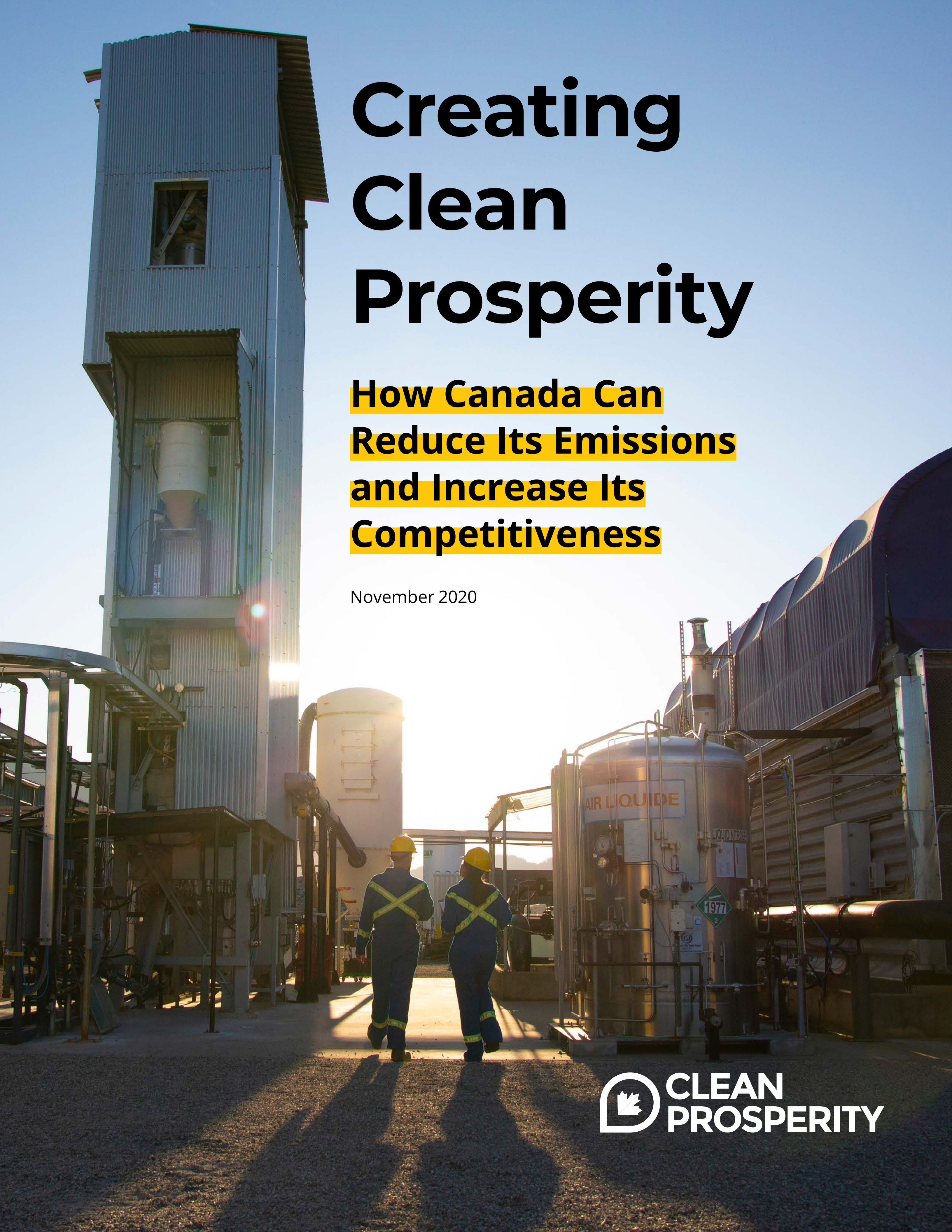
Creating Clean Prosperity

How Canada Can Reduce Its Emissions and Increase Its Competitiveness

November 2020



CLEAN PROSPERITY

Written by
Michael Bernstein, Executive Director, Clean Prosperity

Contributors
Dave Sawyer, President, EnviroEconomics
Jake Wadland, Communications Manager, Clean Prosperity
Chad Jeudy-Hugo, Director of Policy, Clean Prosperity
Sarah Lazarovic, Vice President of Marketing, Clean Prosperity

Clean Prosperity.ca
info@cleanprosperity.ca

About Clean Prosperity

Clean Prosperity is a Canadian climate policy organization. We advocate for smart Canadian climate policy that uses market-based solutions to reduce greenhouse gas emissions, foster inclusive economic growth and competitiveness, and catalyze global climate action.

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Executive Summary

In this report, we provide recommendations to the Canadian federal government on how to meet its climate targets for both 2030 and 2050 in a way that is effective, affordable, and generates prosperity for Canadians.

The need for Canada to raise its climate ambition has taken on even greater importance with Joe Biden winning the US presidency. President-elect Biden has pledged more ambitious climate action, leading the world towards a net-zero global economy by 2050. Among his priorities will be major investments in clean technology.

There are many reasons to believe that Canada can be a winner in the emerging low-carbon economy, but Canada also faces major risks to its energy sector and economy more broadly. It's therefore more critical than ever that Canada demonstrate a clear path towards reaching its climate goals. This report presents a vision for how that should be achieved.

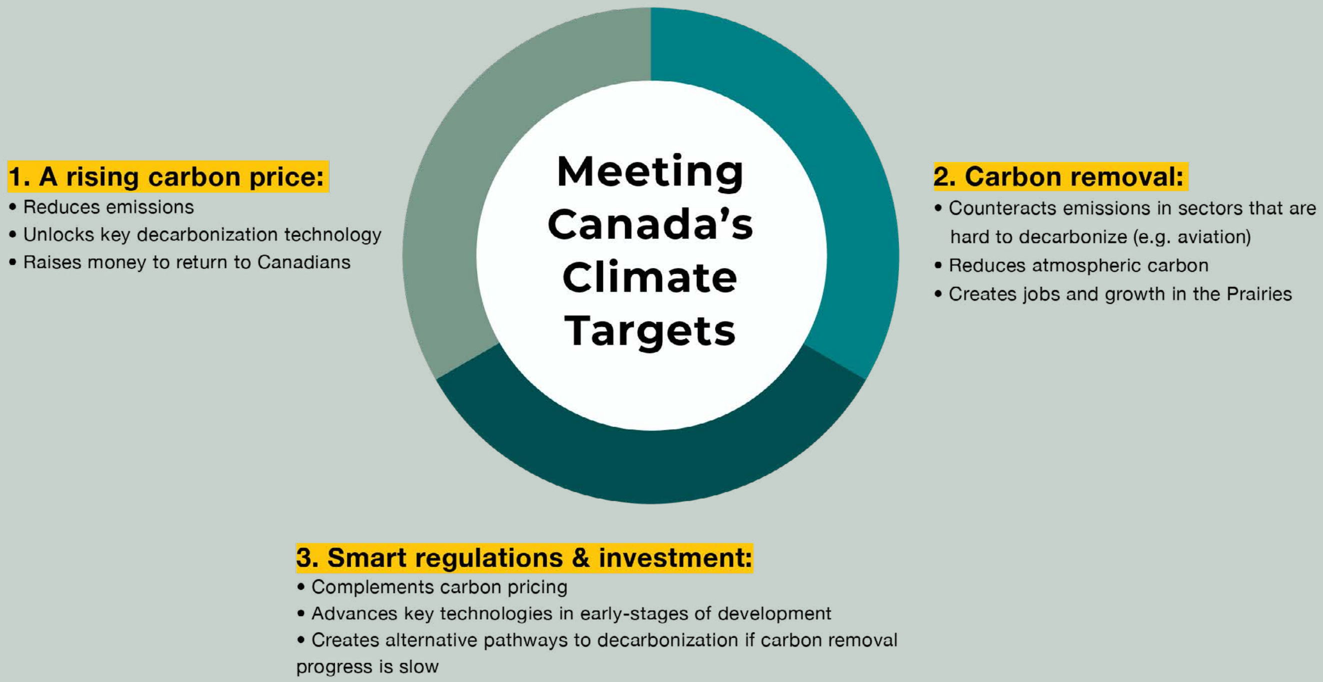
The analysis in this report leans heavily on modelling work Clean Prosperity commissioned from Navius Research. The modelling examined various scenarios of the role carbon pricing can play in reaching our climate goals.

Carbon pricing is widely recognized as the most cost-effective way to reduce greenhouse gas emissions. Our modelling results highlight that carbon pricing has a clear role to play in reducing emissions, while also showing that complementary policies will clearly be needed as well. In short, Canada needs a "carbon pricing plus" approach.

To meet Canada's emissions targets, Clean Prosperity recommends that the federal government prioritize three broad areas for policy action:

- Increase carbon pricing by $10/tonne[1] per year through 2040 while also making the policy fairer.
- Catalyze the market for atmospheric carbon removal.
- Enact smart investments and regulations that reduce emissions beyond what carbon pricing could do alone.

Figure 1: Three Key Areas for Policy Action



[1] All currency amounts are expressed in Canadian dollars except where otherwise noted.

Policy Area 1: Carbon Pricing Improvements

By increasing the carbon price by at least $10/tonne per year through 2040, including inflation, Canada can reduce emissions by 71-159 Mt in 2030, achieving most, if not all, of the reductions needed to meet its 2030 Paris Agreement target.[2] The range is based on three scenarios we ran for how the federal government could use carbon pricing. In Scenario 1, the government maintains an output-based pricing system for industry and continues to increase pricing by $10/tonne per year through 2030. Scenario 2 resembles Scenario 1 except the government replaces the output-based pricing system (OBPS) with a full carbon price for industry. Scenario 3 resembles Scenario 2 except the government increases the carbon price by $15/tonne per year through 2030.

Looking longer-term, carbon pricing is equally impactful in helping Canada meet its 2050 net-zero target. If the carbon price continues to rise by $10/tonne per year through 2040, Canada will reduce gross emissions between 250 Mt (Scenario 2) to 319 Mt (Scenario 3) in 2040, closing about 50-60% of the gap to the 2050 net-zero goal.

Raising the carbon price through 2040 will have another critical benefit that will increase the emissions impact beyond what is modelled—it will accelerate market adoption of a range of promising technologies that Canada will need to decarbonize, such as clean hydrogen, carbon capture and storage, direct air capture (DAC), as well as new, as-yet unknown technologies. A rising carbon price of $10/tonne per year will exceed the per-tonne costs of carbon removal in the 2030s, allowing us to reach an inflection point in our decarbonization efforts where market forces will be a key driver of emissions reductions.

[2] Our estimate of the gap to the 2030 target is 128 Mt in gross emissions. The federal government's "with additional measures" scenario suggests the comparable gap is 77 Mt due to modelling differences including the impact of the Clean Fuel Standard.

Figure 2: Impact of increasing carbon pricing on climate targets

	Emissions Reduction (Mt)		As share of gap to Climate Target (%)*		Carbon Price ($, 2020)	
	2030	**2040**	**2030 (Paris)**	**2040 (Net-zero)**	**2030 (Paris)**	**2040 (Net-zero)**
Scenario 1 (OBPS + $10/t pa)	71	N/A	92%	N/A	120	N/A
Scenario 2 (Full pricing $10/t pa)	114	250	148%	49%	120	195
Scenario 3 (Full pricing $15/t pa to 2030, $10/t pa to 2040)	159	319	206%	63%	165	241

Note: The emissions gap in 2030 is assumed to be the 77 Mt gap used by the federal government, based on their projection that emissions are currently expected to be 588 Mt in 2030. The gap to net zero is assumed to be 508 Mt, which is derived based on the 588 Mt starting point in 2030 and assuming emissions need to decline to 80 Mt. The gap to net zero is shown for 2040 as carbon pricing is not expected to rise beyond 2040. Between 2040 and 2050, technologies like direct air capture will become cost-competitive due to rising carbon prices and are projected to scale up to cover any remaining emissions gap.

