Compete and Succeed in a Net Zero Future

First Annual Report to the Minister of Environment and Climate Change **January 2023**

Net-Zero Advisory Body

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Message from the Co-chairs to Minister Guilbeault

DEAR MINISTER GUILBEAULT,

On behalf of all members of the Net-Zero Advisory Body, we are pleased to present our first annual report, as mandated under the ***Canadian Net-Zero Emissions Accountability Act*** (CNZEAA). This report contains 25 pieces of advice on Canada's transition to net-zero emissions by 2050, to improve net-zero governance, to actively steer the economy towards a competitive net-zero future with a modern, effective net-zero industrial policy, and to build widespread momentum for pathways to a true net-zero energy system.

The measures proposed in the **2030 Emissions Reduction Plan** (ERP) set credible foundations upon which a more ambitious transition can be built. While we are confident our advice will help put Canada on the right path, bringing the full suite of ERP measures and proposals to fruition as quickly and rigorously as possible is required for success. However, different ERP measures have differing momentum to implementation. Some that have been contentious, like the light-duty Zero-Emission Vehicle mandates, are gaining public support and there is a clear path to implementation.

Other measures, like the oil and gas sector emissions cap, are earlier in their evolution, may encounter resistance, and yet are critical to attaining Canada's 2030 emission reduction targets. Unlike other heavy industry sectors like steel and cement, emissions from the oil and gas sectors are still rising, and the track record of the oil and gas sector suggests self-regulation will be difficult. Despite some improvements in emissions intensity of oil and gas production, emissions from the oil and gas sector rose by 18.8% between 2005 and 2019 while emissions from the rest of the economy declined by 6.1%. Without an oil and gas emissions cap, Canada is unlikely to attain its 2030 emission target. We extend our full support in favour of adopting a rigorous but fair cap on oil and gas emissions.

Our report outlines numerous suggestions for other actions we feel should be taken to make positive change in the areas of net-zero governance, industrial policy, and energy systems. These actions should be implemented through careful application of the NZAB's 10 foundational values and design principles, as well as with partnership and involvement from leaders across provinces, territories, Indigenous nations, industry, and civil society.

It is an honour to serve as Co-chairs of the Net-Zero Advisory Body. We feel strongly that independent advice to the Government of Canada about the most likely pathways to a net-zero Canada by 2050 is more important than ever, now that the effects of climate change are impacting the lives of Canadians directly in ways predicted by scientists and Indigenous knowledge holders for decades.

DAN WICKLUM AND MARIE-PIERRE IPPERSIEL
Co-chairs of the Net-Zero Advisory Body

Executive Summary

With the passing of each year, we set record high temperatures and witness increasingly frequent and severe extreme weather events. These new normal climate conditions will continue to afflict Canadians, and Indigenous peoples in particular, including through forest fires, storms, hurricanes and flooding that damage communities and disrupt daily life. This trend will continue and worsen as long as our prosperity and well-being rely on a carbon-based economy. It is time for Canada to end this dependence and accelerate the attainment of a net-zero emissions society.

With 27 years left until 2050, it is not enough to accelerate the decline of emissions — success must be about the construction of a prosperous net-zero future for all Canadians. Achieving this requires urgent actions, from the way we collectively govern ourselves to the tools we use to steer the country to sustainable prosperity. This is a difficult and long-term undertaking. The key to success is getting on a credible pathway to net-zero by 2050 in a manner that responds to our unique domestic challenges and opportunities, while joining emerging initiatives with partners abroad and learning from others' approaches (e.g., the **United States' Inflation Reduction Act** and the **European Union's Green Deal**).

Canada must remain at the forefront of the net-zero movement to ensure competitiveness in the global economy, sustain well-being, create good jobs, and attract investments to leverage competitive advantages. Our advice to the Minister of Environment and Climate Change will help Canada make the shift towards a more sustainable, fair and flourishing future for all Canadians. This report contains 25 pieces of advice that will help strengthen net-zero governance in Canada, build the industrial policy that Canada needs to thrive in a clean economy, and transform our energy systems for a net-zero future. **The full content of the advice, which contains key nuances, can be found in the main report.**

Through our **Net-Zero Governance** line of inquiry, we acknowledge that no single entity can, on its own, permanently decarbonize the Canadian economy. Success depends on setting the right framework for all parts of society – all orders of

government, industry, and civil society – to progress steadily down pathways to a net-zero emissions society. To that end, we analyzed Canada's capacity under four pillars of good governance: (1) informed decision-making through informed use of net-zero modelling; (2) alignment of federal mandates with net-zero objectives; (3) shared leadership across all orders of government, Indigenous peoples, the private sector, and civil society, and; (4) monitoring and reporting on progress towards net-zero. We believe that practical steps must be taken to better align these four pillars with Canada's legal obligation to achieve net-zero emissions by 2050.

Advice 1

The Government of Canada should direct that all federal agencies, departments and Crown corporations publicly articulate their role in helping Canada achieve net-zero emissions. The Government of Canada should then empower these organizations to play a more ambitious role by formalizing net-zero objectives in their corporate mandates, changing mandates if required, ensuring that executive compensation is meaningfully and transparently linked to climate mitigation performance, and applying common reporting standards.

Advice 2

The Government of Canada should catalyze the development of net-zero champions across Canada and build issue-specific coalitions comprised of federal, provincial, territorial, non-governmental, private and Indigenous entities.

Advice 3

The Government of Canada should ensure there is a public-facing, easily understood net-zero dashboard, providing Canadians with access to progress indicators, notably quarterly data on GHG emissions trends by sector, and leading indicators of progress. This might be best done in collaboration with external organization(s).

Advice 4

The Government of Canada should establish an independent modelling and data centre of excellence, operational by June 2024. The new centre of excellence would contribute to developing independent modelling, establishing relationships with other orders of government, and encouraging collaboration on net-zero modelling and analysis.

Advice 5

Environment and Climate Change Canada should close the 2-year data lag for reporting more detailed and accessible data on GHG emissions, starting with emission-year 2023. Environment and Climate Change Canada should launch quarterly reporting of GHG emissions, similar to the European Union.

Advice 6

Federal departments, agencies, and Crown corporations should increase their expertise and capacity related to data, analyses, and interpretations of net-zero modelling activities. This would increase their ability to support their organization's net-zero planning efforts, allow more strategic interactions across organizations, and facilitate collaboration with the new centre of excellence.

Advice 7

Environment and Climate Change Canada should do modelling runs on a continuous basis throughout the year and decouple them from the release of climate plans to increase learning and ensure robust analyses.

Advice 8

The Government of Canada should broaden its approach to Emissions Reduction Plan (ERP) development, while including modelling to net-zero in all future ERPs. Future plans should include, among other elements, a detailed qualitative analysis of the character of the Canadian economy associated with declining GHG emissions, and risk and competitiveness analyses.

Advice 9

The Government of Canada should issue guidance on proper analysis in support of climate policy, similar to the **United Kingdom Treasury Aqua Book**, to strengthen the use of models in support of decision-making.

Our **Net-Zero Industrial Policy** line of inquiry identifies concrete steps to implement the pathways-centred approach outlined in our **Net-Zero Pathways: Initial Observations** report (2021). A net-zero industrial policy would facilitate the building of domestic industries that both secure Canada's competitive position in the global economy and contribute to driving Canada to net-zero by 2050. The recommended process follows international best practices for the development of a modern industrial policy. The process starts with defining the desired end states by key sectors, defining time bound competitiveness goals on a pathway to the desired end state, and then developing a roadmap facilitated by third party intermediaries that encompasses all the elements required to attain the competitiveness goals, creating, or transforming key industrial sectors.

The federal government recognized industrial policy's value in its **2022 Fall Economic Statement**: "Canadian workers need a robust industrial policy." However, Canada has yet to set up the structures and methodologies to institutionalize a true net-zero industrial policy in a way that differentiates it from previous initiatives.

Canada needs to develop industrial policy to help translate the emissions reduction targets and regulatory signals in **A Healthy Environment and a Healthy Economy** and the **2030 ERP** into concrete action in the physical economy. This will help drive down the costs of innovation, position Canada as a leading source of net-zero value-added goods and services in resilient global supply chains, and build coalitions of support for ambitious climate and competitiveness policy. This can be done by taking the following steps:

Advice 10

The Government of Canada should urgently drive the development and implementation of a Canadian net-zero industrial policy to complement the **2030 ERP**, consistent with the process outlined in section 2.2.

Advice 11

The Government of Canada should initially focus its Canadian net-zero industrial policy on a limited number of priority sectors that have significant economic opportunities for growth and benefits across all regions of Canada. Identification of priority sectors could build on our analysis in section 2.4.

Advice 12

The Government of Canada should establish time-limited strategy tables to develop net-zero competitiveness goals for priority sectors and create roadmaps, bringing together relevant federal departments with industry, independent experts, labour, provincial and territorial representatives, and Indigenous interests. The competitiveness goals would align with the ERP sectoral emissions targets, support regulatory mechanisms, and achieve economic growth objectives.

Advice 13

The Government of Canada should use independent intermediaries to support these tables by providing and engaging expertise in key sectors and developing and deepening sectoral buy-in. Strategy tables should support experimentation, learning, and evaluation.

Advice 14

Central agencies should be responsible for leading, coordinating, and monitoring the implementation of net-zero industrial policies based on a system-level strategy to ensure coherence and timely progress.

Advice 15

The Government of Canada should refocus existing funds, such as the **Strategic Innovation Fund** and the **Canada Growth Fund**, on portfolios of projects and investments aligned with its net-zero industrial policy.

Advice 16

The Government of Canada should use international trade policy to support its industrial policy goals and to build secure supply chains for the inputs and technologies required to reach net-zero.

Advice 17

The Government of Canada should ensure regulatory approval processes accelerate the objectives of the net-zero industrial policy.

Advice 18

The Government of Canada should align its skills and jobs agenda with industrial policy competitiveness goals.

Our third line of inquiry looks at **Net-Zero Energy Systems**, which covers energy production, conversion, transmission, distribution, storage, and consumption within and across regions. Canada's current energy systems are not set up to achieve our emissions reduction targets. While the **Clean Electricity Regulations** will play an important role achieving a net-zero grid by 2035, these alone will be insufficient to incentivize the expansion of carbon-free or low carbon energy production to the levels needed to supply the energy required for net-zero industrial processes, buildings heating and cooling, and transportation in 2050.

The NZAB elected to focus its initial efforts on some aspects of our electricity system. Future work will include a more fulsome analysis of the electricity system and other potential system components.

Interconnections between provincial and territorial electricity systems may yield economic benefits while accelerating the elimination of GHGs. The transformation of Canada's energy systems will also increase Indigenous peoples' self-determination. While it will take multiple years to chart a path forward, we provide seven pieces of advice to start.

Advice 19

The Government of Canada should facilitate the development of a vision for net-zero energy systems, akin to Canada's nation-building project of the 21st century, based on the 10 principles proposed in section 3.1.

Advice 20

The Government of Canada should ensure pathways to a net-zero grid by 2035 are consistent with pathways to a right-sized, net-zero grid by 2050.

Advice 21

The Government of Canada should support independent research and modelling activities to understand the costs-benefits of net-zero pathways that use more interties compared to those that rely on other strategies.

Advice 22

The Government of Canada should launch the Pan-Canadian Grid Council as soon as possible to facilitate cross-sectoral, pan-Canadian dialogue on the topic of net-zero interties and grid.

Advice 23

The Government of Canada should reduce the length of approval processes for projects that are compatible with net-zero to ensure they are working towards, not against, emissions targets and net-zero competitiveness goals.

Advice 24

The Government of Canada in cooperation with the provinces and territories should compile, share and promote best practices in regulatory processes across the federation and from other jurisdictions outside of Canada.

Advice 25

The Government of Canada, should embed principles of the United Nations Declaration for the Rights of Indigenous Peoples when it makes decisions pertaining to energy sector transformation, setting an example for other orders of government.

The 25 pieces of advice presented in our 2022 Annual Report are meant to complement our 40 pieces of advice from our Submission for the 2030 ERP. We feel strongly that attaining a prosperous, fair, and net-zero Canada depends on collective commitment and shared leadership. Fostering and securing widespread commitment to net-zero should be a priority of all governments in the first half of the current decade. There is more certainty than uncertainty on the path forward.

Acknowledgement

This report was developed by the members of the Net-Zero Advisory Body, who collectively reside on the territories of Treaty 6, Treaty 7, and Treaty 13, the homeland of the Métis, the traditional territories of the Blackfoot Confederacy, the Tsuut'ina, the Îyâxe Nakoda, the Mississaugas of the Credit, the Anishnabeg, the Chippewa, the Haudenosaunee and the Wendat nations, the unceded traditional territories of the xʷməθkʷəy̓əm (Musqueam), Sḵwx̱wú7mesh (Squamish), and səlilwətaɬ (Tsleil-Waututh), Wolastoqiyik (Maliseet), and Mi'kmaq nations, and a territory with a long history of meeting and exchange among many nations (Montréal), notably the Haudenosaunee and the Anishinabeg nations.

Our work was made possible by more than a hundred individuals and organizations who contributed their time and expertise to help inform our advice, including the organizations we met with to help us develop our 10 foundational values and design principles. The organizations we met with to help inform our deliberations for this report can be found in Appendix A. We also want to recognize the valuable contributions of federal, provincial and territorial officials who supported the Net-Zero Advisory Body through briefings and information-sharing.

About the Net-Zero Advisory Body

Originally launched in February 2021 and formalized under the ***Canadian Net-Zero Emissions Accountability Act*** **(CNZEAA)** in June 2021, the Net-Zero Advisory Body's legislated mandate is to provide independent advice to the Minister of Environment and Climate Change with respect to achieving net-zero emissions by 2050, including:

- Greenhouse gas (GHG) emissions reduction targets for 2030, 2035, 2040, and 2045;
- Emission Reduction Plans from the Government of Canada, including measures and sectoral strategies that the government could implement to achieve a GHG emissions target; and,
- any matter referred to it by the Minister.

We are mandated to conduct engagement activities related to achieving net-zero emissions and to take into account a range of factors, including environmental, economic, social, and technological considerations. As per our mandate, our advice must be informed by the best available scientific information and Indigenous Knowledge.

Consistent with our **Terms of Reference**, we are pleased to present our 2022 Annual Report to the Minister of Environment and Climate Change, our first publication required under the CNZEAA. The decision to implement our advice rests with the Government of Canada.

NZAB members

CO-CHAIR
Marie-Pierre Ippersiel
President and CEO, PRIMA Québec

CO-CHAIR
Dan Wicklum
President and CEO,
Transition Accelerator

Catherine Abreu
Founder and Executive Director,
Destination Zero

Linda Coady
President and CEO,
B.C. Council of Forest Industries

Simon Donner
Professor, Department of
Geography, University of
British Columbia

Sarah Houde
CEO, Propulsion Quebec

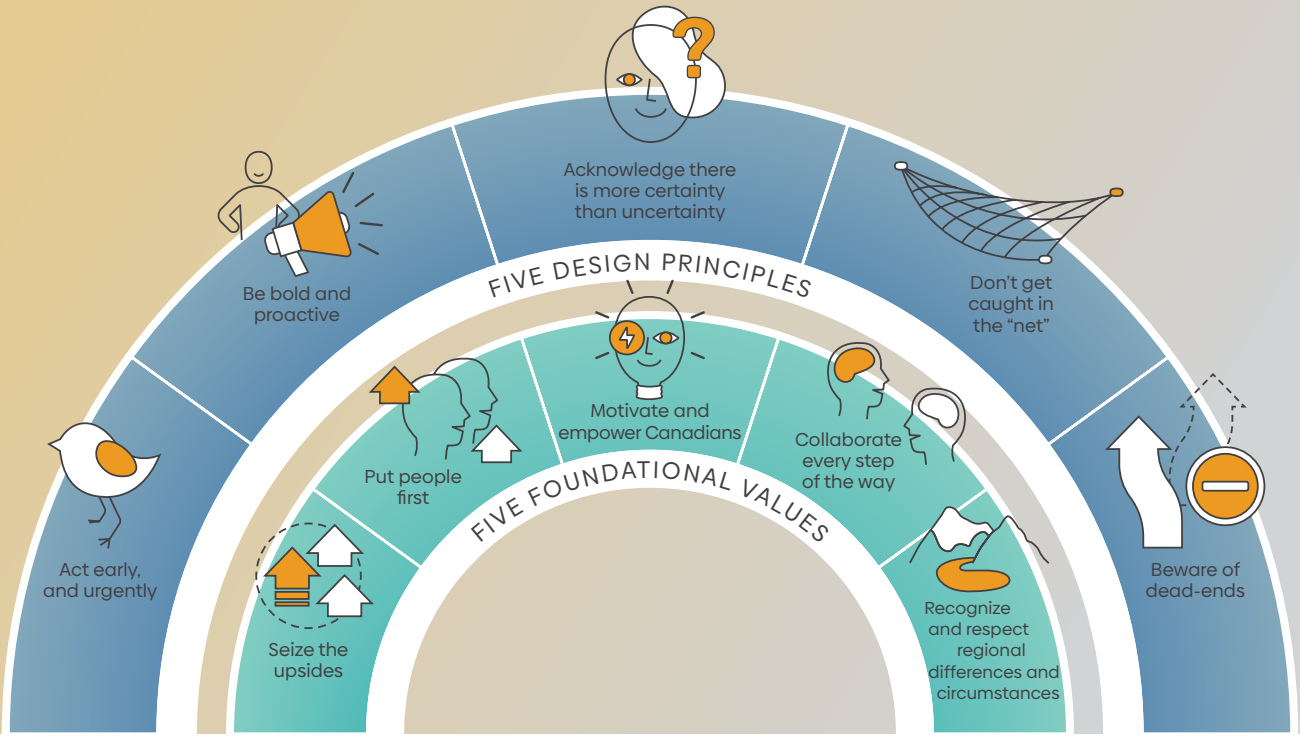
Gaëtan Thomas
President and CEO,
Conseil Économique
du Nouveau-Brunswick

John Wright
Former President, SaskPower

Yung Wu
CEO, MaRS Discovery District

Values and principles

The NZAB has identified 10 values and principles that we believe are essential to developing the most likely pathways for Canada to achieve net-zero by 2050.



