October 2021

Assessing the 2021 Federal Liberal Climate Plan

A report from Clean Prosperity

Report authors
Michael Bernstein
Dave Sawyer
Seton Siebert
Jake Wadland
Jason Clark

Clean Prosperity worked with ESMIA and EnviroEconomics to independently model the Liberal Party of Canada's 2021 election climate plan, in order to understand its emissions-reducing potential and its cost to Canadian households.

CleanProsperity.ca

CLEAN PROSPERITY

Table of Contents

Executive Summary

Purpose

The Liberal Party of Canada (LPC) made major climate policy announcements over the past year, culminating in their 2021 federal election climate platform. The policies — including carbon pricing, a clean electricity standard, large investments in industrial decarbonization, and many others — are an attempt to meet a climate target of a 40-45% reduction in greenhouse gas emissions below 2005 levels by 2030 (referred to below as the “2030 climate target”).

Clean Prosperity worked with the modelling firm ESMIA and the environmental-economic consulting firm EnviroEconomics to independently model the LPC climate plan, in order to understand its emissions-reduction potential and its cost to Canadian households.

Our research sought to determine the emissions reductions that would be achieved by the LPC plan under various scenarios in both 2030 and 2050, the impacts of LPC policy on energy and technology in relevant sectors of the economy, and the costs of the plan to households. The plan was modelled against a status quo reference scenario that assumed no new climate policy beyond what is already legislated.

Findings

Our analysis and modelling suggests that the LPC climate plan, if fully implemented, could achieve a 37% to 41% drop in emissions by 2030, relative to 2005.

The LPC’s climate plan gives it a reasonable chance, though no guarantee, of meeting its 2030 climate target.

The extent of emissions reductions within that 37%-41% range is dependent on fossil fuel prices and their impact on oil and gas production. If fossil fuel prices remain relatively high, emissions will be reduced by 37%; but if prices and production are lower, our projections show that the LPC will slightly exceed the lower bound of the 2030 target. The difference in emissions between these high and low oil price scenarios is about 30 Mt in 2030.

Modelling long-term emission outcomes should always be viewed with caution. Providing specific forecasts of emissions reductions in 2030, let alone 2050, can create a false sense of precision when, in reality, the reductions are hard to predict precisely, and are based on many assumptions required to project future emissions outcomes. Our modelling also does not consider factors like the role of provincial climate action, which could accelerate or obstruct emissions reductions.

Still, we believe the key takeaway from our results is that the LPC's climate plan has put Canada on a path that gives it a reasonable chance, though certainly no guarantee, of meeting its 2030 climate target. For that reason, the priority for the LPC and the Government of Canada will need to be effective implementation of announced policies, while also putting in place the building blocks for deeper decarbonization in the 2030s and 2040s.

Beyond the top-line emissions-reduction numbers, we assessed how each sector of the economy evolves under the proposed climate policies. In our modelling scenario where fossil fuel prices are relatively high, we find large emissions reductions are achieved by the LPC plan, relative to the reference scenario in 2030, in transport (43 Mt), public electricity and heat (29 Mt), manufacturing (20 Mt), and buildings (19 Mt). In aggregate, two sources related to oil and gas — extraction and fugitive emissions — deliver the largest reductions (58 Mt) even as production grows, due to large improvements in emissions intensity.

Although the government's plan to date has focused on achieving 2030 emissions-reduction targets, we also assessed the impact it would have on emissions by 2050, given that net-zero is the ultimate goal of climate action. The picture for 2050 shows substantial progress towards net-zero, but also significant remaining emissions. Specifically, our modelling finds that the LPC policies reduce emissions to between 282 and 288 Mt by 2050. This represents just under 40% of today's emissions, and it assumes that policy pledges like reaching net-zero in oil and gas and buildings are both fully achieved. Hitting net-zero, therefore, will require significant additional policy action.

We also examined the cost to households from LPC policies. Although the cost of inaction is almost surely higher than the costs of effective climate policy, it is still critical to understand how policy choices will affect household budgets. In 2025, assuming for the purposes of this analysis that a system comparable to the federal carbon-pricing backstop applies across Canada, the LPC climate plan would generate a net benefit to households of $535 million in 2025. Five years later, Canadians would face a net cost of $2.2 billion. However, the cost impact on households is highly dependent on income. Those earning less than $86,000 come out ahead, while households with higher earnings end up with a net cost.

Recommendations

Prioritize the Highest-Impact Policies for 2030

"Prioritize the highest-impact policies."

Given that prioritizing among the many proposed policies is inevitable, we recommend placing a high priority on the following three policy areas, which represent over three-quarters of the emissions reduction potential to 2030. Each of these areas will also be important for long-term decarbonization and competitiveness:

a) The Clean Electricity Standard: Mandating net-zero emissions in electricity by 2035 can generate over 20 Mt of emissions reductions by 2030. A zero-carbon grid will also serve as the backbone for decarbonizing other areas of the economy.

b) Oil and gas sector emissions, including methane emissions: Regulations in this sector could generate as much as 40 Mt of emissions reductions by 2030, representing one of the largest opportunities for decarbonization this decade. The oil and gas sector can also be a key player in developing the energy and technology needed for the net-zero economy.

c) Road and off-road vehicle policies: The package of policies affecting road and off-road vehicles can reduce emissions by almost 35 Mt by 2030. Importantly, most of these reductions are not in passenger vehicles but rather heavy-duty trucks and miscellaneous vehicles like ATVs, garbage trucks, winter service vehicles, and onsite transport at industrial facilities. Nonetheless, the full range of policies proposed by the LPC in this sector will be important, including those for passenger vehicles, not just from an emissions-reduction perspective but also to develop the domestic zero-emission vehicle supply chain that can be a key source of future economic growth. The government will need to ensure that reductions in emissions — especially from heavy-duty vehicles and miscellaneous transport — support long-term decarbonization, rather than only short-term targets.

Develop the Building Blocks for Net-Zero

The package of policies proposed by the Liberal Party will generate significant emissions reductions by 2030, but substantial new policy will be needed to meet the goal of net-zero emissions by 2050. To meet its longer-term goals, we recommend prioritizing the following building blocks:

d) Map out the post-2030 path: We recommend that the government undertake a rigorous and transparent research effort, guided by extensive modelling, to map out a variety of decarbonization pathways that would successfully achieve net-zero under different future scenarios. This exercise would identify the policies and investments needed to give Canada the best chance of successfully reaching net-zero. The output of this process could be modelled on the reports generated by the UK government's Climate Change Committee and should also include an assessment of the infrastructure needed for net-zero. In developing long-term plans, the government should also develop a carbon budget approach to evaluating low-carbon policies and investments.

e) Develop a national carbon management strategy: Net-zero will require massive growth in carbon capture and carbon dioxide removal technologies. It's hard to see how we can meet our climate ambitions without these technologies. The government should create a national carbon management strategy to unlock growth in this sector.

f) Transition to full industrial carbon pricing with a border carbon adjustment: Industrial emissions remain high in 2050, according to our modelling of the LPC climate plan. To decarbonize industry we recommend transitioning to a full industrial carbon price combined with a border carbon adjustment that helps preserve competitiveness.

g) Develop the policy package for net-zero buildings: Without more policy to back up the commitment to net-zero buildings, that sector will still have 30 Mt of emissions in 2050. The federal government should move with haste over the next few years to develop and implement a package of policies in partnership with other levels of government that can fulfill the commitment to a net-zero buildings sector by 2050.

1. Introduction

The Liberal Party of Canada (LPC) made several major climate policy announcements over the past year, culminating in the release of their climate platform during the 2021 federal election campaign. The policies are intended to help the country meet the federal government's new international climate target: a 40-45% reduction in emissions by 2030, relative to 2005 levels. Among the LPC policies are a carbon price that rises to $170/tonne by 2030, a clean electricity standard to create a 100% net-zero grid by 2035, a commitment to make 50% of all new vehicle sales zero emitting by 2030, and a pledge to regulate emissions in the oil and gas sector to reach net-zero by 2050. So how do the Liberal policies stack up?

In this report, Clean Prosperity analyzes the Liberal Party of Canada's climate plan to understand both its emissions-reduction potential and its cost to Canadian households.[1] We focus primarily on 2030, but also look ahead to 2050 to understand the degree to which the Liberals' package of policies sets Canada up to meet the goal of net-zero by 2050.[2]

To undertake our analysis, Clean Prosperity used the North American TIMES energy model (NATEM) maintained by the modelling firm Energy Super Modellers and International Analysts (ESMIA). We paired that with a household cost model prepared by EnviroEconomics, a consulting firm that specializes in analyzing the economic implications of environmental policy. Our methodology is further explained later in the paper.

Our research aimed to answer four key questions about the proposed LPC policy package:

1) How do the emissions reductions from LPC policies compare to the climate target for 2030?
2) What is the impact of the LPC climate policies on energy and technology in each relevant economic sector (e.g. buildings, heavy industry, etc.)?

[1] Throughout this report, we attribute the Liberal Party of Canada's climate policies to the party rather than to the Government of Canada, because a significant number of the proposed policies were not yet implemented or even adopted by the federal government when this report was written.
[2] We conducted this analysis during the federal election campaign of 2021 — a separate parallel analysis was also conducted on the Conservative Party of Canada's climate plan. That report will be posted on our website once released at CleanProsperity.ca.

3) How well do the LPC policies set Canada up for reaching net-zero by 2050?
4) What are the costs to households over the next decade of implementing the proposed LPC policies?

The rest of the paper is organized as follows. Section 2 describes our methodology. Section 3 presents an overview of our findings. Section 4 looks at emissions reductions sector by sector, with a focus on our results for 2030. Section 5 looks at pathways to decarbonize Canada's energy supply by 2050, and how our modelling results compare to other modelling of a net-zero energy system. Section 6 describes the impact of the LPC climate policies on household costs. Section 7 provides recommendations to the federal government.

2. Methodology

Models Used

To model the emissions impact of the Liberal plan, we used ESMIA's NATEM model. NATEM is an application of the TIMES model generator, which is supported by an international collaboration that includes the International Energy Agency. NATEM is a technology-rich model that describes the entire integrated energy system, as well as non-energy emissions-producing sectors of the 13 Canadian provinces and territories. The model provides a rigorous analytical basis for identifying least-cost solutions to achieve energy and climate objectives without compromising economic growth.

