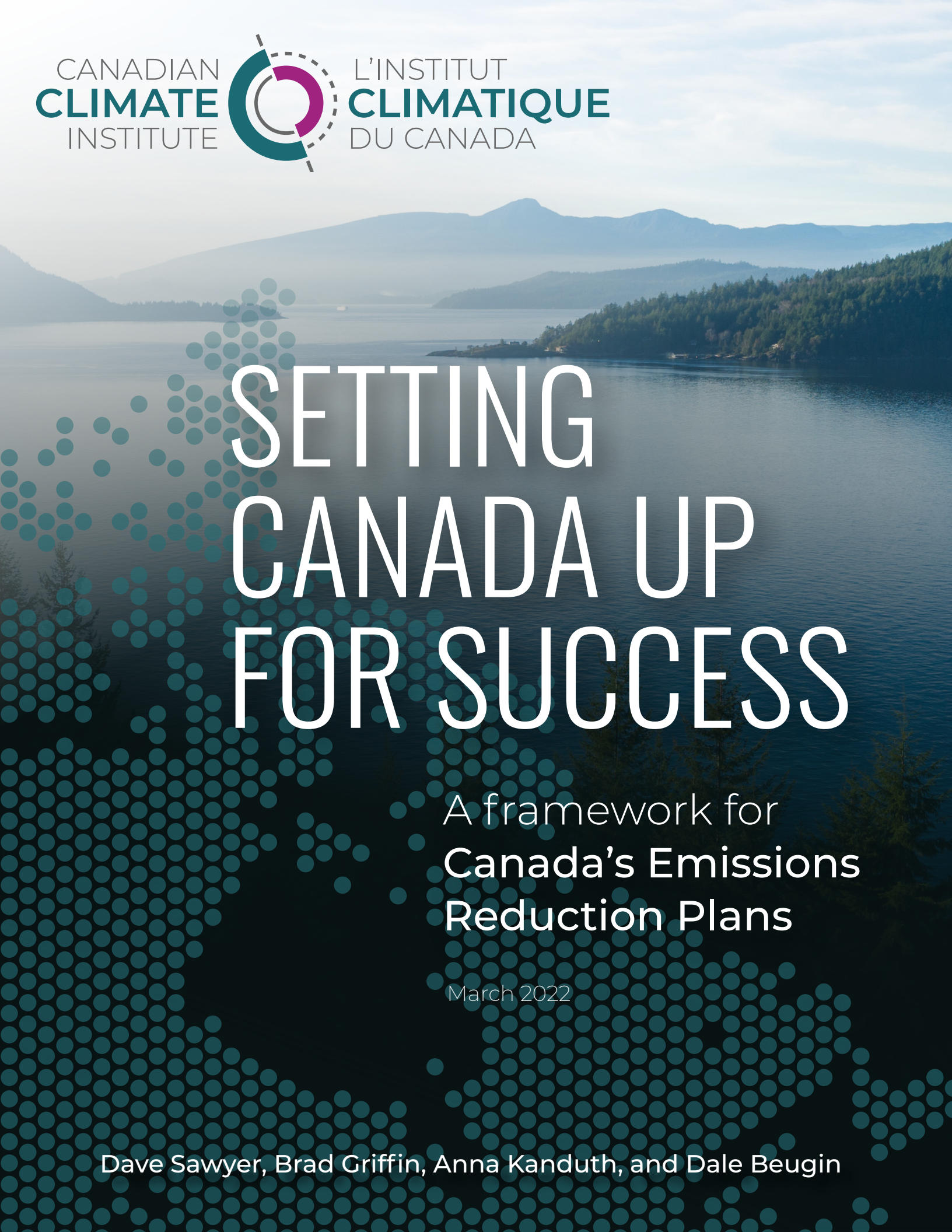

CANADIAN CLIMATE INSTITUTE

L'INSTITUT CLIMATIQUE DU CANADA

SETTING CANADA UP FOR SUCCESS

A framework for Canada's Emissions Reduction Plans

March 2022

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THE 2030 EMISSIONS REDUCTION PLAN AND WHY IT MATTERS

Canada is at a climate governance inflection point. To confront the threat of a warming and increasingly volatile climate, the federal government has committed to reducing greenhouse gas pollution by 40 to 45 per cent by 2030 on the path to net zero emissions by 2050. It has established climate policies that are delivering emission reductions in crucial sectors. These federal actions demonstrate there is more certainty in the need to act than uncertainty. But to reach its 2030 and 2050 climate goals, Canada must now shift toward the *implementation* of ambitious climate policy that builds on the framework established thus far. Stringent and comprehensive climate policies and better governance processes will be needed. Successful implementation of policy to reach Canada's climate goals requires a transparent and accountable governance frame capable of taking stock of progress and adapting policy based on what's working and what isn't.

The foundation for improved federal climate governance is the Canadian Net-zero Emissions Accountability Act, which requires the federal government to "use the best scientific information available and promote transparency, accountability, and immediate and ambitious action in support of achieving" national targets. The Emissions Accountability Act mandates several formalized governance processes, including setting five-year milestones or targets to achieve net-zero emissions by mid-century, routinely publishing Emissions Reduction Plans, tracking and reporting on progress, and seeking independent advice.

Publishing an Emissions Reduction Plan for 2030 by March 2022 is an important first requirement of the Emissions Accountability Act. This first Emissions Reduction Plan must establish an emissions reduction objective for 2026, aligned with the 2030 milestone, and, crucially, it must be both *credible* and *adaptive* to ensure Canada can develop and implement a policy package to reach those targets. Because Emissions Reduction Plans are a new and important emissions reduction planning tool for the federal government, it is important to get them right. To do that, a process of continuous improvement will need to be a defining feature of the plans.

So what would constitute a credible and adaptive plan? A credible Emissions Reduction Plan, this report argues, is one that enables effective policy capable of reducing emissions to reach the targets. And an adaptive Emissions Reduction Plan is one that is transparent about the detailed work that underpins the Plan, identifies who is accountable for its implementation, and establishes a process to course correct as needed.

This report from the Canadian Climate Institute proposes a framework for an effective Emissions Reduction Plan that draws on the Emissions Accountability Act, international best practices in stocktaking, policy expertise from the Institute's Expert Panels, and the Institute's experience in independent policy assessment. It also builds on the Initial Observations of the Net-Zero Advisory Body.

This report also uses original analysis and modelling to illustrate sectoral targets and emission pathways for 2026 and 2030 that are consistent with net zero by 2050.

Following the release of the 2030 Emissions Reduction Plan in March 2022, the Climate Institute will follow up this report with an independent assessment of the first Emissions Reduction Plan to determine whether it is sufficient to achieve the 2030 target and put Canada on the path to net zero by 2050. That assessment will identify any gaps in the Emissions Reduction Plan, as well as opportunities for strengthening it.

Our overarching goal in these two reports is to promote a cycle of continuous improvement to support the drafting and implementation of the first—and subsequent— Emissions Reduction Plans as a foundation for good climate governance in Canada for decades to come.

The remainder of this report is organized as follows:

- Section 2 sets the context by briefly summarizing the main elements of the Emissions Accountability Act, including the planning, reporting, and accountability mechanisms.
- Section 3 defines a framework for the Emissions Reduction Plan.
- Section 4 offers conclusions that stem from this framework.
- The Annex uses the Climate Institute's net zero modelling and analysis to develop illustrative sectoral emissions pathways for the 2026 and 2030 targets.

2 A CLOSER LOOK AT CANADA'S NEW CLIMATE GOVERNANCE FRAME

In June 2021, the Canadian Net-Zero Emissions Accountability Act received Royal Assent, establishing a climate accountability framework for the federal government. The Act cements Canada's net zero target into law, mandates that five-year milestones be set en route to 2050, and establishes formal governance structures and accountability measures to help keep the federal government on track.