As the carbon price rises, the policy should also be made fairer to increase public understanding and acceptance. We recommend a series of actions including sending the rebate proceeds directly to Canadians on a quarterly basis, increasing the rebate top-ups to non-urban residents (funded with the GST charged on carbon pricing), providing small business tax credits to small and medium-sized enterprises (SMEs), and addressing the unique challenges faced by farmers pertaining to activities like grain drying.

Policy Area 2: Carbon Removal

Carbon removal is needed both to offset harder-to-abate emissions (e.g. aviation) and to remove carbon from the atmosphere to avoid crossing climate red lines. Canada will likely need to remove billions of tonnes of carbon from the atmosphere by 2050. Reaching this level of removal cannot be done with natural solutions alone; instead it will require significant investment in negative emissions technologies (NETs).

Carbon pricing will play a key role in scaling NETs like direct air capture. If the carbon price continues to increase by $10/tonne per year, the carbon price will exceed the cost of DAC in about 2035, enabling major scale-up of the technology.

Bringing the costs of NETs below the carbon price will only occur if public policy incentivizes the buildout of NETs such as DAC in the 2020s, as deployment is the key to moving down the cost curve. To incentivize the ramp-up of NETs, we recommend that the government, in coordination with international partners, pursue a combination of policies including direct procurement, tax credits, financing guarantees, funding research and development, and enacting enabling policies to address non-cost barriers.

Policy Area 3: Smart Investments & Regulations to Fill the Gap

A third component of Canada's climate plan should be to develop smart climate policies that can complement carbon pricing in three ways: 1) addressing emissions in sectors that do not respond well to carbon pricing, such as buildings and agriculture; 2) advancing high-potential technologies that need targeted policy support in early stages of development before market forces plus carbon pricing help scale them up (e.g. clean hydrogen), and 3) establishing an alternative policy pathway to address harder-to-abate emissions, in case NETs do not scale up as quickly as expected.

Our modelling provides high-level guidance on where the biggest pockets of emissions will persist even with carbon pricing, and what types of investments will be needed to close the gap. Based on these data as well as a literature review, we offer a set of starting-point recommendations for this third area of policy action, including policies to: further decarbonize industry with tailored sector strategies; invest in clean electricity and clean fuels such as hydrogen; invest in research and development to reduce agricultural emissions; and regulate fugitive emissions.

Canada Can Win

Taken together, the policies we recommend can help Canada capitalize on the greatest economic opportunity of this century—the transition to a low-carbon economy. In fact, there are many reasons to believe Canada can be a global leader, including our clean electricity grid, abundant natural resources, and burgeoning cleantech sector.

Prosperity for Alberta and Saskatchewan

Our policy recommendations also stand to bring significant benefits to the Western provinces generally and the oil and gas sector specifically, helping ensure that no region is left behind. Carbon pricing gives the oil and gas sector a tremendous incentive to innovate and create lower-carbon products, including kickstarting the clean hydrogen economy. That's why many oil and gas sector leaders are vocal supporters of carbon pricing.

Skilled workers from the oil and gas sector, using existing technology and expertise from the sector, can also be key partners in the effort to grow the carbon removal industry. The development of this industry stands to bring major economic benefits to Alberta and Saskatchewan, the two provinces that are home to many of the most suitable sites in Canada for storing carbon underground. At scale, this industry could generate hundreds of thousands of jobs.

The Time to Act is Now

Time is of the essence. The race to become a leader in clean technology has accelerated now that the US has elected Joe Biden. Canada has no time to waste in enacting the type of smart climate policy recommended in this report.

Summary of Policy Recommendations

Policy Area	
1. Carbon pricing improvements	1a. Increase the carbon price by at least $10/tonne per year through 2040.
	1b. Establish a panel to review the carbon price annually and recommend increases if pricing not achieving sufficient emissions reductions. When not delivering emissions reductions, empower it to raise the price by $10/tonne.
	1c. Work with provinces and international partners to establish a coordinated border carbon adjustment to replace output-based pricing.
	1d. Switch carbon tax rebates to quarterly direct payments.
	1e. Increase rebate top-ups to non-urban residents in line with their increased costs, and fund this with GST revenues on the carbon price.
	1f. Use carbon price rebates to SMEs to fund a small business tax credit of 0.5%, increasing to 1% in 2022.
	1g. Address increased costs for farmers with investments in fuel alternatives and/or a temporary exemption on grain drying fuel.
2. Seeding carbon removal	2a. Pursue natural carbon sequestration opportunities.
	2b. Accelerate the adoption of NETs by stimulating demand, reducing costs, advancing R&D, and accelerating deployment.

Policy Area	
3. Smart investments and regulations	3a. Develop sectoral decarbonization roadmaps, with associated capital plans.
	3b. Provide targeted support packages to high-potential decarbonization opportunities.
	3c. Accelerate investments in clean power grids.
	3d. Invest in growing clean hydrogen.
	3e. Implement a retrofit program covering up to 60% of residential and commercial building stock by 2030.
	3f. Develop a national model net-zero energy-ready building code.
	3g. Incentivize cleaner fuel use and evaluate the Clean Fuel Standard to ensure it remains fit for purpose.
	3h. Introduce feebates that lower the cost of zero-emission vehicles (ZEVs) and help fund scrappage programs.
	3i. Invest in RD&D to address emissions from enteric fermentation.
	3j. Reduce fertilizer emissions with RD&D and pricing incentives.
	3k: Address fugitive emissions through both regulation and pricing.

Introduction

Canadian climate policy can serve two complementary purposes. While it is clearly critical for addressing climate change, it is also increasingly a core driver of economic growth and prosperity. In this report, we examine how climate policy can reduce Canadian emissions, while increasing economic competitiveness in the process.

Below, we make recommendations for the federal government to meet its climate targets—reducing emissions by 30% relative to 2005 levels (i.e. the Paris target), and reaching net-zero emissions by 2050.

Our analysis leans heavily on modelling work Clean Prosperity commissioned from Navius Research that examines the role carbon pricing can play in reaching our climate goals. Carbon pricing is widely recognized as the most cost-effective way to reduce emissions. To understand the impact carbon pricing could have on emissions, we ran several scenarios of how carbon pricing would increase in the coming decades, and what emissions reductions would result. We combined our modelling work with desk research on how clean technology and other climate policy could complement carbon pricing.

Our report demonstrates that carbon pricing has a foundational role to play in reducing emissions, while also showing that complementary policies will clearly be needed as well. In short, the debate between carbon pricing versus other climate policies is misguided—we will need both to reach our climate goals. We call this a "carbon pricing plus" approach.

The first two sections of this report describe the opportunity that the low-carbon economy holds for Canada, and the approach we recommend to design smart climate policy. The next three sections describe our three key areas for policy action. The report concludes by highlighting that the vision for clean prosperity outlined in this report would bring particular benefits to Alberta and Saksatchewan, including the oil and gas sector in those provinces.

The debate between carbon pricing versus other climate policies is misguided - we will need both to reach our climate goals.

A Major Opportunity if We Act (and a big risk if we don't)

The shift to a low-carbon economy is the greatest growth opportunity of this century—projected to generate at least US$26 trillion[3] in economic benefits in the coming decade. If Canada gets its pro-rata share, our cleantech sector will be bigger than our auto sector is today.

Canada has many natural advantages including:

- One of the world's cleanest electricity grids, producing more renewable power than any country outside China, the US, and Brazil, with abundant opportunity to become both cleaner and bigger.
- Natural resources in high demand for cleantech products. Canada has a huge potential to produce clean hydrogen, and is a top-five producer of key minerals for electric vehicles including nickel, cobalt, and graphite, with the potential to become a leading producer of lithium.
- Expertise in the conventional energy sector which can help capitalize on cleantech opportunities including hydrogen, geothermal, lithium, and carbon removal, among others.
- The world's most highly educated workforce, which can be leveraged to attract new investment and global cleantech leaders.

Despite the incredible opportunity, time is short. Other jurisdictions, such as the EU and China, are already moving quickly.

The recent election of Joe Biden as US president also looms large. Biden has committed to an ambitious climate agenda, including leading the world towards net zero emissions by 2050. The Biden administration intends to invest heavily in supporting clean technology, including US$400 billion for research, development, and deployment of clean technology over the next 10 years. Canada needs to act quickly to keep up.

[3] All currency amounts are expressed in Canadian dollars except where otherwise noted.

Biden’s policy agenda also holds special risks for Canada. For example, Biden has pledged to apply "a carbon adjustment fee against countries that are failing to meet their climate and environmental obligations." These fees could pose particular risks for our biggest export, energy, much of it headed south to the US. If Canada is not careful, we could see carbon fees applied to our products at the US border. After all, the US is already moving faster than Canada towards achieving its Paris Agreement targets. Canada needs to up its ambition and demonstrate that it is serious about achieving its 2030 and 2050 climate goals.

To capitalize on opportunities and to avoid risks, Canada needs a more ambitious climate plan that can achieve meaningful emissions reductions in the short term. That’s where smart climate policy comes in.

Designing Smart Policy

At its best, climate policy should not only be good for the climate but should also help our economy grow, create jobs, and be affordable for Canadians.

Figure 3: Criteria for clean prosperity

	Effective	Affordable	Pro-growth	Pro-employment	Enables private sector	Fair and equitable
Metric	• Mt of emissions reduction in 2030/2050 • Cumulative GHG emissions 2030-2050 vs. carbon budget	• $ invested per tonne of GHG emissions eliminated • Total cost	• GDP growth per capita • Growth in value of exports • Business investment growth	• Number of jobs created • Jobs created per Mt of emissions reduced	• Is government intervention needed or could the private sector solve? • Is it scalable across jurisdictions?	• Ensure fair treatment: urban vs. rural, income, ethnicity, etc.
Notes	• Paris Agreement now bare minimum • Must avoid warming over 1.5 °C: 45% emissions reduction by 2030, net zero by 2050	• Inefficient policies cost tens of billions • Climate policy must be affordable to be sustainable	• Best policies increase growth metrics, generating clean prosperity and boosting competitiveness	• Creating jobs critical during the pandemic recovery • Focus should be on jobs of the future in low-carbon economy	• Government should focus on areas where it's uniquely needed—market failures, public goods, early stage research • Government should not pick winners or crowd out private investment	• Treating different groups fairly is important in its own right, and also increase public acceptance, enabling policy to endure

- **Effective.** Reduce emissions sufficiently to meet Canada's global commitments including to the Paris Agreement, and to achieve net zero by 2050.
- **Affordable.** Canadians must be able to afford climate policy, as too many are already struggling to make ends meet, a fact made worse by the COVID-19 pandemic. Wherever possible, policies should reduce emissions at the lowest possible cost per tonne. Ultimately, lower-cost policy will be more sustainable over the long-term.
- **Pro-growth.** Climate policy can and should create economic opportunity across the country, and generate opportunities for Canadian businesses in global markets.
- **Pro-employment.** Climate policy can and should create good-paying jobs in the low-carbon economy of tomorrow.
- **Private sector-focused.** The task of reducing our emissions can best be accomplished if the government encourages and leverages the ingenuity and expertise of Canadian entrepreneurs and businesses. Government should focus on creating the right incentives for the private sector. Public investment should focus on market failures (e.g. early-stage research for technology) or the need to provide infrastructure in the public interest (e.g. public transit).
- **Fair and equitable.** Climate policy should treat groups across the country as fairly as possible, considering factors like regional variation, urban vs. rural, income groups, etc. It should also ensure that disadvantaged communities, such as indigenous peoples, are prioritized given the disproportionate impacts they face from climate change and historic exclusion from meaningful economic opportunities.