We used the NATEM model to generate detailed emissions, energy, and related technology data through 2050. Data from NATEM was then fed into a separate model developed by Seton Siebert and Dave Sawyer of EnviroEconomics. That model takes abatement costs by Intergovernmental Panel on Climate Change (IPCC) emissions category from the NATEM model, and matches them to industry classifications from Statistics Canada using historical emissions-intensity data. These costs are then passed on to households by using a cost pass-through for each sector that is based on a literature review.[3] Further details on this methodology are offered in Appendix 2.

[3] We also ran alternative pass-through scenarios as detailed in Appendix 2.

Policies Modelled

To model the Liberal's climate plan, we reviewed their climate policy announcements, including the 2020 Fall Economic Statement, the December 2020 "A Healthy Environment and a Healthy Economy" plan, the additional climate pledges made in the 2021-22 federal budget, as well as the climate policies announced during the 2021 federal election campaign. Collectively, there are a very large number of proposed policies, but we focused on the policies that had enough specificity and potential climate impact to incorporate into our model. Where required, we made simplifying assumptions to help simulate the policies.

The specific policies modelled include:

Carbon Price Rising to $170/Tonne

We assume a carbon price nationally of $50 per tonne (nominal dollars) in 2022 that rises by $15 per tonne per year through 2030, resulting in a nominal price of $170 per tonne at the end of the decade. The retail carbon tax faced by households and small businesses is modelled separately from the system for heavy industry. For the retail carbon tax, 90% of the revenues generated from the carbon tax are returned to households, simulating the design of the federal carbon pricing backstop.[4] For the industrial carbon pricing system, we apply a simplified version of large-emitter programs that currently exist across Canada, which limit the average cost impact on balance sheets, thereby protecting competitiveness.[5]

Canada Infrastructure Bank Spending

There is a total of $6 billion in Canada Infrastructure Bank spending, which is allocated as follows:

---

[4] This is a simplifying assumption. Provinces without the federal backstop have their own systems in which they determine how to use the revenue generated from carbon pricing.

[5] We do this by applying the full carbon price to industry but limiting impacts on production by constraining the elasticity response of demand. We also ran a separate carbon pricing-only scenario to validate that this simplified version of industrial pricing did not impose average costs that are not reflective of current large-emitter programs that use emission-intensity benchmarks to limit cost exposure for heavy industry.

$1.5 billion for zero-emission buses: We assume this is used to reduce the cost and thus increase the stock of zero-emission buses.

$2.5 billion for clean power: This money is used to subsidize renewable generation, transmission, and storage technologies.

$2 billion for energy-efficient retrofits in commercial buildings: Money is used to subsidize building technologies ranging from insulation to electric heat pumps.

Buildings

Residential retrofits: The $2.6 billion in funding from the 2020 Fall Economic Statement is included. Those funds provide $5,000 grants to individual homeowners through 2027.

Home retrofits: The 2021 federal budget committed $4.4 billion over five years to the Canada Mortgage and Housing Corporation for zero-interest loans of up to $40,000 for home retrofits.

Transport

Zero-emission vehicle (ZEV) mandate: A ZEV target was implemented which requires that 50% of sales of light-duty vehicles in 2030 be zero-emission, and 100% by 2035.

Incentives for Zero-Emission Vehicles Program (iZEV): An investment of $1.5 billion to extend $5,000 rebates to individuals that purchase light-duty zero emission vehicles priced under $50,000.

ZEV tax write-off: A 100% tax write-off for commercial light-, medium-, and heavy-duty ZEVs.

Charging stations: A series of policies to support charging stations have been announced, including $700 million to build at least 50,000 electric and hydrogen stations across Canada.

Clean Fuel Standard: An average emissions intensity for liquid fuels is modelled based on the emissions intensity schedule listed in the draft Clean Fuel Regulations, culminating with a target of 81.84 grams of CO_2e per MJ in 2030. This target is then extended from 2030 through 2050.

Fuel efficiency standards: Based on the commitment to align Canada's light-duty vehicle regulations with "the most stringent performance standards in North America post-2025," we assume that the corporate average fuel economy (CAFE) standards are maintained through 2025 and then are strengthened by 6% per year through 2030.

Electricity

Clean Electricity Standard for 2035: We model a clean electricity standard that leads to a net-zero emissions electrical grid by 2035, where any remaining emissions must be offset with negative emissions.

Industry

Net Zero Accelerator: $8 billion in funding for heavy industry to decarbonize their operations. We model this as a reduction of up to 25 Mt per year in industrial emissions using the most cost-efficient path, based on the assumption that due to free-rider rates and the cost of large-scale emissions reductions, emissions reductions will occur at the conservative rate of $320 per tonne. The Net Zero Accelerator modelling does not specifically account for the investments in helping steel companies convert to electric arc furnaces that were announced earlier this year.[6]

Investment tax credit for carbon capture, utilization, and storage (CCUS): An investment tax credit (ITC) for CCUS projects is modelled as a 50% subsidy on the capex costs of new CCUS facilities across sectors including electricity, steel, cement, chemicals, and pulp and paper. The federal government expects the ITC to achieve 15 Mt of annual reductions by 2030. The 50% rate

[6] Our focus is on the overall rate of decarbonization that can be expected from the full $8 billion deployment, but we acknowledge that, if implemented according to plan, the first two projects funded by the Net Zero Accelerator will reduce emissions at a lower rate than $320 per tonne. However, historically, government funding programs for emissions reductions do have very high free-rider rates (50% or more).

was chosen as an educated guess of the final level based on Clean Prosperity's involvement in some of the consultations around the ITC (although our modelling results show that the tax credit will not achieve 15 Mt in emissions reductions by 2030).

Reductions in methane emissions: We model the Liberal commitment to reduce methane emissions from oil and gas by 75% in 2030 relative to 2012 levels.

Waste

Waste methane capture: Regulations to increase the number of landfills that collect and treat methane, and ensure that existing operations make improvements to collect everything they can.

Agriculture

Agricultural funding: Investments of $165 million over seven years for clean technology in agriculture, including $50 million to help farmers purchase more efficient grain dryers that will reduce their carbon tax bills.

Sector-Wide Net ZeroPolicies

There are two additional pledges within the Liberals' 2021 climate platform that could have a big impact on emissions, but are also difficult to model because they are commitments to bring entire sectors to net-zero. We have made our best attempt to simulate the likely policies proposed while also providing data in Appendix 1 showing the emissions estimates in the absence of these two policies.[7]

[7] On one hand, these two policies will make an important impact on decarbonization, so we felt they should be included. But we also recognize that commitments without a clear policy to achieve the commitment are typically not modelled because they lack detail and because a target without a policy is not typically seen as a credible-enough commitment. On the other hand, the Liberals have demonstrated a willingness to enact ambitious climate policy (e.g. the carbon price) and their pledge to reduce emissions from the oil and gas industry, for example, mentions that they will impose regulations to cap emissions including five-year targets starting in 2025.

The two policies are:

Regulations on emissions from the oil and gas sector: A commitment to regulate net-zero emissions in the oil and gas sector by 2050, with five-year targets beginning in 2025. To simulate this policy, we programmed several actions into the model:

1) We tell the model to maximize the electrification of oil and gas extraction by 2050, and to find a cost-optimal pathway to reach that 2050 target.
2) We force all new steam generation to utilize low-carbon technologies.
3) We add carbon capture and storage (CCS) to all upstream point sources by 2050, focusing on installing CCS when new equipment is needed (there's no legacy equipment by 2050).
4) We eliminate all venting and flaring by 2050.
5) We add negative emissions in the form of direct air capture by 2050 to offset any remaining emissions within the sector. Note that we focus on net-zero emissions within oil and gas extraction (we do not include refining or other downstream activities).

Building sector net-zero strategy: The Liberal climate platform commits to "launch a National Net-zero Emissions Building Strategy, which will chart a path to net-zero emissions from buildings by 2050 with ambitious milestones along the way." We impose a constraint in this sector that forces the model to determine a cost-optimal pathway to eliminating emissions from buildings by 2050, which roughly follows a straight-line decline rate (i.e. a similar reduction each year to 2050).

Finally, we do not model the commitments made by the Liberal government to nature-based solutions. Instead, we rely on an estimate of those emissions reductions provided by Environment and Climate Change Canada (ECCC) from its "A Healthy Environment and a Healthy Economy" plan of 2020.

Other Assumptions

To understand the impact of the Liberal policies on greenhouse gas emissions, we modelled the LPC plan and compared it to a reference case which includes only existing federal and provincial climate policies that have been legislated or regulated. The reference case policies closely resemble the policies in ECCC's "With Measures" scenario, though our reference case shows higher emissions in 2030 than does the ECCC scenario.[8]

The LPC and reference cases were then compared against each other under both a low and high fossil fuel price scenario, using price data from the Canada Energy Regulator (CER). We also conducted a sensitivity analysis with additional modelling runs that varied the technology hurdle rate (i.e. the pace of adoption of new technology) and that excluded net-zero policies in buildings and oil and gas, since we have few specifics on how those sector-wide policies will be implemented. More details on those additional modelling runs are offered in Appendix 1.

On fossil fuel prices, we created a high energy price scenario that follows CER's Reference Case. The CER Reference Case forecast assumes no new climate policy is implemented, and estimates the price of WTI crude oil at US$71 per barrel from 2030-2050, while natural gas prices will be US$3.50 per MMBtu at Henry Hub in 2030 and US$4.25 in 2050 (all prices in 2019 dollars).

We also model a lower energy price scenario that is based on CER's Evolving Scenario. In this scenario, a barrel of WTI oil is US$51 in 2030 and declines gradually to US$46 by 2050. Natural gas is US$3.35 per MMBtu in 2030, rising to US$3.75 in 2050. Although this scenario is not the main case for the CER, we believe it is a very plausible scenario. In 2021, for example, BP forecast long-term oil prices at US$55 from 2021-2050. The IEA Net Zero scenario envisions an even lower oil price of US$25 in 2050 and US$2 per MMBtu of natural gas.

We refer to the high energy price modelling run as LibPlan1 and the lower price modelling run as LibPlan2.

---

[8] For details on the policies in ECCC's "With Measures" scenario, see Canada's Fourth Biennial Report to the United Nations Framework Convention on Climate Change (UNFCCC). While ECCC's latest estimates for that scenario is that it will lead to total emissions of 674 Mt by 2030, our reference case has 695 Mt in 2030 because there are several sectors where we cannot see a plausible pathway to reaching ECCC's projections (e.g. in electricity, we do not see a path with current policy to reaching 11 Mt of emissions in 2030, as shown in the ECCC projections, given the amount of natural gas used for electricity production forecasted for 2030 by ECCC).

