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CARBON PRICING FOR THE PARIS TARGET: CLOSING THE GAP WITH OUTPUT-BASED PRICING

OFFICE OF THE PARLIAMENTARY BUDGET OFFICER
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The Parliamentary Budget Officer (PBO) supports Parliament by providing economic and financial analysis for the purposes of raising the quality of parliamentary debate and promoting greater budget transparency and accountability.

This report updates and extends PBO's analysis of the additional carbon pricing needed to achieve Canada's greenhouse gas emissions target in 2030 under the Paris Agreement.

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Summary

This report updates and extends PBO's analysis of the additional carbon pricing needed to achieve Canada's greenhouse gas (GHG) emissions target in 2030 under the Paris Agreement.

We provide an updated estimate based on a broad carbon levy and extend our analysis to incorporate additional carbon pricing using an Output-Based Pricing System (OBPS), taking into consideration alternative structures. Estimates of the corresponding impacts on the Canadian economy are also provided.

Canada's GHG emissions and the Paris target

Under the Paris Agreement, Canada has committed to reduce its GHG emissions by 30 per cent below 2005 levels by 2030. Based on current data, this translates into a level of 511 megatonnes (Mt) of CO_2 equivalent.

Based on current policies and measures that have been announced, but are not yet fully implemented, Environment and Climate Change Canada (ECCC) projects that Canada's GHG emissions will decrease from 716 Mt in 2017 to 588 Mt in 2030, after accounting for the contribution of the Land Use, Land Use Change and Forestry (LULUCF) sector.

- Announced policies and measures include the federal carbon pricing system under which the fuel charge rises to $50 per tonne in 2022, remaining at this level through 2030.
- Announced policies and measures are not sufficient to achieve Canada's GHG emissions target in 2030—there is a gap of 77 Mt in projected emissions relative to the Paris target.

Output-Based Pricing System (OBPS)

An OBPS is designed to provide a financial incentive for industrial emitters that are energy-intensive and trade-exposed (EITE) to reduce their emissions while remaining competitive, helping to protect against carbon leakage.

Firms covered under an OBPS face a carbon price on their emissions above a certain limit, which is based on a "standard" and is expressed as a fraction of emissions per unit of output. Firms with emissions below the limit receive credits which can be purchased by other firms, creating a financial incentive to reduce emissions.

Given the uncertainty surrounding the federal OBPS beyond 2022, we consider two scenarios that provide a plausible range of outcomes to achieve the Paris target in 2030.

- In the first scenario, under an OBPS with a dynamic structure, the standard evolves over time and the carbon price that OBPS firms face is the same as the carbon levy that applies to the rest of the economy.
- In the second scenario, under an OBPS with a static structure, the standard is fixed and OBPS firms continue to pay only the $50 per tonne under the existing system. That is, they are shielded from additional carbon pricing and so their international competitiveness is not affected.

Estimates of additional carbon pricing to achieve the Paris target

Using the computable general equilibrium model ENVISAGE, we estimate the additional carbon price that would be needed to reduce Canada's GHG emissions by a further 77 Mt in 2030, closing the gap between the Paris target and emissions projected under current policies and measures.

- PBO estimates that the additional carbon pricing necessary to achieve the Paris target ranges from $67 per tonne in 2030 (under the broad-based carbon levy) to between $81 (under the dynamic OBPS) and $239 per tonne (under the static OBPS) in 2030.
- This levy would be in addition to the existing federal fuel charge that rises to $50 per tonne in 2022.
- Combined with the $50 per tonne federal fuel charge, households and non-OBPS firms could face an explicit carbon price ranging from $117 per tonne to $289 per tonne in 2030.

The additional carbon pricing in our scenarios differs significantly from the existing federal fuel charge under the federal carbon pricing system. We assume that additional pricing would apply more broadly, covering all sectors and would be applied to all provinces and territories.

The estimated broad-based carbon levy of $67 per tonne is somewhat higher than our estimate of $52 per tonne in last year's report. This reflects database and reference-year updates, as well as changes to model calibration.

Estimated impacts on the Canadian economy

Similar to the federal fuel charge under the current carbon pricing system, we assume that revenues from additional carbon pricing are returned to households in lump-sum payments.

- Under a broad-based carbon levy, PBO estimates that the level of real GDP in 2030 would be 0.49 per cent lower than the level of real GDP in 2030 projected under current policies and measures.

- Under an OBPS, PBO estimates that the level of real GDP in 2030 would be between 0.47 per cent (with dynamic structure) and 0.62 per cent (with static structure) lower than the level of real GDP in 2030 projected under current policies and measures.

While the overall impact on the economy is similar across the scenarios considered, the sectoral impacts are more pronounced, indicating varying degrees of dislocation, as the substantially higher carbon levy under the static OBPS causes households and non-OBPS firms to significantly alter their behaviour.