Introduction

2022 was a landmark year for climate change in Canada. The federal government's 2030 Emissions Reduction Plan (ERP), published in March 2022, was the first plan released under the *Canadian Net-Zero Emissions Accountability Act* (CNZEAA), a critical piece of legislation that provides both predictability and accountability for achieving Canada's emissions reduction targets. Consistent with our advice for the 2030 ERP, the Government of Canada has committed to reach a net-zero electricity grid and mandate 100% of passenger vehicle sales be zero emissions by 2035, put in place a cap on the emissions of the oil and gas sector, reduce oil and gas methane emissions by 75% by 2030, and develop a green building strategy. As of 2022, more than 50 Canadian companies representing over $643B in annual revenues now have net-zero commitments (Net-Zero Tracker, 2022; ECCC, 2022).

The National Inventory Report shows that emissions in Canada declined by 66 Mt CO_2 eq. in 2020, or 9.3% from 2005 emissions, with the largest reductions coming from transportation (-27 Mt), stationary combustion (-22 Mt) and fugitive sources (-17 Mt). However, these numbers cannot be seen as true progress, as much of these observed reductions are attributable to reduced economic activity during the early stages of the COVID-19 pandemic. There is strong evidence that global emissions are now returning to pre-pandemic levels (International Energy Agency). Even if these reductions were permanent, Canada would still need to reduce its emissions by a further 229 Mt CO_2 eq. to meet its 2030 target of 40-45% below 2005 levels, equivalent to eliminating all emissions from the Atlantic provinces, Québec, Saskatchewan, and British Columbia. We cannot afford to slow down, especially as the mechanisms to deliver on ERP commitments are often still being developed and have not yet reached the implementation stage.

While climate plans to date set a strong foundation for reducing emissions, there needs to be widespread understanding that removing GHG emissions from the economy is fundamentally different from reducing GHGs. Incremental changes to existing systems will not put Canada on the path to net-zero emissions and prosperity by 2050. We need to define the desired future systems now to allow sufficient time to invest and build the infrastructure — physical, social, and institutional — of tomorrow. Building pathways between the current state, and defined future state is a recipe for success. Setting the right mindset is therefore the first milestone of any pathway to net-zero, and it is the thread that tied together our work in 2022, and the 25 pieces of advice we provide in this report.

TABLE 1: Percentage change of sectoral emissions in Canada, by province and territory, 2005 to 2020

Industry	Province/Territory: BC	AB	SK	MB	ON	QC	NB	NS	PE	NL	YU	NT	NU	Sectoral emissions in 2020 (Mt CO_2 eq.)
Oil and Gas	+1%	+26%	-40%	-12%	-39%	-48%	+23%	-99%	-32%	-21%	-100%	-77%	-	179
Electricity	-76%	-39%	-12%	-88%	-91%	-44%	-63%	-41%	-94%	+17%	+148%	NA	NA	56
Transport	+12%	+21%	+55%	+19%	-16%	-5%	-30%	-17%	-9%	+6%	+32%	-21%	-3%	159
Heavy Industry	-22%	+1%	+74%	-20%	-28%	-18%	-55%	-63%	+798%	-54%	+63%	+2%	-16%	72
Buildings	+5%	+30%	+16%	+15%	+6%	-24%	-32%	-24%	-36%	4%	-52%	24%	18%	88
Agriculture	+9%	-7%	+14%	+3%	+8%	+9%	-22%	-28%	-10%	+20%	-100%	-100%	-	69
Waste	-27%	+41%	0%	0%	-11%	-3%	-28%	-20%	-15%	-7%	+16%	+5%	+29%	27
Coal Production	12%	-38%	-5%	-	-	-	-100%	-67%	-	-	-	-	-	2
Light Manufacturing and more	-36%	+29%	+29%	+27%	-25%	-5%	-38%	+14%	0%	+48%	+179%	NA	NA	20
Trend of emissions 2005-2020	-3%	+8%	-8%	+6%	-27%	-12%	-37%	-36%	-15%	-9%	+6%	-19%	+3%	-
Provincial Emissions in 2020 (Mt CO_2 eq.)	**62**	**256**	**66**	**22**	**150**	**76**	**12**	**15**	**2**	**10**	**1**	**1**	**1**	**672**

Lines of inquiry

In our **Submission** to the 2030 ERP, we provided 40 pieces of advice covering solutions for Canada's three largest GHG emitting sectors – Oil and Gas, Buildings and Transportation – as well as for Net-Zero Governance. Since then, we have decided to take another approach to priority setting. Sectors are important to consider, but taking a system-based approach offers new potential by shedding light on cross-cutting solutions. These are three of the foundational areas of actions that need to be undertaken in Canada to achieve widespread emission reduction:

1. **NET-ZERO GOVERNANCE:** The network of institutional strategies, capacities, and relationships required – both inside and outside of government – to achieve net-zero emissions by 2050. Our advice focuses on strengthening net-zero modelling, ensuring all federal entities play a strong role in attaining a net-zero society, developing and sustaining shared leadership for net-zero, and effectively and transparently monitoring and reporting on progress;

2. **NET-ZERO INDUSTRIAL POLICY:** The use of a combination of policy tools and facilitated collaborations, that harness the creativity and leadership of both the public and private sectors to create, build, or shape an industry and advance its competitiveness in the global economy while addressing problems that the market alone cannot address, all while driving Canada to a net zero emissions society. Our advice focuses on the necessity of a net-zero industrial policy and the process and institutions required for its success. We illustrate our advice with a vision and potential competitiveness goals for four priority sectors; and,

3. **NET-ZERO ENERGY SYSTEMS:** The components related to energy production, conversion, transmission, distribution grids, storage, and consumption. Our advice focuses on changing the ways we think about, manage, and collaborate to transform our energy systems to align them with the imperatives of net-zero emissions.

The selection of these lines of inquiry was guided by extensive engagement activities, review of literature, discussions with lay and expert Canadians, and early discussions with Indigenous experts and organizations.

INDIGENOUS KNOWLEDGE

The CNZEAA requires the NZAB to take into consideration the best available science and Indigenous Knowledge. We are confident that our lines of inquiry are consistent with the latest scientific understanding of net-zero by 2050. While they are also informed by the invaluable contributions of a small number of Indigenous organizations with climate expertise, our 2022 lines of inquiry do not do justice to the magnitude and complexity of the challenges faced

by Indigenous peoples in Canada, nor to the insights that can be offered by Indigenous Knowledge. We know that the consideration of Indigenous Knowledge requires more than hearing the views of First Nations, Inuit and Métis on achieving net-zero emissions by 2050, or simply consulting them on activities that have ramifications on traditional lands.

Canada cannot reach its goal of net-zero emissions by 2050 without the full participation of Indigenous peoples in Canada. To help ensure the NZAB's advice truly considers Indigenous Knowledge, we are taking the time to understand the best ways to do so, and have been humbled along our journey with many lessons learned and reminders of the differing circumstances, needs and opportunities of the hundreds of Indigenous communities across the country. We strive to create a respectful space for Indigenous Knowledge to influence the definition of net-zero priorities in Canada, as doing so will help align the net-zero transition and Canada's journey to true Reconciliation with Indigenous peoples.

The proper consideration of Indigenous Knowledge will require sustained efforts and time. This year, we undertook the development of an Indigenous engagement strategy in partnership with an Indigenous-led organization, to build deeper and long-lasting relationships with First Nations, Inuit and Métis in Canada. We understand the Minister will prioritize appointing more Indigenous people as members of the NZAB at the earliest opportunity and we welcome this development. Net-zero by 2050 will not be possible without the full and active participation of Indigenous peoples as partners and decision-makers.

Core definitions

NET-ZERO emissions means that "anthropogenic emissions"[1] of GHGs into the atmosphere are balanced globally by anthropogenic removals of GHGs from the atmosphere over a specified period" (Intergovernmental Panel on Climate Change [IPCC], 2018). Canada's net-zero commitment includes all GHGs generated within Canada across all sectors. This definition is consistent with international GHG accounting standards in which each country accounts for emissions produced within its borders. Emissions from GHG-producing exports are accounted for in the country of use.

A **PATHWAY** connects where we are today with where we want to go. But it is not just a line on a graph. A pathway captures all the elements required to transform a system to better respond to societal needs and meet net-zero emission goals (e.g., the character, magnitude, and sequence of changes in technologies; infrastructure; business models; societal practices; mindsets; governance structures; investments; reporting requirements; and, policy or regulatory frameworks). A pathway has a clear beginning and defined end, with connecting steps that are refined over time based on learning.

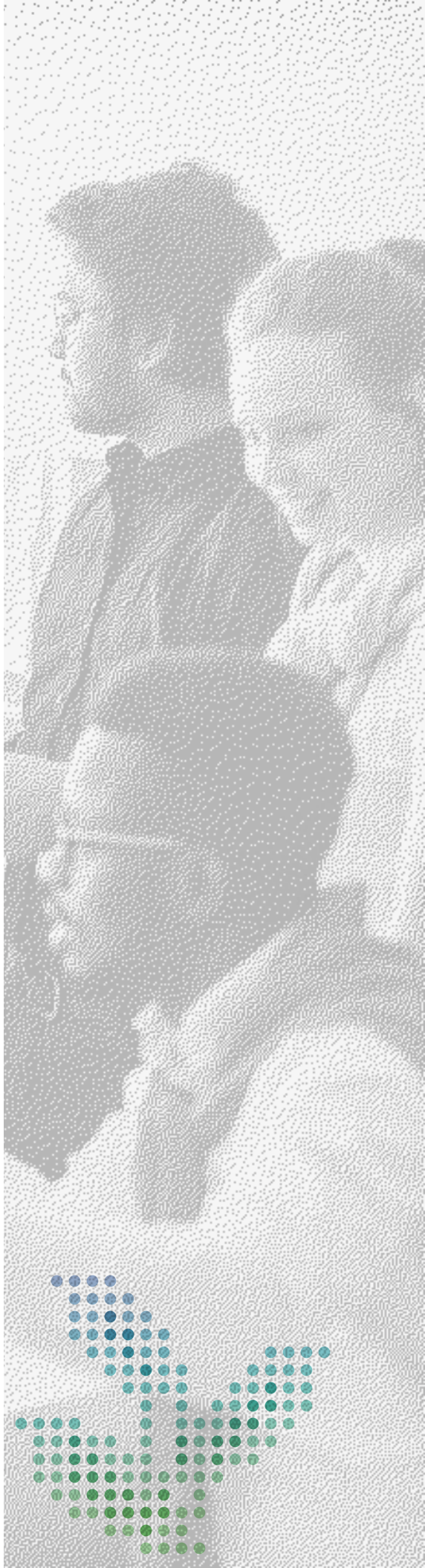
[1] *Anthropogenic emissions refers to greenhouse gas emissions caused by human activities.*

ENGAGEMENT WITH CANADIANS

Consistent with our foundational values and our legislated mandate, engagement is an essential component of our work and the key to motivating and empowering Canadians. Hearing from and considering diverse perspectives allows us to enhance the quality of our advice, recognizing the wide range of conversations taking place across Canada on how to achieve net-zero by 2050.

The NZAB has identified youth and families as the priority target audience for our immediate future engagement activities, since many of the solutions we consider today will be theirs to implement, maintain, and improve. Youth are already at the forefront of climate action. We believe in the importance of providing them with the tools they need to better respond to the challenges that lay ahead, make their voices heard, and lead change in their communities and within their families. To help deliver on this commitment, the NZAB has provided financial support to four organizations across Canada for their engagement with youth and families until March 2024. We also organized a series of design thinking workshops with youth to better understand what they expect from the transition to net-zero emissions by 2050. These insights will be published as part of a What We Heard Report, which will be released in 2023.

The NZAB has also been active in expanding its reach to various stakeholders, rights-holders, decision-makers, and the Canadian public, leveraging social and traditional media, and developing a durable network with key climate organizations and experts in Canada and abroad. Working with the Canadian Climate Institute and international counterparts, we co-chaired the **International Climate Councils Network**, a forum to facilitate collaboration and mutual support between climate councils from around the world. Engagement activities such as these will become a more significant feature of our work in the years to come.



Year-in-review

2022 marked the first anniversary of the NZAB under the CNZEAA. We have been active in reaching out to the Canadian net-zero community to raise awareness and engage on our work. Our main accomplishments include:

The selection of three lines of inquiry for 2022; setting the right framework to successfully achieve net-zero emissions and position Canada for economic success.

With the Canadian Climate Institute, co-hosting the 2030 in Focus: Getting the Next Decade Right on Net-Zero Conference in Ottawa, which attracted the participation of approximately 250 in-person individuals and over 1500 online registrations.

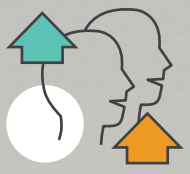
Our submission to the 2030 ERP, providing 40 pieces of advice to reduce emissions, consistent with net-zero pathways in the oil and gas, transportation, and buildings sectors, as well as on governance.

Identified priorities for an Environment and Climate Change Canada call for proposals for research projects from leading academic experts and research organizations across Canada to research on our specific lines of inquiry.

Co-chairing the International Climate Councils Network, a forum to facilitate collaboration and mutual support between climate councils from around the world, with the Canadian Climate Institute, Haut conseil pour le climat de France, Guatemala's National Climate Change Council, and the Guatemalan Climate Change Science System.

Establishing or deepening partnerships with the Commissioner of the Environment and Sustainable Development, the Sustainable Finance Action Council, the Canadian Climate Institute, and the Canada Energy Regulator, among others.

Year-in-review (continued)



Communicating our advice at conferences and events, including COP 27, GLOBE Series, and the Retrofit Canada Conference, as well as with the Office of Superintendent of Financial Institutions, Bank of Montreal, and the Canadian Chamber of Commerce, and many more.

Briefings and interviews with more than 50 domestic and international experts across our three lines of inquiry, and hosting eight roundtables with 52 participants in relation to industrial policy and net-zero energy systems.

Meeting with six Indigenous organizations with expertise on climate change, as a starting point to our longer-term journey towards the consideration of Indigenous Knowledge.

Developing a new partnership with an Indigenous-led organization to conduct a net-zero Indigenous landscape analysis and an engagement strategy.

Financially contributing to four organizations across Canada to support their engagement with youth and families until March 2024 and holding a series of design thinking workshops with youth.

Proactive efforts to minimize GHG emissions from NZAB operations where possible, notably through virtual operations and reduced domestic and international travel.