Once we generate emissions results from the NATEM model, we still need to consider several emissions-reduction activities that are external to the model. In particular, the following are deducted to determine the total emissions that remain in the Canadian economy:

1) Land use, land use change, and forestry (LULUCF): Canada's managed lands are treated as a net sink for greenhouse gases after factoring in emissions associated with land use changes and harvested wood products. Since LULUCF is not part of the NATEM model, we use ECCC's latest estimates that LULUCF will generate a net emissions reduction of 17 Mt in 2030.[9]
2) Western Climate Initiative (WCI) Credits: The Quebec cap-and-trade system generates credits through its link to the California cap-and-trade system. In 2030, these credits are estimated to represent 13 Mt of emissions reductions.
3) Nature-based solutions: A variety of pre-existing policies to protect nature, restore wetlands and peatlands, reduce fertilizer use, and plant two billion trees have been collectively estimated by ECCC to reduce emissions by 10 Mt by 2030.

While these deductions are all used by the Government of Canada in their latest emissions reporting, they are not without some controversy. For example, LULUCF calculations do not include emissions events like wildfires in non-managed forests (they are assumed to be part of natural climate variance). WCI credits are an estimate and are not yet governed by internationally-accepted climate accounting rules, so there is a risk that these emissions could also be counted by California. And none of these emissions estimates have been independently verified through our modelling.

Our modelling only contemplates the use of carbon dioxide removal (CDR) technologies like direct air capture to offset remaining emissions from the oil and gas sector in 2050. CDR technologies are unlikely to make a meaningful difference to net emissions before 2030. However, it is possible that they will become a significant factor in the 2030s and 2040s as the country attempts to reach net-zero by 2050, especially if further policies are adopted to accelerate their deployment.

[9] Details about how Canada calculates its LULUCF emissions can be found in Annex 2.6 of this document.

In addition, our modelling does not include 28 Mt of emissions that are counted by ECCC in their estimates for 2030 under the "With Additional Measures" scenario. A review of Canada's fourth biennial report to the UNFCCC shows that 15 Mt of these projected reductions are likely to overlap with the policies we have already modelled for the buildings and electricity sector, while a further 13 Mt are not attributed to specific policies and thus cannot be properly assessed.[10]

3. Emissions Reductions: Overall Findings

Overall, our modelling estimates that the Liberal climate plan would achieve between a 37% and 41% drop in emissions by 2030, relative to 2005, with the results highly dependent on fossil fuel prices and their impact on oil and gas production (our modelling finds, perhaps unsurprisingly, that higher prices lead to increased production). The path to the Liberals' enhanced Paris Agreement target of 40-45% is therefore in reach, but may not be met with the current suite of policies alone if long-term fossil fuel prices remain relatively high. On the other hand, if fossil fuel prices and production are lower, our projections show that the Liberals will slightly exceed their target.

Table 1: Emissions reductions in 2030 under different scenarios

The Paris Agreement target for 2030 is a 40-45% reduction below 2005 levels

		2030	
		Emissions (Mt)	**Reduction**
Fossil fuel prices	**Higher**	458	37%
	Lower	428	41%

Providing such a specific forecast of emissions reductions can create a false sense of precision when, in reality, the reductions are hard to project precisely, and are based on many assumptions we have had to make in the model. There are inevitably judgment calls that must

[10] Under Canada's fourth biennial report to the UNFCCC, all but 13 Mt of the emissions reductions under the "With Additional Measures" scenario are attributed to specific policies. It is theoretically possible, therefore, that the emissions reductions from our model underestimate the reductions potential in 2030 of previously announced policies.

be made in any modelling exercise, which means that there are plausible pathways for emissions to be both significantly lower or higher than the results from our model simulations (see Box 1).

Box 1: Reasons our modelling could be too optimistic or too pessimistic

There are many factors, both internal and external to our model, that could either accelerate or obstruct emissions reductions in the coming years, and that could lead readers to see our modelling as either too pessimistic or too optimistic.

For example, our modelling could be seen as overly optimistic because we assume:

1) All of the proposed policies in our model will be implemented during this federal government's mandate.
2) Jurisdictional issues and/or on-the-ground implementation barriers do not slow down decarbonization. For example, provinces have an important role to play in electricity generation and transmission, and may not take the necessary steps to achieve a 100% net-zero electricity grid by 2035. Similarly, installation of heat pumps to reduce emissions in residential buildings will require upgrades to local distribution networks that may or may not occur fast enough to match federal ambition.
3) Pledges to regulate emissions to net-zero in the oil and gas sector and the building sector will not only be met, but will lead to greenhouse gas reductions that start this decade.

On the other hand, our modelling could be seen as unduly pessimistic because:

1) Our emissions forecasts do not consider further climate action by provinces, even though it's almost certain that at least some provinces will implement new policies to reduce emissions before 2030.
2) Technological progress could accelerate decarbonization through the introduction of new commercial technologies or by lowering the cost of existing technologies below what is forecasted in the model.

3) Our reference case scenario starts with higher emissions in the economy than the model used by ECCC, for reasons explained later in this report.

No modelling exercise is perfect, and this one is no exception. While we acknowledge the limitations of our modelling, we believe that this report serves as a helpful tool to better understand the potential impact that the Liberal Party of Canada's policies themselves — independent of some of the external factors listed above — could have on greenhouse gas emissions and household costs.

We believe the key takeaway from our results is that the Liberal Party's climate plan has put Canada on a path that gives it a reasonable chance, though certainly no guarantee, of meeting its 2030 climate target. For that reason, the priority will need to be effective implementation of the plan while preparing for the post-2030 period, as we explain further in the recommendations.

Under LibPlan1 (higher fossil fuel prices), the largest emissions reductions achieved by the LPC plan relative to the reference scenario, which models the status quo without the LPC climate policies, are in transport (43 Mt), public electricity and heat (29 Mt), manufacturing (20 Mt), and buildings (19 Mt). Categories that relate to oil and gas production — oil and gas extraction and fugitive emissions — deliver a combined reduction of 58 Mt, resulting from a combination of lower production levels and improvements in emissions intensity (i.e. CO_2e per TJ).

While the Liberal plan generates significant reductions in emissions by 2030, the picture looks different in 2050. This is not surprising, since most of the LPC climate policies to date have focused on the 2030 target.[11] Nonetheless, it is important to also understand how the proposed policies contribute to achieving net-zero emissions by 2050, since that is the ultimate goal. Our modelling finds that the Liberal suite of policies leaves between 282 and 288 Mt of emissions in the economy by 2050. That amounts to just under 40% of today's emissions still entering the

[11] Some important steps have been taken to pursue longer-term decarbonization, such as the passing of the Net-Zero Emissions Accountability Act and the establishment of the Net-Zero Advisory Body.

atmosphere at mid-century. Hitting net-zero, therefore, will require significant additional policy action.

4. Emissions Reductions: Sector-by-Sector Findings

To examine the Liberal plan's impact on different sectors of the Canadian economy, we focus on the modelling run with higher fossil fuel prices, LibPlan1. We have chosen the higher emissions case as it is our view that policymakers should be designing policy to achieve the needed emissions reductions even in the face of strong potential headwinds for climate action, such as high fossil fuel prices. However, we highlight areas, particularly within the energy sector, where a lower fossil fuel price scenario produces significantly different results. The breakdown of emissions from four additional modelled scenarios is presented in Appendix 1.

In our sectoral analysis, we use the emissions categories defined by the IPCC rather than the economic classification typically used by the Canadian federal government, since we do not have enough information to replicate that economic classification.[12] The results are summarized in Table 2.

[12] We encourage the Government of Canada to release more details of their modelling breakdown to enable better comparisons between government and third-party modelling.

CLEAN PROSPERITY

Table 2: Emissions under LibPlan1 by IPCC sector in 2030 and 2050 (Mt CO_2e)

	2030			2050	
	LibPlan1	vs. RefPlan1		LibPlan1	vs. RefPlan1
Stationary combustion	**201**	**-107**		**94**	**-208**
Public electricity and heat production	12	-29		4	-17
Petroleum refining industries	18	-4		20	-3
Oil and gas extraction	73	-33		17	-94
Mining	5	-1		6	-1
Manufacturing industries	37	-20		40	-26
Construction, agriculture, and forestry	6	-1		7	-3
Buildings (commercial and institutional)	26	-7		0	-31
Buildings (residential)	26	-12		0	-31
Transport	**151**	**-43**		**116**	**-77**
Fugitive sources	**33**	**-25**		**21**	**-44**
Industrial processes	**47**	**-4**		**46**	**-4**
Agriculture	**59**	**-6**		**55**	**-17**
Waste	**6**	**-12**		**6**	**-18**
Direct air capture	**0**	**0**		**-16**	**-16**
Less*					
Land use, land use change and forestry	-17			-17	
Western Climate Initiative (WCI) credits	-13			-13	
Nature-based solutions (NBS)	-10			-10	
Total	**458**	**-197**		**282**	**-383**

* LULUCF, WCI, and NBS data are ECCC estimates for 2030. We use the same data in 2050 for illustrative purposes.

For the analysis below, we compare the Liberal plan to a reference scenario (RefPlan1) for 2030 that projects emissions to decline to 693 Mt by 2030 without Liberal policy, a figure that is about 20 Mt higher than the baseline projections released by ECCC in May 2021. Though we tried to align our baseline to ECCC's projections, there are certain sectors where we are unable to replicate their results.[13]

In the section that follows, we describe some of the most important takeaways from comparing LibPlan1 and RefPlan1. We focus on the differences in 2030, though highlight some results from 2050 where we feel it's merited. More analysis on 2050 is presented in the next section of the report.[14]

Stationary Combustion

Electricity

In our model, the electricity sector shows a very steep drop in emissions by 2030, falling 29 Mt relative to RefPlan1. In 2030, electricity emissions are just 12 Mt, which is a remarkable drop of 50 Mt relative to 2020 levels.[15]

The key policy driving these reductions is the Clean Electricity Standard, which incentivizes a rapid shift from fossil fuels to non-emitting sources of electricity. By 2030, fossil fuel power, mainly natural gas, is just 2.6% of electrical generation. The largest increase in non-emitting capacity comes from wind and solar, which grow by a combined 238 TWh by 2030. In contrast, fossil fuel electricity declines by 85 TWh, while overall electricity generation grows by 156 TWh.