Summary of sectoral emissions impacts in 2030

Megatonnes of CO_2 equivalent	**Broad-based carbon levy**	**OBPS with dynamic structure**	**OBPS with static structure**
Electricity	-4	-4	1
Oil and gas	-14	-10	8
Industry	-14	-15	-7
Transportation	-15	-17	-36
Agriculture	-1	-1	-2
Buildings	-9	-10	-19
Waste and others	-20	-20	-21
LULUCF and WCI	0	0	0
Total	-77	-77	-77
Real GDP impact in 2030 (%)	*-0.49*	*-0.47*	*-0.62*
Additional carbon price in 2030 ($ per tonne)	*67*	*81*	*239*

Source: Parliamentary Budget Officer.

Note: Real GDP impacts are measured as the percentage difference between the level of real GDP in 2030 (under each scenario) and the level of real GDP in 2030 projected under current policies and measures. LULUCF refers to Land Use, Land Use Change and Forestry. WCI refers to Western Climate Initiative. Totals may not add due to rounding.

The results of the scenarios we considered illustrate a trade-off between the protection provided to energy-intensive and trade-exposed (EITE) industries through an OBPS and the level of the carbon price/sectoral dislocation.

Increasing protection for EITE industries through an OBPS would result in higher carbon prices for households and non-OBPS firms, as well as greater sectoral dislocation in the economy. That said, our results also suggest that the trade-off in terms of the overall impact on the economy would be marginal.

1. Introduction

The Paris Agreement builds upon the United Nations Framework Convention on Climate Change (UNFCCC), requiring countries to outline and communicate their post-2020 climate actions. The Agreement's central aim is to limit the increase in global temperature to 1.5 to 2.0 degrees Celsius above pre-industrial levels.[1] Under the Agreement, countries put forward nationally determined contributions to reduce their greenhouse gas (GHG) emissions by 2030 as an interim step toward that goal.

On 15 May 2015, Canada submitted its economy-wide target to reduce GHG emissions by 30 per cent below 2005 levels by 2030.[2] Based on current data, this translates into an emissions target of 511 megatonnes (Mt) of CO_2 equivalent in 2030.

In December 2019, Environment and Climate Change Canada (ECCC) published its annual GHG emissions projections as part of Canada's 4th Biennial Report to the UNFCCC (BR4).[3] The report presents Canada's GHG emissions projections under different scenarios. Under the With Additional Measures (WAM) scenario—which serves as the baseline for our analysis—emissions are projected based on federal, provincial and territorial policies and measures that have been announced but not yet fully implemented.

According to ECCC's projection under the WAM scenario, announced policies and measures are not sufficient to achieve Canada's GHG emissions target in 2030—there is a gap of 77 Mt.

Similar to last year's report, we use the computable general equilibrium model ENVISAGE (Environmental Impact and Sustainability Applied General Equilibrium) to estimate how much additional carbon pricing would be needed to achieve the Paris target, as well as estimate the corresponding impact on the Canadian economy.

This year's report provides an updated estimate based on a broad carbon levy and extends the analysis to incorporate additional carbon pricing using an Output-Based Pricing System (OBPS), taking into consideration alternative structures.[4]

The following section presents the baseline emissions projection and key underlying assumptions. The subsequent sections present our estimates of the additional carbon pricing needed to achieve the Paris target and the impact on the Canadian economy.

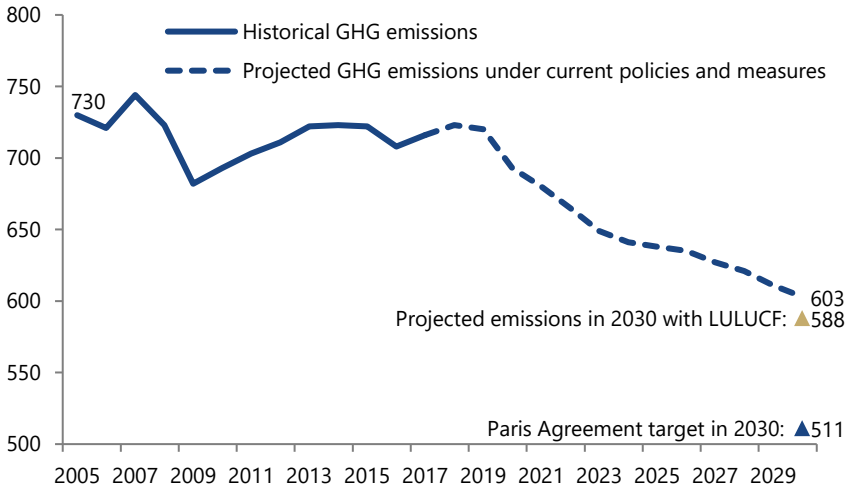
2. GHG emissions under current policies and measures

To examine the additional carbon pricing needed to achieve the Paris target, we start from ECCC's projections in the 4th Biennial Report to the UNFCCC (BR4). This does not, however, imply an endorsement of those projections as outcomes of the Pan-Canadian Framework (PCF) and other related government policies.[5] Their role is simply to isolate as much as possible the incremental carbon price required to achieve the Paris target.

The baseline GHG emissions projection on which our analysis is based, is the With Additional Measures scenario in BR4 that includes federal, provincial and territorial policies and measures that have been announced but not yet fully implemented (Figure 2-1).