NZAB Submission to the 2030 ERP

STRENGTHENING GOVERNANCE FOR LIKELY PATHWAYS TO NET-ZERO BY 2050

1. Direct that all federal agencies, departments and Crown corporations publicly articulate their role in helping Canada achieve net-zero emissions
2. Mandate that all executives in the federal public service must take a course on climate change and net-zero
3. Prioritize the development of a climate change data, insights, and monitoring digital platform by the end of 2023
4. Ensure that the models and analytical approaches used to project and assess Canada's progress towards emissions reduction targets are transparent, robust, and coordinated
5. Improve the coordination of engagement processes
6. Improve net-zero communications
7. Leverage intergovernmental platforms to identify gaps and overlaps in government actions and promote net-zero solutions
8. Develop a net-zero workforce

PUTTING THE BUILDINGS SECTOR ON THE MOST LIKELY PATHWAYS TO NET-ZERO BY 2050

9. Adopt a pathways approach in the proposed National Net-Zero Emissions Building Strategy
10. Use regulations to send clear signals and provide certainty about the trajectory of building decarbonization
11. Accelerate and streamline the publication and adoption of national model building codes
12. Use complementary policy tools to incentivize action in the buildings sector and reward success
13. Prioritize transition of heating systems while ensuring the stability of the electrical grid
14. Increase the ambition of federal actions on property and fleet operations
15. Integrate net-zero requirements into all building-related federal funding opportunities
16. Encourage the use of a "shadow carbon price" to show the cost savings of retrofits
17. Seek out opportunities to decarbonize multiple buildings at once
18. Evaluate federal decarbonization programs for residential buildings to ensure maximum effectiveness and equity
19. Support the development of innovative net-zero technologies for the buildings sector

PUTTING THE TRANSPORTATION SECTOR ON THE MOST LIKELY PATHWAYS TO NET-ZERO BY 2050

20. Grow public transportation options
21. Regulate more zero emission vehicle (ZEV) sales as soon as possible
22. Implement and expand measures that support electric vehicle uptake
23. Encourage ZEV adoption
24. Expand the strength and scope of the Clean Fuel Standard
25. Take a supply-chain lens to help the auto sector transition
26. Ensure sufficient investment for zero-emissions heavy freight
27. Drive innovation to reduce emissions in aviation and marine subsectors

KEY GUIDING PRINCIPLES TO INFORM THE DEVELOPMENT OF QUANTITATIVE FIVE-YEAR TARGETS FOR THE OIL AND GAS SECTOR

PRINCIPLES FOR TARGET DESIGN

28. Do not set targets in isolation
29. Set clear boundary conditions for success
30. Recognize that fair may not mean equal
31. Set and implement without delay
32. Align the timing of targets with implementation feasibility
33. Prioritize the largest sources of emissions
34. Drive new and more ambitious actions

PRINCIPLES TO SET THE CONDITIONS FOR SUCCESS

35. Prioritize people and communities
36. Provide certainty while continuously improving data and monitoring
37. Show accountability through reporting
38. Reinforce and strengthen existing regulations
39. Provide only responsible supports to industry
40. Ensure approval processes for projects are working towards, not against, the targets

1. Net-Zero Governance

The NZAB defines governance as the network of institutional strategies, capacities, and relationships required – both inside and outside of government – to achieve net-zero emissions by 2050. No single entity can, on its own, permanently get Canadian society to net-zero emissions. Success depends on setting the right framework for all parts of society to move in the same direction via regulations, standards, and incentives, consistent with credible pathways to net-zero emissions.

Canada possesses a complex governance landscape, due to shared constitutional powers over the environment, uneven distribution of GHG emissions across sectors, provinces, territories and Indigenous communities, and historical legacies that influence how different orders of government work with one another. Governance issues have been used to help explain Canada's poor track record on meeting its climate targets, notably in the **2021 Report of the Commissioner of the Environment and Sustainable Development**. As this country has done many times before, the key will be to find unique, made-in-Canada solutions that motivate concrete action.

At its core, good governance is about aligning mandates and responsibilities with shared objectives, ensuring decisions are made using the best available information, executing decisions, and monitoring and reporting on progress. This section identifies specific actions that can have a tangible impact on decision-making, resourcing, and accountability mechanisms.

Our Submission to the 2030 ERP contained eight pieces of advice on governance. We are pleased that two of them – mandatory training for executives in the federal public service, and developing a net-zero workforce – are being implemented. More time will be required to determine how the federal government responds to two other pieces — improved communications, and stronger coordination of engagement. The remaining four pieces of advice – mandates, improving inter-jurisdictional collaboration through shared leadership, progress monitoring platform, and modelling – are expanded upon in this annual report.

1.1 NET-ZERO MANDATES FOR FEDERAL ENTITIES

All players—public and private alike—have to determine how they can contribute to net-zero by 2050 by adjusting their corporate priorities, planning and decision-making processes, procurement criteria, and risk management strategies, among other actions. Doing so will help tie together efforts to reduce emissions and continuously improve economic, social, and environmental well-being.

Since the introduction of the Pan-Canadian Framework on Clean Growth and Climate Change in 2016, federal departments launched over one hundred policies and programs to reduce emissions. However, it is unclear whether these emissions reduction efforts are always compatible with pathways to a net-zero society. The federal ecosystem also includes more than 200 institutions, Crown corporations, and agencies responsible for supporting or regulating various economic sectors or providing direct services to Canadians, and many of these operate at the core of complex economic systems. They are sometimes the only public organization with the expertise needed to assess transition scenarios for their area of responsibility. Leveraging their capacity would help generate solutions that can steer entire economic sectors in the right direction, even if this means going beyond existing mandates or balancing out incompatible objectives. Without formal mandates, many organizations will not have the corporate legitimacy and legal frameworks they need to maximize their contribution to net-zero.

Examples of net-zero mandates

With the expected launch of the **2023 Energy Futures Report**, the Canada Energy Regulator (CER) will use its technical expertise and resources to model pathways to net-zero by 2050 for the energy sector. But to have a meaningful impact on the energy landscape, the CER's net-zero mandate should be expanded to cover the entirety of its operations, notably its regulatory functions.

The Canada Pension Plan (CPP) committed to meet **net-zero emissions by 2050 across all scopes of emissions**. The CPP contributed to the Task Force on Climate-related Financial Disclosures and publishes the carbon footprint of its portfolios on an annual basis (60.5 Mt CO_2 eq. for global non-government holdings in 2021, equivalent to 9% of Canada's 2020 emissions). While there is no question that the CPP takes the transition seriously, a formal mandate would support accountability on requirements for transition investments and the execution of net-zero plans.

The Canadian Mortgage and Housing Corporation launched a funding program for **green housing and retrofits**. While important, a targeted initiative differs from embedding net-zero pathways across the entirety of CMHC's levers on the housing market. Only the latter approach will lead to the structural changes required to ensure federal housing market policy is net-zero compatible.

The NZAB acknowledges some federal entities have already begun exploring means of contributing to net-zero attainment. The NZAB acknowledges and that the Government committed to introduce an Integrated Climate Lens that would formalize the consideration of emissions reductions in Cabinet decision-making. Our advice proposes to enact changes that go further, ones that permeate throughout entire management, accountability and incentive structures of federal entities. While some federal organizations have made meaningful progress, to maximize the effectiveness of these initiatives, net-zero mandates should be expanded to cover the entirety of corporate operations, be weighted on an equal footing with pre-existing corporate mandates, and be subject to auditing. Even where a net-zero mandate currently exists, there could be considerable untapped potential.

Advice 1

The Government of Canada should direct that all federal agencies, departments and Crown corporations publicly articulate their role in helping Canada achieve net-zero emissions. The Government of Canada should then empower these organizations to play a more ambitious role by formalizing net-zero objectives in their corporate mandates, changing mandates if required, and ensuring that executive compensation is meaningfully and transparently linked to climate mitigation performance. A common framework under the responsibility of the Treasury Board should be applied to ensure minimum standards, transparent reporting, and benchmarking. Opportunities for advancing co-benefits, notably on adaptation, should also be embedded in the mandates of key institutions.

1.2 SHARED LEADERSHIP FOR NET-ZERO

Achieving net-zero by 2050 is dependent on an unprecedented level of collaboration among federal, provincial, territorial, municipal, First Nations, Métis and Inuit governments. Numerous experts, notably the **Commissioner of the Environment and Sustainable Development**, point to insufficient intergovernmental coordination to explain, in part, three decades of missed climate targets.

While the NZAB shares these concerns, there are reasons for optimism. More than sixty years ago, Canada created a system of free, universal healthcare, a project that challenged the concept of what governments can deliver to citizens. Governments still argue over policies and costs, but they no longer question the policy's contribution to Canadian society. This is the outcome we must strive for with respect to net-zero. Under the right framework, Canadian federalism can smooth out variations in ambition at any given moment, promote solutions in line with regional circumstances, and allow for the experimentation of approaches and benchmarking of progress.

What is clear is that many of the tools for implementing pathways to a competitive net-zero emissions society fall in provincial, territorial and municipal jurisdiction. Examples include the adoption of building codes, electricity transmission, land-use planning, route optimization for the transport of goods and people, and training and education, which all fall within provincial and territorial jurisdiction. When emissions reduction opportunities occur on traditional or treaty lands, many of the emerging infrastructure needs will have implications for Indigenous rights, while also offering direct benefits and offering opportunities for greater self-determination.

Additional examples of provincial and territorial leadership can be found across the federation (Table 2). Canadians must have a clearer understanding of the measures that require provincial and territorial actions to materialize, and governments must find new ways of collaborating among themselves and with Indigenous interests.

To counter inertia, more attention must be paid to creating and resourcing issue-specific coalitions to promote the increase of ambition and defend sensitive policies at the regional level. Increasing the number of net-zero champions across regions is a practical measure that the Government of Canada can take to grow cooperative federalism over time. We define net-zero champions as individuals or organizations that boast the expertise, credibility, and networks required to successfully promote the uptake of solutions within their regions and sphere of activities. These can be industrial associations, not-for-profit organizations, municipal or Indigenous governments, utilities, or public institutions with a firm commitment to following the **principles of the High-Level Expert Group on Net-Zero Emissions Commitments of Non-State Entities**.

While this approach has similarities with the **Net-Zero Challenge** launched by Environment and Climate Change Canada (ECCC) in 2022, the Challenge does not currently possess the scale required to build widespread momentum in economic sectors and provinces with rising emissions. As we outline in our Industrial Policy line of inquiry, economic benefits build support for a net-zero future in ways that penalizing GHG emissions does not (**Meckling et al. 2015**). Four of the five most potentially impactful policies put forward in the 2030 ERP are regulatory in nature: (1) carbon pricing, (2) cap on oil and gas emissions, (3) clean electricity regulations, and (4) clean fuel regulations (**Canadian Climate Institute**, **2022**). These measures can be best implemented successfully if impacted regions realize the environmental and economic benefits of reducing emissions. Building active, regional, and high-impact coalitions can help advance this thinking.

Advice 2

The Government of Canada should deliberately develop net-zero champions across Canada and build multi-party issue-specific coalitions to advance key net-zero issues. Champions that benefit from federal support should be required to follow guidelines such as the United Nations High-Level Expert Group on the Net Zero Emissions Commitments of Non-State Entities.

TABLE 2: Percentage change of sectoral emissions in Canada, by province and territory, 2005 to 2020

POLICY LEVER	IMPACT ON NET-ZERO PATHWAYS	LEADING EXAMPLES
Land-use planning	• Prevention of urban sprawl • Sustainable management of population growth • Optimization of distance travelled • District-wide heating and cooling systems • Conservation of natural carbon sinks	Diverse examples from municipalities, as highlighted by the Federation of Canadian Municipalities (2019)
Promotion, exploration, production, and transformation of natural resources	• Securing critical minerals and their refinement • Regulation of fossil fuel production • Market opportunities for new energy carriers	Alberta: Hydrogen Roadmap Québec: Plan québécois pour la valorisation des minéraux critiques et stratégiques 2020-2025
Building codes	• Maximization of energy efficiency • Create demand for net-zero building materials • Integration of buildings and transports • Mitigation of electricity peaks	British Columbia: all new buildings net-zero by 2030

TABLE 2: Percentage change of sectoral emissions in Canada, by province and territory, 2005 to 2020 (continued)

POLICY LEVER	IMPACT ON NET-ZERO PATHWAYS	LEADING EXAMPLES
Electricity production, transmission, and use	• Institutional mandates of utilities • Affordability and reliability of energy • Expansion of clean production capacity • Deployment of proven technologies • Optimization of consumption • Peak demand management • Expansion of transmission lines • Out-of-province flows and trades	Hydro-Québec's 2022-2026 Strategic Plan New Brunswick's, Nova Scotia's, Prince Edward Island's, and Newfoundland and Labrador's Atlantic Loop
Education and trades	• Climate education and training programs • Requalification of trades • Mitigating specialized labour shortages • Generational mindset shifts	University of Saskatchewan: Community Appropriate Sustainable Energy Security Program
Transportation	• Modal shifts to public and active transportation • Modal optimization for traffic and freight • Reducing distance travelled	City of Toronto: Downtown Mobility Strategy Clean B.C. Transportation Roadmap to 2030
Landfills and waste management	• Promotion of waste reduction • Capture of waste emissions • Biomass conversion • Regulation of forestry • Protection of lands and carbon sinks	City of Kitchener City of Saint-Hyacinthe City of Regina
Financial regulation	• Climate-related disclosures of provincial financial bodies • Regulation of systemic financial risks	Most provincial regulators currently explore systemic risks from climate change

1.3 COMPREHENSIVE, CENTRALIZED AND ACCESSIBLE MONITORING PLATFORM

In **Net-Zero Pathways: Initial Observations (2021)**, we noted how pathways capture all the elements required to transform a system to better respond to societal needs and meet net-zero emissions targets. A wide range of factors, some easily identified and measured, will determine whether Canada is able to reach net-zero by 2050 - examples include ZEV market shares, number of charging stations, electricity storage costs, renewables to gas price ratios, clean power generation capacity, energy demand, restoration of natural carbon sinks, and heat pump coverage. Progress on net-zero pathways can only happen if a proper monitoring framework follows key indicators, such as those noted above. There is currently no systematic monitoring and accessible reporting of the trends of these net-zero indicators.

Canada's progress to net-zero is reported in two ways, but neither captures the net-zero indicators required to inform people of progress in ways that they can relate to, build support for emissions reduction action, and identify sectors or regions that are misaligned with net-zero pathways on a timely basis. First, the government set a Nationally Determined Contribution for 2030, corresponding to 40 to 45% below 2005 levels by 2030, and reports annually on national emissions through the **Official Greenhouse Gas Inventory**. Consistent with the CNZEAA, additional targets will be set every five years, starting in 2025 for the 2035 target. Second, program-level indicators are being used to report on progress, but these need considerable improvement and only imperfectly relate to net-zero by 2050. For example, in 2020-21, out of 86 federal departments and agencies for which **results were publicly available**, only six had established indicators of relevance. Almost two thirds of these indicators belong to Environment and Climate Change Canada and Natural Resources Canada programs, gaps exist in the range of indicators being monitored, and results are unavailable for about 25% of them.

A new source of information must bridge the gap that currently exists between the national monitoring of GHG emissions and program-level assessments of performance, though the latter would benefit from a stronger alignment with Canada's commitment to achieve net-zero by 2050. We observe growing momentum for a dedicated platform to act as a one-stop-shop for progress monitoring towards 2050. The recent launch of the **440 Megatonnes** project by the Canadian Climate Institute represents one of the most credible attempts at doing so to date. International examples can be found in the work of the **United Kingdom Climate Change Committee**, **Germany**, and the **Haut conseil sur le climat de France** (annex A.2). The Government of Canada has a role to play in the success of third-party initiatives, in particular with respect to addressing the data gaps that impede the monitoring of key trends by independent experts.

Advice 3

The Government of Canada should create a public-facing net-zero dashboard, providing Canadians with easy access to meaningful information, notably quarterly data on GHG emission trends by sector, and leading indicators of progress. This is best done in collaboration with external organizations.

- This reporting platform should provide a repository of authoritative information to communicate the trends, pace, and magnitude of progress.
- Any information presented that is based on net-zero modelling should reflect the six pieces of advice related to modelling (presented in the next section).
- This platform should encourage the accountability of non-federal entities where appropriate.
- Opportunities to track outcomes of direct interest to Canadians and communicate the benefits of the transition should be explored simultaneously (e.g., transit time, jobs, energy affordability, housing quality, and health benefits).

1.4 CANADA'S NET-ZERO MODELLING CAPACITY

Governments use modelling to explore problems and evaluate the effectiveness of initiatives. When used appropriately, analyses and modelling can direct the use of limited resources towards their most productive use, shed light on complex interactions, and build understanding of the potential impacts of policies, actions, and investments. Used inappropriately, models can steer thinking towards dead-end pathways and provide a false sense of progress (e.g., McLaren et al., 2019, Rising et al., 2022). What is unique to climate policy models is their scope, complexity, and extended time horizons, as well as the fact that they were not designed to capture the profound nature of the social and economic changes we ask them to emulate.

Models are critical to the development of credible and effective net-zero plans. However, to maximize the odds of avoiding the most serious consequences of climate change, Canada must ramp up its net-zero modelling rigour, capacity, and transparency and reconsider how results are used to inform decision-making, communicate with Canadians, and sustain public accountability.

Our advice provides a path forward to maximize the benefits of net-zero modelling while minimizing inherent weaknesses, with a view to increasing

the strength of our analytical tools and models on a continuous basis. Our advice should not be construed as suggesting that net-zero modelling done to date was inappropriate or wrong. We are confident the Government of Canada based its decisions on the best available models as of 2022, but we are equally confident that there is room to markedly improve these tools. The modelling and analysis issues raised in this report are experienced around the world and cannot be used as an excuse to be indecisive or to lower the pace of the transition.