The Emissions Accountability Act requires the federal government to release an Emissions Reduction Plan for each milestone year, including 2030, 2035, 2040, and 2045. The Emissions Reduction Plan for 2030, which will also include an interim greenhouse gas emissions objective for 2026, is due by the end of March 2022, with subsequent plans due at least five years before the next milestone date.

The forthcoming Emissions Reduction Plan will outline the measures and strategies that the federal government intends to implement to achieve its 2030 emissions reduction target of 40 to 45 per cent reductions below 2005 levels. According to the Act, the Emissions Reduction Plan must also include several additional components:

- A summary of Canada's most recent greenhouse gas emissions inventory.
- A description of how the Emissions Reduction Plan incorporates Canada's international climate change commitments (Canada's enhanced Nationally Determined Contribution) and accompanying submissions.
- A description of any relevant sectoral strategies.
- A description of emissions reduction strategies for federal government operations.
- A timeline for implementation.
- Projections of the greenhouse gas emissions reductions resulting from the policy measures and strategies, including projections for economic sectors.

- A summary of cooperative policy measures or agreements with provinces, territories, and other governments in Canada.
- An explanation for how the plan contributes to Canada's net zero target.

The Emissions Accountability Act also establishes a series of reporting requirements and accountability mechanisms:

- **PROGRESS REPORTS:** The Minister of Environment and Climate Change Canada is to prepare a report relating to each milestone year, outlining the progress that has been made, including an update on the implementation of the Emissions Reduction Plan. The Minister's progress report is due at least two years before the milestone year, with the first progress reports mandated for 2023, 2025, and 2027.
- **ASSESSMENT REPORTS:** After every milestone year, the government must prepare a report that determines whether the target has been met and assesses the role the Emissions Reduction Plan played in achieving it. If the target is not met, the Minister must provide a rationale for the gap as well as a description of actions the government will take to fill it.
- **INDEPENDENT ADVICE:** The Emissions Accountability Act mandates that the Net-Zero Advisory Body (NZAB) be established to provide the Minister with independent advice on targets and Emissions Reduction Plans, including policy measures and sectoral strategies. NZAB must submit an annual report to the Minister outlining its advice and activities.
- **INDEPENDENT ASSESSMENT:** At least once every five years, the Commissioner of the Environment and Sustainable Development (CESD) is to produce a report examining the progress of Emissions Reduction Plan measures and provide recommendations for improving the plan's implementation. The first report is due by the end of 2024.
- **MINISTER OF FINANCE ANNUAL REPORT:** In addition to the Emissions Reduction Plan reporting cycle, the Emissions Accountability Act mandates that the Minister of Finance, in cooperation with the Minister of Environment and Climate Change, must publish an annual report outlining key measures that the federal public administration has taken to manage its climate change financial risks and opportunities.

> Annual, independent progress reports are best practice, as they create regular opportunities for course correction and enhance government accountability.

While regular reports by the federal government, the CESD, and NZAB establish a clear process for monitoring and reporting, the Emissions Accountability Act does not mandate annual, independent oversight. The CESD's assessments schedule for "at least once every five years" will lag policy development and leave an accountability gap. Annual, independent progress reports are best practice, as they create regular opportunities for course correction and enhance government accountability. This and subsequent reports will seek to fill that reporting gap, drawing on the Climate Institute's independence, credibility, and analytical capacity.

EMISSIONS TARGET DEFINITIONS RELEVANT TO AN EMISSIONS REDUCTION PLAN

NET ZERO: By 2050, Canada will be taking as many emissions out of the atmosphere as it puts in, rather than leaving them there to trap heat and contribute to further climate change. In effect, any remaining emissions in 2050 would need to be offset by measures to permanently remove the same amount of carbon from the atmosphere.

2030 TARGET: Canada's enhanced Nationally Determined Contribution under the United Nations Framework Convention on Climate Change is a 40-to-45 per cent reduction below 2005 levels by 2030. This target is now binding under the Emissions Accountability Act.

MILESTONE: A binding emissions reduction target published under an Emissions Reduction Plan for 2030, 2035, 2040, or 2045 that puts Canada on a path to net zero.

OBJECTIVE: An interim non-binding target before a milestone. A 2026 objective is to be published under the first Emissions Reduction Plan for 2030.

HARD CAP: A binding emissions constraint above which emissions are not permitted or can be offset from outside of the regulated entities.

SOFT CAP: A non-binding emissions target above which emissions can exceed the target though obtaining reductions from elsewhere or making compliance payments.

PATHWAYS: A pathway connects where we are today with where we want to go. According to the Net-Zero Advisory Body, a pathway captures all the elements required to transform a system to better respond to societal needs and meet net-zero emission goals.

EMISSIONS PATHWAY: An emissions projection that aligns with an objective or milestone on the way to net zero. It could be national or specified by sector and ideally is presented as a range that reflects uncertainty in emissions drivers. It could be a technologically achievable pathway identifying the frontier of potential emissions reductions or it could be a policy-induced emissions pathway, setting a trajectory that is achievable for a given policy package.

3 A FRAMEWORK FOR A SUCCESSFUL EMISSIONS REDUCTION PLAN

The credibility of Canada's first Emissions Reduction Plan will hinge on its perceived seriousness in laying out a "transparent and scientifically rigorous plan" to deliver emission reductions aligned with the net zero milestones.[1] This section presents a framework consisting of three elements to ensure that an Emissions Reduction Plan can credibly deliver greenhouse gas reductions consistent with Canada's emissions reduction ambitions:

1. An emissions pathway consistent with net zero;
2. Policies that credibly reduce emissions to the milestone; and
3. Governance processes that are responsive, taking stock of progress, and update to course correct.

We discuss each element in turn.

ELEMENT 1: An emissions pathway consistent with net zero

As a first level of credibility, the Emissions Reduction Plan must identify, as per the Emissions Accountability Act, national milestones that are consistent with a national emissions pathway to net zero by 2050.[2] Emissions pathways link current emissions to long-term emissions and provide a benchmark to assess progress to targets. Short-term progress underpins long-term ambition because national emissions have inertia: it takes time to replace existing stock of emissions-intensive buildings, vehicles, and industrial facilities with low-carbon alternatives. Publishing the sectoral composition of the national emissions pathway helps communicate possible sectoral contributions.

[1] The Act mandates that targets are set based on the best scientific information available and to promote transparency, accountability, and immediate and ambitious action in relation to achieving those targets (§ 4).
[2] The Act requires the Emissions Reduction Plan to define greenhouse gas emissions milestones that are consistent with pathways to net-zero emissions nationally by 2050 (§§ 6 and 7 (1)). As part of this framing, a description is required about how the Emissions Reduction Plan considers Indigenous knowledge, Canada's international commitments, such as Canada's enhanced Nationally Determined Contribution, and submissions to the Net-Zero Advisory Body (§§ 8 (a) – (d)).

Three main indicators can measure the extent to which an Emissions Reduction Plan credibly and transparently identifies a national emissions pathway consistent with the relevant targets (objectives or milestones) and with achieving net zero by 2050.

INDICATOR 1A: Transparent modelling and analysis define a technologically achievable emissions pathway to the milestone.

Each Emissions Reduction Plan is mandated to publish the value for the next milestone for national emissions while identifying a technologically achievable emissions reduction pathway to get there. While the 2030 national target and hence the 2030 milestone are now set, neither the 2026 objective nor the subsequent milestones after 2030 have yet been defined.

A credible Emissions Reduction Plan will use integrated economy-wide modelling to identify a technologically achievable emissions pathway. Such analysis underpins credible and realistic emissions reduction pathways that connect current emissions to subsequent national milestones and net zero to 2050. Such a pathway would avoid a heavy reliance on wild-card technologies that are not fully scalable before the milestone year, or dead-end technologies that lock in systems and technologies that will become emissions liabilities before 2050. Emission levels and a reduction pathway charting annual per cent reduction would be reported from the projections, benchmarked against the latest year of published emissions.