Figure 2-1 Canada's GHG emissions projected under current policies

Megatonnes of CO_2 equivalent



Source: Environment and Climate Change Canada.

Note: Projected emissions levels correspond to the With Additional Measures scenario in Canada's 4th Biennial Report to the UNFCCC. LULUCF refers to Land Use, Land Use Change and Forestry. Projection period covers 2018 to 2030.

Under current policies and measures that have been announced, but are not yet fully implemented, ECCC projects that Canada's GHG emissions will decrease from 716 Mt in 2017 to 603 Mt in 2030. Including the contribution from the LULUCF sector (removing 15 Mt of emissions in 2030) reduces

projected emissions to 588 Mt in 2030, which is 77 Mt above the Paris target of 511 Mt.[6]

The 77 Mt gap is slightly smaller than the gap of 79 Mt in our 2019 report, which was based on ECCC's 2018 Additional Measures Case. This reflects revisions to historical data as well as recent policy changes, such as the elimination of the provincial carbon tax in Alberta.

Under the PCF, the federal fuel charge rises to $50 per tonne in 2022 and remains at $50 per tonne through 2030 under current policy. The framework also includes the federal Output-Based Pricing System[7] (Box 2-1), as well as other regulatory requirements such as the Clean Fuel Standard.[8] Annex 2 in BR4 (see Table A2.39) provides a detailed description of federal, provincial and territorial policies and measures included in the WAM scenario. Implicit in the WAM scenario is that measures in provinces and territories which have their own frameworks will maintain equivalency to the federal carbon pricing backstop (that is, the federal fuel charge and OBPS).

Box 2-1 OBPS in ECCC's WAM scenario

The federal OBPS is a regulatory trading system for industry. It is designed to provide a financial incentive for industrial emitters that are energy-intensive and trade-exposed (EITE) to reduce their emissions while remaining competitive. Such a system helps to protect against carbon leakage, which occurs when production and related emissions move to another jurisdiction with less stringent carbon policies. The federal OBPS covers approximately 35 per cent of Canada's emissions (Dobson, et al., 2019).

In ECCC's With Additional Measures scenario, firms covered under the federal OBPS face a carbon price on emissions generated within a facility that exceed an annual limit (instead of paying a levy on the fuels they purchase). The price is nominally set equivalent to the carbon levy applied in the rest of the economy.

The annual limit is calculated as a facility's production multiplied by a "standard", which is expressed as a fraction, generally set at 80 per cent, of average emissions intensity (that is, GHG emissions per unit of output). In calculating a facility's annual limit, average emissions intensities remain fixed at their 2014-2016 average.

Facilities under the OBPS that emit below their emissions limit do not pay a carbon levy, and in fact receive surplus credits from the Government that can be traded or banked for future use. The value of surplus credits they receive is equal to the amount of their emissions below the limit multiplied by the federal carbon levy. This creates a financial incentive for a facility to reduce its emissions below its limit.

Box 2-1 continued

Facilities under the OBPS that emit above their emissions limit are required to pay the federal levy, purchase credits from other firms or use banked credits, but only for their excess emissions.

The federal carbon levy thus represents an upper limit on the value of the surplus credits. Theoretically, the lower limit is zero, which could be reached if emissions reduction/removal technology advanced rapidly.

As BR4 notes, the federal government is in the process of developing a GHG offset system. Firms under the OBPS that implement projects that reduce or remove GHG emissions from the atmosphere will receive "offset" credits that can also be sold to other firms or banked for future use. This system is not incorporated in ECCC's With Additional Measures scenario.

Since the federal OBPS is part of the carbon pricing backstop, provinces may implement their own system. As of June 2020, 5 provinces and 2 territories were covered by the federal program (Prince Edward Island, New Brunswick, Ontario, Manitoba, Yukon, Nunavut, and hybrid coverage in Saskatchewan). Other provinces have their own programs which the federal government has deemed sufficient (Alberta, British Columbia, Northwest Territories, Nova Scotia, and Quebec).

Under ECCC's WAM scenario, the composition of reductions in emissions across sectors of the Canadian economy is not uniform (Table 2-1). Relative to 2017, the largest contributor to reducing GHG emissions is the electricity sector (56 Mt), where the accelerated phase-out of coal-fired electricity has a significant impact. Transportation emissions are projected to fall by 33 Mt from 2017 levels due in part to projected increases in fuel efficiency and an increasing share of zero emission vehicles.

Table 2-1 Sectoral emissions under current policies and measures

Megatonnes of CO_2 equivalent	Historical		Projected		Change 2017 to 2030
	2005	2017	2020	2030	
Electricity	119	74	51	18	*-56*
Oil and gas	158	195	206	199	*4*
Industry	87	73	77	80	*7*
Transportation	162	174	170	141	*-33*
Agriculture	72	72	74	74	*2*
Buildings	86	85	80	62	*-23*
Waste and others	47	42	43	42	*0*
LULUCF and WCI	-	-	-31	-28	*-28*
Total	**730**	**716**	**670**	**588**	**-128**

Source: Environment and Climate Change Canada.