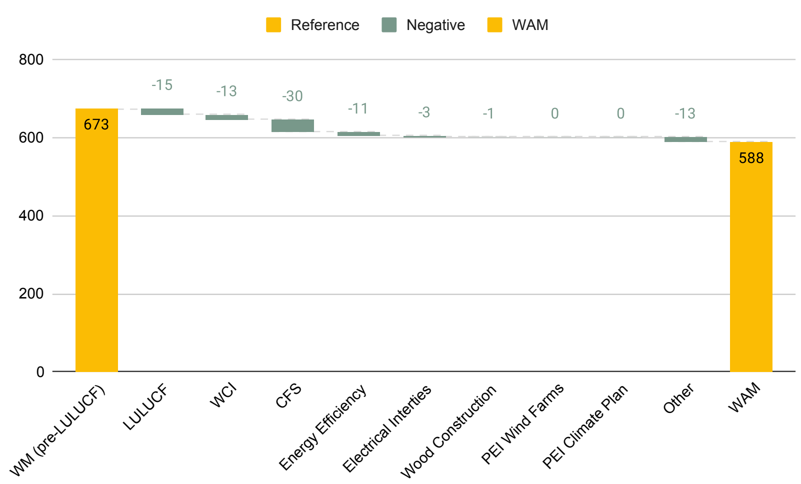
Setting the Goalposts: The 2030 and 2050 Targets

The federal government has committed to two climate targets: reducing emissions to 511 Mt by 2030 (the Paris commitment), and achieving net zero emissions by 2050.[4] We believe the federal government should also consider cumulative emissions between 2020 and 2050, a concept known as the carbon budget which is further described in the Appendix.

2030 Target

Environment and Climate Change Canada (ECCC) uses several different projections to show the gap to their 2030 target. One scenario called the “With Measures” (WM) scenario includes all the legislated policies federally and provincially and results in gross emissions of 673 Mt. But a second scenario, coined the “With Additional Measures” (WAM) scenario, adds a set of policies that have been announced but not legislated. The WAM scenario—combined with credits from Land Use, Land Use Change and Forestry (LULUCF)—shows total emissions of 588 Mt in 2030. It’s the WAM scenario that the government relies on when they describe the gap to their Paris target as 77 Mt (see Figure 4).

Figure 4: Emissions in 2030 under ECCC’s With Measures (WM) and With Additional Measures (WAM) Scenarios

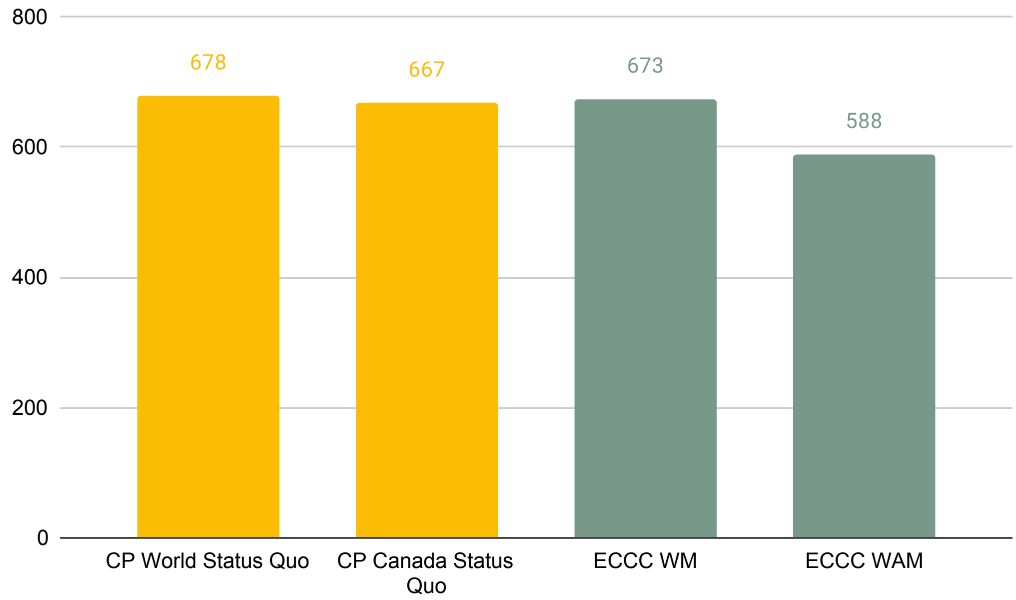


Source: Environment Canada’s 4th Biennial Report to the UNFCC
Notes: WCI = Western Climate Initiative offset credits; LULUCF = Land Use, Land Use Change and Forestry; CFS = Clean Fuel Standard; “Other” refers to measures that are not specified in the source document

[4] Net zero means we remove enough emissions from the atmosphere to offset any remaining emissions.

In the modelling we present below, we also start by modelling two baseline "status quo" scenarios to help evaluate the incremental emissions impact of carbon pricing. The first scenario—CP World Status Quo—assumes a similar level of global climate action as exists today. The second scenario—CP Canada Status Quo—assumes that the rest of the world takes more ambitious action on climate policy, while Canadian policy remains unchanged. Our status quo scenarios are very similar to the WM scenario from ECCC, but vary by a few megatonnes due to modelling differences (see Figure 5). We do not model the additional policies presented in the WAM scenario, but we do analyze how adding the WAM policies to our modelling would impact the results.

Figure 5: Emissions in 2030 for CP baseline scenarios vs ECCC scenarios



Source: ECCC, CP/Navius Modelling

In the 2019 election, the federal Liberal party pledged to "exceed Canada's 2030 emissions goal," though no specifics have been offered about what that means in practice. Therefore, the gap to Paris should be seen as the minimum gap to 2030, but perhaps not sufficient to meet pledges made by the governing Liberal party.[5]

[5] The federal government is expected to make an announcement about their 2030 target before the end of 2020.

2050 Target

Canada is among a growing list of countries who have pledged to hit net zero emissions by mid century. While the federal government has stated its commitment to reach net zero by 2050, few details have been provided as to how this will be defined. For example, it is widely expected that some emissions will still occur in 2050 but that they will be offset by removing carbon from the atmosphere (i.e. any positive emissions will be cancelled out by negative emissions). In this report, we make the assumption that net zero means that just over 10% of gross emissions (~80 Mt) will remain in 2050, though our findings and recommendations would change very little even if gross emissions were modestly higher or lower.[6]

The net-zero target is critically important for avoiding the worst impacts of climate change. The cumulative emissions that Canada and the rest of the world put in the atmosphere over the next three decades will be equally determinative in the effort to combat climate change. This topic—the carbon budget—is discussed further in the Appendix.

[6] We arrived at 80 Mt based on the assumption that Canada would hit its Paris target of 511 Mt on a gross emissions basis in 2030, would reduce emissions by 5% per annum through 2035, and would reduce them at 10% per annum thereafter through 2050.

Policy Action Area 1: Carbon Pricing

The federal carbon pricing system is widely recognized as the lowest-cost, most pro-growth way to reduce emissions due to its simplicity, transparency, and flexibility. Carbon pricing has been endorsed by hundreds of economists in Canada, the US, and around the globe.

Carbon pricing is like a tailwind that moves all boats in the right direction—it incentivizes every part of our economy to reduce emissions, and levels the playing field with fossil-fuel based production. It signals to businesses and entrepreneurs that there will be money to be made in new technology and innovation that reduces carbon footprints.

Carbon taxes work. The Canadian government has estimated that the current set of carbon pricing policies nationwide, which will reach $50/tonne of CO_2 in 2022, will reduce emissions by 50-60 Mt by 2030, the largest reduction of any climate policy in the Pan-Canadian Framework on Clean Growth and Climate Change. This 50-60 Mt is not included, and is therefore additional, to the emissions reductions we estimate below with increased carbon pricing.

Emissions Impact: Carbon Pricing Can Eliminate the Paris Gap

Working with Navius Research, we modelled how increasing the carbon price, beyond the $50/tonne level scheduled for 2022, would help Canada achieve its climate commitments. We looked at three main scenarios. In Scenario 1 and Scenario 2, we increased the carbon price by $10/tonne per year, plus an adjustment for inflation, through 2030. The way carbon pricing applied across the economy differed by scenario, with Scenario 1 including an output-based pricing system (OBPS) and Scenario 2 using full industrial pricing. A third scenario resembled Scenario 2 except that carbon pricing was increased by $15/tonne per year through 2030, then $10/year thereafter. Further details are included in Box 1:

BOX 1: Three Carbon Pricing Scenarios

Scenario 1 (OBPS + $10/t increase per year through 2040):

Carbon pricing is divided, like today's system, between a fuel levy and an output-based pricing system (OBPS) for industry. The fuel levy applies to the same emissions as today and it is assumed that provincial pricing systems follow the same increased pricing trajectory as the federal carbon price.

The OBPS follows the design of the current federal system, but the benchmark stringency of the system tightens by one percentage point per year for all sectors except electricity. In the electricity sector, increases in the stringency of performance standards for coal and new natural gas plants announced by the federal government are simulated. After 2030, the OBPS system is converted to a full price on industrial emissions.

Scenario 2 (Full industrial pricing + $10/t increase per year through 2040):

The OBPS system is replaced after 2022 with a full price on industrial emissions that matches the fuel levy applied in the rest of the economy. Revenue generated from industry is recycled back to these large emitters in the form of tax cuts. Further, the rest of the world is assumed to take more ambitious climate action, reducing the risk of carbon leakage. In practice, this scenario can be viewed as a full carbon price with a border carbon adjustment.

Scenario 3 (Full industrial pricing + $15/t increase per year through 2030, $10/t thereafter)

Similar to Scenario 2 but the carbon price increases by $15/tonne per year until 2030, and then reverts back to $10/tonne per year until 2040.

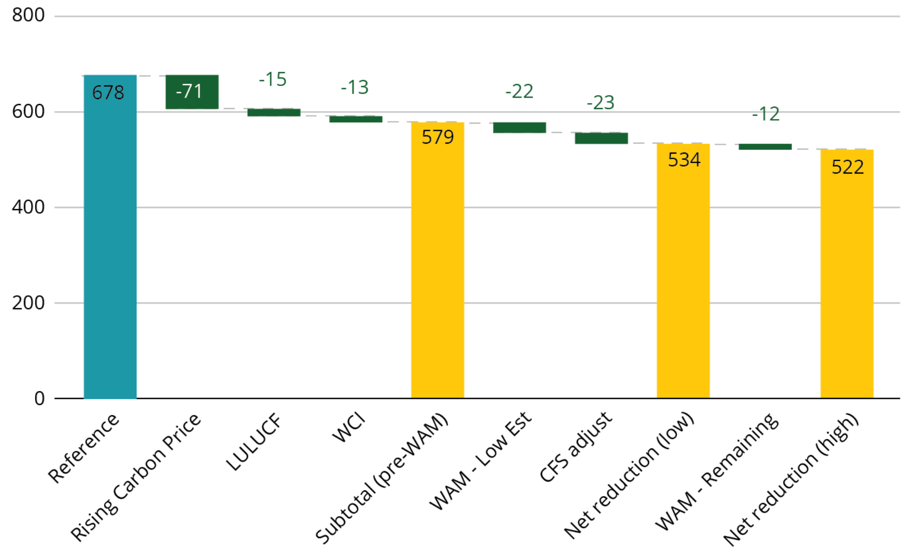
After 2030, we focus exclusively on Scenario 2 and Scenario 3 as we believe they present the most realistic pathways to achieving net zero emissions by 2050. By 2030, key players in the global economy should be pricing carbon at a high enough rate to enable Canada to shift from the OBPS system for industrial emitters to full industrial pricing, paired with a border carbon adjustment. This is what is modelled in Scenarios 2 and 3.

Reductions in 2030

In Scenario 1 (OBPS), which most resembles today's system, we find that raising the carbon price leads to an additional 71 Mt of emissions reductions by 2030, in addition to the 50-60 Mt from the existing carbon pricing policy. When combined with ECCC's estimates for additional reductions that are expected from their WAM scenario, emissions would decline to between 522-534 Mt, leaving a gap of 11-23 Mt to the Paris target.[7]

[7] The range provided depends on how much overlap is assumed between ECCC's WAM policies and the rising carbon price in the CP/Navius model.