A credible Emissions Reduction Plan is also transparent with respect to assumptions. Key information from the analysis and modelling that underscores the greenhouse gas emissions projections are presented, especially activity levels assumed for the sectors and the resulting emissions intensity. All scenarios supporting the Emissions Reduction Plan would be clearly numbered, with major assumptions documented, and published. Ideally, the models themselves would be accessible to third parties to verify results and sensitivities.

INDICATOR 1B: The emissions pathway is stress tested to reveal alternative trajectories.

An Emissions Reduction Plan that stress tests its emissions pathways increases the robustness and credibility of emissions projections, assisting with long-term planning by revealing major uncertainties that need to be addressed through planning. There is, in other words, more certainty than uncertainty in the emissions pathway. Important emissions drivers that should be stress tested include global action to reduce emissions, technology cost and removal efficiency, alternative pathways for energy carriers, energy price fluctuations, and economic activity levels.

INDICATOR 1C: The Emissions Reduction Plan includes emissions pathways by sector.

A transparent and credible Emissions Reduction Plan provides a disaggregated view of Canada's emissions pathway to the milestone and on to net zero. Sectoral detail is a requirement of the Emissions Accountability Act, though publishing emissions pathways for each sector is not.[3] However, providing sectoral emissions pathways would add to the usefulness of the Emissions Reduction Plan by setting expectations about what sectors can contribute to the milestone. This is not to say that the sectoral emissions pathways necessarily become binding caps for the sectors, but rather would be provided for informational purposes only. The economic sector categories would be consistent with past Environment and Climate Change Canada emissions projections, making comparisons with past projections possible.

Annex 1 provides a sector-by-sector approach to implementing this portion of the framework using the Climate Institute's net zero modelling. A total of 62 scenarios were developed by stress testing combinations of technology, energy transition, policy, global action, commodity prices, and economic activity assumptions. All scenarios are compliant at the national level for Canada's 2030 target and net- zero by 2050. Sectoral emissions pathways are presented for large emitters, oil and gas, buildings, transportation, agriculture, waste, and others. The median values in the sectoral emissions pathways presented in Annex 1 should not be interpreted as a target reduction for a sector. Instead, a policy-induced pathway would be developed taking account of technical feasibility, compliance flexibility, and financial impact considerations. For example, an oil and gas cap set at the median of the Institute's 62 net zero pathways of 138 megatonnes would be too high. Instead, a cap set in the range of 100 to 120 megatonnes would be more reflective of a policy-induced pathway to 2030.

ELEMENT 2: Policies that credibly reduce emissions to the milestone

This second element of the framework is focused on assessing the policy package that an Emissions Reduction Plan presents to achieve the milestone target.[4] Absent credible policy measures, emissions pathways remain hypothetical and lack credibility. A credible Emissions Reduction Plan should

[3] The Act requires the Emissions Reduction Plan to provide sectoral detail. It requires projections for each economic sector included in Canada's reports under the UNFCCC (§§ 10 (1) (a) and (f)) and ultimately a progress report on the implementation of sectoral strategies ((§§ 2 (b), 10 (1) (a) and (f)).

[4] Requirements for the Emissions Reduction Plan from the Act that inform the potential of the emissions reduction policy package to deliver on the milestone pathways include presenting emission trends and projections data, policy measures and sectoral strategies, the timing of implementation, and cooperative action within the federation to be expected (§§ 10 (1) – (g)).

therefore identify federal, provincial, and territorial policy measures capable of delivering on the milestones or objective. Sectoral detail would provide critical transparency regarding expected progress—and challenges—in achieving national milestones. It would also provide a means of assessing the expected impact and progress of sector-level strategies published under the Emissions Reduction Plan.

Three main indicators can measure the extent to which an Emissions Reduction Plan describes a credible policy-induced emissions pathway.

INDICATOR 2A: Policy measures are detailed, specific, and concrete.
In a credible Emissions Reduction Plan, the emissions reduction policies to achieve the milestone are listed, numbered, and described in terms that reveal their expected effectiveness at reducing emissions. Such information would ensure that the outcomes of the policies are trackable. Similarly, an implementation schedule for the Emissions Reduction Plan, its policies, and the major elements of sectoral strategies would be provided. Implementation accountabilities would also be identified.

Given that policies are staged over time, with some policies already implemented and others still in development, distinct levels of detail would be required depending on the stage the policy is at:

a. **LEGISLATED POLICIES** would be described in terms of the emissions covered, the stringency of policy to the milestone year, the funding allocated, and the projected range of greenhouse gas emission reductions to be achieved or indicators of intermediate policy outcomes (for example, the new market share of heat pumps deployed in residential buildings).

b. **DEVELOPING POLICIES** would be described in terms of the emissions to be covered, a likely range of stringency to the milestone year, the funding to be allocated, concrete timelines for implementation, and the expected range of reductions or indicators of intermediate policy outcomes, such as the share of non-emitting electricity generated.

c. **ANNOUNCED POLICIES** would be described in terms of the emissions to be covered and the range of emission reductions expected, along with concrete timelines for policy design and implementation.

Policies that cut across sectors would be identified separately from sector-specific policies. Departmental responsibilities and accountabilities for policy implementation would be made clear.

INDICATOR 2B: Transparent analytics demonstrate the contribution of policies to milestones.

Providing details on the assumed stringency and coverage of modelled policies increases the transparency and credibility of an Emissions Reduction Plan. Emissions trends and modelling projections of the policy-induced emissions pathway would clarify the contribution of the policies to the overall target and highlight emissions reduction inefficiencies associated with policy interactions. Central to this would be a transparent view on economic, energy, and technology outcomes from the projections.

Disaggregating contributions of multiple policies to sectoral pathways would demonstrate the expected contributions of sector-level strategies in a credible Emissions Reduction Plan. Similarly, provincial and territorial policy contributions or agreements that are material to the milestone targets would be listed and modeled, and the expected emission reductions would be identified.

There will be limits on the information that can be made public, including confidential data under the Statistics Canada Act, or that is determined to be budget or cabinet confidential.

INDICATOR 2C: Policies and implementation risks are stress tested.

In a credible Emissions Reduction Plan, sensitivity analysis would transparently demonstrate the extent to which projected emissions reductions from policy measures are robust to uncertainty. The analysis and modelling scenarios would explore sensitivities that affect policy outcomes across a wide range of implementation risks and emissions drivers including economic, energy carrier, and technology drivers. This sensitivity analysis can also identify key implementation risks to achieving the milestones.

ELEMENT 3: Governance processes that are responsive, take stock of progress, and update to course correct

This element of the framework focuses on issues related to ensuring a process of continuous improvement toward achieving milestones.[5] A credible Emissions Reduction Plan would support governance processes to take stock, update, and course correct, adjusting for uncertainty and updating policy on

[5] The Act includes several reporting and accountability checks, including three progress reports before 2030 and an interim report on progress to the 2026 milestone. Requirements for the progress reports mirror the elements of the Emissions Reduction Plan in terms of providing updates on emissions trends and projections to the milestone year, cooperative action and agreements, and federal measure, sectoral strategies and government operations. Importantly, there is a built-in updating mechanism in the Act, where the Minister must "consider whether the target should be changed" accounting for the most recent developments in science, technology and greenhouse gas emissions management (§ 14 (1.1)).

a routine basis consistent with changing circumstances and new information. The Plan would embrace an iterative process by design.

Four main indicators can measure the extent to which an Emissions Reduction Plan is credible because it is adaptive, supporting good governance, implementation, and continuous improvement.

INDICATOR 3A: The Emissions Reduction Plan looks backward as well as forward to assess the outcomes of policy measures.