Note: Projected emissions levels correspond to the With Additional Measures scenario in Canada's 4th Biennial Report to the UNFCCC. LULUCF refers to Land Use, Land Use Change and Forestry. WCI refers to Western Climate Initiative. Totals may not add due to rounding.

In addition to current policies and measures, the key drivers underlying ECCC's emissions projection include economic growth, population, energy prices and technological change. Table 2-2 provides a high-level summary of ECCC's economic assumptions.

Table 2-2 Key economic and demographic assumptions

Average annual growth rate, %	Projected		
	2017-2020	2020-2025	2025-2030
Real GDP growth	1.7	1.8	1.6
Population growth	1.4	1.0	1.0
Labour force growth	1.0	0.8	0.6
CPI inflation	1.9	2.0	2.0
Oil price (2017 US$/bbl)*	63	66	69
Natural gas price (2017 US$/mmbtu)*	2	3	3

Source: Environment and Climate Change Canada.

Note: * denotes end of period values.

Prior to the recent economic downturn (see Box 2-2 for a discussion of the impact of the COVID-19 pandemic), the Canadian economy was projected to grow by 30.1 per cent, and the population by 17.8 per cent, over the period 2017 to 2030 under the ECCC scenario.

Box 2-2 COVID-19 and ECCC's With Additional Measures scenario

This report has not incorporated potential impacts of the COVID-19 pandemic. The baseline projection used in our report is based on the most recent projections published by ECCC, which were published in December 2019 before the start of the pandemic.

The impacts of the pandemic on GHG emissions, however, are multi-faceted and thus difficult to project without making strong assumptions. Preliminary observations on emissions suggest that the effect will be transitory and likely short lived (for example, see Le Quéré, et al., 2020). Nonetheless, there are some factors that suggest emissions will be lower and therefore our estimates of the additional carbon pricing required to achieve the Paris target could be overstated somewhat.

For instance, consider that while the growth of real GDP in 2020 will be below the rate in the ECCC scenario, there is a consensus that GDP growth will accelerate once the pandemic is over (IMF, 2020). However, the level of economic activity will likely be somewhat lower—even in the long run—due to permanent impacts on the capital stock and labour force.

Since GHG emissions are linked to the level of economic activity, this means that emissions in 2030 would be lower than projected in ECCC's With Additional Measures scenario.

However, there are also offsetting factors. While reduced economic activity, in general, should act to lower emissions, postponed efficiency gains will push in the opposite direction. Moreover, changes in work/lifestyle could also have permanent impacts. Teleworking could become more prevalent in enough industries that demand for office space would be lower. That would slow the rapid gains in commercial building energy/power efficiencies that are built into ECCC's projection. On the other hand, the need for travel (even to the office) could be reduced by the recent acceleration of video conferencing technologies, contributing to lower emissions.

We anticipate that ECCC's 2020 GHG emissions projection will incorporate impacts from the COVID-19 pandemic. We will update our analysis in a future report.

The link between economic growth and GHG emissions has weakened as the manufacturing sector has become a smaller part of the economy, and new technologies are less fossil-fuel intensive. Nonetheless, it remains an important driver. Transportation and heating, for example, remain closely linked to both population and economic growth. The PCF is therefore working to bring down emissions against the backdrop of an expanding economy where those services will be in greater demand.

3. Estimates of additional carbon pricing for the Paris target

To reach the Paris target by closing the projected 77 Mt emissions gap, we use a (slightly) modified version of the ENVISAGE model (van der Mensbrugghe, 2019) and the GTAP database (Aguiar et al., 2019) to estimate the additional carbon pricing that would be required (see Appendix A). We analyse additional carbon pricing under a broad-based carbon levy as well as under an Output-Based Pricing System, taking into account different structures.

At present, it is not clear what will happen to the administration of the federal OBPS beyond 2022. Given the uncertainty surrounding its evolution, we consider two cases of the OBPS to provide a plausible range of outcomes for its implementation.

In the first case, we consider a "dynamic" OBPS structure, such that the emissions standard changes over time and the price of emissions exceeding the limit is the same additional carbon levy paid by other non-OBPS firms and households.

In the second case, the OBPS structure is "static" such that the emissions standard is fixed over time and OBPS firms continue to pay $50 per tonne while non-OBPS firms and households pay the additional carbon levy. Thus, relative to the baseline scenario, OBPS firms do not face any additional carbon pricing.[9]

Similar to our 2019 report, we assume that additional carbon pricing needed to achieve the Paris target will begin in 2023 and rise through 2030. We also assume that additional carbon pricing applies uniformly across provinces and territories.[10] In all cases, revenues from additional carbon pricing are returned to households in lump-sum payments, similar to the federal fuel charge.

3.1. Broad-based carbon levy

Under a broad-based carbon levy, we estimate that additional carbon pricing rising from $7 per tonne in 2023 to $67 per tonne in 2030, would be required to achieve the Paris target. Adjusted for inflation, the additional carbon price in 2030 would be $55 per tonne expressed in 2020 dollars.