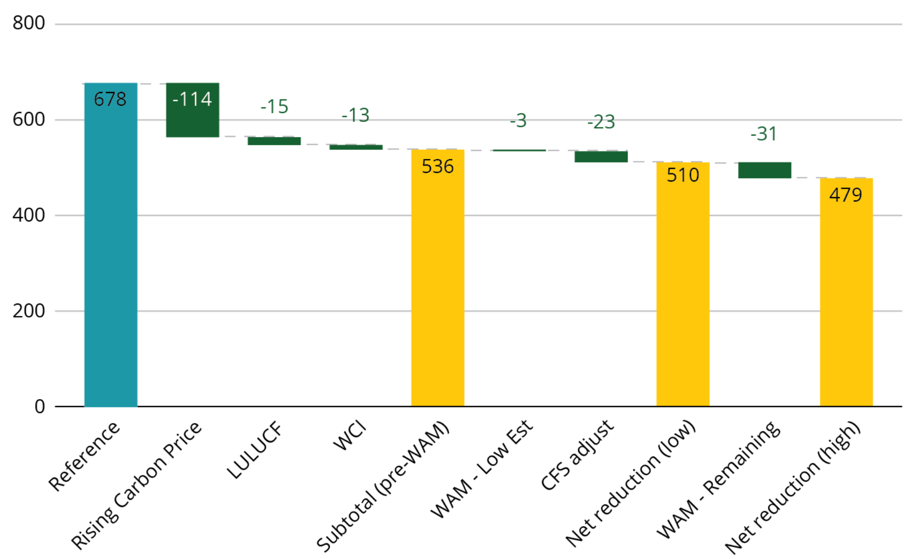
Figure 6: Emissions in 2030 under CP Scenario 1 with an OBPS (Mt)



Note: Starting with baseline emissions of 678 Mt, carbon pricing in Scenario 1 reduces emissions by 71 Mt. Emissions credits (from Land Use, Land Use Change and Forestry plus Western Climate Initiative) reduce emissions by 28 Mt. The total net emissions in 2030 then depends on the assumption around how much of the With Additional Measures (WAM) reductions overlap with the emissions reductions from carbon pricing shown in the CP model. Based on a sector-by-sector comparison of emissions in 2030, we believe that the maximum overlap between WAM and CP modelling is 12 Mt, resulting in emissions of 534 Mt in 2030. If there is no overlap, emissions drop a further 12 Mt to 522 Mt.

In Scenario 2, where a full carbon price is applied to industry (including process and fugitive emissions), emissions reductions increase significantly. The rising carbon price generates an additional 114 Mt of reductions. When combined with ECCC's estimate from the WAM scenario, emissions in 2030 would decline to between 479-510 Mt, exceeding the Paris target by as much as 32 Mt

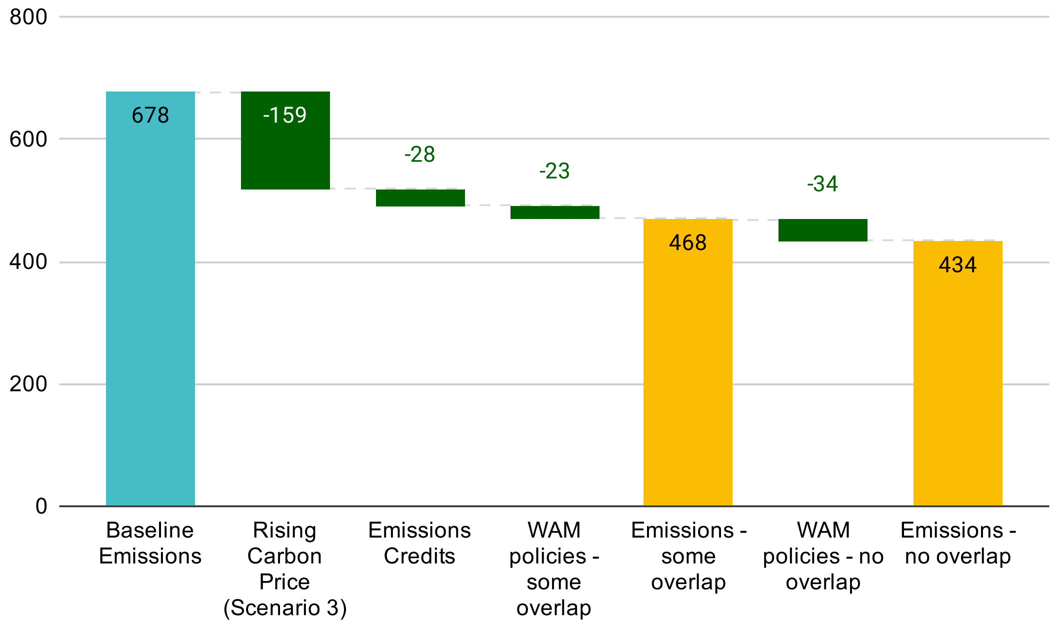
Figure 7: Emissions in 2030 under CP Scenario 2 with full pricing (Mt)



Note: See explanation for Figure 6. The same approach is used in this scenario.

Figure 8: Emissions in 2030 under CP Scenario 3 with full pricing of $15/t per year (Mt)

In Scenario 3, where pricing rises $15/tonne through 2030, emissions drop further. The rising carbon price generates 159 Mt of emissions reductions alone. When combined with LULUCF and WCI credits, emissions in 2030 would be 491 Mt, 20 Mt below the Paris target. Adding the WAM measures could drop emissions as much as an additional 57 Mt, resulting in emissions of 434 Mt.



Note: See explanation for Figure 6. The same approach is used in this scenario.

Based on these scenarios, it is clear that a rising carbon price could close most or all of the gap to the Paris target.

BOX 2: Modelling Sensitivities

Of note, our estimates do assume an inflation adjustment to both the base price and the annual increases in the price per tonne. Without such inflation, emissions impact would be slightly lower in 2030, by approximately 10 Mt depending on the scenario.

Our estimates are also sensitive to oil prices. In our base case, we have assumed an average long-term WTI price of US$55 per barrel, in line with recent projections made by BP. We also modelled higher and lower oil price forecasts. A higher oil price of US$85 per barrel would increase emissions by 6-7 Mt whereas a lower price of US$35 would significantly reduce emissions by 45-83 Mt in 2030 depending on the scenario.[8]

Figure 9: Summary of emissions impact from different carbon pricing scenarios

	Emissions Reduction (Mt)		As share of gap to Climate Target (%)*		Carbon Price ($, 2020)	
	2030	2040	2030 (Paris)	2040 (Net-zero)	2030 (Paris)	2040 (Net-zero)
Scenario 1 (OBPS + $10/t pa)	71	N/A	92%	N/A	120	N/A
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Scenario 3 (Full pricing $15/t pa to 2030, $10/t pa to 2040)	159	319	206%	63%	165	241

Note: The emissions gap in 2030 is assumed to be the 77 Mt gap used by the federal government, based on their projection that emissions are currently expected to be 588 Mt in 2030. The gap to net zero is assumed to be 508 Mt, which is derived based on the 588 Mt starting point in 2030 and assuming emissions need to decline to 80 Mt. The gap to net zero is shown for 2040 as carbon pricing is not expected to rise beyond 2040. Between 2040 and 2050, technologies like direct air capture will become cost-competitive due to rising carbon prices and are projected to scale up to cover any remaining emissions gap.

[8] A lower oil price leads to less oil production which, in turn, means fewer emissions.

Reductions beyond 2030

While much policy attention is rightly focused on Canada achieving its 2030 goal, Canada's 2050 net-zero goal is equally critical. And carbon pricing is perhaps even more critical in the effort to reach net zero.

To examine emissions impacts post-2030, we model only the two scenarios (Scenarios 2 and 3) with full industrial pricing paired with a border carbon adjustment (BCA), as we assume that such a system will become necessary by the 2030s to keep pace with global decarbonization efforts.[9]

In Scenario 2, as the carbon price continues to rise in the 2030s, emissions reductions will continue to grow, reaching 250 Mt by 2040. In this latter decade, inflation is an important factor. Without inflation adjustments, reductions drop to 216 Mt. These numbers are incremental reductions, in addition to the 50-60 Mt that are already part of the government's 2030 forecasts.

We do not expect carbon pricing to need to rise beyond 2040, as a price of $150-200 per tonne will unleash the technology needed to help Canada's economy reach net zero. By 2040, our modelling suggests carbon pricing will have already closed half (49%) of the gap to net zero.

In Scenario 3, carbon pricing has an even greater impact. The rising carbon price reduces emissions by 319 Mt in 2040, covering over 60% of the gap to net zero.[10]

There is good reason to believe that the impact of carbon pricing would go well beyond what we have modelled. As we will show below, a rising carbon price will make a range of clean technologies (e.g. hydrogen, carbon capture and storage) viable over the next two decades in a way that would exceed the emissions reductions from the model.

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[9] One of the biggest impediments to transitioning towards full pricing with BCAs is the lack of similar policy in the US, a fact that is likely to change under the new Biden administration.

[10] We define net zero as 80 Mt of gross emissions in 2050, as explained in an earlier footnote.

While much policy attention is rightly focused on Canada achieving its 2030 goal, Canada's 2050 net-zero goal is equally critical. And carbon pricing is perhaps even more critical in the effort to reach net zero.

Increasing the Carbon Price

***Recommendation 1a:* Continue to increase the carbon price by at least $10/tonne per year, including adjustments for inflation, through 2040 when the costs of negative emissions technologies (NETs) are expected to drop below the carbon price.**

Raising the carbon price is a key mechanism to help Canada meet or exceed its Paris targets, as shown above. Without a rising carbon price, the federal government will be forced to rely on a set of regulations and investments that will be more expensive and less sustainable than relying on the market to achieve those same reductions. Regulations and investments do play an important role in complementing carbon pricing (see Policy Action Area 3 below), but a rising carbon price should be at the heart of a cost-effective climate plan.

Raising the carbon price through 2040 will have another critical benefit—it will provide an important boost to a range of promising technologies that Canada will need to decarbonize, such as clean hydrogen, carbon capture and storage, as well as new, as-yet unknown technologies. Of particular importance, we project that by about 2035 the carbon price will exceed the cost of direct air capture (DAC), which will enable the industry to grow rapidly in the years that follow. Further details are provided in Policy Action Area 2 on Carbon Removal.

***Recommendation 1b:* Appoint and empower an independent panel to review the carbon price annually to determine if it is achieving expected emissions reductions. If expectations are not being met, the panel would have the authority to raise the price up to an additional $10/year.**

The independent panel of experts would ensure that carbon pricing is having its intended effect. The panel would need access to detailed modelling for how pricing and other policies can help reduce emissions. Using that and other data, the panel would be empowered to independently raise the carbon price up to an additional $10/year if emissions were not declining quickly enough to meet Canada's climate targets. The panel could also recommend other policies to complement carbon pricing, though it could not act on these independently from Parliament.

There is a precedent for such a panel; the Canada Employment Insurance Commission sets the EI premium rate independently of Parliament.

Increasing Impact at Home & Abroad—Full Pricing with a BCA

***Recommendation 1c:* Work with provinces and international partners to establish a coordinated border carbon adjustment to replace output-based pricing.**

As clearly shown by the modelling presented above, Canada's carbon pricing policy could have even greater impact in decarbonizing our economy if the full carbon price was applied to industry. Our analysis suggests that this change would increase the emissions-reduction impact of carbon pricing by 43 Mt by 2030, putting Canada in a position to meet its pledge to exceed the Paris target of 511 Mt.

Policy that incentivizes greater emissions reductions from heavy industry will impose costs on these sectors in the short term, but the proceeds of the carbon price can be used to help these sectors decarbonize—or to defer other business costs. Further, by decarbonizing more quickly, Canadian industry gives itself a better chance at competing in the low-carbon economy. And it reduces the likelihood that exports like oil and gas will face border carbon fees when entering the US (or other jurisdictions).

Applying the full carbon price to industry must be done in a way that is fair. That's why any shift to full pricing in industry should be done in conjunction with a BCA that maintains a level playing field between foreign and domestic producers. A BCA puts a carbon fee on imports so that they face the same costs as domestic producers that pay carbon taxes. It then rebates the carbon tax back to exporters to keep them on a level playing field with global competitors.

Using a BCA would protect domestic businesses from unfair competition against imports that originate in jurisdictions with more lax environmental policy, and it would ensure that our exporters can compete on an even playing field in global markets. Think taxing upstream emissions on Saudi oil coming into Canada, while allowing Alberta's oil to compete in global markets without the carbon tax.