---

[13] For example, the electricity sector results from ECCC's modelling shows 11 Mt of remaining emissions in 2030, but we cannot replicate those results given the amount of electricity production from natural gas that is forecasted by ECCC. Our projections in electricity are thus substantially higher for 2030.

[14] Given the difficulty of projecting 30 years into the future, including potential new technologies that could emerge, we consider the 2050 results for each sector directional rather than an exact prediction.

[15] The ECCC projections show emissions from electricity generation at 11 Mt in 2030, but we find it difficult to see how such a low level of emissions could be reached in 2030. In fact, the breakdown of electrical generation in 2030 in ECCC's latest public results seem to indicate that the natural gas plants still operating in 2030 have emissions per GWh well below the best performance of current natural gas facilities.

By 2035, emissions in the electricity sector drop to 0, driven by the Clean Electricity Standard (though carbon pricing and other policies would contribute significantly even in the absence of the electricity standard).[16] While there is some growth in hydro and nuclear, the vast majority of the growth in electricity generation — to both cover the decline in fossil fuels and provide the additional capacity needed — comes from wind and solar.

Table 3: Share of electrical generation by source in 2030, LibPlan1 vs. RefPlan1

	LibPlan1	RefPlan1	Difference
Hydro	52.4%	63.5%	-11.1%
Coal	0.1%	0.3%	-0.2%
Fuel oil	0.0%	0.2%	-0.2%
Natural Gas	2.5%	13.1%	-10.7%
Nuclear	8.2%	10.2%	-2.0%
Biomass	1.1%	1.9%	-0.8%
Wind	23.7%	7.0%	16.6%
Solar	7.8%	2.0%	5.7%
Hydrogen	0.0%	0.4%	-0.4%
Decentralized renewable	4.4%	1.3%	3.1%
Total	**100.0%**	**100.0%**	**0.0%**
Non-Fossil	97.5%	86.3%	11.2%

[16] In a separate modelling run, we show carbon pricing alone reduces emissions by 10 Mt in the electricity sector by 2035, though 25 Mt still remain by that date.

Oil and Gas Extraction

Oil and gas extraction shows 33 Mt fewer emissions by 2030 relative to a projection of 106 Mt in 2030 in the reference case. These reductions are largely driven by the oil and gas regulations that the LPC have proposed to bring forward to ensure that the sector reaches net-zero by 2050.

In the model, one of the major approaches oil and gas firms use to comply with those regulations is electrification. Electricity use in the energy sector grows 500% compared to RefPlan1, to over 150 TWh in 2030. A significant share of that electricity is deployed for steam generation, where electrification leads to almost 11 Mt of reductions relative to RefPlan1. Electrification of oil upgrading and gas production processes makes up much of the rest. There's also 3 Mt of carbon capture deployed in 2030 under LibPlan1, 2 Mt more than RefPlan1.

Table 4: Key statistics for oil and gas extraction in 2030

	2020	2030	
	Peak month*	**RefPlan1**	**LibPlan1**
Oil production (MBpd)	4.9	6.2	5.4
Gas production (BCFpd)	16	19.8	17.6
Emissions intensity (t/TJ)	-	4.9	3.9
Emissions (Mt)	-	105.9	72.8

* Data is from peak month of production for 2020, based on data from CER for oil and gas.

Of note, these emissions reductions occur while oil production reaches 5.4 million barrels per day (MBpd) in 2030, an increase of more than 460,000 barrels per day relative to peak 2020 production levels. Similarly, gas production grows to 17.6 billion cubic feet per day (BCFpd), an increase of 1.6 BCFpd relative to the 2020 peak (there's also about 0.3 BCFpd coming from renewable natural gas).

Emissions intensity drops significantly, enabling emissions reductions even as production grows. The combined production emissions per TJ of oil and gas is 20% lower under LibPlan1 in 2030, relative to RefPlan1.

To illustrate the impact of prices and production levels on emissions, let's compare LibPlan1 to LibPlan2, where fossil fuel prices are assumed to be lower. Under LibPlan2, emissions from oil and gas extraction are 23 Mt lower in 2030 (50 Mt in LibPlan2 vs. 73 Mt in LibPlan1). That's largely because of the difference in production levels that result from lower oil and gas prices. LibPlan2 shows 3.5 MBpd of oil production versus 5.4 MBpd for LibPlan2. Natural gas production also exhibits a significant change. LibPlan2 results in 16.6 BCFpd of natural gas, compared to 17.6 BCFpd under LibPlan1.

Of note, most of the difference in production levels is due to differences in oil and gas prices; both LibPlan1 and LibPlan2 assume the same climate policies, showing that the policies themselves are not a key determinant of whether oil and gas production grows or declines over the next decade (and the production levels in our model should not be seen as forecasts but rather an estimate of potential outcomes based on the specific assumptions used in our simulations).

Under LibPlan2, emissions intensity drops even further, by 27% in 2030 relative to RefPlan2, as decarbonization initiatives cover a larger share of the remaining base of oil and gas production.

Commercial, Institutional and Residential Buildings

The residential and commercial building sectors are also important sources of reductions, generating a combined 19 Mt fewer greenhouse gas emissions in 2030 than RefPlan1.

A significant source of the reductions is energy efficiency, as the LPC plan leads to an 8% reduction in energy services for residential buildings and a 3% reduction for commercial buildings relative to RefPlan1 in 2030. These reductions in demand occur fairly uniformly across end uses, from space and water heating to lighting, freezing, and more. And they occur despite growth in total floor space, illustrating a significant drop in emissions intensity.

There is also a switch in sources of energy as natural gas use drops significantly, and electricity, bioenergy, and geothermal sources grow (Table 5).

Looking at 2050, where the model optimizes a least-cost pathway to net-zero, we find that emissions reductions are driven by energy efficiency and electrification. In terms of efficiency, there is a 25% drop in energy needed to power residential and commercial buildings in 2050 compared to RefPlan1, all while the stock of buildings continues to rise. The remainder of the reductions come from decarbonizing energy sources; the vast majority of energy in buildings in 2050 is zero-emissions electricity.

Table 5: Energy by source for commercial and residential buildings in 2030 under LibPlan1 (% of total)

	LibPlan1	RefPlan1	Difference
Electricity (centralized)	48.0%	44.4%	3.6%
Electricity (decentralized)	5.4%	1.1%	4.3%
Oil product	1.7%	1.7%	0.0%
Natural gas	37.4%	46.6%	-9.2%
Bioenergy	4.4%	4.9%	-0.5%
Geothermal and thermal solar	3.0%	1.2%	1.9%
Hydrogen	0.0%	0.0%	0.0%
Total	**100.0%**	**100.0%**	**0.0%**

Manufacturing Industries

The manufacturing sector generates a significant 20 Mt of reductions under the LPC plan relative to RefPlan1, with about half the reductions coming from the capture of biomass combustion emissions at industrial facilities, such as pulp and paper mills, that are treated as negative emissions. When an industrial plant uses biomass for energy, the emissions are not counted under IPCC accounting systems because they are assumed to be part of the natural cycle (i.e. biomass would decompose anyway over time, and the resulting methane and other gases would end up in the atmosphere). Consequently, the capture of biomass combustion emissions is treated as a net-negative process.

Under the LPC plan, the investment tax credit for CCUS, among other policies, incentivizes wide scale adoption of bioenergy with carbon capture and storage (BECCS). In total, there is just under 10 Mt of BECCS used in industrial production by 2030, helping to significantly drive down emissions.

Treating biomass energy with carbon capture as a net carbon sink is controversial, and the argument would break down completely if the use of biomass led to incremental clearing of trees and plants, beyond what would occur naturally, to help feed growth in this industry.

In addition to reductions from BECCS, energy efficiency and switching from fossil fuels to cleaner fuels like hydrogen also contribute to emissions reductions. Overall, we see a decline of 10 Mt in pulp and paper, 4.5 Mt in chemicals, and 1-1.5 Mt declines in cement and iron and steel.[17]

Transport

Emissions from the transport sector are 43 Mt lower in 2030 under LibPlan1 versus RefPlan1. Over half of the reductions stem from road transport (22.8 Mt), with a significant portion also coming from miscellaneous vehicles (11.4 Mt), a category that includes vehicles like ATVs, garbage trucks, and winter service vehicles. Railways, shipping, aviation and pipelines together account for the remaining 8.8 Mt.

[17] While the model drives investment in BECCS disproprotionately towards pulp and paper mills, we believe it's equally plausible that CCUS deployment will be more evenly spread across industrial uses. We also note that the Net-Zero Accelerator has announced funding for the installation of electric arc furnaces at two large steel facilities in Ontario which, if implemented, would drive emissions down further in the iron and steel sector.

Table 6: 2030 greenhouse gas emissions by transport mode (Mt CO_2e)

	LibPlan1	RefPlan1	Difference
Air	5.1	9.6	-4.5
Road	99.0	121.8	-22.8
Rail	5.4	7.5	-2.1
Marine	2.0	3.6	-1.6
Miscellaneous	29.0	40.4	-11.4
Pipeline	10.9	11.5	-0.6
Total	**151.3**	**194.3**	**-43.0**

In road transport, significant reductions (6 Mt) come from the switch in passenger vehicles from conventional gasoline to electric. By 2030, 44% of the car stock is all-electric and another 4% is hybrid, versus 29% across both categories in RefPlan1.

There is more modest electrification in the light truck fleet as electric vehicles make up 6% and 8% of passenger and freight light trucks respectively in 2030.[18] But because those vehicles are used heavily, the switch results in a 3.4 Mt reduction in emissions.

[18] Although passenger light trucks are included in the ZEV policy that stipulates 50% of new light-duty vehicle sales need to be zero emission by 2030, we assume that is an average across the entire light-duty fleet. Electric cars end up accounting for more than 50% of vehicle sales in their class, and light trucks end up well below 50%.

Table 7: Share of transport stock by vehicle type in 2030 under LibPlan1

	Cars			Passenger light trucks			Freight light trucks		
	RefPlan1	LibPlan1	Difference	RefPlan1	LibPlan1	Difference	RefPlan1	LibPlan1	Difference
Conventional (gasoline)	67%	49%	**18%**	91%	89%	3%	87%	79%	**8%**
Conventional (diesel)	2%	2%	1%	5%	4%	0%	7%	6%	1%
Conventional (natural gas)	0%	0%	0%	0%	0%	0%	0%	0%	0%
Conventional (propane)	1%	1%	0%	0%	0%	0%	1%	1%	-1%
All electric	27%	44%	**-17%**	3%	6%	-3%	1%	8%	**-7%**
Plug-in hybrid	2%	4%	-2%	1%	1%	0%	0%	0%	0%
Hybrid	0%	0%	0%	0%	0%	0%	4%	6%	-1%
Hydrogen	0%	0%	0%	0%	0%	0%	0%	0%	0%
Flex fuel (E85)	0%	0%	0%	0%	0%	0%	0%	0%	0%
Total	**100%**	**100%**	**0%**	**100%**	**100%**	**0%**	**100%**	**100%**	**0%**

Note: Totals and differences listed may be impacted by rounding.