Leading, lagging, and projected indicators all support course correction and policy updating. An adaptive Emissions Reduction Plan would break down emissions trends and drivers by sector, identifying the impact of policy measures versus other macroeconomic, energy, and emission drivers on sector projections. A sector-by-sector analysis of emissions projections would help explain what is anticipated to change in the future and the impact of policy. This analysis would bolster the credibility of an Emissions Reduction Plan and provide insights for ongoing improvements to emissions projections, policies, sector strategies, and future Emissions Reduction Plans.

INDICATOR 3B: The Emissions Reduction Plan identifies data needs for tracking progress and filling gaps.

A process to identify and fill data gaps would ensure that the information in an Emissions Reduction Plan is ultimately available to track both emissions and the main drivers of emissions reductions, such as EV sales. Notably, the typical publication lag for the National Inventory Report of about two years will need to be shortened if timely emissions data is to inform ongoing progress assessments.

INDICATOR 3C: The Emissions Reduction Plan reports emissions accounting risks.

In an adaptive Emissions Reduction Plan, information is provided on "what changed" given that successive projections will differ from previous years. Significant anomalies or changes in year-over-year outcomes, such as on-going adjustments to accounting methodologies, mistakes, or major assumptions, would be reported. Transparency regarding these changes and adjustments supports the credibility of an Emissions Reduction Plan.

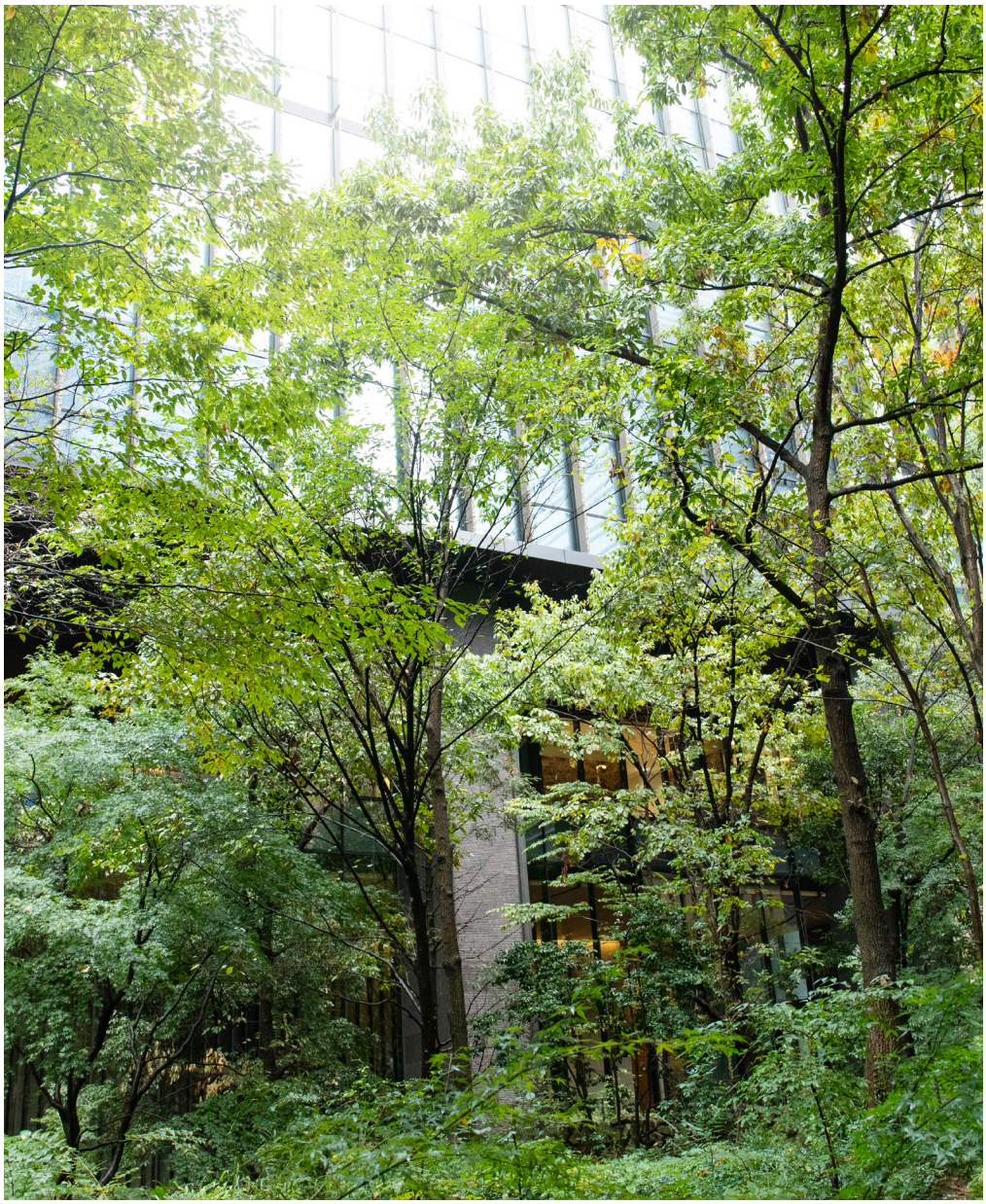
INDICATOR 3D: The Emissions Reduction Plan considers other aspects of policy performance.

An adaptive Emissions Reduction Plan would consider the performance of policy measures—both historical and projected—across multiple criteria. In addition to contributions to achieving emissions milestones, it would also consider:

- The ***cost-effectiveness*** of policy measures and sectoral strategies: Sector emissions pathways should be broadly consistent with cost-ef-

fective pathways. Minimizing costs helps maintain economic prosperity while achieving emissions milestones and increases the durability of these policy pathways.

- ***Distributional considerations*** for policy measures and sectoral strategies: The Emissions Reduction Plan would identify asymmetrical impacts of policy including implications for Indigenous Peoples, competitiveness impacts, and income impacts on households and vulnerable populations. It would also identify policy measures to address any adverse distributional impacts or provide transitional assistance for workers or communities.



4 CONCLUSION

> Because climate governance in Canada is going to be an ongoing process of continuing improvement, it is unrealistic to expect the first plan to include all the elements of the framework presented here. Over time, we would expect more complete and comprehensive reporting and refined governance processes.

The four successive Emissions Reduction Plans that will guide us to net zero by 2050 are central to the successful implementation of the Canadian Net-Zero Emissions Accountability Act. Getting these plans right and ensuring that each successive plan builds on and learns from previous ones will be important to designing and implementing the policy necessary to bend Canada's emissions to net zero by 2050. If done right, Canada's Emissions Reduction Plans have the potential to send long-term investment and behavioural change signals though setting expectations on the effort needed to reach targets. By communicating expected outcomes, the plans will also provide important benchmarks from which performance can be tracked and course corrections made as needed. The plans can be a much-needed upgrade to federal climate accountability, but only if they are credible and adaptive.

Emissions Reduction Plans are a new and important emissions reduction planning tool for the federal government. Because climate governance in Canada is going to be an ongoing process of continuing improvement, it is unrealistic to expect the first plan to include all the elements of the framework presented here. Over time, we would expect more complete and comprehensive reporting and refined governance processes.

The framework we have proposed is focused on ensuring Canada's Emission Reduction Plans are both *credible* and *adaptive*. A credible Emissions Reduction Plan process must formalize and make transparent several government functions that have typically been opaque. These include how emissions projections are developed and communicated, how stringent the policies are, how progress is measured, and the rigour and independence of the review. An adaptive Emissions Reduction Plan sets the governance frame to routinely take stock of process, and then course correct through policy adjustments as needed. This framework is intended as a solid basis for continuous improvement to these functions.

Emissions Reduction Plan development and implementation provides an opportunity for the federal government, provinces, and territories to deepen cooperative actions to reduce emissions. There is also clear scope to increase the involvement of Indigenous Peoples. Working collectively across governments to develop and implement elements of Canada's Emissions Reduction Plans should be a shared objective. As such, this framework can help to coordinate cooperative efforts by providing a touchstone for coordinating policy and taking stock of progress across the federation.