In March 2022, we advised the Minister of Environment and Climate Change to ensure the models and analytical approaches used by the Government of Canada are transparent, robust, and coordinated. In summer 2022, to expand on these pieces of advice, we commissioned 37 interviews covering a large portion of the Canadian net-zero modelling community, including individuals that use model outputs to guide their decisions. The interviewees included scholars, federal and provincial officials, non-governmental organizations (NGOs), think tanks, as well as international experts.

What is modelling?

Modelling is a method of representing the behaviour of a system, like the atmosphere or the economy, in abstract terms using mathematical equations. These equations simplify a vastly more complex reality, such that we can test hypotheses and forecast the future behaviour of systems.

As more attention was brought to the ways in which governments could reduce GHG emissions, it became necessary to forecast the impacts of different measures using energy-economy models, an approach that tries to anticipate the evolution of economic growth, energy consumption, and GHG emissions over time. In Canada, as in other Organisation for Economic Cooperation and Development (OECD) nations, national energy-economic models were created in the wake of energy supply shocks during the oil crises of the 1970s. Growing interest in environmental issues (e.g., smog and acid rain) led to the integration of polluting emissions into these models. The same types of models are now being used to explore net-zero scenarios.

These models allow us to understand how introducing changes to the system (e.g., a new policy or decline in the price of a technology) impacts emissions reductions over time. Models are now increasingly being used to explore net-zero scenarios. Because structural factors such as economic and population growth, energy uses, sources and prices, performance of technologies, interactions between economic sectors, and international trade significantly impact future emissions trajectories, modellers must introduce a complex set of equations and assumptions that reflect reality as closely as possible.

Since most pathway designs cannot be explicitly represented in mathematical equations, modellers must also make simplifying assumptions about the way pathway steps will be implemented. Doing so introduces uncertainty.

While models are central to good policy-making, their use entails inherent risks in the absence of an adequate governance framework. One of the most common concerns being raised is that models are often akin to "black boxes": only a handful of experts understand the factors that drove a model's output, and most models being used in support of Canadian net-zero policy do not currently open their structure to peer review. Most challenges, however, can be addressed with an adequate governance model, which we propose in this section of the Annual Report.

1.4.1 IMPROVING THE QUALITY OF MODELS

Canada's net-zero modelling community is small, but capable. A large portion of the pan-Canadian modelling capacity lies within the federal government, notably in Environment and Climate Change Canada, Natural Resources Canada, Transport Canada, Agriculture and Agri-Food Canada, Finance Canada, and independent agencies (e.g., the Canada Energy Regulator). While some provinces have established independent modelling capacity, most rely on private contractors. Some provincial entities (e.g., public and private utilities) and private companies (e.g., banks, energy firms) maintain their own models for internal use. In the academic sector, a variety of research groups, particularly in engineering and economics, have developed and applied models to explore different dimensions of climate policy (Rhodes et al., 2022).

Canadian net-zero modelling faces a complex suite of unaddressed risks and challenges. None of these are unique to Canada, but we appear to lag behind the United States (U.S.), the European Union (EU), and the United Kingdom (U.K.) in the depth of our expertise, the range of initiatives we support, access to data, promotion of experimental approaches, and in systematically acknowledging the challenges associated with net-zero modelling. Initiatives have been undertaken over the last few years to address some of these difficulties. For example, Natural Resources Canada funded the creation of the Energy Modelling Initiative, and Environment and Climate Change Canada improved the transparency of its modelling in the 2030 ERP and committed to convene an expert-led process to strengthen its modelling practices.

While these are steps in the right direction, strengthening modelling capacity in Canada requires larger scale actions. Canada has already invested over $100 billion to reduce GHG emissions. Public and private investments can be expected to grow markedly over time. Good governance calls for extensive assessments of policy effectiveness through more and better modelling, in federal departments and agencies, but also in other groups. The overwhelming majority of interviewees acknowledged ongoing difficulties with how modelling informs climate policy, drawing attention to four main challenges:

A THE NET-ZERO MODELLING COMMUNITY IS FRAGMENTED AND OPAQUE, AND EFFORTS AMONG GOVERNMENTS, PRIVATE CONSULTANCIES AND ACADEMICS ARE RARELY COORDINATED.

Many factors work against enhanced transparency and coordination, such as insufficient resources to allow for the testing of a model's sensitivity to assumptions and documentation of modelling runs, or perceived risks of model weaknesses being exploited to seed doubts about achieving net-zero. Private model operators guard the inner workings of their models to ensure a proprietary advantage, and government officials are bound by confidentiality provisions associated with developing advice to Ministers and Cabinet.

Information on a model's structure, core assumptions, selection of scenarios, suite of included measures, depiction of technological pathways, and amount and nature of sensitivity analyses are necessary to understand what a given set of model outputs are saying. Without transparency and collaboration on assumptions, data management, and model structures, it is nearly impossible to compare the results of different emissions models, appreciate which factors drove the divergence of results, and engage in the collective learning required to produce better models and policy design.

Stronger disclosure would increase credibility, accountability and legitimacy of climate plans. By making modelling practices and assumptions more transparent, the the Government of Canada can strengthen public confidence in climate policy and focus debates on the conditions required for implementation. This, in turn, can redirect public scrutiny to the entities holding actual levers of emissions reduction. Various levels of transparency are possible, from a basic description of a model's structure, key inputs and assumptions, to open access to the inner workings of a model and data for third parties to review, use, and improve.

Building a vibrant and diverse net-zero modelling community is a long-term undertaking that will require continuous improvements. It is an effective means of identifying the best climate policies and strengthening Canada's long-term climate performance. Ambitious initiatives are needed to strengthen Canadian capacity, and to move away from a subset of federal departments and agencies, a small number of consultancies, and fragmented academic groups holding the bulk of Canadian expertise and mostly operating in isolation.

B THE GOVERNANCE OF NET-ZERO MODELLING DOES NOT CURRENTLY MITIGATE THE RISK OF MODEL UNCERTAINTY DIMINISHING THE ROBUSTNESS OF POLICY DECISIONS.

Emissions projections from models in different policy scenarios are critical to guiding the level and form of policy interventions necessary to shift Canada to a net-zero pathway. However, there is concern within the Canadian energy and policy expert community that models currently overestimate the impact of existing and proposed policies on near-term emissions reductions (to 2030). This is due to uncertainties around policy implementation, which is never seamless in practice, and around the optimal method of incorporating existing and planned policies in the models.

Overestimating, or underestimating, the effect of policies on emissions can have a tangible effect on decision-making. For example, if the carbon price is incorrectly determined by a model as being sufficient to achieve net-zero in a given sector of the economy, the government may not create and implement necessary complimentary sector-specific policies to achieve the desired emissions cuts. Model outputs alone cannot guarantee that policies will meet their goals.

C THERE ARE DIFFICULTIES IN ACCESSING TIMELY, CREDIBLE AND COMPREHENSIVE DATA.

No matter how sophisticated and accurate a model structure is, the quality of output depends on the quality of input. Data is derived through sampling processes, surveys, academic studies, and estimates. Securing access to reliable data is a costly, lengthy, and complex undertaking. The main barrier for a group wishing to begin modelling climate policies in Canada is the acquisition of high-quality data. Even for established modellers, access to data is a major barrier that prevents the development of insightful analysis.

Some critical information is currently unavailable in Canada, such as data on Canada's vehicle fleet, the distance covered by vehicles, monthly fuel consumption within provinces and territories, energy use by industrial subsectors, and the production and consumption of biofuels (see **Whitmore & Pineau, 2022** for data gaps). Data gaps are particularly prominent for remote, northern and Indigenous communities. The two years it takes for the federal government to release emissions data has been raised as another challenge (e.g., 2022 data will only be available in 2024).

D IT IS CURRENTLY IMPOSSIBLE TO ATTRIBUTE GHG EMISSIONS REDUCTION OBJECTIVES TO INDIVIDUAL MEASURES.

This hinders efforts to monitor whether or not an investment achieved the desired outcome. This issue arises from insufficient time being afforded to modellers to undertake multiple runs to test the impact of policies, limited transparency of model assumptions, as well as limited collaboration across government, private, academic, and not-for-profit modellers.

Advice 4

The Government of Canada should establish an independent modelling and data centre of excellence, operational by June 2024. The centre should be similar to the **Canadian Institute for Health Information** and the **U.S. Energy Information Administration**, and be given the legislative authorities required to protect sensitive data without hindering access. Representatives from academia, NGOs, and federal, provincial, territorial, and Indigenous governments should sit on the board of directors. The mandate of the centre of excellence should include:

- Developing and maintaining new net-zero modelling tools, including a suite of open-source tools and data sets;
- Collecting, managing and publishing data of relevance to net-zero modelling and maintaining a public repository;
- Coordinating model inter-comparison and multi-scenario modelling efforts among government, academic and private groups, to increase robustness of emissions projections, bring coherence to scenario development, and identify key uncertainties;
- Offering authoritative net-zero modelling services to federal, provincial, territorial, Indigenous and municipal governments, and third-party organizations;
- Systematically reviewing data gaps and developing a plan to fill them;
- Training government officials, policy advisors, and highly qualified personnel on modelling, use and interpretation;
- Establishing national minimum transparency standards on model structure, data, assumptions, and scenario design, in collaboration with government officials, academic experts and consultancies.

The new centre of excellence would contribute to developing independent modelling capacity, establishing relationships with other orders of government, and encouraging collaboration on net-zero modelling and analysis. An independent entity with sufficient resources can steer such an initiative to fruition. The creation of a new centre of excellence must not delay the Government of Canada in improving the quality of its net-zero modelling, increasing transparency, and undertaking collaborative projects with external experts and other orders of governments, and taking steps to address the issues described above in the centre of excellence's mandate. The need for improved data, analyses and modelling should also not be used as an excuse to delay action, nor decrease the ambition of net-zero pathway development and implementation.

Advice 5

Environment and Climate Change Canada should close the 2-year data lag for reporting more detailed and accessible data on GHG emissions, starting with emission-year 2023. Environment and Climate Change Canada should launch quarterly reporting of GHG emissions, similar to the European Union.

Advice 6

Federal departments, agencies, and Crown corporations should increase their expertise and capacity related to data, analyses, and interpretations of net-zero modelling activities. This would increase their ability to support their organization's net-zero planning efforts, allow more strategic interactions across organizations, and facilitate collaboration with the new centre of excellence. This should include dedicated resources for the development of sectoral models, experimental scenario development, sensitivity analysis, documentation, and training. All government-led modelling exercises and analyses should be undertaken transparently and in partnership with external experts.

1.4.2 IMPROVING THE USE OF MODELS IN SUPPORT OF NET-ZERO PATHWAYS

Models clarify thinking, examine the conditions under which a scenario holds true, and explore areas of uncertainty. Yet the insights they generate depend on a critical examination of the results. Ultimately, no model result is strong enough on its own to chart the path forward without a critical examination by decision-makers, and comparisons across multiple model runs. Our interviews shed light on two limitations in the way model results are currently being used for policy development.

A THERE IS LIMITED RECOGNITION OF THE INHERENT COMPLEXITIES ASSOCIATED WITH USING HISTORICAL MODELS (I.E., CARBON-BASED ECONOMY MODELS) TO FORECAST FUNDAMENTALLY DIFFERENT ECONOMIC STRUCTURES 27 YEARS FROM NOW.

Models are developed in a specific context, impacting the stories they can and cannot tell. The models currently being used to explore net-zero scenarios are calibrated by verifying their ability to account for historical developments. But over time, deep structural changes may mean that established relationships, which are inherent to the model's structure and performance, no longer hold true. For example, in a world committed to net-zero, higher oil prices will not automatically lead to increased exploration. Since a model's

structural features are rarely reworked, the reliability of a model tends to decline over time while their complexity increases, especially for an undertaking as transformative as net-zero by 2050. As time goes by and new model modules are added, it also becomes increasingly difficult to understand the factors that drove model outputs.

This leads to older models being poorly suited to identify transformative pathways (Pye et al. 2021). As of November 2022, very few net-zero studies had been done in Canada, and those that had, generally suggest that a very large-scale application of negative emissions technologies are required to meet net-zero by 2050 (e.g., Canada's Long-Term Strategy, 2022). Twenty years ago, no model had the ability to propose or predict the rise of zero emission-vehicle technologies; these emerged from a confluence of scientific, industrial and government initiatives. Public officials, NGOs, industries, consumers, and scientists propose innovative solutions—models do not. Over-reliance on models can lead to decision-makers being overly dependent on imperfect quantitative assessment tools.

B THE EXPECTATIONS OF DECISION-MAKERS AND THE PUBLIC ON THE MEANING OF MODEL RESULTS ARE NOT IN LINE WITH THEIR INHERENT LIMITATIONS.

The 2030 ERP provides a single number on GHG emissions reduction to be achieved by 2030, and the government positions the plan as being sufficient to meet this number. As all models have strengths and weaknesses, bringing multiple models to bear can provide a stronger understanding of solutions. Presenting models as one of many tools used in the development of net-zero pathways would help ensure that expectations are consistent with the uncertainty of modelling exercise.

Model results are best understood when they are accompanied by a description of assumptions, sensitivity analyses, and confidence intervals based on multiple policy scenarios. This is a time-consuming process. In a fast-track policy development process, there is rarely enough time to conduct extensive sensitivity analyses and attribute emissions reductions to specific measures. Since it can take many days to complete a single modelling run in many models, only two to three different sets of assumptions can be tested over the course of a week.

Focusing climate plans on the result of one specific modelling run also contributes to a misleading sense of security. The absence of confidence intervals (e.g., error bans) in climate plans suggests a level of precision that does not reflect the methodological limitations of net-zero modelling, and contrasts with the practices of the Intergovernmental Panel on Climate Change. The fact that a model can generate a quantitative figure does not make the analysis more rigorous than a qualitative assessment—its quality depends on how the modelling was done and on the assumptions which generated the outputs. This observation applies to both government-led initiatives, as well as net-zero reports from private consultants, NGOs and think tanks.

An emerging suite of tools can give a more adequate understanding of

potential net-zero pathways. These may involve emphasis on detailed sector and subsector models (rather than whole-of-economy models), on physical flows (rather than financial flows), on modelling tipping points when systems flip from one dominant state to another (rather than equilibrium adjustments, which is the current norm), and on more adequate mapping of demand side options that may eventually be required to reach net-zero (even those that appear unappealing today). The U.K.'s 6th carbon budget, for example, leverages some of these emerging approaches. To our knowledge, these approaches are not currently in use in Canada.

Advice 7

Environment and Climate Change Canada should do modelling runs on a continuous basis throughout the year, and decouple them from the release of climate plans to increase learning and ensure robust analyses.

Advice 8

The Government of Canada should include modelling to net-zero in all future ERPs, but should not base the plan solely on macro-economic modelling. Moving forward, there needs to be a recognition of the inherent difficulties associated with modelling a structurally different economy. ERPs should include a detailed qualitative analysis of the character of the Canadian economy associated with declining GHG emissions, the steps required to secure emission reductions, associated competitiveness opportunities and risks (see our advice on industrial policy), and linkages between adaptation and mitigation actions. New Zealand's Emission Reduction Plan provides a good example of this type of approach.

Advice 9

The Government of Canada should issue guidance on proper analysis in support of climate policy, similar to the United Kingdom Treasury Aqua Book, to strengthen the use of models in support of decision-making.

2. Net-Zero Industrial Policy

The NZAB defines industrial policy as any set of deliberate measures to redirect economic activity to solve problems that, left to itself, the market will not address (Sabel, 2022). Industrial policy seeks to create and shape industry, but unlike the top-down, protectionist measures of the past, a modern industrial policy is an institutionalized process for strategic collaboration between industry and government and for learning in the face of uncertainty.

A net-zero industrial policy aims to build domestic industries that both secure Canada's competitiveness in the global economy and contribute to reducing or eliminating emissions, consistent with the targets and plans established under the CNZEAA. Industrial policy uses the real economy – the production, purchase and flow of goods and services – to provide direction and certainty about opportunities for growth in a net-zero future.

A net-zero industrial policy is a concrete way of implementing the pathways-centred approach outlined in our Net-Zero Pathways: Initial Observations report (2021). It starts with defining an end goal and then lays out a roadmap that encompasses all the elements required to transform an industry. A proactive industrial policy is central to achieving the urgent transformation required by net-zero, driving down the costs of net-zero technologies, and building new coalitions of support for climate action.