An even larger source of emissions reductions (13.4 Mt) in road transport comes from heavy-duty vehicles. The reductions are achieved in part by a shift away from diesel vehicles in heavy-duty trucking. Much of the switch is to less emissions-intensive, but still fossil-fuel based, options like natural gas. In addition, there is a reduction in total freight miles driven under LibPlan1.

Table 8: Share of heavy-duty vehicle stock by vehicle type in 2030

	% of vehicle stock in 2030		
Heavy-duty vehicles	**RefPlan1**	**LibPlan1**	**Difference**
Conventional (diesel)	90%	82%	**-8%**
Conventional (natural gas)	9%	15%	**6%**
All electric	1%	1%	0%
Hydrogen	0%	2%	**2%**
Total	**100%**	**100%**	**0%**

Miscellaneous transport is also a large source of reductions (11.4 Mt). This category includes off-road vehicles like ATVs and onsite transport at industrial facilities, as well as a variety of other road transport such as winter service vehicles and garbage trucks. Due to the diversity of items in this category, there are no overarching trends to highlight, other than to note that this array of vehicle types can be an important source of emissions reductions and that clean fuel standards combined with carbon taxes are able to partially decarbonize this area of transport in our modelling, primarily by incentivizing greater use of biofuels.

Emissions continue to decline between 2030 and 2050, with total transport emissions dropping 35 Mt to 116 Mt. While a significant drop, the large amount of remaining emissions should be a concern for the government and a priority for additional policy support. In particular, only road transport emissions decline post-2030 (by 43 Mt) whereas all other modes of transport see increases in emissions given growth in economic activity. Within road transport, virtually all of the remaining 56 Mt of emissions are attributable to heavy-duty (largely diesel) vehicles. A significant amount of emissions (34 Mt) also come from miscellaneous transport in 2050.

Fugitive Emissions

Fugitive emissions drop precipitously under the LPC plan — in 2030, they are 25 Mt below levels in RefPlan1. The primary driver of this decline is the regulations requiring a 75% reduction in fugitive methane emissions relative to 2012 levels. Indeed, in LibPlan1 the additional 25 Mt decrease in emissions relative to the reference case — largely due to a curtailment of venting and flaring — is achieved even while oil and gas production increases. Notably, though, fugitive emissions still persist through 2050, with 21 Mt remaining by mid-century. This is due to the fact that the announced regulations do not extend beyond 2030 yet, and we have not assumed that the net-zero oil and gas regulation includes net-zero fugitive emissions.

Process Emissions

Process emissions see a slight decrease under the LPC plan of 4 Mt in 2030 relative to RefPlan1, and remain 4 Mt lower than RefPlan1 in 2050. These modest process emission declines occur across the board, from minerals to chemicals to metals, but all reductions are fairly modest.

Agricultural Emissions

Agricultural emissions decline by about 6 Mt in 2030, with reductions occurring mostly in enteric fermentation (3 Mt) and agricultural soils (2 Mt). The funding for agricultural clean technology, combined with carbon pricing, helps reduce emissions in this sector, but the reductions are primarily due to shifts in demand for agricultural products. Agriculture continues to see declines in emissions after 2030. By mid-century, agricultural emissions are 17 Mt below the RefPlan1 figures, though there are still 55 Mt of emissions to address or offset.

Waste Emissions

There is a significant decline in waste-sector emissions of 12 Mt by 2030 relative to RefPlan1. The decline is largely attributable to the regulation requiring greater investments in methane capture at solid waste disposal sites. While the Liberal plan anticipated that the policy would lower emissions by 6 Mt, we find that waste sector emissions drop 10 Mt over the decade. The extra capture at landfill gas sites means there is 28,000 TJ in 2030 of extra landfill gas to help displace other sources of methane.

In 2050, absolute emissions from waste drop to 6 Mt, 18 Mt lower than under RefPlan1.

5. Pathways to Decarbonizing the Energy Supply

At the heart of the effort to decarbonize the Canadian economy is converting to an energy system that emits net-zero carbon dioxide by 2050. In this section, we examine four of the key solutions that will be needed to decarbonize energy — electricity, hydrogen, biofuels, and carbon capture and storage. In particular, we compare the deployment of these four solutions in our modelling of the LPC climate plan to modelling of a net-zero pathway for 2050 produced by the Trottier Energy Institute, using the same NATEM model we used in this report (we refer to this net-zero scenario below as "the Trottier Net-Zero Scenario").

The Trottier Net-Zero Scenario serves as a useful reference point to understand how the four key solutions may need to be further scaled up in order to meet the net-zero goal. This scenario, however, is just one vision of the net-zero energy system and should not be taken as the only possible pathway. As the Canadian Institute for Climate Choices (CICC) demonstrated in their 2020 report, "Canada's Net Zero Future," there are a variety of pathways to net-zero including several "wild card" technologies whose future viability will help shape the path Canada ultimately travels down. For that reason, we also compare our results to the data from the CICC report to show alternative potential pathways, even though a different model (the Navius gTech model) was used to generate those results. Overall, we find a strong likelihood that by 2050 at least some, if not all, of the four solutions will need to grow beyond the levels induced by the LPC climate policies.

Electricity Supply

Electrification will be at the heart of any net-zero scenario. It's clear that we will need more electricity, though how much more is still uncertain. Some experts believe we will need to double or even triple electricity production by 2050 if we are to electrify large segments of transport, buildings, and industry.[19] Indeed, the Trottier Net-Zero Scenario shows electrical generation

[19] The federal government's "A Healthy Environment and a Healthy Economy" plan, released in December 2020, states that Canada will need "to produce up to two to three times as much clean power as it does right now" by 2050, though it is not clear if they are referring only to the current base of clean power or to all electricity generation.

more than doubling by 2050 to over 1300 TWh (under the assumption that there are no major structural changes in the economy).[20]

On the other hand, there are reports showing electricity growth will be more modest. For example, the CICC report forecasts electricity production at between 700 and 860 TWh in 2050. While on the lower end of electricity production forecasts — a fact that may be partially due to measurement differences across the models[21] — a lower-electricity future could occur if other fuel sources, such as bioenergy, are more heavily relied upon and/or if energy efficiency helps contain demand.[22]

LibPlan1 does increase electrical production dramatically over the next three decades, with the total TWh generated more than doubling by 2050 (Table 9). The increases are on par with the Trottier Net-Zero Scenario. Yet, LibPlan1 still has hundreds of megatonnes of emissions remaining in the economy by mid-century, suggesting that even greater electrification could be needed to reach net-zero.

The largest source by far of the expanded generating capacity in our model comes from renewables, with centralized solar growing 10 times by 2050 and wind and decentralized solar by five times, relative to 2020 production levels. The electrical system relies on a massive increase in storage to manage these intermittent resources.

[20] This growth in electricity is what's needed to hit net-zero, but there will also be large amounts of energy — likely coming from electricity — that will be needed to power carbon dioxide removal technologies to draw down carbon from the atmosphere after we reach net-zero.

[21] Comparisons of electricity models need to be made cautiously, given that the electricity balance that underpins the studies is not always made clear. For example, our estimates of total electricity production include utility generation, industrial generation, and exports. The CICC estimates do not include generation for exports, which can be considerable (at least 40 TWh in our modelling).

[22] In fact, the version of the gTech model used by CICC did not have a module for electrolysis-based hydrogen, which may have shifted a significant amount of energy use from sources like biomass and natural gas towards electricity.

Table 9: Electricity production under LibPlan1

	Total production (TWh)				% Change from 2020	
	2020	2030	2050		2030	2050
Coal	43	1	-		-98%	0%
Fuel oil	2	-	-		-100%	0%
Natural Gas	61	20	-		-68%	0%
Hydro-electricity	393	417	448		6%	114%
Nuclear	83	65	170		-22%	204%
Biomass	8	9	12		8%	149%
Wind	35	188	447		431%	1262%
Solar (centralized)	6	62	195		979%	3413%
Solar (decentralized)	6	35	45		479%	756%
Hydrogen	0	0	11		-16%	139733%
Total	**639**	**795**	**1329**		**124%**	**208%**

Note: Rows may not sum to the total listed in the bottom row due to rounding.

Hydrogen

Hydrogen will be an important tool for decarbonization, especially as a source for end uses that are not well-suited for electrification (e.g. long-haul shipping), as an industrial feedstock, and perhaps as a means of electricity storage.

Hydrogen production grows under LibPlan1, but falls well short of the amount needed in the Trottier Net-Zero Scenario. While hydrogen use in 2050 is 57% higher than in 2020, reaching 223 PJ, that's only about one third the amount of hydrogen energy modelled in the Trottier report. Further, the CICC modelling shows a range of 294 to 628 PJ. These results suggest that LibPlan1 is still short of the type of hydrogen production that is likely to be needed by 2050.

Most of the hydrogen in LibPlan1 is used in industry, including for oil production and refining, though there is a large amount of hydrogen also used for electricity generation.

The vast majority (86%) of the hydrogen produced in 2050 is still being generated by steam methane reformation of natural gas under LibPlan1. The model is choosing natural gas production based on assumptions that natural gas will be a cheaper way to generate hydrogen, but this may not be consistent with a net-zero pathway, especially if a high percentage of the emitted greenhouse gases aren't captured. Indeed, in the Trottier Net-Zero Scenario, the vast majority of hydrogen is produced from biomass, with the emissions captured to generate negative-emissions hydrogen.[23]

Table 10: Hydrogen production and use under LibPlan1

	Total production (PJ)				% change from 2020	
	2020	2030	2050		2030	2050
Commercial (natural gas mix)	0	0	0		100%	0%
Electricity	0	0	64		-16%	139733%
Industrial (pure)	49	88	90		80%	184%
Industrial (natural gas mix)	0	0	0		-52%	0%
Transport	3	22	27		585%	823%
Oil production and refining	86	43	42		-50%	49%
Total	**142**	**153**	**223**		**8%**	**157%**

Note: Rows may not sum to total as there are minor uses of hydrogen in other sectors not shown in the table, such as residential blending with natural gas.