There's another compelling reason to use a BCA—it's the best way for Canada to influence global emissions. Charging a carbon fee on imports will incentivize our trading partners to consider their own carbon pricing programs. After all, those countries would rather keep the revenue themselves.

Moving towards a global carbon pricing system could be a lynchpin in the effort to address climate change. The IMF has estimated that a global carbon price of at least $100/tonne would be enough to keep the world below 2 °C of warming, and would be three times as effective as all the pledges made in the Paris Agreement.

The world is beginning to move towards BCAs. The EU will be tabling legislation in 2021 to bring in its version of a BCA by 2023. Of particular significance, US President-elect Joe Biden has proposed a similar policy in his climate platform. These two developments present a perfect opportunity for Canada to develop its own policy, and ensure that the Canadian version is aligned with proposals coming from Brussels and Washington.

Improving the Policy: Fairness and Feasibility

As the price rises, it is critical for the federal government to ensure that the policy is perceived to be fair and is understood by Canadians. This will help increase public support and ensure that the policy endures for the long term. In particular, we recommend:

Recommendation 1d: **Switch carbon tax rebates to a quarterly direct payment to Canadians.**

All the proceeds from carbon pricing are returned to Canadians, leaving most households better off. But only about a third of eligible Canadians even know they're receiving the rebate because it is buried in their income tax return.

The government should switch the rebate to a direct payment (either direct deposit or physical cheques) that is issued quarterly. This will increase support for carbon pricing. It will also help reduce emissions—as research on similar programs like the Canada child benefit shows that recipients use their payments to invest in areas that match the objectives of the program. Lastly, it will save the government money (over $35 million annually by 2022) by avoiding the financing costs currently incurred by sending all the money out to Canadians in advance of collecting the carbon fees.

***Recommendation 1e:* Increase the rebate top-ups to non-urban residents in line with the increased costs faced by rural and suburban residents. Fund this change using the GST charged on the carbon price.**

Rural residents currently receive a 10% top-up on their rebates to account for the fact that they face higher fuel and heating costs with fewer alternatives to reduce these costs. Our research—using Statistics Canada data—indicates that the definition of rural is too narrow and that rural households spend on average 20% more on carbon costs relative to the same household in an urban area. We also find that suburban households face 10% higher costs than urban residents, especially fuel costs, suggesting that they merit top-ups as well.

We recommend the government increase the top-ups to rural and suburban residents—while expanding the definition of rural—to more fully address the additional costs these groups face from carbon pricing relative to urban residents. The costs of these top-ups should be funded with the GST collected on the carbon tax (estimated at $235 million annually by 2022). Refunding the GST collected on the carbon tax has the additional benefit of reducing public concern about a "tax on a tax".

***Recommendation 1f:* Use the carbon price funds allocated to SMEs to fund a small business tax credit of 0.5%, increasing to 1% in 2022.**

Small and medium-sized enterprises (SMEs) currently receive 7% of the total proceeds from carbon pricing through two energy-efficiency grant programs. But these programs are cumbersome and only benefit a select set of SMEs.

We recommend that the government instead adopt a small business tax credit that would effectively reduce the small business tax rate by 0.5% in 2021, rising to 1% equivalent by 2022. The government could afford to do this by redirecting the funds that had previously been earmarked for the energy-efficiency programs referenced above. This tax credit would only apply in provinces which are part of the federal carbon pricing backstop (currently Ontario, Saskatchewan, Manitoba, and Alberta).

As carbon pricing continues to rise, the SME tax credit will grow as well. By 2030, assuming carbon pricing continued to rise by $10/year, we estimate that the federal government could provide a tax credit equivalent to a 3% reduction in the small business tax rate.[11]

***Recommendation 1g:* Address the costs faced by farmers through supportive investments or temporary exemptions on fuel used to dry grain.**

As carbon pricing rises, there will be some farmers who face disproportionate cost increases. In many cases, these farmers are also unable to pass on their extra costs. Where they can pass on higher costs, the impact can be higher food costs for consumers. A particular challenge for farmers is the costs associated with grain drying.

The federal government should consider how to best address these concerns. One option might be to offer financial support that reduces fossil fuel use, such as subsidies for higher-efficiency grain dryers or retrofits to existing dryers, or investments in anaerobic digesters or geothermal wells on-farm. The federal government could build on some initial programs it has developed in this area such as the Alberta Efficient Grain Dryer Program funded through the Canadian Agricultural Partnership.[12]

Based on consultations with agricultural groups, the federal government could also consider a 5-10 year carbon tax exemption for fuel used in grain drying. This would provide time to ramp up the availability of low-carbon alternatives.

Benefits from Carbon Pricing

Rebates for Canadians

While a rising carbon tax will increase the costs of gasoline and home heating, the rebates will also grow in tandem. In 2030, with the carbon price rising to $120 per tonne (in 2020 dollars) and assuming non-backstop provinces adopt similar policies, the average household in Canada would receive over $1,700 to offset carbon costs and/or to invest in reducing their carbon footprint. In Saskatchewan and Alberta, rebates to the average household will reach $3,600 and $5,600 respectively (see Figure 10).

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[11] Calculations were based on the costs of small business rate reductions profiled in the Ready Reckoner online tool, adjusted to 2030 using GDP assumptions from the PBO's Economic and Fiscal Outlook for 2020 and an inflation adjustment of 2% per annum. Costs to provide the small business tax credit were then compared to revenue available to offset this tax credit in 2030, based on data from the CP/Navius model and assuming that SMEs would receive the same share (7%) of proceeds that they received today.

[12] This was a fairly modest program but is a step in the right direction. Programs of this nature will continue to require provincial cooperation.

Figure 10: Carbon rebates to the average household in 2030, by province (assuming all used a system similar to the federal backstop)

British Columbia	**$911**
Alberta	**$5,644**
Saskatchewan	**$3,664**
Manitoba	**$1,236**
Ontario	**$1,270**
Quebec	**$783**
New Brunswick	**$1,488**
Prince Edward Island	**$773**
Nova Scotia	**$985**
Newfoundland and Labrador	**$1,756**
Territories	**$3,739**
Canada	**$1,709**

Note: Carbon pricing rises by $10/tonne per year through 2030. Ninety percent of the fuel levy charge is used for rebates. Population in 2030 and average household size is based on Statistics Canada projections. Average household size varies from 2.2 to 2.6 depending on province.[13]

Accelerating Technology Adoption

Carbon pricing can help unlock a set of pivotal technologies that will enable us to decarbonize while growing our economy. In this section, we illustrate the impact carbon pricing would have on two specific technologies—carbon capture and hydrogen—but the benefit of carbon pricing is that it offers a helpful boost to all technologies that can reduce emissions. Given the strong potential for carbon pricing to incentivize both known and as-yet unknown technology, the emissions impacts we've modelled in this paper are very likely understating the impact of pricing.

[13] Family-of-four figures, often cited by ECCC, would be slightly higher than the figures shown here: e.g. in 2020 the average Ontario household received $436 whereas a family of four received $448.

Carbon Capture

Increasing carbon pricing can accelerate the adoption of carbon capture and storage technology (CCS). As the International Energy Agency has noted, "reaching net zero will be virtually impossible without carbon capture, utilization, and storage." CCS is critical because there are many industrial activities that will be expensive to decarbonize—carbon capture provides a way to address these emissions without having to shut down production. CCS is expected to grow rapidly in the coming years, with the global market estimated in the hundreds of billions of dollars.

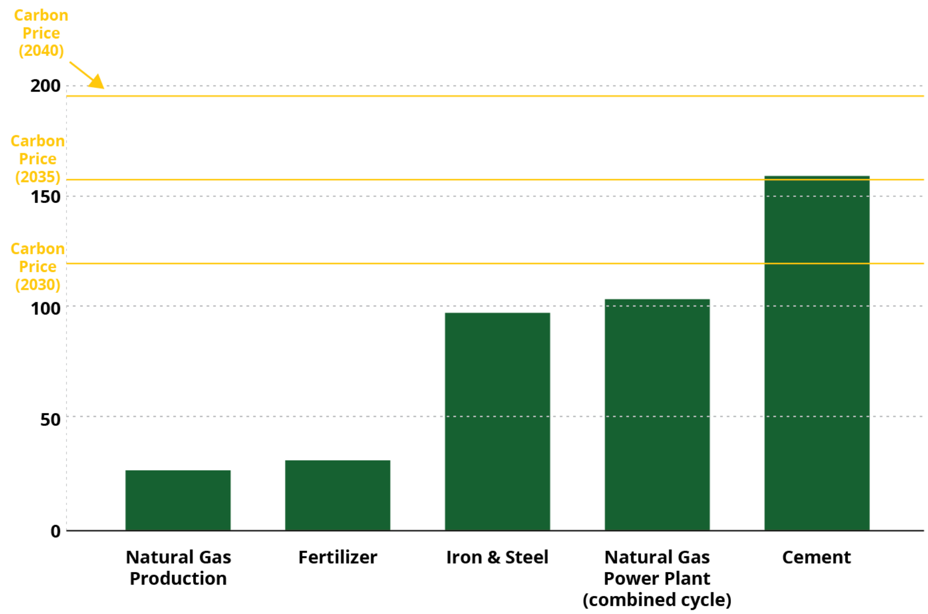
Canada has made some early progress on CCS. Of the 23 CCS facilities operating or under construction globally, four are in Canada. This includes the Shell Quest project that has already captured 5 Mt of emissions since 2015 from its hydrogen processing facility, as well as the newly completed Alberta Carbon Trunk Line which will transport about 1.6 Mt of carbon per year with the potential to increase supply in the future.

While CCS requires a significant capital outlay, the costs per tonne are modest. The Quest project is capturing carbon dioxide at $80/tonne and Shell has stated that, if they built it again, they could reduce costs down to $60/tonne. And while the costs of CCS range depending on where it is applied, Figure 11 shows that costs can be as low as $20/tonne, and that even the most expensive CCS is just over $150/tonne. A rising carbon price will make more and more CCS projects profitable—even in the absence of other policy mechanisms, discussed later in the report.

One potential obstacle to aggressively expanding CCS is the significant upfront investment required - the Quest project, for example, received $865 million from the governments of Canada and Alberta to build and operate the facility.

A promising Canadian venture, Svante, is trying to address that challenge. Svante produces modular CCS systems that are half the cost of traditional CCS. Svante is an example of the type of technology that could be further incented through a rising carbon price.

Figure 11: CCS costs per tonne (including capex) versus recommended carbon price increases in Scenario 1 and 2 (Canadian dollars, 2020)



Note: CCS costs based on nth-of-a-kind plant, per Global CCS Institute data, converted to Canadian dollars. Carbon prices are based on Scenario 2 figures.

Clean Hydrogen

Switching to clean hydrogen as an energy carrier has the potential to help decarbonize a wide variety of sectors including industrial processes, long-haul aviation, shipping, and electricity storage. All told, utilizing clean hydrogen presents the opportunity to replace up to one third of all emissions.[14]

Unlocking the opportunity in hydrogen will require policy support, and carbon pricing can play a major role. A rising carbon price can make the use of clean hydrogen—either "green hydrogen" produced without fossil fuels or "blue hydrogen" produced with natural gas and CCS—profitable in a variety of hard-to-abate sectors.[15]

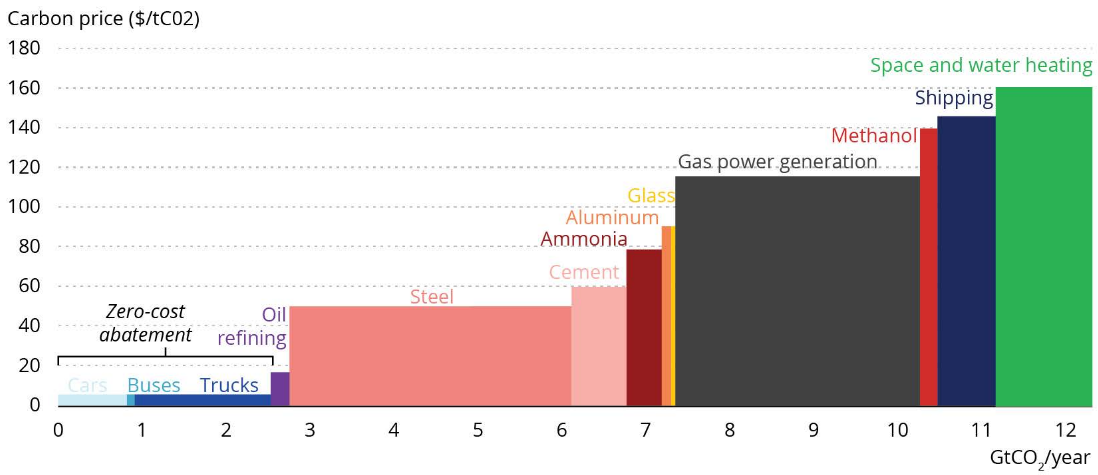
[14] This illustrates hydrogen's potential—but it will compete with other low-carbon solutions such as biofuels, renewable natural gas, and electrification. Even if hydrogen only "wins" in some applications and in some jurisdictions, its impact will be large.