Historically, industrial policy has been used by governments around the world both to protect important domestic industries and to promote the growth of emerging sectors. In Canada, federal, provincial and territorial governments have used industrial policies to create, protect and expand key industries, such as in transportation, telecommunications, and natural resources. With the turn to market-focused approaches and criticism of government intervention in the economy in the 1980s, industrial policy fell out of favour in many countries, including Canada, but never fully disappeared. In the face of global shocks such as the 2008–2009 financial crisis and more recently, the COVID-19 pandemic, governments around the world have more openly begun to implement policies to protect, grow, and create specific industries.

In the last decade, Canada has introduced a variety of measures, plans, and strategies targeting innovation

and growth across the economy and in specific sectors. Unfortunately, design and implementation has been piecemeal, with focus spread across too many priorities and limited coordination and monitoring across federal departments and different orders of government. For example, the **Economic Strategy Tables** convened private sector stakeholders with federal officials to identify sector-specific opportunities and released a final report in 2018; however, the tables have not been institutionalized as an ongoing forum for collaboration (Allan, 2022).

Canada has also launched strategies specifically focused on growing net-zero industries, including the **Small Modular Reactor Roadmap** (2018), the **Mines to Mobility Strategy** (2019), the **Hydrogen Strategy** (2020), the **Net-Zero Carbon Concrete Roadmap** (November 2022), the **Canadian Critical Minerals Strategy** (December 2022), and the **Regional Energy and Resource Tables** (launched June 2022). These strategies are an opportunity to organize government and private sector action in the industries they target and across different regions, but they could be strengthened by being brought together explicitly under a net-zero industrial policy that follows the principles and process we outline in section 2.2. Similarly, federal funding programs, such as the **Strategic Innovation Fund** and the emerging **Canada Growth Fund**, could play a stronger role by proactively identifying a portfolio of strategic investments to move specific sectors forward (**Allan et al., 2022**).

2.1 WHY CANADA NEEDS A NET-ZERO INDUSTRIAL POLICY

Adopting a net-zero industrial policy would provide a strong complement to the ERP, allow Canada to be more proactive in meeting its climate objectives, and respond to the urgent pressures of global competition in the emerging net-zero economy. It is also necessary to create and strengthen economic opportunities for Canadian workers, supporting a fair transition. A net-zero industrial policy would provide certainty about the transformations required, increase accountability in the transition to net-zero, ensure Canadians benefit from emerging global economic opportunities, reduce risks in an uncertain world, and build coalitions of support for climate action.

While carbon pricing has been a central pillar of Canada's climate policy, recent studies have shown that in practice, carbon prices must be set at a higher threshold to have material impact on behaviours (**Cullenwald and Victor, 2021**). In a Canadian context, the politics of carbon pricing reduces the likelihood of the price ever being set high enough to motivate true transformation and deep decarbonization. The carbon pricing regime creates a foundation on which other policies, regulations and strategies can build for maximum effectiveness. The signals carbon prices send about the scale and pace of change are broad and diffused; these signals need to be translated into concrete direction to reshape industries and overcome sector-specific challenges. Industrial policy can provide this direction and supports structural transformation, taking into account regional circumstances. It can help Canada set clear priorities and objectives, which will in turn strengthen

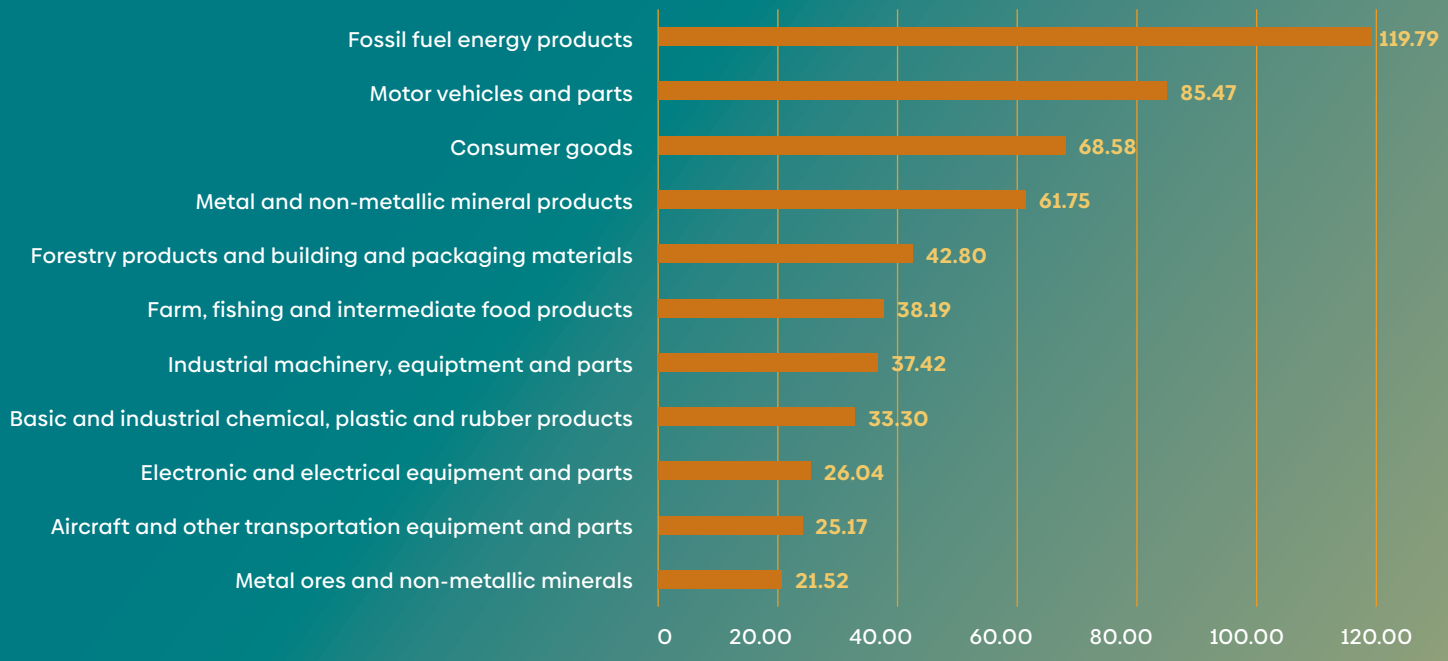
policy implementation and accountability and provide greater certainty about where to invest public and private funds. By providing strategic focus for innovation and investment, industrial policy can also drive down the costs of key technologies needed to achieve net-zero.

Seizing the upsides of net-zero is only possible if Canada acts now to establish its place in the emerging global green economy. Exports have been a key driver of growth in Canada and they remain critical to small, open economies such as ours (Allan et al., 2022). Canada's leading export goods are fossil fuel energy products, motor vehicles and parts, and metal and mineral products (Statistics Canada, 2022). In 2019, these represented 21%, 15%, and 11% of $560.03 billion in total exports, respectively.

FIGURE 1:

Canadian Goods Export in 2019 (C$ BILLION)

SOURCE: Statistics Canada



By 2050, the value of these exports will need to have evolved into net-zero alternatives. New global value chains are already rapidly emerging, for example in batteries and renewable energy technologies. Many of Canada's key trade partners, particularly the EU with its European Green Deal, and the U.S., with the Inflation Reduction Act, are actively pursuing green industrial policies and are looking to establish supply chains with like-minded countries (Hiel, 2020). Without urgent action on industrial policy, Canada risks falling out of sync with its peers and missing critical opportunities to add value to its exports.

U.S. Inflation Reduction Act — Implications for Canada

In August 2022, the U.S. passed the Inflation Reduction Act (IRA), which introduced significant public investment and tax incentives for clean energy and clean technologies. The IRA explicitly aims to build domestic energy production and manufacturing and to create and protect domestic jobs while helping the U.S. make significant progress in reducing its emissions. Preliminary modelling by the Rapid Energy Policy Evaluation and Analysis Toolkit (REPEAT) shows the IRA has the potential to reduce U.S. emissions by 41% below 2005 levels by 2030, compared to 26% with current policies. The scale of public investment sends a strong signal to industry and investors about the certainty and urgency of the net-zero transition.

The IRA has significant implications for Canada. It brings the U.S. in line with Canada's commitment and ambition to get to net-zero. Thanks to strong diplomacy and advocacy by Canadian governments and industry, the final legislation includes Canadian products and components in its electric vehicle (EV) rebates, recognizing the cross-border integration of the automotive sector. However, the IRA also creates a risk of diverting private capital to the U.S. and harming Canadian firms through protectionist measures, particularly for steel and forestry products (Beck, 2022).

Establishing these new value chains can also reduce the risk of geopolitical factors slowing Canada and the world's progress towards net-zero. For example, Russia is an important global producer and exporter of critical minerals, including battery-grade nickel, and Russia's war on Ukraine and subsequent sanctions highlight the vulnerability of current supply chains for batteries and other clean technologies (**OECD, 2022**). As discussed in Section 2.4, Canada could serve as a reliable source of critical minerals and associated value-added products, allowing it and other countries to establish supply chains that are more resilient to geopolitical dynamics. Industrial policy should aim to address potential threats and weaknesses in supply chains and to mitigate dependencies on other jurisdictions for supplying the necessary goods to achieve net-zero.

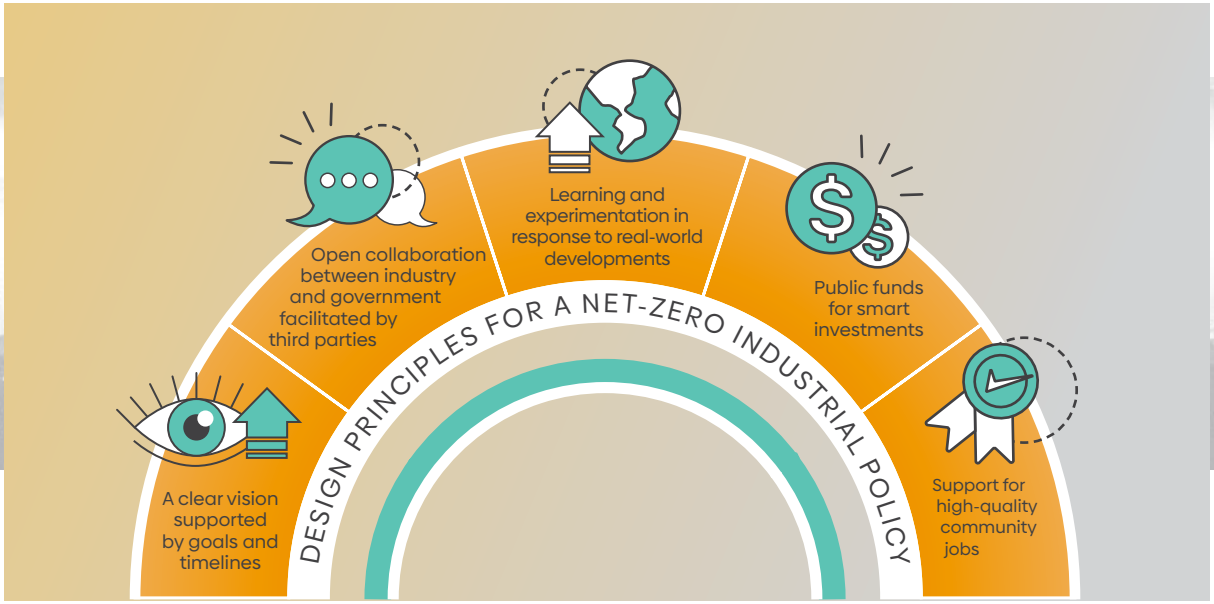
Because it creates clear economic opportunities, net-zero industrial policy is a powerful tool for building coalitions in support of climate policy. As noted earlier in our Governance section, rather than imposing costs or regulations on industries, industrial policy supports their establishment by growing the number of beneficiaries of the transition into more climate-friendly parts of the economy. In contrast to carbon pricing, the benefits of industrial policy are concentrated, creating a new set of stakeholders invested in the climate transition. Once industries have invested in low-carbon technologies, techniques, or products, a positive feedback loop emerges: these firms now have an incentive to support strengthened climate policies to maintain their competitive advantage, even as government supports for their industry are withdrawn over time (**Meckling et al., 2015**).

Advice 10

The Government of Canada should urgently drive the development and implementation of a Canadian net-zero industrial policy to complement the 2030 ERP, consistent with the process outlined in section 2.2.

2.2 ESTABLISHING AN EFFECTIVE NET-ZERO INDUSTRIAL POLICY PROCESS

A successful Canadian net-zero industrial policy should be based on five design principles that reflect best practices around the world.



The first essential design principle of industrial policy is a clear vision tied to goals that focus action and provide a picture of the technological change needed to achieve net-zero. We refer to these goals as net-zero economic competitiveness goals: quantitative economic metrics that are aligned with Canada's net-zero objective and reflect how Canada can maintain or grow its place in the global supply chains of 2030 and 2050.

Net-zero economic competitiveness goals are set at the sectoral level rather than in relation to broad innovation or economy-wide objectives: this sectoral focus provides actionable direction for the development of net-zero technologies and enabling infrastructure. In Section 2.4 we provide concrete examples to illustrate what such net-zero economic competitiveness goals could look like in practice for four priority sectors.

Public-private collaboration through ongoing forums for deliberation, facilitated and led by third-party intermediaries, and ongoing evaluation is a second key design principle of effective industrial policies. Good information flows between government and industry are essential to creating trust and buy-in in the industrial policy process.

Industry-specific expertise is needed to set realistic goals, develop tailored policy interventions, and evaluate progress on the ground. However, industrial transformation is disruptive and must go beyond the current commercial interests of incumbent industries. As a result, there is a risk that industrial policy processes will face resistance from incumbents or capture by special interests, particularly at the early stages of change where emerging industries face power imbalances. Government vision and commitment and the use of third-party intermediaries is required to direct this process, balance interests, and invest in the long-term benefits for all of society (**Hastings-Simon, 2019**).

In Canada, responsibility for climate, energy, and innovation policy is split between multiple departments and between federal, provincial/territorial and other jurisdictions. This creates challenges for coordination and monitoring of outcomes. To avoid adding to this complexity, a net-zero industrial policy must clearly assign roles and deadlines within each part of the process. The government's role is to implement and monitor success—developing government capacity and establishing strong oversight of results within government is thus critical.

Independent organizations play an important role as brokers between industry and governments in industrial policy. They can act as sources of credible expertise, help maintain a strategic focus, and build connections. Experimentation, learning, and adapting quickly to new information is a third key design principle of industrial policy, but governments often struggle to be nimble enough to quickly adjust goals, policies, and plans to new information. Independent brokers can provide a venue for research and learning in support of ongoing flexible and adaptable industrial policies.

Experts and stakeholders we spoke with emphasized that Canada needs to substantially increase its investment in net-zero solutions, and that current funding approaches are insufficient. A fourth design principle of industrial policy is to make smart investments by identifying portfolios of projects that collectively have a strong potential to transition an industry to net-zero. This runs counter to the current approach of evaluating potential benefits and risks at the individual project level. Investments of public funds also need to be strategic and proactive in identifying critical projects, addressing sector-specific barriers, and supporting a well-trained, innovative workforce. This links to the final design principle that a net-zero industrial policy and new investments need to create not just more jobs, but high-quality jobs that support families and communities.

Examples of institutional structures for successful industrial policies

In 2013 the U.K. released its Offshore Wind Industrial Strategy, setting a target of installing 30 gigawatts (GW) of offshore wind power by 2030 (later increased to 40 GW and subsequently, to 50 GW). In 2018, this was updated and renewed as the Offshore Wind Sector Deal. The Offshore Wind Industry Council was established and now brings together 24 members from government, utilities, private companies, and stakeholders to oversee and drive the implementation of the Sector Deal. The U.K. also relies on independent expert organizations such as the Offshore Wind Innovation Hub, which has developed roadmaps in collaboration with industry and academia. These roadmaps "provide government and industry with a single, validated source of information on the key challenges and innovation priorities within the U.K. offshore wind sector".

Similarly, the EU Battery Alliance was launched in 2017 with the objective of building a pan-European battery industry to capture a new market estimated to be worth €250 billion per year in 2025. This included a target of building 10–20 gigafactories (equivalent to approximately 500-1000 GW hours of batteries) The Battery Alliance now includes more than 750 members from governments, economic development agencies, and industry. Independent agencies, including InnoEnergy and Agora Energiewende, support strategy, implementation, and assessment.

Both of these initiatives have produced results: as of 2020, the U.K. had installed 17.63 GW of wind power, with a further 9.8 GW in the project pipeline (McNally, 2022), while projects in development under the EU Battery Alliance stand to produce 800 GW hours of batteries by 2030 (Batteries News, 2022).

Advice 11

The Government of Canada should initially focus its Canadian net-zero industrial policy on a limited number of priority sectors that have significant economic opportunities for growth and benefits across all regions of Canada. Identification of priority sectors could build on our analysis in section 2.4.