Combined with the $50 per tonne federal fuel charge, households and firms could face an explicit carbon price of $117 per tonne in 2030. Adjusted for

inflation, the combined carbon price in 2030 would be $96 per tonne expressed in 2020 dollars.

The incentive to reduce emissions through substitution or reductions in emission-causing activities is widespread. Emissions will decrease even in sectors that were not initially affected as much under the With Additional Measures scenario (Table 3-1).

Table 3-1 Sectoral GHG emissions with a broad-based carbon levy

Megatonnes of CO_2 equivalent	Historical: 2017	Under current policies: 2030	With additional carbon pricing: 2030	Impact of additional carbon pricing
Electricity	74	18	14	-4
Oil and gas	195	199	186	-14
Industry	73	80	66	-14
Transportation	174	141	126	-15
Agriculture	72	74	73	-1
Buildings	85	62	53	-9
Waste and others	42	42	22	-20
LULUCF and WCI	-	-28	-28	*0*
Total	**716**	**588**	**511**	**-77**

Sources: Environment and Climate Change Canada and Parliamentary Budget Officer.

Note: Projected emissions levels under current policies correspond to the With Additional Measures scenario in Canada's 4th Biennial Report to the UNFCCC. LULUCF refers to Land Use, Land Use Change and Forestry. WCI refers to Western Climate Initiative. Totals may not add due to rounding.

Although the projected GHG emissions gap of 77 Mt is close to the size of the gap in our 2019 report (79 Mt), the estimated broad-based carbon levy in 2030 is somewhat higher: $67 versus $52 per tonne. The higher estimate reflects database and reference-year updates, as well as changes to model calibration.

3.2. OBPS with dynamic structure

In this scenario, we incorporate an OBPS alongside a carbon levy to close the 77Mt emissions gap.

The OBPS in this scenario is based on a time-varying standard and adopts the same output-based standard (OBS) fractions used in the carbon pricing backstop (see Appendix B). Starting in 2023, the emissions intensity used to calculate a facility's limit is set each year based on actual (realized) emissions and output. This means that, on average, firms within an industry under the OBPS will pay a price on a fixed proportion of their annual emissions.[11] For example, if the OBS fraction in the standard is set at 80 per cent for an

industry, firms within this industry will always pay, on average, a carbon levy on 20 per cent of their GHG emissions.

In addition, the carbon price that OBPS firms must pay for the emissions that exceed their limit is the same additional carbon levy that non-OBPS firms and households pay, which increases over time.

Under an OBPS with this dynamic structure, we estimate that the additional carbon price required to achieve the Paris target would increase from $9 in 2023 to $81 per tonne in 2030. Adjusted for inflation, the additional carbon price in 2030 would be $66 per tonne expressed in 2020 dollars.

Combined with the $50 per tonne federal fuel charge, households and firms could face an explicit carbon price of $131 per tonne in 2030. Adjusted for inflation, the combined carbon price in 2030 would be $107 per tonne expressed in 2020 dollars.

The additional carbon price in this scenario is $14 per tonne higher compared to the broad-based carbon levy scenario above. The higher carbon price is required in this scenario because firms under the OBPS expand their production relative to the broad-based carbon levy scenario. These firms effectively receive a lump-sum transfer by having a substantial portion of their emissions excluded from the additional carbon levy, which lowers their average cost of production.

The impact on sectoral emissions is similar to the broad-based carbon levy scenario above. However, there is a discernible shift from reductions in the oil and gas sector to the transportation and buildings sectors—which are where household emissions would be recorded (Table 3-2).

Table 3-2 Sectoral GHG emissions with OBPS – dynamic structure

Megatonnes of CO_2 equivalent	Historical: 2017	Under current policies: 2030	With additional carbon pricing: 2030	Impact of additional carbon pricing
Electricity	74	18	14	-4
Oil and gas	195	199	189	-10
Industry	73	80	66	-15
Transportation	174	141	124	-17
Agriculture	72	74	73	-1
Buildings	85	62	52	-10
Waste and others	42	42	22	-20
LULUCF and WCI	-	-28	-28	*0*
Total	**716**	**588**	**511**	**-77**

Sources: Environment and Climate Change Canada and Parliamentary Budget Officer.

Note: Projected emissions levels under current policies correspond to the With Additional Measures scenario in Canada's 4th Biennial Report to the UNFCCC. LULUCF refers to Land Use, Land Use Change and Forestry. WCI refers to Western Climate Initiative. Totals may not add due to rounding.

These results suggest that excluding a substantial portion of a firm's emissions from a carbon levy has only a modest impact on emissions relative to the case where a broad-based levy is applied. There is not a significant increase in emissions under an OBPS with a dynamic structure since firms face a strong incentive to reduce them.