[23] Even this pathway is uncertain, as the Trottier report acknowledges. Assessing the technical feasibility of generating large quantities of hydrogen from biomass requires further study. It is also possible, as the Trottier report highlights, that electrolysis becomes the dominant means of producing hydrogen.

Biomass

Biomass energy is derived from organic materials. It can include everything from agricultural and forest residues, to food crops like corn and soy, to manure and landfill waste. Although combusting energy products derived from biomass does send greenhouse gases into the atmosphere, those greenhouse gases would have entered the atmosphere as the biomass decayed. Thus, in theory, biomass can be used without adding more cumulative carbon dioxide into the atmosphere.[24] And when the burning of biomass is combined with CCS, the emissions are considered to be net negative.

Under LibPlan1, the use of biomass to generate energy more than triples by 2030 and then shows a slight decline through 2050. Bioenergy is a key tool in the next decade to reduce greenhouse gas emissions from transport and industry, where alternatives are either expensive or impractical. For example, it is used to power many off-road and miscellaneous vehicles that otherwise would need to be replaced. Biomass use slows after 2030 both because of limited availability and because the capital stock is replenished with low-carbon options (e.g. electric equipment replaces combustion-based equipment).[25] As Table 11 shows, biomass is used primarily for biofuels, renewable natural gas, and industrial applications.

The scale-up of bioenergy under LibPlan1 approaches the level seen in the Trottier Net-Zero Scenario. In the Trottier study, biomass is used to produce just over 2,000 PJ of energy in 2050, compared to just under 1,800 PJ under LibPlan1. But the extra 200 PJ of energy in that scenario is all devoted to hydrogen production. The CICC predicts between 1,300 and 3,600 PJ of bioenergy in 2050, demonstrating that it has the potential to play a much larger role in the net-zero energy system than under LibPlan1 — though such a scenario would require much greater use of second-generation biofuels, which the CICC still considers a “wild card”.

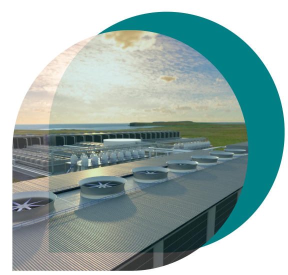
[24] However, if biomass use grows there is a risk that plants and trees might be cut down to feed demand. This would generate additional emissions beyond the natural carbon cycle.
[25] There may be, for example, 500 PJ of additional available biomass but not much more under the constraints of the NATEM model. Of course, estimating actual biomass availability is a challenging exercise and additional modelling could be done to further explore this topic.

Table 11: Biomass use under LibPlan1

	Total production (PJ)				% change from 2020	
	2020	2030	2050		2030	2050
Industrial use	181	370	402		104%	122%
Space heating	137	74	149		-46%	9%
Electricity production	113	68	32		-40%	-72%
Biofuel production	73	884	719		1113%	888%
Renewable natural gas production	22	431	429		1827%	1816%
Hydrogen production	0	1	1		-	-
Total	**532**	**1883**	**1776**		**254%**	**234%**

Carbon Capture

Carbon capture is a critical technology both for addressing emissions from point sources that are hard to eliminate directly, and to pull carbon out of the atmosphere to offset any emissions that remain in 2050 and beyond. Forms of carbon capture that generate negative emissions, such as direct air capture (DAC), are also going to be needed to draw down carbon from the atmosphere after net-zero is achieved. We refer to DAC and other forms of negative emissions collectively as carbon dioxide removal (CDR) technologies.



Under LibPlan1, there is significant growth in CCS deployment over the next decade, totalling almost 15 Mt by 2030, up from just under 2 Mt in 2020.[26] Much of the capture is in industries

[26] For this project, the NATEM model did not take into account the more than 1 Mt of carbon captured at the Sturgeon Refinery and Redwater Fertilizer Facility, which are connected to the Alberta Carbon Trunk Line.

where concentrated streams of carbon dioxide generated through biomass combustion — in paper mills, for example — can be cost-effectively captured and stored to generate negative emissions. Bitumen upgrading also sees an increase in carbon capture.

After 2030, total emissions reductions from CCS doubles, but almost all the growth is in direct air capture, which scales up to help the oil and gas industry meet the net-zero target for that sector. While the 31 Mt of capture that occurs in 2050 is a major increase from the 2020 figures, it pales in comparison to the amount of CCS that is likely to be needed. The Trottier Energy Institute report finds that there will be a need for 156 Mt of carbon capture by 2050. A separate analysis by Navius Research, which simulated over 100 net-zero scenarios, found that carbon capture would be needed for between 93 and 365 Mt of emissions by 2050.

Table 12: Carbon capture under LibPlan1 by end use (Mt)

	2020	2030	2050
Coal power generation	1	1	-
Industrial (pulp and paper, chemicals, etc.)	-	11	11
Oil sands upgrading	1	3	4
Direct air capture	-	-	16
Total	**2**	**15**	**31**

6. Household Costs

In addition to forecasting emissions cuts, we believe it is critical to understand the costs of any climate plan for Canadians. While there are a range of methods for looking at costs, we focus particularly on costs to Canadian households in this section.

Any discussion of costs should start with the acknowledgement that taking no action to reduce emissions may appear to be less costly than acting, but will actually impose huge costs on society due to the negative impacts of climate change. For example, a recent report from insurer Swiss Re found that climate change could cost the Canadian economy over $100 billion by 2050.

Nonetheless, we believe that climate policy must be affordable for Canadians, both as a virtue in and of itself, and because any policy that imposes too large a burden on households is unlikely to be accepted by Canadians, especially over the long term.

We analyze household costs using a carbon-cost flow-through model from EnviroEconomics to calculate the costs of the Liberal climate policy for Canadian households, both in aggregate, on average, and for household income groups. The model allocates carbon costs from the LPC plan to those sectors that supply goods and services within the economy. Costs are then passed through the economy, reflecting the relationship between how goods and services are supplied and used within Canada. Based on this view of Canada's economic structure, the model tracks indirect or embodied carbon costs in consumption and investment, but also direct carbon costs in fuel purchased. To capture the impact of the carbon tax rebating to households, we assume that all provinces have a carbon-pricing system mirroring the federal carbon-pricing approach, where 90% of the revenues are returned to households. This is a simplifying assumption as some provinces have their own systems and use the funds as they see fit.[27] Additional detail about our methodology can be found earlier in this paper as well as in Appendix 2.

[27] We hope to provide results for some provinces in the fall or winter of 2021. We have made the simplifying assumption due to time and scope issues, as our objective here is to understand the high-level impacts of the LPC plan on household costs.

Table 13: Costs to households under LibPlan1 in 2025 and 2030

	Total cost (millions, $2020)	
	2025	2030
Carbon tax costs	-$11,477	-$16,143
Carbon tax rebates	$15,257	$21,430
Other climate policy costs	-$3,245	-$7,463
Net cost/benefit	$535	-$2,175
	Average cost per household ($2020)	
Household income	**2025**	**2030**
Under $21,600	$302	$246
$21,600 to $43,299	$219	$117
$43,300 to $64,899	$308	$234
$64,900 to $86,599	$188	$56
$86,600 to $107,999	$16	-$196
$108,000 to $161,999	-$211	-$530
$162,000 and more	-$574	-$1,057

Note: Positive numbers are net flows to households and negative numbers are costs to households. These figures are estimates for the average household and should be considered directional despite the precise figures.

We find that the LPC climate plan — under LibPlan1 — would generate a net benefit to households of $535 million in 2025. Five years later, Canadians would face a net cost of $2.2 billion.

The reason that costs are fairly modest despite the ambitious set of climate policies proposed by the Liberals is that Canadian households receive more in rebates from the carbon tax than they pay in costs. Although Canadians face a cost of $16.1 billion from the carbon tax in 2030, they receive over $21.4 billion in revenue from the carbon tax system. These funds offset the costs households face from the rest of the climate policies in 2030.

The impact on households varies significantly depending on income level. Higher-income households pay the most, while lower-income households end up receiving a net benefit even in 2030 for two reasons. First, higher-income households have higher consumption and therefore pay more, directly for fuel and indirectly for goods and services purchased, as a result of climate policies such as carbon pricing and the Clean Fuel Standard. Second, since carbon tax revenue is distributed evenly to all Canadian households, after adjusting for household size, some of the funds paid by higher-income households are effectively transferred to lower-income households through rebates.

The net annual impact on households of different income levels is shown in Table 13. In 2030, the average household earning over $162,000 pays just over $1,000, whereas all those earning less than $86,000 receive a net benefit of between $56 and $246 after accounting for the carbon tax rebate.[28]

7. Recommendations

Our main objective in producing this report was to better understand how the package of climate policies proposed by the Liberal Party would impact energy and emissions in the Canadian economy over the next decade, and in the longer term through 2050.

Our analysis shows that the Liberal Party's policy proposals give it a reasonable chance of meeting its enhanced 2030 targets if it can put all its policy proposals into practice, but that there is still a long way to go to reach net-zero. For this reason, we focus our recommendations for 2030 on how to prioritize across policies, whereas we recommend the federal government develop additional policies for 2050.