[15] Blue hydrogen is more cost-competitive in the short-term but still produces carbon emissions, both from upstream mining activities where methane can be released and because carbon capture typically sequesters no more than 90% of the emissions from refining methane into hydrogen. Many analysts expect that green hydrogen will outcompete blue hydrogen in the medium-term as costs of renewable electricity and electrolyzers decline.

Figure 12 shows that a massive amount of carbon emissions could be eliminated by clean hydrogen at what BloombergNEF (BNEF) calls “surprisingly low carbon prices.” In particular, US$50/tonne would be enough to switch to renewable hydrogen in steel making, US$60/tonne for heat in cement production, US$78/tonne for ammonia synthesis, and US$90/tonne for aluminum and glass manufacturing.

BNEF assumes a US$1/kg delivered cost of hydrogen which credible sources have predicted will occur within the next decade. But even at current prices for blue hydrogen, data from the Canadian Transition Accelerator indicates that a carbon price of $60 per tonne would make blue hydrogen competitive with grey hydrogen, and $160 per tonne would make it competitive with natural gas for thermochemical applications. The Transition Accelerator also expects blue hydrogen to reach the US $1/kg threshold by 2030 in some regions of the country, including the Alberta heartland.

Figure 12: Marginal abatement cost curve from using $1/kg hydrogen for emissions reductions, by sector in 2050



Source: Bloomberg/NEF

Canada is a low cost producer of hydrogen and has the potential to be a global leader. And Canada is home to at least one company with a potential game-changing technology. Proton Technologies, based in Calgary, has discovered an innovative way to extract hydrogen from oil and gas wells while leaving carbon and other byproducts underground. The plant they are building in Saskatchewan would be the world's first zero-emission hydrogen reservoir, and the company estimates it can produce hydrogen for as little as $0.10 per kg at the wellhead.

In addition to CCS and hydrogen, one area where carbon pricing could play a particularly important role is in carbon removal, which is the subject of the next section.

Policy Action Area 2: Carbon Removal & Carbon Pricing

For Canada to decarbonize effectively, it will need a significant carbon removal program, for several reasons. First, removing carbon from the atmosphere is needed to counteract emissions from some sectors (e.g. aviation) that will be very difficult and/or costly to decarbonize directly before 2050.

Second, even after reaching net zero by 2050, the world will need a massive effort to pull carbon out of the air and sequester it in order to reduce atmospheric levels of carbon enough to stay below a 1.5 °C increase in temperature by 2100.

Third, unless the world rapidly increases the pace of decarbonization, there will be a need to rely more heavily on carbon removal before 2050, to ensure the world does not exceed the global carbon budget and stays below the 1.5 °C target in 2100.

Importantly, carbon removal should not be used as a reason to defer the critical effort to reduce existing emissions. Reducing existing emissions is essential and must be pursued without delay.

Developing the NETs sector will take time, likely decades, to build out and grow to scale. That's why it's so critical for Canada, and other countries, to act now to develop the technologies that will be needed in the coming decades.

Carbon Removal via Natural Solutions

***Recommendation 2a:* Proceed cautiously with nature-based solutions, ensuring that they are verifiable, "insurable", and don't crowd out negative emissions technologies.**

Natural solutions—planting trees, restoring wetlands, soil sequestration—can help remove carbon from the atmosphere and come with many other benefits to the environment.

The federal government has pursued some nature-based solutions already. Among its commitments is a pledge to plant two billion trees which would remove at least 3 Mt of emissions annually by 2030. There is potential to expand on this commitment.[16] A quarter of Canadian farmland is considered to be degraded; a mix of afforestation, reforestation, and conservation would help sequester additional carbon—up to 22 Mt of emissions annually according to a Corporate Knights analysis. The federal government should consider direct support to farmers to sequester this carbon, along the lines of the successful agricultural land use services model.

Yet, there are limits to the potential of nature-based solutions. A number of natural solutions, such as planting trees, store carbon for a relatively short period of time—hundreds of years at best, not thousands—and are at risk of releasing carbon due to disturbances such as forest fires and pest infestations. In some cases, planting trees could even be counterproductive in snowy regions as it can reduce the albedo effect. For these reasons, we believe it is risky to rely on nature-based solutions for a significant share of the negative emissions that will be required. Where nature-based solutions are counted as part of Canada's effort to reduce atmospheric carbon, those credits should be verified and "insured" so that there is a clear plan to re-sequester any carbon that escapes back into the atmosphere through future disturbances (e.g. forest fires, or pest infestations).

In addition to challenges around permanence, there is also a limit to the total amount of carbon that Canada can remove via natural solutions. Estimates of the sequestration potential from natural solutions in Canada are in the range of 1-1.5 Gt from now through 2050. Based on our modelling, Canada will need much more than that to reach net zero by 2050.[17]

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[16] A particularly important related area of focus should be on conserving natural ecosystems that currently contain stores of carbon that might be released if that land was developed.
[17] Our modelling indicates that we will need as much as two to three times as much carbon removal by 2050 to stay within our carbon budget, as described in the Appendix.

Carbon Removal via Negative Emissions Technologies (NETs)

Developing and scaling up NETs opens up an important pathway that increases Canada's chances to meet its 2050 goal.

There is a range of negative emissions technologies that could play a major role in reducing emissions, including increased ocean alkalinity, advanced weathering and bioengineering with carbon capture and storage. In this section, we focus on direct air capture because it is the most commercially advanced and can illustrate the potential of this sector. The policy measures that we recommend at the end of this section are designed to support growth in a variety of NETs, not only DAC.

DAC can remove a tonne of carbon at a cost of between $200 and $250 today. And as the technology scales up, there's good reason to believe it could go as low as $150/tonne or less.[19]

Canada has all the ingredients to be a world leader in DAC. It is home to one of the leading global DAC companies, Carbon Engineering, which has signed a deal to build the largest DAC plant in the world. Canada also has ample underground carbon storage capacity—mostly in Alberta and Saskatchewan—plus a burgeoning cleantech sector. And the expertise from Canada's oil and gas sector can be leveraged to build out this industry.

By accelerating policy support for DAC, Canada should gain first-mover advantage as a global exporter of the technology. And this will create lots of jobs—every new 1 Mt plant creates 3,500 jobs across its supply chain. Many of these new jobs would likely be clustered in Alberta and Saskatchewan.

Scaling up DAC won't be without challenges—it will require building hundreds, if not thousands, of plants to meet our targets, plants which require significant amounts of new clean energy to operate. It also requires the build-out of a supply chain that will require significant time and major investments. But this technology—or others that emerge to compete with it—are clearly required and can benefit Canada's economy.

[18] While BECCS has clear shortcomings, include competing for land use with other needs, Canada is one country where BECCS could particularly promising. Ocean alkalinity holds particular promise as scaling up is relatively straightforward and would primarily require more lime production.

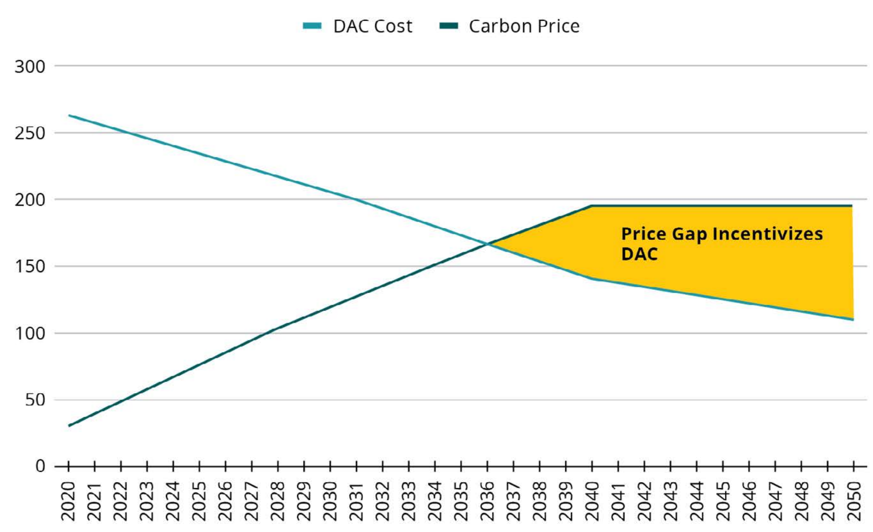
[19] Data based on conversations with industry experts and review of academic literature. See, for example, Fasihi et al. (2019).

Carbon Pricing & DAC

In the long term, increasing the carbon price will be critical to helping NETs, such as DAC, achieve the needed scale. If the carbon price continues to increase by $10/tonne per year, and if DAC deployment begins to accelerate, we expect that the carbon price will exceed the cost of direct air capture in about 2035, enabling major scale-up of the technology thereafter (see Figure 13).

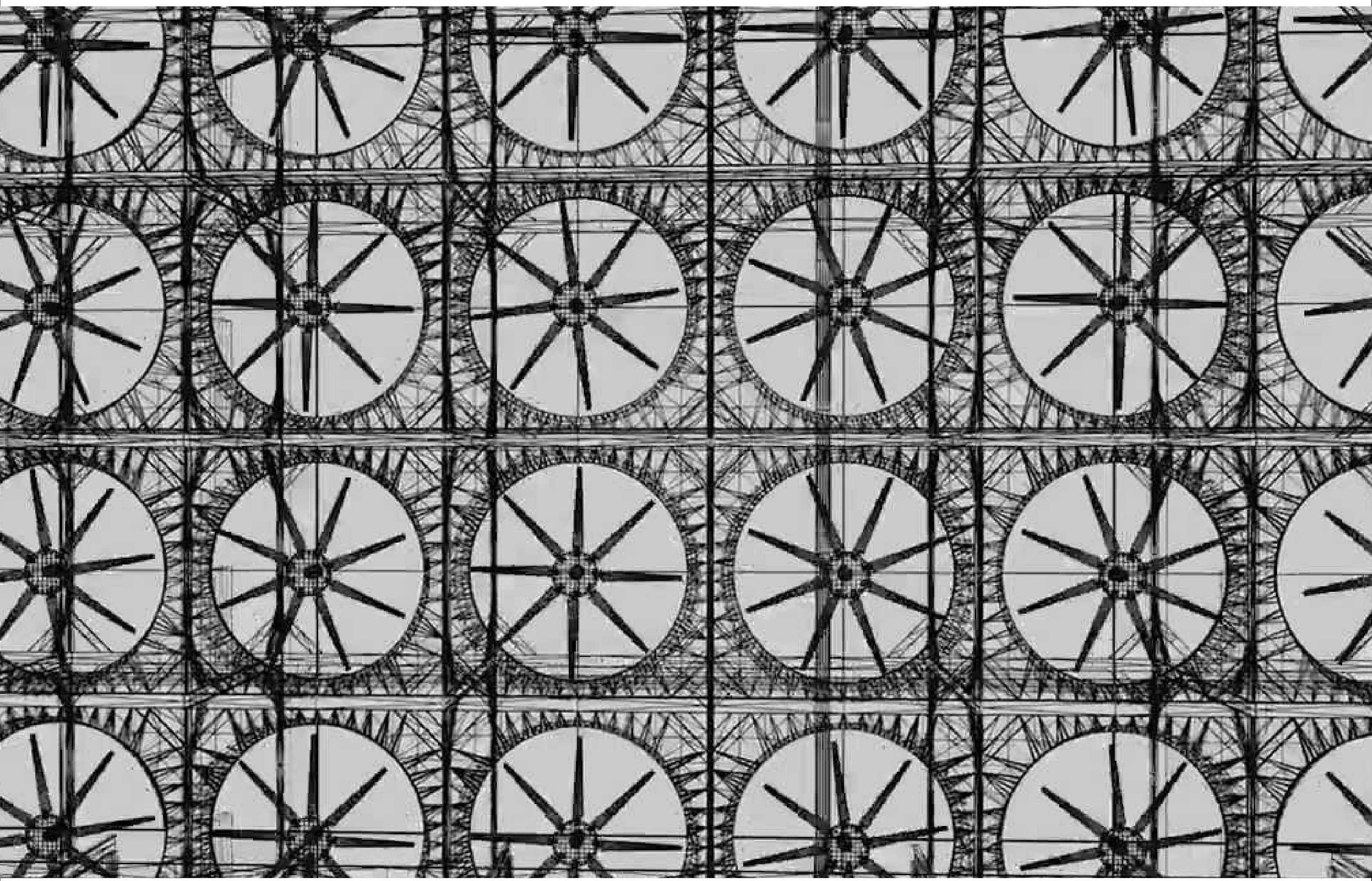
The point at which negative emissions technologies like DAC see costs per tonne drop below the carbon price will represent a watershed moment for efforts to fight climate change. It will clear the way for market forces to drive scale-up of the DAC sector (though government policy will still be needed to ensure an appropriate enabling environment, such as rapid permitting). It is hard to overstate how significant this moment could be.