OBPS firms respond as if they were subject to the full carbon levy on *all* of their emissions.[12] This is because firms recognize that if they reduce emissions, they will either avoid having to pay for them, or generate credits that can be sold to other firms. The output-based standard is treated by these firms as a lump-sum transfer, equivalent to an output subsidy.[13]

3.3. OBPS with static structure

As an alternative to the dynamic OBPS structure in the above scenario, we consider the case where the emission-intensity in the standard remains fixed at its 2022 level, with the same OBS fractions as above.[14]

In this scenario, firms subject to the OBPS are shielded from an *additional* carbon levy on their emissions. That is, starting in 2023 and through 2030, OBPS firms continue to pay a carbon levy of $50 per tonne on emissions that exceed their annual limit. Thus, this structure maintains a similar degree of international competitiveness for OBPS firms compared to our baseline scenario. The additional carbon levy for firms and households outside of the OBPS therefore adjusts to bring about the reduction in GHG emissions to achieve the Paris target.

Under an OBPS with this static structure, we estimate that the additional carbon price required to achieve the Paris target would increase from $26 in 2023 to $239 per tonne in 2030. Adjusted for inflation, the additional carbon price in 2030 would be $196 per tonne expressed in 2020 dollars.

Combined with the $50 per tonne federal fuel charge, households and non-OBPS firms could face an explicit carbon price of $289 per tonne in 2030. Adjusted for inflation, the combined carbon price in 2030 would be $237 per tonne expressed in 2020 dollars.

Since OBPS firms contribute approximately 35 per cent of Canada's GHG emissions and given that a significant portion of the remaining emissions are from non-CO_2 sources, the additional carbon levy required to achieve the Paris target impacts only about half of all GHG emissions. Consequently, the additional carbon levy is significantly higher in this case compared to the scenarios with a dynamic OBPS structure and the broad-based levy.

The distribution of that impact is now substantially different from the broad-based carbon levy and dynamic OBPS scenarios (Table 3-3). The burden borne by non-OBPS sectors is much higher. This is particularly the case for households (included in the transportation and buildings sectors). Indeed, most of the additional reduction comes from the household sector since the waste and others sector is a small source of levied emissions.

Table 3-3 Sectoral GHG emissions with OBPS – static structure

Megatonnes of CO_2 equivalent	**Historical: 2017**	**Under current policies: 2030**	**With additional carbon pricing: 2030**	**Impact of additional carbon pricing**
Electricity	74	18	19	1
Oil and gas	195	199	207	8
Industry	73	80	74	-7
Transportation	174	141	105	-36
Agriculture	72	74	71	-2
Buildings	85	62	42	-19
Waste and others	42	42	21	-21
LULUCF and WCI	-	-28	-28	*0*
Total	**716**	**588**	**511**	**-77**

Sources: Environment and Climate Change Canada and Parliamentary Budget Officer.

Note: Projected emissions levels under current policies correspond to the With Additional Measures scenario in Canada's 4th Biennial Report to the UNFCCC. LULUCF refers to Land Use, Land Use Change and Forestry. WCI refers to Western Climate Initiative. Totals may not add due to rounding.

4. Estimates of the impact on the Canadian economy

Our estimates indicate that the additional carbon pricing necessary to achieve the Paris target of 511 Mt ranges from $67 to $239 per tonne in 2030 under the scenarios considered.

Based on the assumption that revenue from additional carbon pricing would be transferred back to households as lump-sum payments, we estimate that the level of real GDP in 2030 would be between 0.47 and 0.62 per cent lower than the level of real GDP in 2030 projected under current policies and measures in our baseline scenario (Table 4-1).[15]

Table 4-1 Economic impact of additional carbon pricing to achieve the Paris target

	Additional carbon price ($ per tonne)	GDP impact in 2030 (%)*
Broad-based carbon levy	67	-0.49
OBPS with dynamic structure	81	-0.47
OBPS with static structure	239	-0.62

Source: Parliamentary Budget Officer.

Note: (*) The impact is measured as the percentage difference between the level of real GDP in 2030 (under each scenario) and the level of real GDP in 2030 projected under current policies and measures.

The range of these impacts translates into a reduction of 0.06 to 0.08 percentage points in average annual real GDP growth over 2023 to 2030. Thus, instead of the Canadian economy growing at 1.72 per cent annually, on average, over 2023 to 2030 under current policies and measures, we project that it would grow at 1.64 to 1.66 per cent annually, on average, over the same period with additional carbon pricing to achieve the Paris target.

The economic impacts under the broad-based carbon levy and the dynamic OBPS scenarios are similar. This is not entirely surprising given the integration of additional carbon pricing across OBPS and non-OBPS sectors, as well as evolving output-based standards. The additional "protection" for OBPS firms is essentially balanced by the higher cost imposed on non-OBPS sectors relative to the broad-based levy scenario.

Under the OBPS scenario with a static structure, the magnitude of the economic impact is only slightly larger compared to the dynamic OBPS and

broad-based levy scenarios. This appears surprising at first glance given that the additional carbon price for non-OBPS sectors is 3 to 3½ times larger. This result stems from two key factors.

First, the revenue generated from the significantly higher carbon levy under the static OBPS scenario is recycled back to households, which helps to support aggregate demand in the economy from non-OBPS sectors (Table 4-2).

