province is developed and financed entirely by private investors. These private investors receive their basic revenue from the sale of electricity through a real-time energy market with fluctuating electricity prices. Therefore, the size, fuel source, and location of new generation facilities in Alberta is determined by private investors that base their decisions on a variety of factors, including the cost and performance of different technologies.

Similarly, Alberta's energy and mining sectors are driven by private investments and private business decisions. While Alberta strives towards establishing a competitive and robust policy and regulatory framework to facilitate responsible and efficient energy and mineral development – as well as to attract investment – energy and mining companies are the center business decisions, including when and where to develop the resources and what technologies are deployed to support the development.

Alberta Innovates

Alberta Innovates is Alberta's Research and Innovation (R&I) engine. As the largest and most comprehensive R&I agency in the province, Alberta Innovates works with a range of sectors including health, energy, environment, agriculture and finance. This scope gives the organization a unique role in the R&I system and that provides a wide-angle lens to identify opportunities, challenges and gaps where R&I is of value. Through an end-to-end approach, clients are

supported through the phases of Discovery, Development and Use on their path to establishing commercial success.

Alberta Innovates' investments, connections, platforms and expertise are leveraged to stimulate effective ways of solving the challenges of today and tomorrow. Clients are guided through the innovation system and existing cross-sectoral R&I partnerships and collaborations are used to connect clients with the right resources at the right time – helping to propel great ideas forward while gathering important market-driven evidence along the way.

Alberta Innovates has three pathways of action and future plans that can contribute to the advancement and deployment of SMRs in Alberta. The ability to propel innovation in the province, coupled with a strategic focus on diversifying Alberta's low-carbon economy makes action on SMRs a potential opportunity through:

- Connection of SMRs to the Alberta Innovates Strategic Priority Areas;
- Support for SMR Technology or Knowledge Development Initiatives in Focus Areas of Investment; and
- Contributions to Knowledge

1. Connection of SMRs to the Alberta Innovates Strategic Priority Areas

Alberta Innovates has a strategic priority to develop emerging technologies, with a focus on:

- Developing emerging technologies, including in areas such as Data-Enabled Innovation; Digital Technology for Business Transformation; Clean Technology; and Innovative Production and Distribution.
- Enhancing knowledge workforce.
- Embracing the digital future.

Global climate change and a political and social imperative to respond to this challenge presents a growth opportunity for renewables and other clean tech solutions. Alberta can leverage its existing, highly-skilled workforce and leadership role in clean technology innovation to advance SMR technology.

SMRs are well-positioned to play a role in Alberta's innovation portfolio with the focus on clean technology as one of Alberta Innovates' three strategic priority areas. Alberta can leverage its existing strengths to advance SMRs for development and deployment in Canada.

2. Support for SMR Technology or Knowledge Development Initiatives in Focus Areas of Investment

One of Alberta Innovates' Focus Areas of Investment is Clean Resource Technologies. The organization invests in clean technologies that improve environmental sustainability and economic diversification. The Clean Resource Technologies focus area has prioritized development of emerging technology for the near- and medium- term. Alberta Innovates

supports projects that can help contribute to progress towards Alberta's 2030 targets as identified in the Alberta Research and Innovation Framework.

The 2030 Innovation Targets are intended to inspire transformational solutions in the following areas of importance:

- Emerging technologies;
- Energy and GHG mitigation;
- Environment and climate adaptation; and
- Agriculture, food and fibre production.

Projects that are aligned with the program focus areas and contribute to 2030 Innovation Targets are prioritized for funding and support.

Projects seeking funding from Alberta Innovates must demonstrate a clear and justified value proposition in Alberta. Technology solutions can originate from anywhere globally but must address challenges and opportunities of importance to Alberta. Projects that will be researched, piloted, and/or demonstrated, and implemented in Alberta with long-term Alberta-based infrastructure and/or resources being prioritized.

Project funding can be up to, but typically do not exceed, $2 million per project and can support 25 – 50 per cent of total project costs, with remaining funding (including cash and in-kind support) from other project partners and other funding agencies.

Projects that advance SMR deployment for Alberta applications, or utilize Alberta's strengths in manufacturing, operations and industrial services would be well-aligned with Alberta Innovates Clean Resource Technologies focus in Renewable and Alternative Energy. Initiatives that further low-carbon energy solutions in the province would be welcome to apply for funding through the Clean Resources Continuous Intake process.

3. Contributions to Knowledge

Alberta Innovates funded studies in 2016 and 2018 in collaboration with the Canadian Oil Sands Innovation Alliance (COSIA) and Pacific Northwest National Laboratory focused on the current status of SMR technologies and feasibility for application in Alberta's oil sands. These studies assessed the techno-economic feasibility of SMRs using well-understood reference facilities for in situ Steam Assisted Gravity Drainage operations, surface mining operations and bitumen partial upgrading facilities. The studies concluded that SMR technologies are capable of providing the electricity, process steam, high temperature steam, and hydrogen requirements of the reference oil sands facilities. The reports highlight key considerations that should be taken into account prior to down-selecting decisions are made on promising technologies to advance in Canada.

These studies are publicly available and can be contributed to further the discussion about the deployment of SMRs in Alberta applications.

- Deployability of Small Modular Nuclear Reactors for Alberta Applications
- Deployability of Small Modular Nuclear Reactors for Alberta Applications – Phase II

Alberta Innovates and Invest Alberta are open to discussions for additional feasibility studies that build upon this previous body of work, as updated information can help to develop potential deployment strategies for SMRs in Alberta.