Figure 13: Carbon pricing and DAC costs, 2020-2050 (Canadian dollars)



Note: The projections shown in the figure are based on CP analysis of a variety of sources, including: Fasihi et al. (2019) using the conservative growth and cost case assumptions and the conservative cost assumptions associated with high temperature heat DAC; the Rhodium Group analysis of costs discussed here; the National Academies of Sciences, Engineering, and Medicine report on DAC cost projections; and conversations with industry experts. Our projections assume that DAC will grow significantly over the next 30 years, reaching at least 7.5 Gt of carbon removal capacity by 2050 as outlined in Fasihi et al. (2019). Note that costs assume commercial lending rates; government financing support, as recommended below, would bring costs down.

The decline in DAC costs, however, will be much more likely to occur if Canada develops the DAC sector in the 2020s, as deployment is the key to moving down the DAC cost curve shown in Figure 13. Kickstarting the DAC sector will require a set of policy measures. We recommend that the government enact policies that not only support DAC but also other negative emissions technologies that show promise, such as advanced weathering and increased ocean alkalinity.[20]



[20] These other NETs may, in the long run, become just as important as DAC in providing the needed carbon removal. But we do not have time to wait. We should develop the DAC sector using policy that can also support other NETs over the long-run.

***Recommendation 2b:* Accelerate the adoption of NETs, in coordination with international partners, through a combination of policy actions that stimulate demand, reduce costs, advance R&D, and accelerate deployment. Specifically, we recommend:**

Direct procurement. The carbon removal sector needs early adopters to create a market that will prove out the technology and help bring costs down. The federal government (ideally in partnership with other countries or provincial counterparts) should play this role. We recommend that the government conduct an annual procurement process for carbon removal each year from 2022 through 2025. Each contract would be a commitment by the federal government to pay out at a fixed rate per tonne for carbon removal that would be delivered by suppliers in future years. The commitment would last for up to 30 years, the current lifetime of a DAC plant. Procurement will not only help catalyze growth in the market, it will provide discovery on the cost trajectory of carbon removal technology.

Tax credits. We recommend using tax-based incentives to reduce costs and stimulate demand. There are a range of options (not mutually exclusive) including:

a) Provide a refundable and stackable tax credit of at least $70-100 per tonne for carbon removal that lasts for the lifetime of a plant (30 years). The US already has this type of tax credit (known as 45Q) and is seeing much more activity in the DAC market. If Canada wants to not only keep up but become a leading player in this market, it should adopt a similar policy.

b) Provide a limited-time investment tax credit (ITC) of 30% for the first 10-20 Mt of DAC plants. The capital costs on early projects will inevitably be higher and can be offset with this ITC. When combined with other climate policies—e.g. the rising carbon tax and the clean fuel standard—this will make DAC projects more economic.

Financing and loan guarantees. The government should help reduce the cost of capital through loan guarantees and/or by directing the Canada Infrastructure Bank to prioritize funding for large-scale NET projects, including enabling infrastructure like pipelines to transport captured carbon. The Bank's current focus does not include carbon removal technologies.

Support for RD&D. Funding should be directed to basic research, process improvements, and demonstration projects for both direct air capture and other promising carbon removal technologies. These include advanced weathering where carbon is sequestered through reactions with naturally occurring minerals. The National Academies of Sciences, Engineering, and

Medicine in the US has proposed that its government spend up to US$240 million annually. For Canada to keep up, it should consider $25-50 million for its own program, and coordinate closely with US and international researchers.

Enabling policies. There are a range of non-cost barriers that the government should work to address to unlock private capital. These include geologic data (to identify suitable sites), liability (who is accountable for ensuring that CO_2 stays in the ground), and permitting (ensuring clear and efficient processes).

Offset credits. The federal government should develop clear protocols that enable carbon removal to qualify for credits under both the Federal Greenhouse Gas Offset System and the Clean Fuel Standard. Such protocols have been particularly effective in California as part of the state's Low Carbon Fuel Standard.

Emissions Impact

If the full set of policy recommendations are adopted, we believe natural solutions could offset 30-50 Mt by 2030 and 50-150 Mt by 2050. NETs could contribute modestly in 2030, perhaps 10-12 Mt under optimistic assumptions. But with DAC costs—and perhaps the cost of other NETs—falling below the carbon price in the mid-2030s, the industry should see rapid growth in the late 2030s and 2040s. We believe the DAC industry could contribute 250-500 Mt of annual negative emissions by 2050. While the 500 Mt number may seem high—and would require building hundreds of plants—it is in line with credible global estimates forecasting 10-15 Gt of DAC by 2050. In such a scenario, the 500 Mt figure would represent only 3.3% of the global total, a number Canada can reasonably achieve.

Carbon Capture and Storage

While the focus of this section has been on NETs such as DAC, it's clear that Canada will also need more carbon capture and storage (CCS) technology as well. In fact, in many cases, it will be more cost-effective to first reduce emissions with CCS before moving on to NETs like DAC, as carbon is much more concentrated in flue stacks than in ambient air. We believe that scaling up CCS is an important part of decarbonizing industry, as discussed in Policy Action Area 3 below. We also note that many of the policy recommendations outlined above for NETs, such as tax credits and non-cost barriers, would clearly benefit CCS.

Policy Action Area 3: Additional Cost-Effective Complementary Abatement Policies

While carbon pricing is a critical component of any climate policy, it needs to be complemented with other smart policies and regulations. A third component of Canada's climate plan should be to develop policies that can complement carbon pricing in three ways: 1) addressing emissions in sectors that do not respond well to carbon pricing, such as buildings and agriculture; 2) advancing high-potential technologies that need targeted policy support in early stages of development before market forces plus carbon pricing help scale them up (e.g. clean hydrogen), and 3) establishing an alternative policy pathway to address harder-to-abate emissions in case NETs do not scale up as quickly as expected.

To understand what policies are needed, it's helpful to start by understanding which emissions would remain unaddressed by carbon pricing. Returning to our modelling, we find that under a scenario where carbon pricing continues to rise by $10/year through 2050 (similar to Scenario 2 discussed earlier in this paper), and negative emissions do not offset remaining positive emissions, there would be over 400 Mt of emissions remaining in the economy. Figure 14 shows the largest sources of remaining emissions in this scenario. These emissions span much of the economy, including industry, vehicles, agriculture, and fugitive emissions. Addressing these remaining emissions will require a range of smart investments and regulations. Addressing these remaining emissions will require a range of smart investments and regulations.

Figure 14: Remaining emissions in 2050 by sector (Mt)

Remaining Emissions in 2050 by Sector (Mt)	
Industry	**142**
Manufacturing	53
Mining, O&G	55
Process Emissions	20
Other	14
Vehicles	**107**
Light-Duty	41
Heavy-Duty	51
Off-Road	15
Buildings	**59**
Agriculture	**58**
Fugitive	**15**
Other	**55**
Total	**436**

To better understand potential solutions, we ran a scenario of our model in which we forced gross emissions down to 80 Mt in 2050 in a manner that minimized economic costs. We then compared the investments in green technology in this "Cap Scenario" versus carbon pricing Scenario 2. Figure 15 lists the green technologies that saw the greatest increase in investments under the Cap Scenario.[22]

[22] The CAP scenario is achieved by raising the carbon price high enough to "force" emissions down to net-zero.

Figure 15: Additional investments in technology solutions under a Cap Scenario versus the $10/year carbon pricing scenario

Technology	Investment (Cdn $, Billions)	Comments
Industrial decarbonization solutions	115	Includes CCS, energy efficiency, range of other measures
Renewables	60	Wind, solar, and hydro
Low-carbon fuels	42	Includes hydrogen, biofuels
Electric vehicles	18	
Electricity	15	Transmission & distribution infrastructure
HVACs	8	Demonstrates need for building retrofits

Developing a comprehensive policy agenda to fully tackle the remaining emissions shown in Figure 14 is beyond the scope of this paper. Instead, we provide a set of directional policy recommendations based on the data presented above from our modelling combined with a literature review on climate policy recommendations for Canada. Many of the recommendations echo advice offered by other experts; we provide references to those sources where appropriate.

Decarbonizing Energy and Industry

***Recommendation 3a:* Map Canada's path to decarbonizing, sector by sector, with an associated capital plan.**

This is the first recommendation of the Expert Panel on Sustainable Finance and should inform the government about how to mobilize the capital (public and private) needed to decarbonize the economy. We recommend first prioritizing roadmaps for the industrial sector, especially segments of industry where significant emissions remain after adopting carbon pricing, such as manufacturing, mining, and chemicals. The government should draw on external stakeholders to provide expertise.

Recommendation 3b: **Provide targeted packages of support to high-potential decarbonization opportunities.**

This should be undertaken by a special arms-length agency, as recommended by the Task Force for a Resilient Recovery, to provide the right package of financial incentives, including direct investments, to a range of technologies from geothermal to carbon fiber that hold particular promise for decarbonization.

Recommendation 3c: **Accelerate investments in clean, robust power grids.**

The government should enable grids to receive more renewable power. The federal government is already studying opportunities to expand transmission with a special focus on interconnections between hydropower-rich provinces and their neighbours. These projects have rightly been evaluated on a cost per tonne basis and several promising projects have been identified. At least one project, the Atlantic Loop, appears to be moving forward.

Investments will also be needed to enable the grid to handle significant electrification growth in transport, heating, and industry, and to enable the type of demand response that will make the grid more resilient.

Recommendation 3d: **Invest in growing clean hydrogen.**

The federal government is shortly to publish a national hydrogen strategy. It will be critical to fund that strategy and make targeted investments to help the industry take off. We note that the Task Force for a Resilient Recovery suggested investments should be on the order of $1 billion.

Reducing Building Sector Emissions

Addressing building emissions will require a combination of: a) incentivizing investment in retrofits of the existing building stock, and b) leading the way in helping provinces adopt net-zero-ready building codes for all buildings built after 2030.

***Recommendation 3e:* Embark on an ambitious retrofit program.**

Retrofitting a large share of our residential and commercial building stock is a massive undertaking, but it will create millions of jobs and produce large energy savings. A proposal by Corporate Knights, for example, found that retrofitting 60% of commercial and residential buildings by 2030 would cost $21 billion over 10 years but would create three million jobs (spread out across the entire country), reduce emissions in the building sector by over 50 Mt and generate energy savings for households of $12.5 billion annually by 2030.