Table 4-2 Real GDP relative to baseline in 2030

%	Broad-based carbon levy	OBPS with dynamic structure	OBPS with static structure
OBPS sectors	-3.36	-1.99	0.44
Non-OBPS sectors	0.10	-0.14	-0.84
Total	-0.49	-0.47	-0.62

Source: Parliamentary Budget Officer.

Note: Impacts are measured as the percentage difference between the level of real GDP in 2030 (under each scenario) and the level of real GDP in 2030 projected under current policies and measures.

The OBPS and non-OBPS sectoral GDP impacts are based on an approximation calculated within the ENVISAGE model.

Second, the static structure of the OBPS in this scenario provides additional protection for the covered firms. That is, compared to the other two scenarios, OBPS firms are more competitive internationally and therefore the value of their assets is not affected to the same extent, resulting in higher factor income. This also helps to cushion the impact both on OBPS and non-OBPS firms as well as households.

While the overall impact on the economy under the static structure is broadly in line with the other scenarios, there is considerable dislocation across sectors. This is evident in the large reductions in emissions in the transportation and buildings sectors (Table 4-3). The substantially higher carbon levy is causing households and other non-OBPS sectors to substantially alter their behaviour.

Table 4-3 Summary of sectoral emissions impacts in 2030

Megatonnes of CO_2 equivalent	Broad-based carbon levy	OBPS with dynamic structure	OBPS with static structure
Electricity	-4	-4	1
Oil and gas	-14	-10	8
Industry	-14	-15	-7
Transportation	-15	-17	-36
Agriculture	-1	-1	-2
Buildings	-9	-10	-19
Waste and others	-20	-20	-21
LULUCF and WCI	0	0	0
Total	-77	-77	-77
Real GDP impact in 2030 (%)	*-0.49*	*-0.47*	*-0.62*
Additional carbon price in 2030 ($ per tonne)	*67*	*81*	*239*

Source: Parliamentary Budget Officer.

Note: Real GDP impacts are measured as the percentage difference between the level of real GDP in 2030 (under each scenario) and the level of real GDP in 2030 projected under current policies and measures. Totals may not add due to rounding.

The results of the scenarios we considered illustrate a trade-off between the protection provided to energy-intensive and trade-exposed industries through an OBPS and the level of the carbon price/sectoral dislocation.

Increasing protection for EITE industries through an OBPS would result in higher carbon prices for non-OBPS firms and households, as well as greater sectoral dislocation in the economy. That said, our results also suggest that the trade-off in terms of the overall impact on the economy would be marginal.

Moreover, the impetus for providing additional protection to EITE industries depends on Canada's international competitors. If other countries implement carbon pricing to reduce emissions in their industrial sectors to achieve their Paris targets, the need for providing additional protection to EITE industries in Canada would be obviated. However, no country will likely submit its EITE industries to the full extent of incremental carbon pricing, to avoid losing competitiveness, unless their trading partners do.[16]

Appendix A: Model and database description

The analytical work in this report was undertaken with the ENVISAGE model (van der Mensbrugghe, 2019). The same model underpinned the analysis in our 2019 report. Underlying the ENVISAGE model is the GTAP (Global Trade Analysis Project) database of Purdue University (Anguiar, et al., 2019).

Since the GTAP version 10 database was not yet integrated into the ENVISAGE model when we started our analysis, we adapted that database ourselves. As such, the raw data in our database may differ slightly from subsequent versions of the ENVISAGE model. The GTAP database uses 2014 as a reference year, which is then projected forward.

We also made some modifications to the GTAP base-year data to ensure greater compatibility with GHG emissions data from BR4 and Statistics Canada (2020).[17] Much of that change was focused in the oil and gas, and industrial sectors. Some smaller changes were also implemented in agriculture. When those changes involved emissions from energy sources, the energy volume data were also changed.

ENVISAGE is a general equilibrium economic model, with representation of multiple sources of GHG emissions. PBO's implementation of ENVISAGE includes 23 sectors, with the world aggregated to 4 regions (Canada, United States, European Union, and Rest of World).

We also made a number of changes to ENVISAGE so that ECCC emission projections to 2030 could be incorporated. A particularly important one is that a shadow price was introduced for sources of emissions. That price is used target baseline emission projections.

Since ENVISAGE uses sectors built from detailed input-output tables, it is possible to build a correspondence between its sectors, and those from Statistics Canada. This facilitates building consistency to the data from ECCC.

The sectoral reallocation resulted in a base year (2014) correspondence that matches closely those in ECCC's WAM scenario.

See Appendix A in our 2019 report for additional detail.

Appendix B: OBS fractions

The current federal OBPS starts by defining an industry-level average for emissions intensity across facilities based on a reference period. There is significant variation across facilities even within a firm or industry, so the industry average represents a point of reference for judging emission-efficiency. Some proportion of that average—the output-based standard (OBS) fraction—is then used to define a reduction threshold that should be achievable without unduly compromising an industry's international competitiveness.