ANNEX:
ILLUSTRATIVE SECTOR EMISSIONS PATHWAYS THAT ARE CONSISTENT WITH AMBITION

This annex illustrates how Element 1 of the Climate Institute's framework could be implemented. It does not purport to suggest definitive values to be used for target setting for national emissions or sectors. The sectoral emissions pathways are based on comprehensive modelling analysis reflecting a wide range of possible emissions outcomes across varied assumptions.

The first step in developing Canada's first Emissions Reduction Plan is to establish sectoral emission pathways that are consistent with a net zero economy in 2050. In this section, we provide an illustrative example of how Element 1 of the Institute's framework could be applied. We use the 62 net zero scenarios developed for the Institute's Canada's Net Zero Future report to backcast sector emission pathways that achieve Canada's national 2030 target, which is likely to be the 2030 Emission Reduction Plan milestone.

The Climate Institute's net zero projections map onto the Emissions Reduction Plan framework as follows:

- **Modelling and analysis underpin the emissions pathways.** We used integrated economy-wide modelling to develop a range of emissions pathways working backwards from a national target of net zero in 2050, while hitting the 2030 national target. Emission levels and an emissions pathway in terms of annual percent reduction are reported. Emissions intensity improvements are not reported, however.
- **The scenarios are compliant with net zero in 2050 and with the 2030 target.** All the scenarios achieve Canada's enhanced Nationally Determined Contribution in 2030 and achieve net zero emissions in 2050 of 100 megatons of carbon emissions to be offset. The 2030 target is simulated as 499 megatons (Mt) with an exogenous assumption that 80 megatons of emission reductions would come from nature-based solutions, LULUCF accounting under the UNFCCC, and internationally traded units such as California units imported into Quebec's cap-and-trade system.

- **Sector emissions pathways collectively achieve the 2030 target and are net zero compliant.** The economic sector categories presented below are consistent with past ECCC emissions projections, and include oil and gas, electricity, light duty vehicles (passenger), heavy duty vehicles (freight), residential buildings, commercial buildings, large emitters, agriculture, waste, and others.
- **The scenarios are stress tested.** The emissions pathways are developed from a common set of cost-effective pathways, where the least-cost policy is consistently applied in the 62 scenarios. Nineteen emission drivers were varied in the scenarios, including competitiveness protection for large emitters, global action to reduce emissions, technology cost and emission removal efficiency, alternative pathways for energy carriers, energy price fluctuations, and activity levels. Low oil price scenarios are differentiated given their importance to emissions pathways in some sectors, notably oil and gas and heavy industry.
- **Safe bets and wild cards sort the scenarios.** To help assess technical feasibility for the emission pathways, we sorted the runs into the Institute's taxonomy of *safe bets and wild cards*. Safe bets are those technologies that are largely available and affordable now whereas wild cards are not yet widely available. Generally, we find that for all economic sectors the wild-card technologies form a small share of the total reductions in the pathways prior to 2030. This means generally that the model runs look technically feasible for Canada achieving the 2030 target.
- **An equal share benchmark is identified (as a point of comparison only).** For each sector, the equal share benchmark is the level of emissions in 2030 equivalent to achieving Canada's national target of 40 to 45 per cent below 2005 levels. This benchmark highlights how the range of cost-effective emissions reductions from the modelling compares against the equivalent national target. To be clear, wide differences in abatement costs mean that the cost-effective policy package should not necessarily require all sectors to achieve the same level of reductions; the equal share benchmark does, however, illustrate how sectors can and should contribute more emissions reductions to deliver a cost-effective pathway.

For each sector, a range of indicators bound an emissions pathway:

- Historical emissions for 2005 and 2019.
- The compound annual growth rate in emissions between 2005 and 2019.
- For the years 2026 and 2030, the low, central, and high range in emis-

sions from the 62 net zero runs, estimated as the 20th, 50th and 80th percentiles.

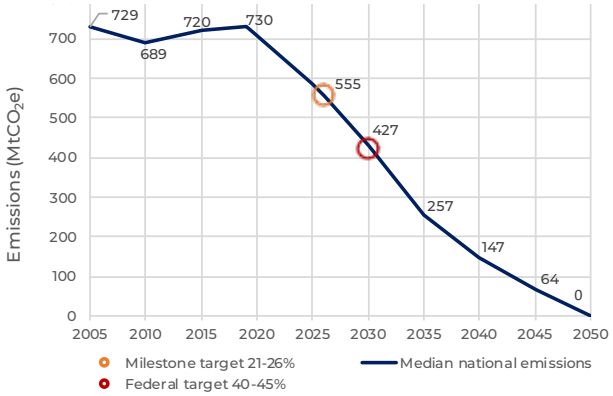
- For objective period 1 (2019 to 2026) and milestone period 1 (2026 to 2030), the annual reduction in emissions for the milestone range and the compound annual growth rate.

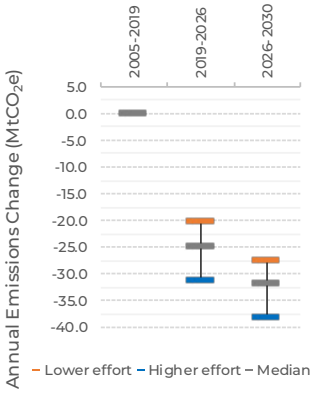
For each sector we also provide a short description of some of the major emissions drivers that explain the range of pathways presented.

Key observations based on this analysis include the following:

- In our modelling, the oil and gas sector displays the greatest variability in emissions based on the range of drivers used to stress test the scenarios. Since this sector also has one of the largest shares of today's emissions in Canada, to some extent it sets the available emissions envelope in other sectors, notably for large emitters where rapid emission reductions are more costly.
- Global oil prices are one of the major determinants of the oil and gas sector's output, and therefore its emissions. Since international oil prices are beyond Canada's control and given the oil and gas sector's large share of national emissions, policies in all sectors should be flexible and adaptable enough to respond to changing global conditions. Stocktaking and course correction will likely play a significant role in future policies.
- Finally, while all sectors will need to achieve rapid decarbonization to reach the 2030 target and beyond, several sectors including buildings, transportation, and especially oil and gas will need to see dramatic shifts from their recent historical growth in emissions to strong annual declines.

National Emissions Pathways to 2030 and Beyond



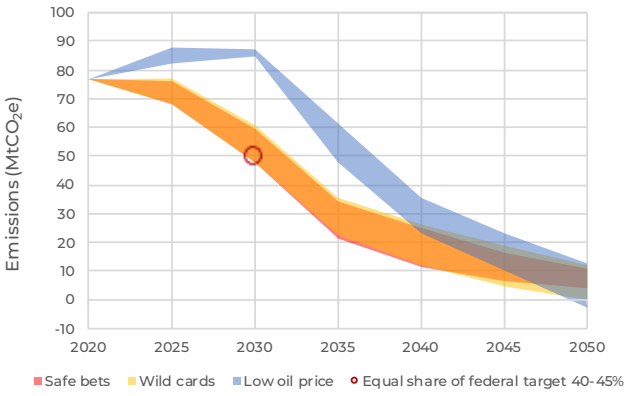


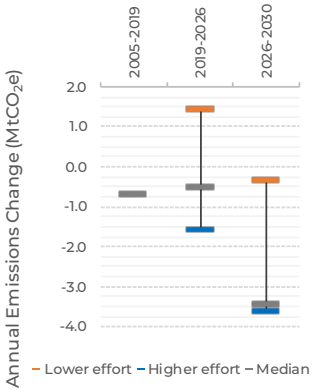
		Historical		Pathway	
		2005	2019	2026 milestone	2030 milestone
		2005-2019		2019-2026	2026-2030
Emissions ($MtCO_2e$)	Lower effort			588.1	477.6
	Median	729.0	730.0	555.1	427.5
	Higher effort			511.9	359.7
Annual change ($MtCO_2e$/yr)	Lower effort			-20.3	-27.6
	Median	0.1		-25.0	-31.9
	Higher effort			-31.2	-38.1
Annual change (CAGR %/yr)	Lower effort			-3.0%	-5.1%
	Median	0.0%		-3.8%	-6.3%
	Higher effort			-4.9%	-8.4%