Advice 12

The Government of Canada should establish time-limited strategy tables to develop net-zero competitiveness goals and roadmaps for priority sectors, bringing together a small number of relevant federal departments with industry, independent experts, labour, provincial and territorial representatives, and Indigenous rights holders. The competitiveness goals would align with the ERP sectoral emissions targets, support regulatory mechanisms, and achieve economic growth objectives. Roadmaps would include key supportive policy interventions and targeted investment areas to build robust, permanent value chains.

Advice 13

The Government of Canada should use independent intermediaries to support these tables by providing and engaging expertise in key sectors and developing and deepening sectoral buy-in. It is critical that these tables are empowered to provide strategic direction, but implementation is a shared responsibility among governments, the private sector, and other relevant parties. Strategy tables should support experimentation, learning, and evaluation.

Advice 14

Central agencies should be responsible for leading, coordinating, and regularly monitoring the implementation of net-zero industrial policies, using a system-level strategy, to ensure coherence and timely progress. Leadership at the centre of government is essential given the complexity of net-zero industrial policy and the need for capacity building within government.

Advice 15

The Government of Canada should refocus existing funds, such as the Strategic Innovation Fund and the Canada Growth Fund, to portfolios of net-zero compatible projects aligned with its net-zero industrial policy that together support the emissions reduction targets in the ERP. It should explore creative and flexible financing options, including the use of public procurement, to advance net-zero industrial policy goals. This means, for example, incorporating support for procurement of Canadian net-zero industrial products and technologies as part of the Greening Government Strategy.

2.3 CREATING AN ENABLING POLICY ENVIRONMENT FOR NET-ZERO INDUSTRIAL POLICY

Just as collaboration is key to success domestically, international collaboration is essential to developing industries that will allow Canada to achieve net-zero (Nahm, 2021). Actively pursuing global collaboration with like-minded countries can bring economic benefits – by establishing Canada as a climate-friendly trade partner, and climate benefits – by finding the most efficient ways to bend the emissions curve globally and reduce the risks of carbon leakage.

Carbon clubs are one successful model to promote such global collaboration. They bring together like-minded countries who agree to set common green industrial policies and low-carbon requirements for industrial products like steel, concrete, fertilizers, etc. In June 2022, the G7 released a statement on their intention to form such a carbon club.

Most industrial projects require significant planning, time, capital investment, and regulatory approvals before they launch. In our consultations with stakeholders, many raised concerns about the time and complexity of regulatory approvals needed for industrial projects and for enabling infrastructure. No stakeholder was of the opinion that regulatory processes are currently positioned to support the pace of change required to get to a net-zero society by 2050. Our advice on this issue reiterates our guiding principles for the Government of Canada's quantitative five-year targets for emissions reductions in the oil and gas sector: regulatory processes should be designed to allow for the timely assessment of projects that will reduce or eliminate GHG emissions. Despite recent and ongoing efforts to renew regulatory processes, it is not clear that there has been sufficient progress.

The success of a net-zero industrial policy also relies on having the right number of workers with the right skills, in the right places. Net-zero industrial policy can create good community-based jobs while supporting the net-zero economy. By prioritizing sectors and setting goals for their growth, a net-zero industrial policy can help provide focus and direction for governments' education and skills programs, as well as providing clear signals to the private sector, educational institutions, and individual workers on where there are likely to be opportunities in the future. The announcements in the 2022 Fall Economic Statement are a good start, but further investments need to be tied to clear sectoral targets developed through the process outlined in our advice.

Advice 16

The Government of Canada should use international trade policy to support its industrial policy goals and to build secure supply chains for the inputs and technologies required to reach net-zero.

Advice 17

The Government of Canada should ensure regulatory approval processes accelerate the objectives of the net-zero industrial policy. The Government of Canada should not assume that recent and ongoing improvements are sufficient to address the current challenges.

Advice 18

The Government of Canada should align its skills and jobs agenda with its industrial policy competitiveness goals.

2.4 EXAMPLES OF NET-ZERO COMPETITIVENESS GOALS FOR PRIORITY SECTORS

To illustrate our advice and provide a starting point for a government-led Canadian net-zero industrial policy, we have identified priority sectors that build on Canada's existing strengths, present significant opportunities in large global markets and provide an opportunity to add value to products and services. A review of studies by the **Boston Consulting Group**, the **Canadian Climate Institute**, the **Industry Strategy Council**, **RBC**, and the **Smart Prosperity Institute, Transition Accelerator, and the Pacific Institute for Climate Solutions**, allowed us to identify seven possible priority sectors for Canada: 1) electric vehicles (EVs) and the battery supply chain; 2) carbon capture, utilization, and storage (CCUS); 3) hydrogen; 4) biofuels and synthetic fuels; 5) value-added agriculture; 6) value-added forestry; and 7) critical minerals. These studies considered factors such as technological readiness, resource and innovation advantages, market potential, investment and venture capital trends, demand outlook, productivity improvement potential, and shares of global investment. Each of these seven sectors demonstrates how Canada can leverage its natural resources to create high-value supply chains in low-carbon technologies.

In addition, we considered regional development opportunities, and, as a result, chose to focus on four of the seven priority sectors: 1) EVs, 2) hydrogen, 3) biofuels and synthetic fuels, and 4) value-added forestry.

We also present examples of net-zero economic competitiveness goals for each of these industries. These goals are intended to serve as a proof of concept or a starting point for further engagement with industry, provinces and territories, experts, labour, and Indigenous rights holders. They will necessarily change with more input and information obtained through an industrial policy process. While the goals we present are based on real-world data and projections, Canada is unlikely to achieve them without targeted, coordinated industrial policies that direct near-term action and investment.

A ELECTRIC VEHICLES AND THE BATTERY SUPPLY CHAIN

Our vision for EV manufacturing would see Canada producing 30% of upstream materials and 10% of batteries and vehicles needed to meet North America's vehicle mandates. It projects Canada finding strategic opportunities along all parts of the "mines to mobility" supply chain: from developing critical minerals to producing battery-active material, batteries, manufacturing parts and components, and assembling vehicles. This builds on Clean Energy Canada's 2022 report on Canada's EV battery supply chain. In addition to setting economic competitiveness goals, advancing the associated and necessary infrastructure for the EV industry, such as charging stations, will be important.

TABLE 3: Examples of 2030 economic competitiveness goals for the EV industry

VEHICLES	**1,300,000 vehicles/year by 2030**
BATTERIES	**200 GWh/year (including 100 GWh for the vehicle fleet and 100 GWh for upstream materials)**
PROCESSED METALS	**685 elemental kilotonne per annum (ktpa)/year**
Lithium	11 elemental ktpa/year (10% of North American market)
Cobalt	32 elemental ktpa/year (35% of North American market)
Nickel	130 elemental ktpa/year (35% of North American market)
Manganese	9 elemental ktpa/year (20% of North American market)
Iron	113 elemental ktpa/year (30% of North American market)
Phosphorous	42 elemental ktpa/year (20% of North American market)
Graphite	350 elemental ktpa/year (35% of North American market)

The goal for vehicles is tied to the Canadian government's 60% zero emission vehicle (ZEV) sales mandate for 2030 and maintains Canada's current position as producer of 10% (~2.2 million) of the vehicles in the North American supply chain. The goals for critical minerals are based on current mining projects in development, identified reserves, an assessment of global competition, and calculations of future markets. These objectives also consider the U.S. 2030 ZEV targets and the battery capacity it will need to reach these. Based on current capacity, Canada has the potential to produce 30% of the materials needed to meet Canadian and U.S. 2030 targets. With sufficient investment and regulatory approvals, Canada could produce more.

Canada has clear strengths to build on along this supply chain. In particular, midstream upgrading of metals and minerals to create precursors and battery-active materials draws on Canada's expertise in chemical processing and adds value to natural resources. Given that battery chemistry is likely to change in the lead up to 2050, this expertise will allow Canada to retool and innovate at a crucial point within the supply chain.

Expanding mining and mineral processing and recycling would allow this industry to expand its regional benefits beyond the current concentration of automotive manufacturing in Ontario and Quebec, where **94% of automotive employment resided as of 2020**, to provide opportunities for communities across the country. To ensure that these benefits are realized, projects must meet high environmental standards and respect Indigenous peoples' sovereignty.

B HYDROGEN

Our vision for Canada is to become, by 2030, a world-leading producer and exporter of low-carbon hydrogen, which would provide a strong base for net-zero in other downstream sectors such as heavy industry, fertilizer, biofuels, and heavy trucks. In the first three of these sectors, black and grey hydrogen is currently used and needs to be replaced by low-carbon alternatives. We have included medium and heavy-duty trucking on the basis that there is not enough nickel to electrify 100% of this sector. Nickel recycling could increase the potential share of electrification for medium and heavy-duty trucking, but is not likely to be readily available until after 2030.

The overall hydrogen target is based on the estimated requirements for these four downstream sectors. Each of these was developed by looking at Canada's current production, growth rates for the sector, and current technologies for applying low-carbon hydrogen (e.g., Direct Reduced Iron in Electric Arc Furnaces for the steel sector). The goal for medium and heavy-duty trucking is scaled for Canada from the **U.S. Department of Energy's Hydrogen Strategy and Roadmap**.

Canada's potential to become a supplier of clean hydrogen in global supply chains has been recognized through initiatives such as the **Canada-Germany Hydrogen Alliance** signed in 2022, and the investment in and build out of hydrogen infrastructure in Alberta's industrial heartland. For example, ATCO Group says it has reached a deal with

Types of hydrogen

GREEN HYDROGEN takes water to produce hydrogen via electrolysis powered by renewable electricity. There are no emissions resulting from this production process.

BLUE HYDROGEN uses fossil fuels (usually natural gas) as a feedstock, but captures the resulting carbon emissions.

GREY HYDROGEN is produced from fossil fuels, generally using steam methane reforming (SMR) method. It produces and does not capture emissions.

BLACK HYDROGEN is produced from coal using a gasification process that produces emissions.

TABLE 4: Examples of 2030 economic competitiveness goals for hydrogen

HYDROGEN	1,350,000 tonnes per year
Steel	250,000 tonnes per year (20% of Canadian steel production)
Fertilizer	688,900 tonnes per year (50% of Canadian ammonia production)
Biofuels	140,000 tonnes per year (as input for 10% sustainable aviation fuels—SAF)
Medium and Heavy-Duty Trucking	286,000 tonnes per year (5% of Canadian market)

Canadian Pacific Railway to build two hydrogen production and refueling stations in Calgary and Edmonton. However, the success of these initiatives will depend on whether Canada develops a solid domestic hydrogen production industry through a net-zero industrial policy.

Canada has many strengths for developing a hydrogen economy, as outlined in the federal Hydrogen Strategy. These include Canadian engineering and chemical expertise and experience from the oil and gas sector. Through its Hydrogen Strategy, British Columbia has also established clusters to build expertise in hydrogen fuel cell technologies. Low-carbon hydrogen presents economic and employment opportunities across many regions of Canada. In particular, regions of Canada that produce natural gas,

such as Alberta and British Columbia, have opportunities for blue hydrogen, providing opportunities for workers that draw on their existing skills from the oil and gas sector.

Green hydrogen can be produced in regions with strong hydro resources such as Québec and British Columbia. However, green hydrogen is not technologically ready to allow a clear estimate of the relative proportions of blue and green hydrogen that Canada should seek to produce in 2030. Further research and development for green hydrogen is needed to advance its contribution towards this sector's production targets. Producing blue hydrogen that has a very low carbon intensity could be compatible with a net-zero society and provide a future market for Canadian fossil fuels. Ultimately, it is eliminating emissions from hydrogen production that matters more than the specific mix of blue or green hydrogen. Production should be located across the country to mitigate transportation challenges, increase proximity with industrial applications, and increase future access to export markets.

C BIOFUELS AND SYNTHETIC FUELS

Our vision for biofuels and synthetic fuels is focused on the aviation sector and would see Canada's feedstocks produce sustainable aviation fuel (SAF) for 10% of Canadian jet fuel demand by 2030. Canada could also become a leader and exporter in the technologies required to produce SAF, providing additional midstream economic opportunities and ensuring Canada is using the most efficient processes. Current policies and incentives, including the **Clean Fuel Standard**, are directing biofuels into cars as ethanol and trucks as biodiesel instead of reserving it for sustainable aviation and marine fuels—this is a legacy of an emissions reduction approach instead of an emissions elimination paradigm. One of the benefits of introducing a net-zero industrial policy is that it can help identify and course correct these types of policy inconsistencies.

These goals reflect existing proposals for SAF projects, consultations with industry, and projected SAF requirements of 10 billion litres per year by 2050; achieving 10% of this by 2030 is deemed realistic if ambitious, since SAF can be produced using existing refineries and is approved for blending into jet fuel at 50%. Canada has biomass resources to produce sufficient SAF for its own needs, opening the potential for exports to other markets in the future. Producing SAF also results in the production of some sustainable diesel, which could be used for maritime applications.

SAF can be produced from a variety of feedstocks, including oilseeds, agricultural residues, forestry residues, ethanol, and municipal solid waste. Canada's strengths in this sector include its existing expertise in agriculture, forestry, and biomass production and refining. Canada could also use its engineering and existing biomass processing expertise to develop SAF-related technologies that it could then export to the world.

The targets in this report focus on wood and agricultural residues as a way of adding value to these resources and bringing benefits to agricultural and forestry communities across the country. Oil and gas communities can also benefit by workers being able to transition their skills and expertise to biofuels production.

TABLE 5: Examples of 2030 economic competitiveness goals for biofuels and synthetic fuels

SUSTAINABLE AVIATION FUEL	1 billion litres annually
From oilseeds, tallows, used cooking oil	600 million litres annually
From wood residues	200 million litres annually
From agriculture residues	100 million litres annually
From power-to-liquids eFuels (made using captured CO_2 + H2 extracted via electrolysis from water)	100 million litres annually

D VALUE-ADDED FORESTRY

Our vision for Canada's value-added forestry is focused on building the supply chain from forests to mass timber to the buildings sector, all while reducing emissions from the sector's operations.

Mass timber can reduce emissions by both sequestering carbon in wood products and displacing cement and steel in the construction industry.

TABLE 6: Examples of 2030 economic competitiveness goals for value-added forestry

MASS TIMBER	200 MMFB (million board feet)
Glue-laminated timber (GLT or glulam) and cross-laminated timber (CLT)	50 MMFB
Nail and dowel laminated timber (NLT and DLT)	25 MMFB
Laminated veneer lumber (LVL), laminated strand lumber (LSL), and parallel strand lumber (PSL)	125 MMFB

These goals are based on current and projected relative market shares for these types of mass timber products. We assume large demand for these products in the buildings sector given parallel efforts to decarbonize, including updates to the national model building codes.

Canada has a strong existing forest sector, but forest product manufacturing is currently dominated by sawn logs, with Canada representing 19% of the world's sawn log exports (**Natural Resources Canada, 2020**). Using a share of this sector for mass timber could add new value to these resources for both domestic use and export. As noted in our **advice on buildings for Canada's 2030 ERP**, there are also opportunities for wood products to be a source of low-carbon building materials. Mass timber can be used in the place of steel and concrete, particularly in large, multistory buildings. There are also opportunities for Canadian companies to take advantage of value-added forestry and expand into modular building design.

Mass timber production could, furthermore, provide jobs and growth opportunities for forestry communities across Canada, particularly those that have seen mills and pulp and paper factories close. This is particularly important as it allows these communities to see opportunities for themselves in a net-zero world.

Mass timber buildings in Canada

The University of British Columbia's Brock Commons Tallwood House is one of a growing number of mass-timber buildings around the world. It takes advantage of new engineered wood products and construction techniques to showcase more sustainable building practices. It was developed as part of the Tall Wood Building Demonstration Initiative launched in 2013 by Natural Resources Canada and the Canadian Wood Council to showcase wood-based solutions for high-rise buildings and build industry capabilities in Canada.

INTERDEPENDENCIES IMPACTING SECTORAL GOALS

There are intersections between the four sectors, and dependencies between them must be considered and used to adjust sectoral policies. Sectors may compete for some of the same resources, both within Canada and with industries from other countries — for example, nickel and copper resources are likely to face high demand and could result in bottlenecks. This will require analysis and strategizing to ensure new resources end up in clean-energy supply chains as opposed to traditional markets. All sectors will also require the expansion of green infrastructure inputs such as clean power and low-carbon transportation corridors. The development of this infrastructure should be indexed to the sectoral targets.

These interdependencies demonstrate the need for systems-level analysis and strategy. Flexible and adaptable systems-level industrial strategies can help identify and align sector-level goals and resource requirements.