For most industries, the OBS fraction is set at 80 per cent, but for some that are particularly vulnerable to international competition, it is set at 90 or even 95 per cent (Table B-1).

Table B-1 OBPS sectors and OBS fractions

OBPS sector	OBS fraction
Mining	80%
Oil and gas	
Pipelines	
Food and tobacco	
Lumber	
Pulp and paper mills	
Non-ferrous metals	
Miscellaneous manufacturing	
Transport equipment manufacturing	
Fertilizer	90%
Petrochemicals	
Petroleum products	
Cement	95%
Gypsum and lime	
Iron and steel	

Source: Environment and Climate Change Canada.

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Notes

1. Additional detail on the Paris Agreement is available at: https://unfccc.int/process-and-meetings/the-paris-agreement/the-paris-agreement. Full text of the Agreement is available at: https://treaties.un.org/doc/Treaties/2016/02/20160215%2006-03%20PM/Ch_XXVII-7-d.pdf.

2. Canada's commitment to reduce GHG emissions by 30 per cent below 2005 levels by 2030 represents a significant but interim step toward the longer-term goal. Beyond 2030, Canada's Mid-Century Strategy examined a reduction path consistent with net emissions falling by 80 per cent below 2005 levels. For additional detail, please consult: https://unfccc.int/files/focus/long-term_strategies/application/pdf/canadas_mid-century_long-term_strategy.pdf.

3. Canada's 4th Biennial Report to the UNFCCC is available at: https://unfccc.int/sites/default/files/resource/br4_final_en.pdf.

4. Of course, any number of policies could be introduced to close the GHG emissions gap, all of which would impose either an explicit price on carbon (a levy or a cap-and-trade system), or a hidden price on the cost of goods and services (regulatory measures or subsidies). The general consensus among economists is that explicit carbon pricing is the most cost-effective approach to reducing GHG emissions. Regulatory measures and subsidies typically impose a higher, albeit less visible, economic cost compared to explicit carbon pricing.

5. In addition to the federal carbon pricing system (that is, the regulatory fuel charge and OBPS), the Pan-Canadian Framework includes "complementary climate actions" (for example, regulatory actions) to further reduce emissions. The PCF also includes "measures to adapt to the impacts of climate change and build resilience; and actions to accelerate innovation, support clean technology, and create jobs". For additional detail on the PCF, see: http://publications.gc.ca/collections/collection_2017/eccc/En4-294-2016-eng.pdf.

6. The LULUCF sector represents a net contribution to GHG emissions. Under the UNFCCC, countries report emissions and carbon removals associated with managed lands.

7. For additional detail on the federal OBPS, please consult: https://www.canada.ca/en/environment-climate-change/services/climate-change/pricing-pollution-how-it-will-work/output-based-pricing-system.html.

   For additional detail on the federal GHG Offset System, please consult: https://www.canada.ca/en/environment-climate-change/services/climate-change/pricing-pollution-how-it-will-work/output-based-pricing-system/federal-greenhouse-gas-offset-system.html.

8. For additional detail on the Clean Fuel Standard, please consult: https://www.canada.ca/en/environment-climate-change/services/managing-pollution/energy-production/fuel-regulations/clean-fuel-standard.html.
9. An alternative interpretation of a "static" OBPS is one where the standard remained fixed, but OBPS firms face the same cost as elsewhere on emissions above the standard. This would lead those firms to reduce emissions to the standard but then undertake no additional actions. To the extent that the $50 carbon levy causes firms to meet the fixed standard, this scenario is equivalent (or close to) the static scenario modelled in this report.
10. The agricultural sector is partially exempted in our modelling, consistent with government policy under the PCF.
11. This scenario fits within the current structure of the OBPS system and is consistent with its intellectual underpinning (see Sawyer and Stiebert, 2017, for the foundational underpinning). That is, firms have an incentive to reduce emissions, but they do not face the full penalty for those they do not abate. Its implementation could be viewed as somewhat optimistic since the government would have to continually adjust the emissions-intensity standard so that firms face the same incentive as elsewhere in the economy.
12. Their behavioural response will be equivalent to a full levy on emissions accompanied by a subsidy on output (see Sterner and Hoglund, 2010).
13. Dobson et al., (2017) provide a similar interpretation.
14. We believe that our static-structure OBPS scenario is comparable to the scenario examined in Ecofiscal Commission (2019), or at least to a similar interpretation of the static OBPS (see Note 9). It is also similar to the implementation in ECCC's WAM scenario. In these scenarios, the standard is held fixed at a reference year, so the degree of protection for those industries increases over time.
15. Our estimate of the economic impact in 2030 under the broad-based levy scenario (-0.47 per cent) is slightly larger, in terms of magnitude, compared to our 2019 report (-0.35 per cent). This reflects database revisions and changes to model calibration.
16. This contrasts studies that find the impact on competitiveness is small (for example, see Bohringer et al., 2012).
17. Along with the GHG emissions projection from BR4, we also used the energy production projections for coal, oil and natural gas, from the National Energy Board (NEB, 2018), which align closely with energy use in the BR4 scenario.