- **Sustained policy effort needed.** Reaching net zero by 2050 will require a strong and sustained policy effort. The level of emission reductions needed from today to meet the 2030 target will need to continue at a similar rate to get to the net zero goal.
- **The 2026 objective is 555 Mt or 3.8 per cent reduction per year from 2019.** The 2026 milestone is based on the median pathway of sector emissions. The 21-26 per cent reduction range indicates a similar milestone window to the 2030 target.
- **Non-policy uncertainties place the 2030 milestone at risk.** The higher (lower) effort values shown at the national level represent a hypothetical case where all sectors achieve more (less) reductions. These higher- and lower-effort cases were not explicitly modelled in the Institute's net-zero study but give an idea of the range of possible national outcomes given the stress testing we conducted. Note that the lower-effort case shown here, where all sectors achieve lower effort, does not meet the 2030 target; collectively the sectors achieve only a 35 per cent reduction.

Large Emitters

Subsectors: chemicals and fertilizers; iron and steel; non-metallic minerals (cement, lime, and gypsum); non-ferrous metals (aluminium, smelting); pulp and paper; and mining.



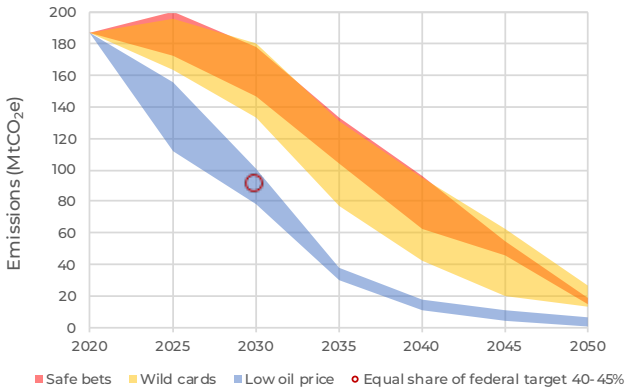


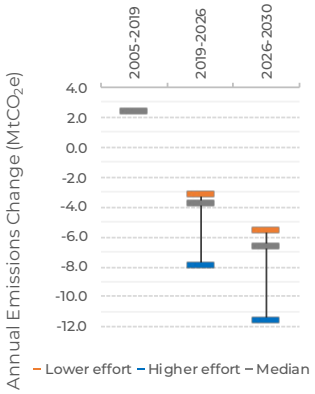
		Historical		Pathway	
		2005	2019	2026 milestone	2030 milestone
		2005-2019		2019-2026	2026-2030
Emissions ($MtCO_2e$)	Lower effort			87.0	85.5
	Median	87.0	77.0	73.2	59.4
	Higher effort			65.9	51.5
Annual change ($MtCO_2e$/yr)	Lower effort			1.4	-0.4
	Median	-0.7		-0.5	-3.4
	Higher effort			-1.6	-3.6
Annual change (CAGR %/yr)	Lower effort			1.8%	-0.4%
	Median	-0.9%		-0.7%	-5.1%
	Higher effort			-2.2%	-6.0%

- Emissions reductions are concentrated in a few sectors, indicating downside risk. To 2030, over half of large-emitter emissions reductions come from the metals sector (iron and steel, smelting, and aluminium). While there is great reduction potential in the large-emitter sector, there is also large uncertainty, mainly about the future of the OBPS; the range of scenarios show over 11 MtCO2e difference in 2030 emissions.
- Low oil prices are a downside risk. When oil prices are low, large-emitter emissions are less constrained to 2030 due to the output and emissions declines in the oil and gas sector. This is especially true of the chemicals sector where over half of emissions are related to production processes and few reduction options exist.
- Getting to net zero by 2050 will need wild-card options. Sectors like cement and lime could gain a lot of flexibility if technologies like CCUS for combustion emissions are available; without these wild cards, relying on safe bets follows a narrower pathway window to net zero.

Oil and Gas (upstream and downstream)

Sectors: upstream oil sands; upstream O&G; and downstream O&G (petroleum refining, etc.)

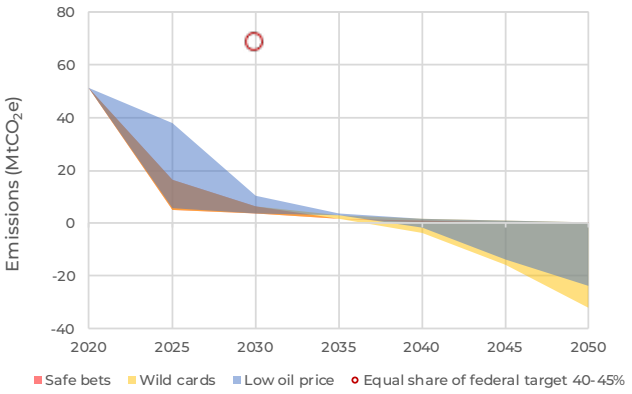


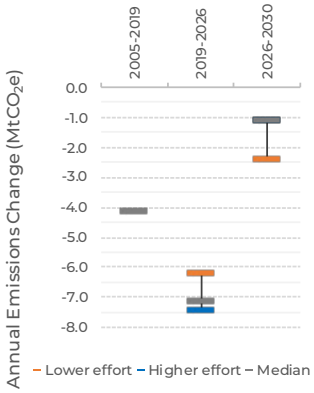


		Historical		Pathway	
		2005	2019	2026 milestone	2030 milestone
		2005-2019		2019-2026	2026-2030
Emissions ($MtCO_2e$)	Lower effort			168.8	146.5
	Median	158.0	191.0	164.7	138.0
	Higher effort			135.5	89.2
Annual change ($MtCO_2e$/yr)	Lower effort			-3.2	-5.6
	Median	2.4		-3.8	-6.7
	Higher effort			-7.9	-11.6
Annual change (CAGR %/yr)	Lower effort			-1.7%	-3.5%
	Median	1.4%		-2.1%	-4.3%
	Higher effort			-4.8%	-9.9%

- Lower oil prices drive production declines in upstream oil and gas, including oil sands, but increase output from the refining sector due to higher demand from transportation fuels.
- Oil sands: Emissions in 2030 can vary by 50 per cent between safe-bet and wild-card scenarios due to changes in domestic upgrading capacity, which depends on the U.S. acting aggressively on climate change. Low global oil prices can affect emissions by just as much due to decreased upgrading capacity expansion and curtailed in-situ and mining operations.
- Upstream: Emissions are almost halved between 2019 and 2030 under all scenarios, mostly by preventing methane venting and increasing machinery efficiency.
- Downstream: Refining output to 2030 increases with the use of an Output-Based Pricing System, and even further when global oil prices are low. While the OBPS doesn't substantially affect emissions from the sector, reductions are halved with low oil prices.