3. Net-Zero Energy Systems

The NZAB defines net-zero energy systems as the production, conversion, transmission, distribution, storage, and consumption of energy required to yield a functional energy system that meets demand and generates net-zero emissions. Renewable and nuclear generated electricity will likely dominate future systems, but other components could include biofuels, fossil fuels or upgraded fossil fuels with carbon capture and storage (e.g., blue hydrogen). While energy systems are becoming cleaner, the way we create and use energy is still the source of 81% of GHG emissions in Canada (Natural Resources Canada, 2021). Given the scale of the challenge of eliminating GHG emissions by 2050, we anticipate energy systems will be an area that we focus on over the next several years. Our 2022 annual report lays the foundation of this work.

New federal actions are creating market signals in favour of a transition to net-zero energy systems. These actions are targeted towards different components of energy systems with the aim of influencing supply and demand to ultimately lower GHG levels and incentivize clean technology development. In the last year alone, the Government of Canada has introduced many new policies and regulations, including:

- Setting a mandatory 100% zero-emission passenger vehicles target by 2035 and 100% zero emissions medium—and heavy-duty vehicles by 2040;
- Releasing a Green Buildings Strategy with an emphasis on increasing energy efficiency and use of non-emitting heating and power;
- Finalizing the Clean Fuel Regulations that reduce the emission intensity of fuels by up to 15%;
- Introducing a framework for the Clean Electricity Regulations to achieve a net-zero electricity grid by 2035; and,
- Presenting options for an oil and gas cap to reduce GHGs from Canada's highest emitting economic sector.

Why Canada needs a cap on oil and gas emissions

GHGs from the oil and gas sector rose by 18.8% between 2005 and 2019 while emissions in the rest of the economy declined by 6.1% (National Inventory Report, 2022). Current policies are not stringent enough to drive oil and gas emissions reductions in line with Canada's 2030 and 2050 targets. Emissions from the industry are still rising. Authoritative institutions such as the International Energy Agency expect that medium—and long-term demand for oil and gas products will fall dramatically. As a result investments in carbon-intensive projects will likely lock in emissions and make it more difficult for Canada to reach its net-zero targets.

A cap, alongside 5-year declining emissions reduction milestones, will provide greater certainty and clearer expectations for emissions reductions in the oil and gas sector. A cap should: (1) result in absolute emissions reductions – rather than emissions intensity reductions – from the sector, in line with net-zero pathways; (2) be designed with limited, short-term compliance flexibility mechanisms; (3) prevent carbon leakage and maintain competitiveness during a global transition to net-zero; and, (4) complement current regulations on reducing methane emissions.

Transforming Canada's energy systems is a challenging undertaking. On their own, existing and announced policies and regulatory actions will not be sufficient to enact the transformational changes needed to get to net-zero. Despite our country's vast potential for clean, renewable energy, Canada is still largely reliant on fossil fuels, like coal, oil and gas, as a primary source of energy. We must achieve net-zero GHG emissions from our energy systems and continue to provide secure, reliable, and affordable energy in the face of the escalating impacts of climate change. Our energy systems must also become more efficient and larger to meet increased demand for energy from a growing population, increased economic activity, and widespread electrification. Adding another layer of complexity is the need to shift our energy supply to low emissions sources faster than ever before, while dealing with resistance to change, a lack of pan-Canadian collaboration, and regulatory systems that were not designed to cope with the magnitude and pace of change required.

Responding to these challenges calls for new ways of understanding and approaching energy system transformation. Thinking in terms of 'systems' allows us to have a more holistic understanding of interconnections between different components, and of the ways that decision-making affects key elements, such as electricity prices or Indigenous sovereignty. Canadian energy systems are influenced by social, political, and economic factors that have moulded the system into its current state. Unlocking system-level, society-wide solutions is only possible if we consider the range of solutions in light of all socio-politico-economic factors.

Since identifying Net-Zero Energy Systems as a line of inquiry, we have heard from experts, stakeholders, and rights holders about how to approach these challenges in new ways. We have had conversations about the best pathways to get to net-zero energy systems, how to evaluate such pathways, and what challenges and opportunities lie ahead. In the following sections, we expand on key themes we heard through our research and engagement efforts and argue we need to change the way we think about energy systems. There is a global consensus that widespread electrification is needed to achieve net-zero. Consequently, while our line of inquiry intends to look at energy holistically, we have focused on some topics related to our electricity systems in sections 3.2, 3.3, and 3.4 as it is a foundational and time-sensitive undertaking for net-zero. By setting an end goal, Canada will be better positioned to solicit and obtain buy-in from Canadians, industry, and institutions.

3.1 A VISION FOR NET-ZERO ENERGY SYSTEMS

Incremental change to our existing energy systems will not be sufficient to get Canada to net-zero by 2050 – our systems need fundamental transformation. Transforming our energy systems to be net-zero also presents an opportunity to improve energy system security and reliability, create healthier communities, and more stable jobs and economic activity. Courage, dedication, and bold leadership from individuals and organizations across key disciplines, sectors, governments, and regions are needed to turn this vision into a reality. A challenge of this magnitude will require unprecedented collaboration, reimagining roles, breaking down outdated institutional structures, and new, innovative problem-solving.

What do we mean by a 'vision'?

When we talk about a vision for net-zero energy systems, we mean defining an end state. Ideally we would have a clearer view on what types of energy and energy carriers, in what amounts, and in what parts of the country, would be most likely to deliver a right-sized net-zero energy system by 2050 Only with description of the likely future energy systems will we be able to create credible, capable, and compelling pathways to net-zero energy for Canada.

The Generation Energy Council released a report in 2018 summarizing findings from a cross-Canada dialogue and engagement process which set out an early vision for a clean energy future. While much has changed since the release of this report, it sets out two detailed scenarios of what life might be like for Canadians a generation from today—with real tangible examples of how lifestyles, work, businesses, and society can change as a result of cleaner and improved energy systems. While a vision this detailed is helpful to inspire people about the ways they can benefit from progress to net-zero, a clear quantitative, technical description of the system itself is still missing.

There is more certainty than uncertainty when it comes to energy systems. We know that vehicle electrification, heating and cooling buildings in some parts of the country, and some industrial processes will demand more resilient and net-zero electricity sources. However, there is a lack of common understanding as to what net-zero energy systems will be composed of and what this climate-safe future means for our daily lives. Governments, utilities and regulators, and the private sector understand that the current system is incompatible with climate goals, but the path forward remains contentious. Individuals and families may experience anxiety in the face of an uncertain energy future, and what it means for them. Developing a vision for future net-zero energy systems is the first step. The objectives of developing a vision for energy systems are to provide greater clarity, optimism, and inspiration to Canadians and industry on the future of energy, while dispelling myths, and improving energy and climate literacy.

All of the specifics of how to achieve net-zero energy systems are beyond the scope of what can be achieved in our first annual report. By defining an end-state, identifying barriers and opportunities, and determining ways to help decision-makers evaluate different pathways, we are confident Canadians will be able to envision a better, cleaner future that should help avoid the worst impacts of climate change. A compelling vision can trigger the right decisions and align everyone's action towards a net-zero future, from individual consumer choices to large-scale capital allocation.

Advice 19

The Government of Canada should facilitate the development of a vision for net-zero energy systems, akin to a nation-building project of the 21st century, based on a set of principles. This vision should be widely communicated to the Canadian public, industry, and organizations in a way that resonates for all. The following principles should serve as building blocks to a Canadian net-zero energy vision:

- Provide Canadians and industries with reliable, secure, and affordable energy.
- Be built from predominantly clean, non-emitting energy sources.
- Be established in partnership with Indigenous peoples and involve shared decision-making.
- Accommodate regional economic differences and allow for diverse technological solutions
- Leverage domestic advantages and new supply chains.
- Be supported by a flourishing clean technology industry.
- Be operated by Canadian workers equipped with the skills and training to succeed.
- Be resilient to the impacts of climate change.
- Enhance Canada's economic competitiveness while improving energy efficiency and security.
- Result in environmental and social co-benefits, such as reduced energy poverty and improved air quality.

KEY MESSAGES TO SUPPORT NET-ZERO ENERGY SYSTEMS TRANSFORMATION

Decarbonizing Canada's electricity grids must be the nations-building project of the 21st century

Canada is made up of a complex network of provincial, territorial, and local electricity systems, which include a mix of private and public utilities, independent regulators operating under different regulatory regimes, varying access to natural resources, and differing political values and entrenched industries.

While the entire country is confronted with the challenge of decarbonizing the grid, the Government of Canada has limited influence over how the transition occurs in individual provinces and territories. Beyond regulations and financial incentives, it does not hold the appropriate jurisdictional policy levers to initiate a net-zero grid. Provinces and territories are responsible for managing their energy systems, including setting the cost of electricity and determining the generation mix. The distributed responsibilities with regards to energy between the two orders of government have been a source of tension and confusion in the past.

A solution to this challenge would be to bring key players in the electricity space together to work towards a net-zero grid as a national project, much like the building of the trans-Canadian railway. Establishing a Pan-Canadian Grid Council, an initiative outlined in the **Minister of Natural Resources' 2021 mandate letter** could be a viable solution. The federal government's efforts to establish **Regional Energy and Resource Tables** to identify and accelerate opportunities to transform Canada's traditional resource industries and advance emerging ones are also a step in the right direction but may lead to regional priorities distracting from the need for system-level coherence. Indigenous nations will be integral to this process and new governance models that put Indigenous rights and sovereignty at the forefront are critical.

The world is moving towards net-zero energy systems — and there are opportunities to seize.

There is already momentum behind the shift to clean energy, and evidence that pathways to net-zero energy systems are becoming a reality. Global business is increasingly placing emphasis on making net-zero compatible investments. Companies with high environmental, social, and governance (ESG) standards are looking to do business in regions with plentiful clean electricity. Many Canadian regions could have a competitive advantage if they built, grew, and sustained thriving clean energy industries.

Electrification is the key to unlocking pathways to net-zero. Decarbonizing electricity grids, adding grid capacity and building out enabling technologies can create new industries, new revenue sources for communities and new jobs for workers, while potentially reemploying displaced workforces. It could also create opportunities for Indigenous peoples to lead energy projects and share economic benefits.

There will be costs associated with energy systems transformation — but the long-term savings will be greater.

Energy system transformation will result in more upfront costs associated with capital expenditures to construct new clean

energy projects. This may have an effect on taxes or electricity rates. Canadians need to know how the transition will be financed and how it will impact their day-to-day expenses. This is an area of active analyses, but results to date show that the transition to net-zero energy systems will likely result in long-term savings. For example, one study shows that a pan-Canadian energy transition in all sectors would cost up to $43.3 billion annually until reaching net-zero, followed by fuel savings up to $78 billion annually thereafter (**Stringer & Joanis, 2022**). The choices that we make today will determine when costs increase, how much they will increase, and what and when savings will be realized.

Energy systems transformation is an opportunity to strengthen community resiliency.

Diversifying energy-reliant economies within Canada can enhance resilience to global market volatility and strengthen energy sovereignty. Distributed energy systems are an area for further exploration, as they may be capable of withstanding major outages caused by escalating natural disasters resulting from climate change that affect larger-scale grids.

A profile of distributed energy systems:

SUMMERSIDE PEI

Summerside is a town of 16,000 people set along a narrow stretch of Prince Edward Island. After Hurricane Fiona hit in 2022, many island residents were left without power for over a week, in some cases over two weeks. The residents of Summerside had their power back in a matter of days.

The town is in a unique position on PEI because it owns its local electrical utility and has invested heavily in renewables and storage. One of the keys to their success was assuring that citizens were given a stake in the transition.

For decades, Summerside relied on electricity supplied by New Brunswick via underwater cables, but the town wanted to break free of reliance on other provinces for energy imports. Not only have renewables helped the town's energy system grow more resilient to extreme weather events, but the electricity rates are a fraction of the cost they would be if Summerside were importing more power. Their 'Heat for Less Now' program uses the town's growing smart grid to connect customers directly with cheap wind energy that can be banked in Electric Thermal Storage (ETS) systems located right in community members' homes to help conserve excess energy and keep rates down.

In 2009, the city built its first 12-megawatt wind farm. This was followed by a 336-kilowatt solar array and a new $69-million, 21-megawatt array equipped with a 10-megawatt lithium-ion battery storage system to get the city generating 65% of its energy from local renewables by the end of 2022. This latest project, called the Summerside Sunbank, represents the next step in energy independence and autonomy for the small town as it plans to achieve 100% of its energy locally in the near future. According to the mayor, "When residents can see where the money has gone, it gives you a better social licence to continue to build."

Roles and responsibilities in energy system decision-making and management

FEDERAL GOVERNMENT: Responsible for managing energy resources on federal and frontier lands and regulating the international and interprovincial movement of energy and energy goods.

PROVINCIAL / TERRITORIAL GOVERNMENT: The generation, transmission and distribution of electricity in Canada fall primarily under provincial and territorial jurisdiction. Provinces and territories are responsible for energy matters relating to economic and energy security. They are also responsible for the development of natural resources.

LOCAL AND INDIGENOUS GOVERNMENTS: Local involvement in electricity management varies across the country, depending on the arrangement between a local or Indigenous government and the province or territory. Some local governments play a role in managing local utilities, community energy planning, revising land-use regulations, adopting building codes, collaboration, raising awareness and encouraging investments in electricity systems.

REGULATORS: Each province and territory has regulators that operate under unique legal and policy frameworks. Regulatory boards and commissions are responsible for the regulation of the electric, water, gas, and pipeline utilities in Canada, and are involved in project review processes.

UTILITIES: Can be privately-owned, municipally owned, or provincially owned. They can also be vertically integrated, where the same entity owns or controls all stages of electricity delivery, or they can be unbundled, where generation, transmission, distribution and sales are broken into different assets. Alberta is the only jurisdiction in Canada with a fully unbundled electricity sector while Ontario has a hybrid market.

Roles and responsibilities in energy system decision-making and management (continued)

POWER PRODUCERS:

Own assets that generate electricity that comes from a wide range of energy sources and technologies, such as nuclear, hydro, oil, coal, natural gas, wind, solar, geothermal, biomass and biofuels.

TRANSMITTERS:

Help move bulk electricity from generation sources over long distances to reach substations in population centres and other places where electricity is needed.

DISTRIBUTORS:

Are responsible for transmission and electricity distribution over shorter distances—they move energy from generators and transmitters to homes, businesses, schools, etc. Distribution is the last part of electrical power delivery where high-voltage power is reduced to low-voltage power and delivered to end users. In most jurisdictions, utilities own and operate the distribution system and are responsible for billing

SYSTEM OPERATORS:

System operators coordinate, control, and monitor the operation of electrical power systems to balance supply and demand from generation sources to final consumers. Independent system operators exist in Ontario and Alberta, whereas integrated utilities typically manage balancing in other provinces.

3.2 ELECTRICITY GRID DECARBONIZATION AND GROWTH TO 2050

Canada's electricity grid - which is more precisely a network of 13 distinct provincial and territorial grids – includes some of the cleanest electricity in the world and some that falls far short of that designation. Canada's electricity sector emissions have declined by nearly half since 2005, and 82% of Canada's electricity is produced from non-emitting sources; however, some provincial grids are still heavily reliant on fossil fuels. Nova Scotia, Saskatchewan, and Alberta generate over 75% of their electricity using coal, natural gas, and petroleum (Canadian Energy Regulator, 2022). It is important that we achieve a net-zero grid uniformly across Canada's electricity grids by 2035 to ensure that all businesses, institutions, and households can rely on clean, reliable, and secure electricity for day-to-day activities.

The goal of a net-zero power grid by 2035 has been met with some scepticism from incumbent utilities, energy companies, provincial and territorial governments, and other stakeholders who are concerned about the ability to transform under these timelines. In particular, this timeline will be a challenge for regions that are more reliant on fossil fuels like gas and coal to produce electricity, as well as Indigenous communities and communities in rural and remote areas that rely on diesel generation. Other electricity system actors, such as those in renewable power generation and energy storage, are more supportive and optimistic.

Decarbonizing the electricity grid will require an aggressive build out of new projects and infrastructure, which in turn will require access to significant financial capital, and physical (e.g., critical minerals and other materials) and human resources. The challenging timelines for electricity system carbon neutrality are compounded by current skills shortages in relevant sectors, and potential delays from project approval and review processes.

The proposed Clean Electricity Regulation (CER) was introduced in 2022 to send a regulatory signal to provinces, territories, and power producers to discourage further investment in unabated emissions-generating assets and to drive the emissions intensity of existing assets to net-zero by 2035. The CER would establish a performance standard and aid in the phase-out of fossil fuel electricity generation. Carbon pricing would complement the CER by encouraging fuel switching in other sectors to increase demand for clean electricity.