Alberta Innovates is also particularly well-positioned to support knowledge generation and cultivate key relationships to advance the development and deployment of SMRs in Alberta. In early 2021, Alberta Innovates launched the "Small Modular Reactors – an Alberta Innovates Learn How Series" on the organization's Inventure$ Unbound platform. This four-part series introduced the concepts of Small Modular Reactors, SMR strategies from the four provinces participating in the SMR MOU, SMR technologies and conversations around energy transitions.

- Small Modular Reactors 101 – original air date February 16
- Bright Spots, Innovation and Provincial Collaboration – original air date February 23
- Let's Talk Tech – A Deep Dive on SMR Technologies – original air date March 2
- Let's Talk Community – original air date March 9

Alberta Innovates is committed to advancing the understanding of opportunities and challenges with SMR development and deployment in Alberta.

Next Steps

The Government of Alberta supports an energy-only market and welcomes all market-driven generation solutions.

Alberta's Technology Innovation and Emissions Reduction (TIER) Regulation incentivizes investment into low- or no-emitting electricity generation through the TIER electricity benchmark. Under TIER, operators that produce products that are already regulated, are eligible to opt-into TIER regardless of their size or amount of emissions. Therefore, SMRs that produce electricity and/or heat are eligible to opt-in to the TIER regulation, as these are already regulated products under TIER. If SMRs are able to produce electricity and/or heat without any greenhouse gas emissions, they will be able to generate emissions performance credits (EPCs) equal to the level of the High Performance Benchmark (HPB) for these products. The HPB for electricity is 0.37 tonnes per megawatt hour, and the HPB for heat is 0.06299 tonnes per gigajoule.

An Alberta Offset System protocol for nuclear electricity or heating is not currently available. Project proponents are welcome to submit an intent to develop a new protocol to Alberta Environment and Parks (AEP) by the end of 2021. Project proponents must follow AEP's technical guidance for the application. AEP will evaluate the application before advancement of in-depth protocol development work.

Alberta's commitment to an energy-only market and the TIER Regulation provides incentive and stability to investors, and drives competitive pricing. The benefits of this approach are illustrated by more than $2 billion in investment announced for generation projects since 2019. These projects are market-driven and do not require government subsidies.

The use of SMRs can help reduce not only greenhouse gas emissions, but also air emissions. Nuclear energy is a near emissions-free source of heat and electricity. The goal of the Air Quality Management System is to protect human health and the environment through the continuous improvement of air quality. The Government of Alberta committed to achieving the Canadian Ambient Air Quality Standards (CAAQS). Air emission reductions from both industrial and non-industrial sources are needed to achieve CAAQS in Alberta as the standards become more stringent over time. SMRs can displace burning fossil fuels for heat (steam) and electricity generation in industry, and diesel use in remote communities and mine sites. Oil sands and electric power generation sectors emit approximately 25% of the province's air emissions of nitrogen oxides.

Research by the Alberta Geological Survey and initial exploration by Alberta companies have already identified uranium prospects across the province, particularly in northeast and southern Alberta, which have the potential to contribute to the uranium supply chain. Alberta is developing a Mineral Strategy that will help guide the province's mineral exploration and development, including uranium, a potential feedstock for SMRs.

In terms of potential nuclear projects, the Alberta Utilities Commission (AUC) and the Alberta Energy Regulator (AER) are also planning to review how the federal regulatory process for nuclear reactors will interact with Alberta's regulatory system for facilities within each regulators' mandate. This will include direct engagement with the Canadian Nuclear Safety Commission as the main regulator of nuclear activities in Canada. The AUC and the AER will deliver their findings on areas of overlap, uncertainty and duplication between federal and provincial regulatory regimes to the Minister of Energy by the fall of 2023. The Government of Alberta will engage Albertans before subsequently taking any legislative or policy action based on the findings of the AUC and AER reviews.

Indigenous communities in Alberta continue to express interest in partnerships, involvement, and training in all energy sectors, including SMR development. Early Indigenous engagement is recommended to understand the potential concerns and issues that might be important to Indigenous communities such as environmental impacts of uranium mining. If new regulations are developed, it will be necessary to update the Government of Alberta's Guidelines on Consultation with First Nations/Metis Settlements on Land and Natural Resource Management, particularly the sector-specific consultation matrices to address consultation on SMR projects.

Alberta continues to place a strong focus on furthering the province's status as a prime target for private investment in the energy industry and beyond. To that end, the Government of Alberta recently created the Invest Alberta Corporation, with the mandate to engage investors on high profile and high impact investment and provide tailored support to companies considering major

investments. Invest Alberta will work closely with the Government of Alberta, and its partners across the province, to help investors fully understand and capitalize on investment opportunities associated with small modular nuclear reactors.

Since joining the Inter-utility Consultative Committee on Nuclear and SMR Roadmap Steering Committee led by NRCan, Alberta has actively participated in the development of the Canadian Roadmap for SMRs and Canada's SMR Action Plan. In April 2021, Alberta also signed on to the MOU between New Brunswick, Ontario, and Saskatchewan to support the development and deployment of SMRs. Alberta will continue to hold discussions on future opportunities within the sector with stakeholders interested in SMR development. Organizations such as Prairies Economic Development Canada also work to diversify the western economy while improving the quality of life of western Canadians. The department supports areas including community economic development, innovation, and business development.

The Alberta government understands that research and development for innovative technologies such as SMRs is crucial to both growing the economy and improving environmental performance. It is important for the Alberta government to be engaged with the federal, provincial, and territorial governments in Canada, along with other key nuclear stakeholders in the development of SMR technology to ensure our province has an appropriate understanding of the technology to enable ongoing generation and industrial development by the private industry in Alberta. The Ministry of Energy will be leading this collaborative work as we look to the future of SMRs in Alberta and Canada.