The investments in retrofits should be matched with investments in skills training to ensure a ready workforce to implement these retrofits. The Canada Green Building Council has called for $500 million to train a low-carbon workforce to complete the needed construction and retrofits.

***Recommendation 3f:* Develop a model national "net-zero energy ready" building code.**

The federal government should develop a model "net-zero energy ready" building code, as committed to in the Pan-Canadian Framework on Clean Growth and Climate Change, and work with provinces to encourage them to adopt the model code or their own version of it, so that all buildings in Canada built after 2030 can be ultra-efficient and designed with the potential to be net zero.[23]

Addressing Transport Emissions

Carbon pricing will help cut light-duty vehicle emissions in half, but more will need to be done to decarbonize transport. Our modelling shows that emissions from light-duty vehicles (LDVs) will be even more stubborn than heavy-duty vehicles (HDVs). Our "Cap Scenario" which forced emissions down to 80 Mt still had 30 Mt of LDV emissions in 2050 (down 13 Mt from our carbon pricing model), in contrast to HDVs where emissions declined to 12 Mt in 2050.

Even in the Cap Scenario, there is still a mix of vehicles on the roads including electric, hydrogen fuel cell, and standard gas (using biofuels). For this reason, we believe it's important for policy to enable all three decarbonization technologies—electrification, hydrogen, and biofuels—to compete.

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[23] The federal government can only do so much in this area of provincial jurisdiction, but there are ways the federal government can try to persuade provinces. For example, the federal government could use the Council of the Federation to prioritize discussions on a national building code in future meetings of First Ministers on internal trade issues. A harmonized code could break down provincial barriers in the construction industry and facilitate mobility in a sector that is important to national recovery and job creation.

In this section, our lens is emissions reductions but we note that the government will likely have other compelling reasons to act in the transport sector, including reducing air pollution or promoting job creation in the auto sector. Both of these factors might motivate the government to take more aggressive action in building out a domestic zero-emission vehicle sector, whether through direct investments, ZEV mandates, or the like.[24]

***Recommendation 3g:* Incentivize cleaner fuel use while ensuring the Clean Fuel Standard is having its intended effect**

In 2050, our modelling shows that even under our Cap Scenario electric vehicles will be about two thirds of the LDV stock and one third of the HDV stock (new sales would be much more heavily tilted to electric). The results highlight the importance of incentivizing cleaner fuels for the internal combustion engine vehicles that remain on the roads at mid-century. One approach is to strengthen the Clean Fuel Standard (CFS), but the federal government should first assess whether the CFS is achieving its intended results and not overlapping with other policies.

***Recommendation 3h:* Introduce feebates that lower the cost of ZEVs and help fund scrappage programs.**

To accelerate the transition to zero-emission vehicles (ZEVs), the federal government should add a fee to the cost of new internal combustion engine vehicles (ICEs) and use the revenue to incentivize scrappage of older, less-efficient ICE vehicles in favour of ZEVs. For example, one recent study found that every $100 charged in fees on ICEs could fund a $2,000 rebate on ZEVs.

Given that costs of ZEVs are declining rapidly—and a ZEV incentive is already offered by the federal and some provincial governments—we recommend using most or all of the ICE fees to fund a scrappage credit that is issued when Canadians retire a low-efficiency ICE vehicle and purchase a low- or no-emission vehicle in its place. The program could be designed to calibrate the fees and rebates based on the fuel efficiency of the vehicles being scrapped and purchased. In other words, rebates go up if the scrapped vehicle is higher-polluting and/or the vehicle purchased is lower-polluting.

[24] The federal and Ontario governments already made one such significant announcement in the fall of 2020, investing $590 million to help Ford produce EVs at a facility in Oakville.
[25] We adopt Transport Canada's definition of zero emissions vehicles for the purposes of the feebate.

Tackling Agricultural Emissions

Our modelling suggests there will still be 45 Mt of agricultural emissions remaining in 2050 due primarily to enteric fermentation, emissions from animal manure, and agricultural soils.

There are few off-the-shelf solutions to these emissions challenges and we believe a significant share of these emissions will have to be offset by carbon sequestration. Nonetheless, there are some potential solutions which the government can consider to help farmers mitigate these emissions:

***Recommendation 3i:* Invest in RD&D to address emissions from enteric fermentation.**

Enteric fermentation is a digestive process that occurs in ruminants like cattle, sheep, goats, and buffalo, which causes them to release methane. This is the largest source of agricultural emissions both globally and in Canada. While measures like reducing meat consumption or increasing the productivity of animal farming can help, this will not fully solve the problem. Some new technology solutions are emerging such as a promising molecule called 3-nitrooxypropanol. The government of Canada should, in coordination with international partners, fund research and demonstration projects to try to advance the use of 3-nitrooxypropanol and other similar solutions.

***Recommendation 3j:* Reduce fertilizer emissions with RD&D and pricing incentives.**

A significant share of the nitrogen that is applied as fertilizer to fields ends up being released into the atmosphere as nitrous oxide, a potent greenhouse gas that contributes to climate change. Farmers are working on this problem and would benefit from further technical assistance and support to increase the efficiency of their fertilizer, and/or reduce the amount of fertilizer needed (e.g. by planting nitrogen-fixing crops like legumes or adopting organic farming practices). But a key source of reductions will likely come from new technology including nitrification inhibitors. The federal government could fund research and development into this and other technologies. It might also consider enhancing the pricing incentives to reduce fertilizer emissions, over and above what is currently undertaken through the output-based pricing system.[26]

[26] One promising option for reducing emissions in fertilizer production is to switch from using hydrogen produced from fossil fuels to cleaner forms of hydrogen such as blue or green. A large Spanish fertilizer plant is now being built to use green hydrogen.

Regulating Fugitive Emissions

***Recommendation 3k:* Address fugitive emissions through both regulation and pricing.**

Our modelling of a rising carbon price in Scenario 2 above shows that approximately 15 Mt of fugitive emissions will remain in 2050, with nearly all coming from oil and gas sources including leaks, venting, and flaring.

We recommend regulations to require better monitoring and reporting of fugitive emissions, and to eliminate leaks. We also recommend that the remaining fugitive emissions (e.g. venting and flaring) be incorporated into the carbon pricing system as soon as is practical.

Benefits for the West & the Energy Sector

The policies in this document—especially carbon pricing and negative emissions technologies—will bring significant economic benefits to Alberta and Saskatchewan, including presenting major new opportunities for the energy sector.

Carbon pricing is the most appropriate tool to address emissions from our oil and gas sector because it incentivizes emissions reductions while providing a path for continued production of lower-emissions products. Our analysis shows that oil & gas GDP will grow 8% in the next decade, even if the sector is required to pay the full rising carbon price modelled in Scenario 2. Indeed, many oil and gas producers are on the record in support of carbon pricing (see Figure 16). One of the reasons for this support is that carbon pricing provides the business case for investing in lower-carbon solutions. According to MEG Energy CEO Derek Evans, "we need a carbon tax" in order to accelerate the development of carbon-reducing and even carbon-eliminating technologies like carbon capture and storage.

Figure 16: Carbon pricing is the best climate policy for oil, gas, and mining

"[Suncor] has been a huge supporter of a carbon price for literally over two decades."
Mark Little, Suncor CEO

"We need a carbon tax."
Derek Evans, CEO, MEG Energy

"We are also strong supporters of Canada's action on carbon pricing."
Don Lindsay, CEO, Teck Resources

"We have the carbon tax that applies to large emitters like Husky in the oilsands [and] the government is using some of those revenues to help industry reinvest in technology. The combination of both of those policies is particularly powerful."
Janet Annesley, SVP, Husky

"Today, one of Canada's largest industries is coming out in support of a carbon price, identifying it as the most effective and efficient means of driving emissions reductions. "
Pierre Graton, CEO, Mining Association of Canada

"Canadian businesses of all sizes are prepared to accept carbon pricing as a cost of doing business....when done right, carbon pricing can equip businesses for the transition to a lower-carbon economy, and reduce the overall regulatory burden."
Canadian Chamber of Commerce, July 2018

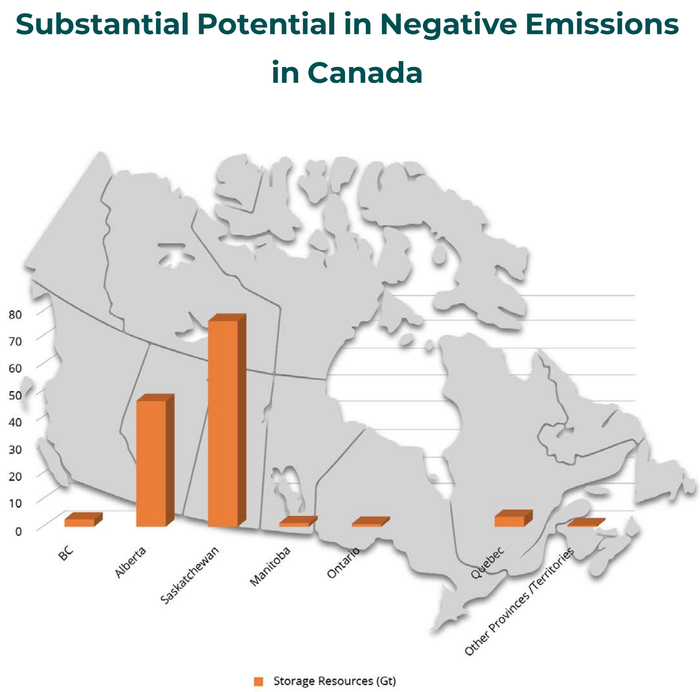
Carbon removal also presents very significant opportunities for both the West and the energy sector. The vast majority of appropriate geologic space for carbon sequestration is in Alberta and Saskatchewan (Figure 17). And the key expertise—drilling wells, building pipelines, pumping carbon underground—are core competencies of the existing oil and gas sector. If Canada gets serious about carbon removal, there could be hundreds of carbon removal plants in Alberta and Saskatchewan leading to hundreds of thousands of associated jobs.

Developing clean hydrogen is another potential game-changing opportunity for the energy sector. If Canada can scale up the extraction technology, its massive hydrocarbon deposits could be used to produce, and perhaps export, low-carbon hydrogen. According to a recent study, Canada is well-positioned to be a low-cost global supplier of this resource.

In short, good climate policy will create clean prosperity, while bringing benefits to areas of the country and economy that may face the biggest risks from the low-carbon transition.

Figure 17: Carbon sequestration potential across Canada

Province/ Territory	Storage Resources (Gt)
British Columbia	3
Alberta	46
Saskatchewan	76
Manitoba	1
Northwest Territories	1
Ontario	1
Quebec	4
Other Provinces / Territories	N/A
Canada	**132 Gt**
"Canada has vast reservoirs that could be used for permanent CO_2 storage[1]"	



Source: National Energy Laboratory, Carbon Engineering Analysis

Appendix: The Global Carbon Budget & the Need for Negative Emissions

This report focuses on achieving net-zero emissions by 2050, the stated goal of the federal government. In this appendix, we briefly highlight the importance of also considering the cumulative emissions that will be produced between 2020 and 2050, a concept known as a carbon budget.

The 2050 net-zero goal adopted by Canada and many other countries comes from the UN Intergovernmental Panel on Climate Change's special report on 1.5C (SR15) released in 2018. In that report, the IPCC described what action would be needed globally to avoid warming of more than 1.5 °C by 2100.

A widely reported IPCC finding is the need to reduce emissions to net-zero by 2050. But the IPCC also makes clear that the cumulative amount of carbon (and other greenhouse gases) produced up to 2050 will be a critical determinant of whether the world will avoid the worst impacts of climate change. The amount of carbon we can safely emit without permanently exceeding the 1.5 °C threshold is the carbon budget.

We expect to provide further details in a future report on how Canada could construct a national carbon budget that is consistent with this global carbon budget target.

For More information:
Clean Prosperity.ca
info@cleanprosperity.ca

1 Yonge Street, suite 1801
Toronto, Ontario
M5E 1W7

Credits
Photos: Unsplash
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