A rigorous Clean Electricity Regulation should:

- Prevent new unabated gas plants from being built;
- Encourage early emissions reductions;
- Strictly limit use of offsets and compliance flexibilities that only operate as time-limited support where absolutely needed to help transition to a net-zero electricity grid by 2035; and
- Be supplemented by complementary policies that:
    - Prioritize energy efficiency and conservation as a pathway to net-zero;
    - Enable and support community-owned clean energy in Indigenous communities;
    - Accelerate the build-out of new net-zero electricity generation projects, including by rebuilding public trust in project approval processes so that necessary infrastructure can be built with community support in a timely fashion;
    - Accelerate the modernization of Canada's electricity grid(s), including through the build-out of transmission interties, to make systems more connected, resilient, and efficient;
    - Support technology development, in particular for storage technologies;
    - Find solutions for peak load demand; and,
    - Encourage intergovernmental collaboration.

The CER alone is not enough to incent the kinds of actions we need to ensure we have enough net-zero electricity by 2050. We need to drastically increase the grid's capacity to accommodate electrification of industrial processes, heating, and electric vehicles. Cleaning the grid – and growing it at the same time - is a significant undertaking. Right-sizing our systems to accommodate electricity as a fuel source means total electricity generation capacity must grow 2.2 to 3.4 times larger than current capacity (Dion et al., 2021). Right-sizing will also require an equivalent upgrade of transmission and distribution systems that are strengthened to withstand the impacts of climate change and natural disasters. The focus on grid decarbonization is critical. There is a risk that utilities and electricity companies will focus too narrowly on decreasing emissions from existing systems, while not doing enough to transform and expand the system. Consistent progress must be made on both fronts to achieve a net-zero energy system by 2050.

Advice 20

The Government of Canada should ensure pathways to a net-zero grid by 2035 are consistent with pathways to a right-sized, net-zero grid by 2050.

Ensuring electricity users maintain uninterrupted access to electricity is critical to foster public trust in net-zero grid pathways. As Europe is currently struggling with the risk of energy shortage and blackout periods resulting from the war in Ukraine and its over-reliance on imported gas from Russia, we are reminded that while electricity gets cleaner, it must also be secure, reliable, and affordable. As the grid becomes more reliant on intermittent clean energy sources like wind and solar, and storage solutions, adding transmission and distribution capacity will become more important to ensure the grid has consistent supply at all hours of the day at all times of year.

In addition, actions that reduce demand for electricity can decrease the pressure on the grid and help ensure that clean energy generation will go further. Many of these actions, including energy efficiency gains in building heating and cooling, transportation and industry, can be implemented quickly and are both cost-effective and impactful. Finally, new opportunities could be realized in expanding supply side solutions or adding additional non-emitting capacity to the grid.

Contextualizing the war in Ukraine and impacts on Canadian energy exports

The energy shortage in Europe is being used to argue for increased investment in more fossil fuel infrastructure in Canada to help meet energy demands in places impacted by the shutoff of Russian energy pipelines. While Europe will require a short-term increase in liquefied natural gas (LNG) imports from trusted trading partners like Canada, the International Energy Agency is clear in its most recent World Energy Outlook that this short-term demand can be satisfied by existing global production and should not be used to justify any buildout of new infrastructure which could create unnecessary fossil-fuel lock-in and the risk of stranded assets. Realistically, any new production infrastructure in Canada would not come online until 2025 at the earliest—too late to help Europe through this short-term crunch.

While Europe is struggling in the short-term to meet energy demand, the long-term forecast shows that demand for fossil fuels will continue to decline in the region. Indeed, the policy response of the EU Parliament to Russia's actions focuses on gradually eliminating gas demand. The EU has also set ambitious clean energy targets, which means that in the coming years, this demand will likely be met through domestic sources.

The war in Ukraine highlights the importance of domestic energy security across all parts of the supply chain. Reliance on imported energy and supportive technologies comes with risks when trade partners initiate disputes and cut off supply. The ensuing price volatility of oil and gas commodities in North America, such as gasoline, has also sparked interest in electric vehicles and new forms of heating.

3.3 EAST-WEST TRANSMISSION PROJECTS AND INTERTIES

Grid interties are often cited as a key to achieving a net-zero grid in Canada. Interties could potentially allow for provinces with cleaner grids to distribute electricity to jurisdictions that are more reliant on fossil fuels or have fewer clean energy sources. For example, there is potential to help decarbonize some electricity grids by connecting hydro-intensive provinces to provinces that rely more on fossil fuels to generate electricity to displace their emitting generation capacity (**Gorski et al., 2021**). Interties can also bring more flexibility in base-load options to regional and local grids, providing a back-up for the development of more distributed energy systems based on efficiency and scale. Further, interties could support enhanced grid flexibility and grid reliability amidst escalating natural disasters resulting from climate change. In short, interties could optimize the way clean energy is distributed across the federation and prevent the unnecessary buildout of new fossil fuel-based electricity sources to provide affordable, reliable energy and to meet growing electricity demands on a net-zero pathway.

The Atlantic Loop Initiative

The Atlantic Regional Transmission Loop is a proposed $5-billion transmission project meant to displace the region's fossil fuel-based electricity supply with hydroelectricity from Labrador and Québec. The project would be a shared venture between the federal government and provincial governments and utilities to support efforts to achieve a net-zero electricity system by 2035. The Atlantic Loop could be a major driver of clean growth in the region with economic and climate benefits that would allow the provinces to reduce pollution levels and enable business ventures that need clean energy sources.

The idea of a more integrated interprovincial electricity grid has been around for decades. Part of the "loop" has already been built, with The Maritime Link beginning to move electricity along a subsea transmission cable from Newfoundland to Cape Breton in 2021. What is needed to complete the loop is north-south transmission running from Newfoundland and Labrador to Québec and then down to New Brunswick and Nova Scotia (transmission already exists between New Brunswick and Prince Edward Island).

Despite the benefits this infrastructure could bring to the region, there is still a lack of detail about how long it would take to build the project and exactly how much it would cost. There are also political considerations as benefits from the Atlantic Loop are unlikely to be evenly split among all the provinces involved. Currently, the parent company of Nova Scotia Power, Emera Inc., has said it will cease work on the Atlantic Loop due to provincial legislation that capped the energy company's ability to increase rates over the next two years.

The challenge is that connecting Canada's electricity systems involves navigating a complex environment of private and publicly owned utilities, distinct regulatory systems, unique sources of electricity, and political differences — not unlike navigating public health issues through a complex patchwork of provincial and territorial healthcare systems. Work is currently underway to connect eastern provincial electricity grids through the Atlantic Loop initiative; however, delays and challenges have surfaced creating concerns about the feasibility of such endeavours. Some provinces are hesitant to initiate intertie projects over concerns about unevenly distributed costs/benefits, reliability, uncertainty, and energy sovereignty.

Ultimately, the grid must decarbonize with or without new interties — Canadians need to understand the household implications and potential savings in either scenario. If we are to achieve a net-zero grid by 2035, there is evidence to suggest that adding some strategic interties that connect provincial grids and redistribute clean energy may be a cheaper pathway. In some circumstances, interprovincial transmission lines could significantly reduce total net costs of grid decarbonization and mitigate costs to ratepayers (Dolter & Rivers, 2018). Intertie projects would also create new jobs in construction and support Canadian natural resource industries in creating demand for materials and other skilled labour. Additional research and modelling could provide a clearer rationale for or against the use of additional interties in pathways to net-zero.

Advice 21

The Government of Canada should support independent research and modelling activities to understand the costs-benefits of net-zero pathways that use more interties compared to those that rely on other strategies, such as increasing local generation.

We heard repeatedly from experts and other interested parties that there is room for interprovincial collaboration on grid expansion and national net-zero efforts. Presently, there are clearer incentives for Canadian provinces and territories to trade electricity with the U.S. and utilize transmission lines that run across the international border. One challenge is that not all provincial and territorial governments and utilities have formally adopted the same level of net-zero ambition. While the federal government is responsible for the oversight of construction, operation and abandonment of interprovincial transmission lines, provincial collaboration is the key to unlocking these projects as each controls and manages its own electricity system.

There could be an appropriate role for the federal government in bringing provinces together behind the idea of a net-zero grid. Public awareness about the transformative potential and economic savings by decarbonizing our electricity

Advice 22

The Government of Canada should launch the Pan-Canadian Grid Council as soon as possible to facilitate cross-sectoral, pan-Canadian dialogue on the topic of net-zero interties and grid.

and energy systems with the support of interties is key in evolving the conversation around a potential national net-zero grid project. Transparent, and publicly communicated information about the costs and benefits associated with transmission projects could generate more public support for these projects.

Pan-Canadian Grid Council

In December 2021, the Prime Minister outlined the need for a Pan-Canadian Grid Council in the Minister of Natural Resources' mandate letter. To advance the commitment to achieve a 100% net-zero electricity system by 2035, the letter directed the Minister of Natural Resources and Minister of Intergovernmental Affairs, Infrastructure, and Communities, to establish the grid council to:

- Promote infrastructure investments, smart grids, grid integration and electricity sector innovation;
- Work with Indigenous partners and communities to support the transformation from diesel-fuelled power to clean, renewable and reliable energy by 2030; and
- Work to connect regions with carbon intensive electricity systems to more clean power by supporting transmission lines and the integration of renewables and clean fuels.

3.4 REGULATORY ENVIRONMENT

Transforming Canadian energy systems will require unprecedented investment in and construction of clean energy infrastructure, including buildout of transmission and distribution lines, new production facilities, and storage systems. To ensure Canada develops and stays on the path to net-zero, projects will need to advance through the regulatory system in a timely manner.

Regulators are meant to provide an independent, evidence-based approval process, produce credible and consistent decisions, reduce risk for investors, and protect ratepayers. There are perceptions that some regulatory processes create barriers to achieving progress towards net-zero by 2050 when an unnecessary over-emphasis on procedure takes precedence over the need to expedite

critical energy infrastructure projects. In this case, the approval process includes energy and utility regulators across the federal government, provinces and territories which review and approve both upstream and downstream electricity projects. There is a broad and complex regulatory environment in Canada. While the Canadian Energy Regulator reviews and enforces environmental standards for energy projects that are under federal jurisdiction (e.g., pipelines), making up approximately 10% of energy projects, provincial-level projects are overseen by provincial and territorial regulators which operate under different legislation, and which apply regulations in different ways.

The current speed of regulatory approvals in federal, provincial, and territorial jurisdiction is too slow to facilitate the buildout of new infrastructure that is needed to achieve a net-zero energy system. Increasing the speed of project approval processes and regulatory efficiency, while not compromising the rigour of these processes, is particularly important to facilitate a net-zero grid by 2035 and a right-sized grid by 2050. This is why we are reiterating our advice from our previous work on principles and conditions for success for the oil and gas sector.

Advice 23

The Government of Canada should reduce the length of approval processes for projects that are compatible with net-zero to ensure they are working towards, not against, its emissions targets and net-zero competitiveness goals. Canada is unlikely to achieve a decarbonized grid by 2035 or net zero by 2050 unless large infrastructure projects can move through the regulatory process quicker than the current pace. Project proponents must also do their part to speed approvals by recognizing and planning projects accordingly, including by building relationships with affected stakeholders and Indigenous rights holders.

We recognize that federal regulators are aware of the problems with the pace of approvals, but it is unclear if proposed or ongoing improvements will be sufficient. There is a real opportunity for regulators to help move Canada's energy transition forward, by facilitating enhanced collaboration among stakeholders and rights holders, helping the public understand the real impacts of the transition, leveraging technical expertise, and helping ensure the transition unfolds in an orderly manner. At the same time, formally expanding the mandate of regulators to include social issues, such as affordability and energy poverty, could further lengthen the regulatory process. There are also limits to regulators' influence over the system, as most of the actions that must be taken are at

the behest of utilities and governments, and regulators are beholden to the legislation they operate under. Regulators have called for more policy clarity and alignment across jurisdictions in order to execute their mandates to the best of their ability. There must also be clearer mechanisms that provide a formalized decision-making role for Indigenous peoples through the project review process. For example, the Muskrat Falls hydroelectric project in Newfoundland and Labrador has faced cost overruns and has faced criticisms due to inadequate public engagement and Indigenous consultation processes—both of which could have potentially been avoided. A public inquiry into the project stated that regulatory oversight did not compare to the standards of other regulatory processes for similar projects in other provinces.

Independent studies have also highlighted advantages of independent regulatory oversight to provide governments with a rigorous assessment of costs and to encourage proponent financial transparency. Developing guidance on net-zero best practices for provincial and territorial regulators could (1) reinforce the net-zero imperative; (2) help create more uniform application of regulations across the federation; and, (3) encourage greater Indigenous participation in the regulatory approval process. Lessons can be learned from the development of the *Impact Assessment Act* and approaches to major projects reviews that honour the legal duty to consult in a meaningful and measurable way, include Indigenous Cooperation Agreements, establish funding support, and Indigenous advisory committees. This guidance could explore the provision of funds and training to support early, active, and ongoing participation of Indigenous peoples across all stages of public engagement.

Advice 24

The Government of Canada in cooperation with the provinces and territories should compile, share, and promote best practices in regulatory processes across the federation and from other jurisdictions outside of Canada.

3.5 INDIGENOUS OWNERSHIP OVER AND BENEFITS FROM ENERGY SYSTEMS

Indigenous peoples have historically been excluded from participating and deriving fair benefits from the energy economy. Indigenous peoples often face disproportionate negative impacts of energy and resource sector development while being underrepresented in the opportunities and benefits created on their traditional territory. Current and future work in transforming energy systems to achieve net-zero must strive to more equitably distribute benefits from clean energy development and avoid exacerbating the negative impacts of energy resource development in Indigenous communities. Indigenous leaders in clean energy have worked to shift this pattern, such that Indigenous entities are now partners or beneficiaries in almost 20% of infrastructure producing renewable energy (Gall, et al., 2022). The share of Indigenous involvement in clean energy projects can continue to increase. As Canada moves towards net-zero, decarbonizes the grid, builds new energy generation infrastructure and transmission, and strives to upgrade regulatory processes, upholding Indigenous rights and self-determination must be a central tenet of these efforts.

The passing of the United Nations Declaration for the Rights of Indigenous Peoples (UNDRIP) into law in 2021 creates a framework by which governments and industry can work with Indigenous peoples to promote sovereignty and self-sufficiency. Facilitating greater Indigenous ownership and involvement in clean energy and electricity projects can be, and in certain cases, already has been achieved through the work of Indigenous leaders and experts. On energy systems, we have begun looking at diesel reliance. In pursuing this topic, we have heard more broadly about Indigenous community energy sovereignty and capacity to participate in the clean energy economy and in conversations about net-zero. We have more work to do as an advisory body to learn and grow our knowledge of these topics.

As we continue to build and grow partnerships with Indigenous peoples as part of our work, we want to amplify the existing work that has already been undertaken. There is already a great deal of work in this space, led and co-led by Indigenous peoples.

Advice 25

The Government of Canada should embed principles in the United Nations Declaration for the Rights of Indigenous Peoples when it makes decisions pertaining to energy sector transformation, setting an example for other orders of government.

Conclusion

The next seven years are meant to be the implementation decade for climate change mitigation. While the Government of Canada has put the foundations in place with the 2030 ERP and previous climate plans, more decisive and concerted action is needed before 2030. Now is the time to push all economic actors to set themselves up to compete and succeed in a net-zero future.

If implemented, we are confident that our 25 pieces of advice contained in this report, in addition to the 40 pieces of advice in our **submission to Canada's 2030 Emissions Reduction Plan** development and our **foundational 10 values and principles**, will significantly contribute to Canada's development and implementation of a pathway to achieve net-zero emissions by 2050. They provide actionable direction on how to create the right structures and systems to reduce and eliminate emissions and set the right mindset to realize a prosperous, just, and sustainable Canada in 2050. It is necessary to address these systemic issues this decade so that after 2030 we can focus on the widespread deployment of net-zero solutions, occupy a clear place in global net-zero supply chains, and ensure all Canadians are empowered to thrive in and contribute to a net-zero society.

Our work continues in 2023, starting with the release of our first Corporate Plan in March. This plan will present our strategic priorities and work plan for the next two years, providing additional certainty and transparency about our activities. In June 2023, we will release a What We Heard report on our engagement activities over the past year. Throughout 2023 we will continue our engagement with Canadians, focusing on youth and families, and work to build deeper relationships with First Nations, Inuit and Métis in Canada.

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Appendix A: Briefings to the NZAB

We thank the following people for providing us with invaluable insights to guide the development of our work. The views expressed in this report are that of the Net-Zero Advisory Body and do not represent the opinions of the experts or stakeholders who contributed to our deliberations.

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- Louise Comeau, Conservation Council of New Brunswick
- Mahima Sharma, Forest Products Association of Canada
- Matt DeVlieger, Government of Canada Privy Council Office
- Matt Poirier, Manufacturiers et Exportateurs du Canada
- Matt Wayland, International Brotherhood of Electrical Workers Canada
- Matthew Fortier, Accelerate Canada
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- Peter MacLeod, MassLBP
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- Pierre-Olivier Pineau, HEC Montréal
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