Electricity Generation

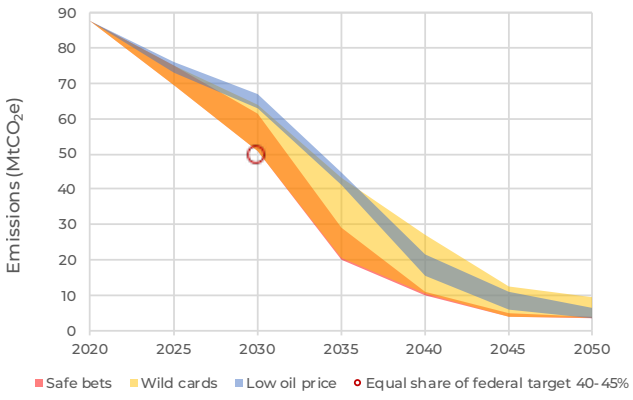


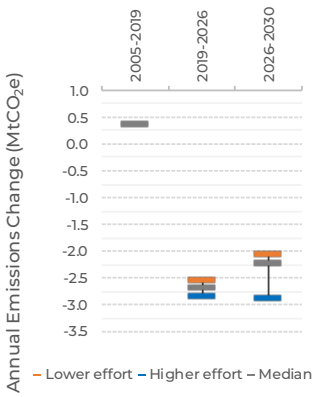


		Historical		Pathway	
		2005	2019	2026 milestone	2030 milestone
		2005-2019		2019-2026	2026-2030
Emissions ($MtCO_2e$)	Lower effort			17.7	8.1
	Median	119.0	61.0	11.0	6.4
	Higher effort			8.7	4.2
Annual change ($MtCO_2e/yr$)	Lower effort			-6.2	-2.4
	Median	-4.1		-7.1	-1.1
	Higher effort			-7.5	-1.1
Annual change (CAGR %/yr)	Lower effort			-16.2%	-17.9%
	Median	-4.7%		-21.8%	-12.5%
	Higher effort			-24.3%	-16.8%

- When oil prices are low, electricity generation emissions are less constrained to 2030 due to the output and emissions declines in the oil and gas sector. When oil sands emissions are lower, the electricity sector has more time to complete the coal power phase-out.
- In all scenarios, the electricity generation sector's emissions are well below the equal share target in 2030. The phase-out of coal power and increases in renewable capacities have driven a fast decline in greenhouse gases since 2005 (which is used to calculate the 2030 target).
- In scenarios where it is more difficult to meet the national emissions cap, power sector emissions fall quickly to 2025 (higher or earlier effort scenarios) due to relatively lower-cost reductions than in other sectors. In these scenarios, the pace of reductions then slows, resulting in fewer annual reductions compared to lower or later effort scenarios.

Buildings

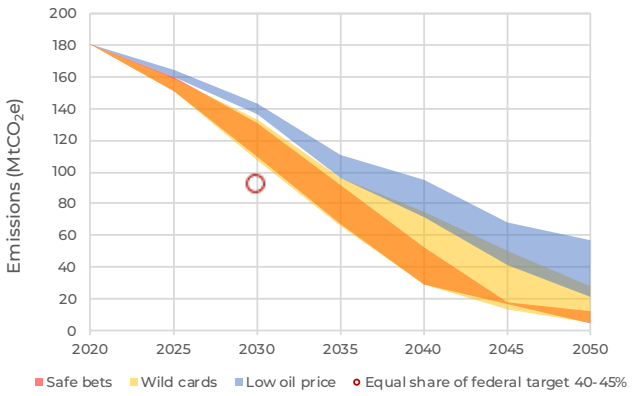


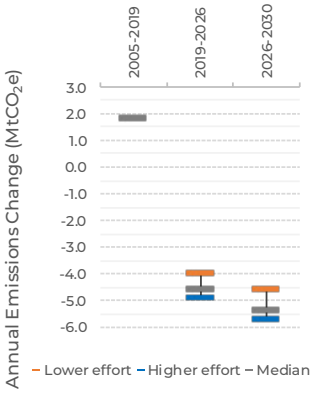


		Historical		Pathway	
		2005	2019	2026 milestone	2030 milestone
		2005-2019		2019-2026	2026-2030
Emissions ($MtCO_2e$)	Lower effort			73.1	64.9
	Median	86.0	91.0	72.2	63.3
	Higher effort			71.0	59.5
Annual change ($MtCO_2e$/yr)	Lower effort			-2.6	-2.1
	Median	0.4		-2.7	-2.2
	Higher effort			-2.9	-2.9
Annual change (CAGR %/yr)	Lower effort			-3.1%	-2.9%
	Median	0.4%		-3.3%	-3.2%
	Higher effort			-3.5%	-4.3%

- All net-zero pathways indicate strong decarbonization in this sector; this will be a dramatic shift away from the annual emission increases over the past two decades. To 2030, electrification will play the largest role in reductions, but contributions will also come from biofuels like renewable natural gas and efficiency gains from improved building practices.
- When the U.S. acts aggressively on climate change, natural gas is more expensive due to decreased supply, driving a shift from efficient gas furnaces to electric air source heat pumps.
- The opposite occurs when global oil prices are lower. In these scenarios, lower carbon prices are needed to meet Canada's 2030 target, which decreases the incentive to install electric heat pumps with building owners opting for more natural gas furnaces.

Transportation



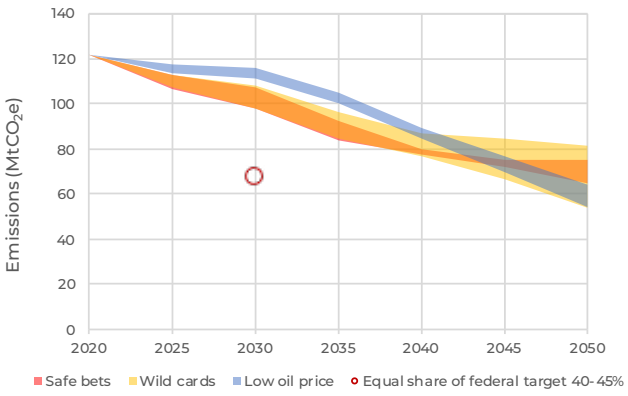


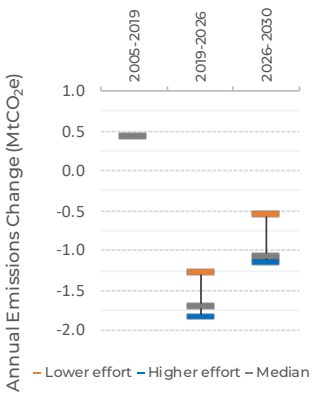
		Historical		Pathway	
		2005	2019	2026 milestone	2030 milestone
		2005-2019		2019-2026	2026-2030
Emissions ($MtCO_2e$)	Lower effort			158.2	139.8
	Median	161.0	186.0	154.1	132.6
	Higher effort			151.7	128.9
Annual change ($MtCO_2e$/yr)	Lower effort			-4.0	-4.6
	Median	1.8		-4.6	-5.4
	Higher effort			-4.9	-5.7
Annual change (CAGR %/yr)	Lower effort			-2.3%	-3.0%
	Median	1.0%		-2.7%	-3.7%
	Higher effort			-2.9%	-4.0%

- Light-duty passenger vehicles: Until 2030, the milestone pathways for this sector are remarkably similar. Sales of electric vehicles and efficiency improvements dominate the emissions reduction options in this sector as the most cost-effective actions.
- Heavy-duty freight vehicles: There is much more uncertainty in this sector due to fewer safe-bet technologies available. Here, hydrogen, electricity, and bioenergy play a large role, but efficiency improvements are still the main decarbonization option to 2030.
- The low oil price scenarios highlight the variability of possible emissions from heavy-duty freight vehicles as internal combustion engines are likely to remain the dominant technology until at least 2030. Gasoline prices have much less impact on the possible emissions from passenger vehicles.

Agriculture, Waste, and Others

Sectors: agriculture, waste, coal production, light manufacturing, construction, and forestry.