[28] These figures are for the average household and there will be variation in costs or benefits within any income group depending on specific household circumstances

Prioritize the Highest-Impact Policies for 2030

The Liberal Party has proposed a wide range of climate policies to help meet its enhanced 2030 climate target. Our analysis shows that the LPC needs to focus on implementing those policies rather than creating new ones. But executing on its many proposals will take time and will require making choices about which ones to prioritize. We recommend that the federal government start with policies that are important over both the short and long term. That means policies that are key to meeting the 2030 target *and* enable deeper decarbonization and/or economic competitiveness over the long-run.[29]

Based on these criteria, we suggest the government place high priority on the following policies, which collectively represent about three-quarters of the emissions reductions required to reach the 2030 target:

a) The Clean Electricity Standard (CES): We estimate that this regulation could generate more than 20 Mt of emissions reductions by 2030. Perhaps more importantly, a net-zero electricity sector will be the backbone of long-term decarbonization, as fossil-fuel powered activities across the economy switch to electrification. Reducing emissions in electricity as fast as possible will also support Canadian competitiveness by enabling the production of low-carbon goods in a global economy that will increasingly be pricing carbon. And it will ensure that Canada maintains its leading position as a low-carbon electricity provider; although we have a low-carbon grid today, the United States, the United Kingdom, and other trading partners are targeting fully decarbonized grids by 2035. Of course, building a zero-carbon electricity system will be complex and will mean working in partnership with provincial and territorial governments, among other stakeholders. It will also require the build-out of significant infrastructure. That's why it's so critical to push ahead on the CES in the near-term.

b) Oil and gas sector emissions regulations, including methane: The effort to regulate emissions reductions in the oil and gas sector, including reducing fugitive methane emissions by 75%, could cut as much as 40 Mt of emissions by 2030, representing one of the largest single

[29] There are other policies that we have not modelled but that have the potential to catalyze significant emissions reductions, such as prioritizing the procurement of low-carbon products, like low-carbon cement and steel.

opportunities for making progress on decarbonization this decade. Cuts in methane emissions in particular also have an important beneficial short-term effect on warming.[30] These actions are also important for the long term, as oil and gas companies can be a key part of achieving a low-carbon future if they are engaged as partners in the transition.

c) Road and off-road vehicle policies: The package of policies affecting road and off-road vehicles can reduce emissions by almost 35 Mt by 2030. Importantly, most of these reductions are not in passenger vehicles but rather heavy-duty trucks and miscellaneous vehicles like ATVs, garbage trucks, winter service vehicles, and onsite transport at industrial facilities. From an emissions-reduction standpoint, the government may want to prioritize the policies — such as tax write-offs, fuel efficiency standards, and the Clean Fuel Standard — that target these vehicles. But it should also consider additional policies that accelerate the transition to net-zero, not just meet 2030 objectives. This is important both because heavy-duty and miscellaneous vehicles still produce significant emissions in 2050 in our model, and because some short-term solutions adopted to decarbonize them may not be compatible with the longer-term net-zero goal.[31] For example, in our simulations, the reductions in emissions from heavy-duty vehicles by 2030 come largely from switching to natural gas, rather than zero-emission vehicles. The government should consider adopting new policy, like a ZEV mandate for heavy-duty vehicles, to stay focused on maximizing long-term emissions cuts.

While significant focus should be placed on heavy-duty vehicles and miscellaneous transport, the full range of policies proposed by the LPC in road transport, including those for passenger vehicles, will also be important — not just from an emissions-reduction perspective, but also to help Canada develop the domestic ZEV supply chain that can be an important area of future economic growth.

---

[30] Methane has more than 80 times the warming effect of carbon dioxide but only lasts in the atmosphere for about 10 years. Reducing methane, as the IPCC has highlighted, is an important way to bend the warming curve in the near term. This is one of the reasons that global efforts to reduce methane emissions are gaining momentum, including through the recent formation of the Global Methane Pledge.

[31] Technically it is possible to use CDR to offset these emissions and make them compatible with net-zero, but we will need such vast quantities of CDR that it is much better to directly mitigate emissions wherever possible.

Other considerations: In addition to the three policy priorities recommended above, another important area of focus for the government should be ensuring it has the right mix of industrial policies to help decarbonize while boosting competitiveness. In particular, it must ensure that it is making wise use of the $8 billion in funds allocated to the Net Zero Accelerator.

Develop the Building Blocks for Net-Zero

The package of policies being proposed by the Liberal Party, if fully implemented, will bring Canada close, if not all the way, to the target of a 40-45% reduction in emissions by 2030. But these policies are not sufficient to do the critical work of achieving even deeper decarbonization beyond 2030. In addition, there is a risk that some policies that help achieve the 2030 target are not a good fit for achieving the net-zero goal.[32] In this section, we highlight the building-block policies that we think will be needed to reach net-zero over the long-term.

We make these recommendations for 2050 with the full understanding that the government will have its hands full implementing the policies it has already proposed. But the need to prepare for long-term decarbonization will require attention over the next few years in order to lay a solid foundation for deeper decarbonization in the 2030s and 2040s. It is ultimately our role to point out what needs to be done, even if it is challenging.

This list should not be seen as comprehensive, but rather as a set of core activities to accelerate decarbonization.

d) Map out the post-2030 path using modelling and carbon budgets: In this report, we use modelling to analyze the degree to which the Liberal Party's current climate plan will contribute to a net-zero transition. However, a far larger effort is needed to gain the level of detailed understanding required to help the federal government best prepare for stewarding the economy towards net-zero by 2050. And this will need to be done while coordinating closely with

[32] As an illustrative example, too much focus on using renewable natural gas for home heating to reduce emissions might divert resources from the effort to switch to net-zero heating sources, such as non-emitting electricity, in buildings over the longer term.

the provinces, territories, municipalities, and the private sector, all of whom would also benefit from more data on pathways to net-zero.[33]

We recommend that the government undertake a rigorous and transparent research effort, guided by extensive modelling, to map out a variety of decarbonization pathways that would successfully achieve net-zero under different future scenarios for the economy and energy system. This exercise would help identify policies and investments that will be needed to ensure that Canada has the best chance of succeeding across various future scenarios, while providing clarity to actors in the Canadian economy about the type of goods and services that may be needed in a net-zero future.[34] The output of this process could be modelled on the reports generated by the UK government's Climate Change Committee, which provides detailed data on multiple net-zero pathways and the policies needed to get there.

In launching this process, the government should engage the Net-Zero Advisory Body, the Canadian Institute for Climate Choices, and Natural Resources Canada's new Energy Transition Dialogue, and will need to ensure these entities have sufficient resources to work effectively.[35] It should also conduct the process in a transparent, inclusive manner that provides outside actors with visibility into the inputs and outputs, and enables comparisons with third-party models.[36]

In developing its long-term decarbonization plans, the government should also adopt a carbon budget approach which outlines the cumulative amount of emissions that Canada is willing to accept until it achieves net-zero.[37] A carbon budget approach would incentivize policymakers (and perhaps private-sector actors as well) to judge emissions-reduction initiatives based on

[33] The patchwork of policies across Canadian jurisdictions is a key challenge that will need to be addressed.
[34] We recommend combining different modelling approaches, including both top-down energy-economy modelling and bottom-up geospatial analysis of energy flows in the net-zero economy (and thus where infrastructure like transmission lines and pipelines may need to be located). A good example of this type of exercise is the Net Zero America study undertaken by Princeton University in 2020.
[35] Of course, the government will need to consult with other key stakeholders, including provinces and territories, and industry.
[36] Ideally the government's modelling work could feed into a forum that compares both public and private sector models and seeks to learn from their differences, using similar principles to the Coupled Model Intercomparison Project for global climate models.
[37] If a single target proves too challenging, Canada could consider a carbon budget range.

what ultimately matters most to the climate — the total amount of greenhouse gases we put into the atmosphere — rather than focusing on an initiative's contribution to an interim target for a specific year, like 2030. A carbon budget approach would also help Canada grapple with the role of negative emissions in decarbonization, as well as determining the country's fair share of the global carbon budget.

e) Develop a national carbon management strategy: Meeting net-zero, in a cost-effective way, will require significantly more point-source carbon capture — perhaps as much as 10 times more than the 31 Mt from our modelling. Canada will also likely need hundreds of millions of tonnes per year of negative emissions by 2050. This will be needed both to offset hard-to-abate sectors (e.g. agriculture) where emissions are likely to remain in 2050, and because there will be a critical need to draw down atmospheric carbon.[38] Since the technology, infrastructure, and skills needed for both CCS and CDR are linked, we believe Canada would be wise to think comprehensively about scaling up both these solutions in an integrated way through a comprehensive national carbon management strategy. This strategy will require holistic thinking about how to create the right package of policies — including research and development funds, infrastructure buildout, economic incentives, and a supportive regulatory environment — to unlock the growth needed in both CCS and CDR. It will also help to coordinate the patchwork of federal, provincial, and territorial policies that currently target this sector in piecemeal fashion.

f) Transition to full industrial carbon pricing with a border carbon adjustment (BCA): In our model, industrial emissions remain stubbornly high in 2050. The combination of stationary combustion in industry and process emissions still produce 100 Mt of greenhouse gases by mid-century, even after factoring in the policies like the Net Zero Accelerator initiative already announced by the LPC. While fully addressing these emissions will likely require sector-by-sector plans developed in partnership with industry, the process would be accelerated if the government transitions towards applying a full carbon price to industry. This would incentivize

[38] Even if Canada reaches net-zero by 2050, we will almost surely exceed the cumulative amount of emissions we can safely put into the atmosphere, thus creating the need to draw down this accumulated carbon. For details, see this Policy Options article.

greater investment and innovation to reduce emissions.[39] The full carbon price should be combined with a BCA that helps preserve competitiveness.

The transition to full industrial pricing with BCAs will be complicated and will require many years to properly prepare and gradually implement. The European Carbon Border Adjustment Mechanism, for example, has been in development for almost two years, and will complete its transition phase at the end of 2025. The EU will gradually move to full industrial carbon pricing between 2026 and 2035. But the long time horizon to full implementation is all the more reason for the Canadian government to begin down this path as soon as possible. The government has already launched a consultation on developing a BCA, and we recommend they move forward expeditiously.[40]

g) Develop the policy package for net-zero buildings: One of the more daunting challenges that Canada must overcome to achieve net-zero is cutting emissions from our building stock. There are over 9 million commercial and residential buildings in Canada — most if not all of those that will still be standing in 2050 need to be retrofitted for efficiency and/or zero-carbon energy sources over the next 30 years. When we model the policies targeted at buildings but exclude the commitment to create a net-zero building strategy, we find that the building sector still has 30 Mt of emissions in 2050. This is why developing the specific policy package to fulfill the commitment to a net-zero building strategy will be so important. The road to a net-zero building sector will be long, as it will require engaging a wide range of stakeholders, educating citizens, training many thousands of workers, and mobilizing hundreds of billions of dollars in financing. The effort will be further complicated by the fact that many levels of government have some jurisdiction over building policy. For these reasons, the federal government should move with haste to develop and implement a package of policies in partnership with other levels of government that can move Canada down the path to net-zero buildings.

[39] The money raised from the carbon price could be recycled back to industry to help them invest in decarbonization.

[40] Clean Prosperity produced a report, in partnership with the International Institute for Sustainable Development, on the design of a Canadian BCA. Clean Prosperity Executive Director Michael Bernstein also wrote an op-ed on why the BCA should be paired with a full carbon price. One important reason is that providing rebates to our exporters can only be allowed under WTO rules if we have a carbon tax, rather than a regulation like the Output-Based Pricing System.