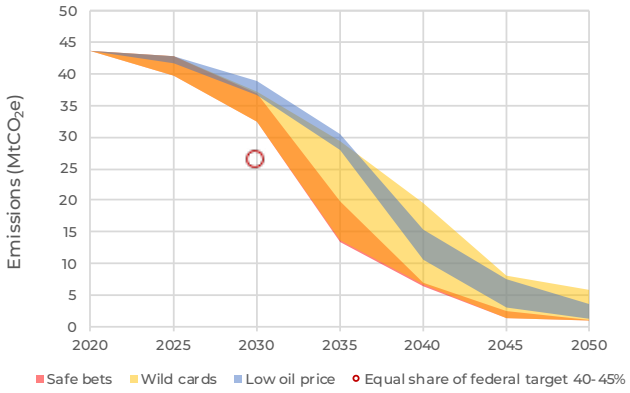


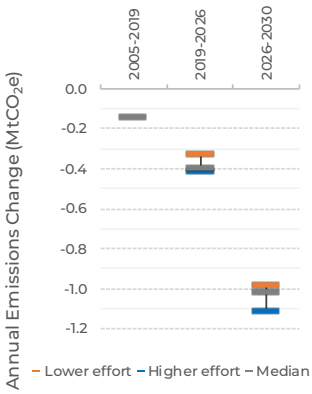
		Historical		Pathway	
		2005	2019	2026 milestone	2030 milestone
		2005-2019		2019-2026	2026-2030
Emissions ($MtCO_2e$)	Lower effort			115.0	112.8
	Median	118.0	124.0	112.1	107.7
	Higher effort			111.1	106.5
Annual change ($MtCO_2e$/yr)	Lower effort			-1.3	-0.5
	Median	0.4		-1.7	-1.1
	Higher effort			-1.8	-1.2
Annual change (CAGR %/yr)	Lower effort			-1.1%	-0.5%
	Median	0.4%		-1.4%	-1.0%
	Higher effort			-1.6%	-1.1%

- Agriculture: Most emissions from this sector are non-combustion and will need targeted (possibly non-pricing) policies to reduce emissions toward net zero.
- Waste: Municipal landfills make up most of this sector. While decarbonization is technically possible, strong carbon prices are needed to drive the installation of methane collection systems.
- Light manufacturing: Given the lower temperature heat needs compared to heavy industry, the businesses that make up light manufacturing are able to electrify and decarbonize their operations more easily.

Additional Sector Emissions Pathways

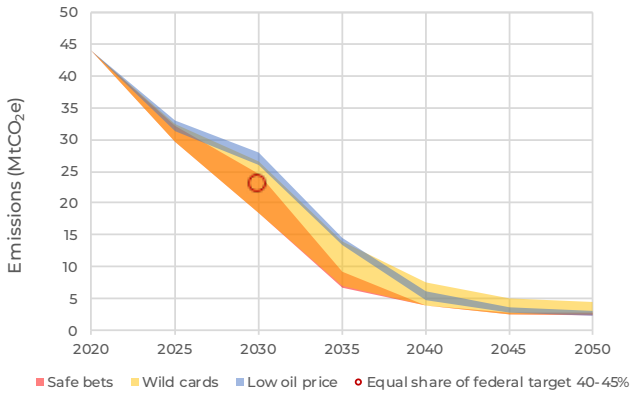
Buildings: Residential





		Historical		Pathway	
		2005	2019	2026 milestone	2030 milestone
		2005-2019		2019-2026	2026-2030	
Emissions ($MtCO_2e$)	Lower effort			41.7	37.8
	Median	46.0	44.0	41.2	37.1
	Higher effort			41.1	36.6
Annual change ($MtCO_2e/yr$)	Lower effort			-0.3	-1.0
	Median	-0.1		-0.4	-1.0
	Higher effort			-0.4	-1.1
Annual change (CAGR %/yr)	Lower effort			-0.8%	-2.4%
	Median	-0.3%		-0.9%	-2.6%
	Higher effort			-1.0%	-2.8%

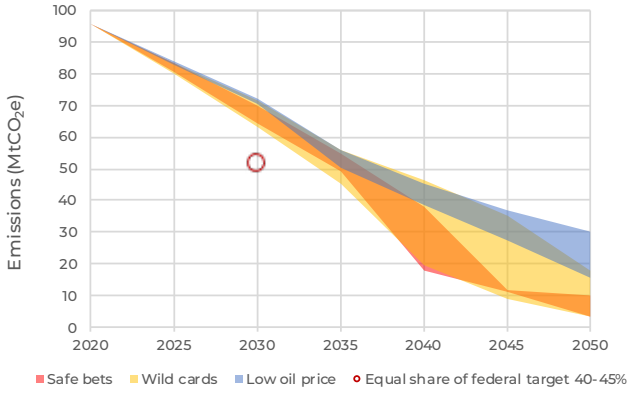
Buildings: Commercial



		Historical		Pathway	
		2005	2019	2026 milestone	2030 milestone
		2005-2019		2019-2026	2026-2030	
Emissions ($MtCO_2e$)	Lower effort			31.4	27.1
	Median	40.0	47.0	31.0	26.3
	Higher effort			29.9	22.8
Annual change ($MtCO_2e/yr$)	Lower effort			-2.2	-1.1
	Median	0.5		-2.3	-1.2
	Higher effort			-2.4	-1.8
Annual change (CAGR %/yr)	Lower effort			-5.6%	-3.6%
	Median	1.2%		-5.8%	-4.0%
	Higher effort			-6.3%	-6.5%

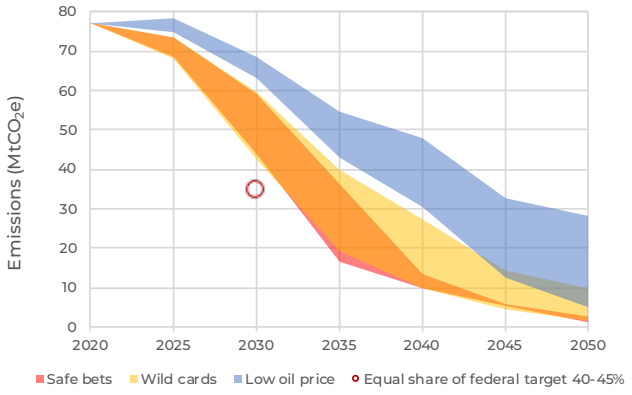
Additional Sector Emissions Pathways

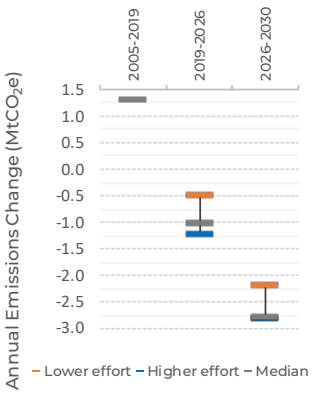
Transportation: Passenger



		Historical		Pathway	
		2005	2019	2026 milestone	2030 milestone
		2005-2019		2019-2026	2026-2030
Emissions ($MtCO_2e$)	Lower effort			80.9	71.7
	Median	90.0	99.0	80.4	70.6
	Higher effort			79.6	68.3
Annual change ($MtCO_2e$/yr)	Lower effort			-2.6	-2.3
	Median	0.6		-2.7	-2.5
	Higher effort			-2.8	-2.8
Annual change (CAGR %/yr)	Lower effort			-2.8%	-3.0%
	Median	0.7%		-2.9%	-3.2%
	Higher effort			-3.1%	-3.8%

Transportation: Freight





		Historical		Pathway	
		2005	2019	2026 milestone	2030 milestone
		2005-2019		2019-2026	2026-2030
Emissions ($MtCO_2e$)	Lower effort			74.6	65.8
	Median	60.0	78.0	70.7	59.5
	Higher effort			69.5	58.3
Annual change ($MtCO_2e$/yr)	Lower effort			-0.5	-2.2
	Median	1.3		-1.0	-2.8
	Higher effort			-1.2	-2.8
Annual change (CAGR %/yr)	Lower effort			-0.6%	-3.1%
	Median	1.9%		-1.4%	-4.2%
	Higher effort			-1.6%	-4.3%

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Any errors in this report are attributable to the Institute.

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