Appendix 1: Emissions Tables from Other Modelling Runs

The tables below show results for the Liberal Climate Plan under different alternative modelling runs by varying the oil price, the technology hurdle rate (a lower hurdle rate implies faster adoption of technology), and varying the inclusion of net-zero plans for oil and gas and buildings.

Table A1: Emissions under LibPlan2 — low oil prices, higher hurdle rate including net-zero plans for oil and gas and buildings (Mt CO_2e)

	2030			2050	
	LibPlan2	**vs. RefPlan2**		**LibPlan2**	**vs. RefPlan2**
STATIONARY COMBUSTION	**177**	**-105**		**95**	**-175**
Public electricity and heat production	10	-28		4	-23
Petroleum refining industries	19	-3		21	-3
Oil and gas extraction	50	-29		15	-57
Mining	5	-1		6	-1
Manufacturing industries	36	-23		42	-23
Construction, agriculture and forestry	6	-2		8	-4
Buildings - commercial and institutional	26	-7		0	-32
Buildings - residential	26	-12		0	-32
TRANSPORT	**153**	**-41**		**122**	**-72**
FUGITIVE SOURCES	**26**	**-20**		**19**	**63**
INDUSTRIAL PROCESSES	**47**	**-4**		**45**	**-4**
AGRICULTURE	**59**	**-5**		**57**	**-15**
WASTE	**6**	**-12**		**6**	**-18**
DIRECT AIR CAPTURE	**0**	**0**		**-16**	**-16**
LESS*					
Land use, land use change and forestry	-17			-17	
Western Climate Initiative (WCI) credits	-13			-13	
Nature-based solutions (NBS)	-10			-10	
TOTAL	**428**	**-187**		**288**	**-236**

* LULUCF, WCI, and NBS data are ECCC estimates for 2030. We use the same data in 2050 for illustrative purposes.

Table A2: Emissions under LibPlan3 — high oil prices, higher hurdle rate excluding net-zero plans for oil and gas and buildings (Mt CO_2e)

	2030			2050	
	LibPlan3	vs. RefPlan3		LibPlan3	vs. RefPlan3
STATIONARY COMBUSTION	**241**	**-66**		**211**	**-88**
Public electricity and heat production	19	-22		0	-21
Petroleum refining industries	18	-4		19	-4
Oil and gas extraction	102	-3		110	-1
Mining	5	-1		6	-1
Manufacturing industries	38	-19		39	-27
Construction, agriculture and forestry	6	0		6	-2
Buildings - commercial and institutional	25	-7		12	-18
Buildings - residential	28	-10		18	-13
TRANSPORT	**152**	**-42**		**122**	**-71**
FUGITIVE SOURCES	**35**	**-24**		**42**	**107**
INDUSTRIAL PROCESSES	**48**	**-4**		**46**	**-4**
AGRICULTURE	**59**	**-6**		**56**	**-15**
WASTE	**6**	**-12**		**6**	**-18**
DIRECT AIR CAPTURE	**0**	**0**		**0**	**0**
LESS*					
Land use, land use change and forestry	-17			-17	
Western Climate Initiative (WCI) credits	-13			-13	
Nature-based solutions (NBS)	-10			-10	
TOTAL	**501**	**-153**		**444**	**-88**

* LULUCF, WCI, and NBS data are ECCC estimates for 2030. We use the same data in 2050 for illustrative purposes.

Table A3: Emissions under LibPlan4 — high oil prices, lower hurdle rate including net-zero plans for oil and gas and buildings (Mt CO_2e)

	2030			2050	
	LibPlan4	**vs. RefPlan4e**		**LibPlan4**	**vs. RefPlan4**
STATIONARY COMBUSTION	**201**	**-101**		**92**	**-210**
Public electricity and heat production	11	-29		4	-19
Petroleum refining industries	17	-4		18	-3
Oil and gas extraction	72	-34		17	-94
Mining	5	-1		6	-1
Manufacturing industries	39	-18		41	-25
Construction, agriculture and forestry	5	1		6	-2
Buildings - commercial and institutional	24	-7		0	-32
Buildings - residential	26	-9		0	-34
TRANSPORT	**140**	**-52**		**107**	**-86**
FUGITIVE SOURCES	**33**	**-25**		**21**	**87**
INDUSTRIAL PROCESSES	**47**	**-4**		**46**	**-4**
AGRICULTURE	**59**	**-5**		**56**	**-16**
WASTE	**6**	**-12**		**6**	**-18**
DIRECT AIR CAPTURE	**0**	**0**		**-16**	**-16**
LESS*					
Land use, land use change and forestry	-17			-17	
Western Climate Initiative (WCI) credits	-13			-13	
Nature-based solutions (NBS)	-10			-10	
TOTAL	**447**	**-199**		**271**	**-263**

* LULUCF, WCI, and NBS data are ECCC estimates for 2030. We use the same data in 2050 for illustrative purposes.

CLEAN PROSPERITY

Table A4: Emissions under LibPlan5 - low oil prices, higher hurdle rate excluding net-zero plans for oil and gas and buildings (Mt CO_2e)

	2030			2050	
	LibPlan5	vs. RefPlan5e		LibPlan5	vs. RefPlan5
STATIONARY COMBUSTION	**199**	**-82**		**163**	**-103**
Public electricity and heat production	11	-27		1	-26
Petroleum refining industries	19	-3		20	-4
Oil and gas extraction	69	-9		60	-11
Mining	5	-1		6	-1
Manufacturing industries	35	-24		36	-28
Construction, agriculture and forestry	6	-2		7	-3
Buildings - commercial and institutional	25	-7		15	-17
Buildings - residential	29	-9		18	-13
TRANSPORT	**154**	**-40**		**123**	**-70**
FUGITIVE SOURCES	**27**	**-19**		**26**	**70**
INDUSTRIAL PROCESSES	**47**	**-4**		**46**	**-4**
AGRICULTURE	**59**	**-5**		**57**	**-15**
WASTE	**6**	**-12**		**6**	**-18**
DIRECT AIR CAPTURE	**0**	**0**		**0**	**0**
LESS*					
Land use, land use change and forestry	-17			-17	
Western Climate Initiative (WCI) credits	-13			-13	
Nature-based solutions (NBS)	-10			-10	
TOTAL	**452**	**-163**		**380**	**-141**

* LULUCF, WCI, and NBS data are ECCC estimates for 2030. We use the same data in 2050 for illustrative purposes.

Appendix 2: Household Cost Analysis Methodology

The following explanation was prepared by EnviroEconomics to explain their work on the household cost analysis in Section 6.

For this study, we assess the distributional impacts of the greenhouse gas mitigation costs of proposed LPC climate policies. The distributional impacts are assessed nationally for households of different household size and income level, as well as broadly for major economic sector categories that include emissions-intensive trade-exposed (EITE) industries, light manufacturing and other industries and services, government, and non-profits.

Forecasts of abatement costs (costs incurred from climate policy) and fuel levy (i.e. retail carbon tax) revenues to 2030 for the LPC plan are directly generated from NATEM modelling results provided to EnviroEconomics. Our modelling does not assess the validity of these costs and only considers how these costs are passed through or not by different industries, and the overall distribution of costs once subsidies and rebates are considered.

Incremental abatement costs associated with 55 IPCC emissions categories are extracted from the latest NATEM modelling of the LPC Climate Plan for the 2020 to 2030 time period.

These emission-abatement costs are then matched with 240 industry classifications from Canada's detailed supply and use tables published by Statistics Canada[41]. The relationship between emissions and industry sectors was determined through the historical representation of direct and indirect greenhouse gas emissions-intensity data published by Statistics Canada.[42] Roughly this means that any emissions reduction from the NATEM modelling is related to a specific industry where the direct costs of abatement are imposed.

Now using Statistics Canada's latest make-use table for all of Canada[1], it is possible to impose a direct cost on an industry, and based on a cost pass through assumption determine how costs are passed on (or not) to consumers of their products (i.e., households, EITE industries, other

[41] Statistics Canada. Table 36-10-0478-01 Supply and use tables, detail level, provincial and territorial.
[42] Statistics Canada. Table 38-10-0098-01 Direct plus indirect energy and greenhouse gas emissions intensity, by industry.

industries, government and non-profit sectors). Different cost pass-through assumptions are considered in the modelling, including a 100% pass-through, 0% pass-through and an average of cost pass-through for each industry determined from the literature. The average cost pass-through rate of all industry abatement emissions is approximately 51% for the LPC plan (i.e., not including direct costs to households) but varies depending on the industry sector. Trade-exposed industry sectors have cost pass-throughs that can be as low as 14%, whereas utilities have average cost pass-throughs above 90%. By running several iterations of the make-use table model it is possible to determine ultimately what economic sector pays the overall national abatement costs.

To track who pays the fuel levy costs, we take an approach similar to abatement costs. We first allocate these costs to industry and households and then track fuel levy costs through the make-use model to determine the ultimate economic sector burdened with these costs.
For households, we then use a household energy and emissions model to estimate how overall household costs identified are distributed by income group and household size. The model simulates the household carbon costs for seven income groups and five household sizes between 2020 and 2030.

The model considers two main categories or types of emission costs that are paid by households for both the abatement costs that are tied to all the policies implemented under each climate plan, as well as separately for the fuel levy to consider the distributional aspect of this policy (i.e., the overall impact is zero because all revenues are returned, however, there are distributional impacts because money is not always evenly returned to all payers). These two categories are direct costs related to household abatement and the fuel levy paid for residential buildings and personal transportation, and indirect costs (i.e., passed through from industry) for abatement and fuel levy costs that are associated with all household expenditures. The approach to estimating household carbon costs is different for each of these groups of compliance emissions but essentially involves:

1. Determining the average emissions intensity (i.e., tCO2e / household type) of different households based on income group and household size[43,44], adjusting the level of emissions intensity in future years to consider the changes in overall emissions to 2030 from the NATEM modelling;
2. Determining the proportion at which the costs associated with these emissions are passed on to households;
3. Estimating the overall household carbon costs in current dollars so they can be compared to expected rebates.

Fuel levy costs are then rebated back to households. In the LPC climate plan the federal backstop income rebate for households of different sizes is employed, such that 90% of overall fuel levy revenues are returned to households. This captures average overall distributional effects for households across Canada, but we would expect differentiated results by province.

[43] Statistics Canada. Table 11-10-0223-01 Household spending by household income quintile, Canada, regions and provinces.
[44] Statistics Canada. Table 25-10-0062-01 Household energy consumption, by household income, Canada and provinces.

For further information, please contact:
info@CleanProsperity.ca

@CleanProsperity

@CleanProsperity