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BEYOND PARIS: REDUCING CANADA'S GHG EMISSIONS BY 2030

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 assesses the impacts of the Government's plan to exceed the 2030 reduction target for Canada's greenhouse gas emissions under the Paris Agreement.

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Summary

The Government recently announced changes to its climate change plan to exceed Canada's 2030 Paris Agreement target for reducing greenhouse gas (GHG) emissions:

- In December 2020, the Government announced a series of measures under the rubric of *A Healthy Environment and a Healthy Economy* (HEHE).
- The Government estimated that the HEHE measures would reduce Canada's emissions to 503 megatonnes (Mt) of CO_2 equivalent, or 8 Mt (31 per cent) below Canada's 2030 Paris target.
- Budget 2021 included further measures to reduce Canada's emissions to 468 Mt, or 36 per cent below Canada's 2030 Paris target.

Announcements and projected GHG emissions in 2030

• **Reference Case emissions in 2030**	674 MtCO2e	With $120 additional carbon pricing and other policies
• ***Paris target***	*511 MtCO2e**	
• **December 2020 HEHE policy scenario emissions**	503 MtCO2e*	Additional non-price policies (some unspecified)
• **Budget 2021 announcement**	468 MtCO2e*	

Sources: Environment and Climate Change Canada and Office of the Parliamentary Budget Officer.

Note: (*) Including LULUCF, WCI and NBS, which reduce reported emissions by 39 Mt under HEHE and 29 Mt in the ECCC Reference Case. The ECCC Reference Case includes carbon pricing of $50 per tonne in 2030.

Under HEHE, the federal carbon levy rises from $50 per tonne in 2022 to $170 per tonne in 2030, which is $120 higher compared to the Environment and Climate Change Canada (ECCC) Reference Case.[1] HEHE projections also include an illustrative tightening in the emissions standards for the Output Based Pricing System (OBPS)—the mechanism under which carbon pricing is applied to trade-exposed energy-intensive industry—by 2 per cent per year starting in 2023. PBO has retained that change.

These visible market-based measures are complemented by other policies which are not immediately visible but, like carbon pricing, can raise the costs of firms' production.

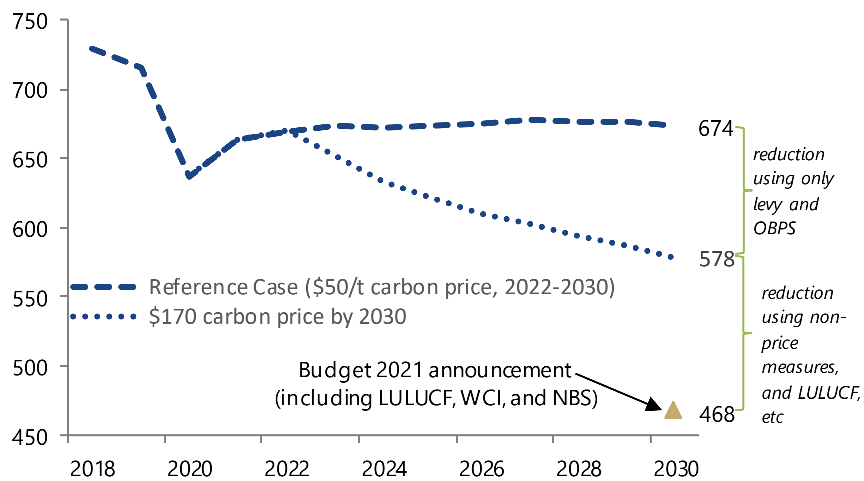
This report's main focus is to estimate the differential impacts on emissions reduction from market-based measures versus less visible regulatory policies. This is within the context of assessing the impacts of the Government's plan to exceed the reduction in Canada's GHG emissions by 2030 under the Paris Agreement.

We estimate that increasing the federal carbon levy by an additional $120 per tonne to $170 in 2030 and tightening OBPS standards will reduce Canada's emissions by 96 Mt: from 674 Mt in 2030 under ECCC's Reference Case to 578 Mt.

Since the Government projected that HEHE and Budget 2021 policies would reduce emissions to 468 Mt in 2030 (including 39 Mt from Land Use, Land Use Change and Forestry (LULUCF), the Western Climate Initiative (WCI) and nature-based solutions (NBS)), we conclude that 71 Mt in emissions reduction is being done through non-price and regulatory measures.

Projected GHG emissions with additional carbon pricing

Megatonnes of CO_2 equivalent



Sources: Environment and Climate Change Canada and Office of the Parliamentary Budget Officer.

Note: The reported reference emissions (674 Mt) and emissions with additional carbon pricing (578 Mt) do not include LULUCF, WCI and NBS, which reduce emissions by an additional 39 Mt.

The non-price measures in HEHE and Budget 2021 are then examined for the "minimum" price equivalent required to achieve the Government's projected emissions level of 468 Mt in 2030.

Since the cost of regulatory policies are not immediately visible, it is imperative to look at their price equivalent, and to anchor them to visible price policies, for example, a carbon levy. This report provides an anchor for the emission cost that non-price measures impose on firms and consumers to reach the projected emissions level of 468 Mt in 2030.

In this case, if the HEHE and Budget 2021 non-price measures are achieved at minimum cost—that is, the actions that firms undertake in response to policy have a minimum cost—we estimate that they would have to be equivalent to an additional $91 per tonne carbon levy to reduce emissions by a further 71 Mt ($72 in 2019 dollars).

We estimate that the HEHE price-based mechanisms that reduce emissions by 96 Mt will lower real GDP by 0.8 per cent in 2030. The non-price measures, if achieved a minimum cost, would further reduce real GDP by 0.6 per cent in 2030. Thus, the combined price- and non-price-based measures in HEHE and Budget 2021 would reduce the projected level of real GDP in 2030 by 1.4 per cent.

These estimates are provided without context. For example, there is no countervailing estimate of the impact that climate change might cause in Canada. We are also not allowing for the possibility of exceptional productivity gains in moving to new technologies. The estimates are, however, useful when looking at base-case projections of growth and government balances under climate policies.

Reducing Canada's GHG emissions to 468 Mt by 2030

	Additional carbon price (per tonne)[a]	**Emissions reduction[b]**	**GDP impact in 2030[c]**
HEHE carbon levy and OBPS	$120	96 Mt	-0.8%
Non-price policies (implicit price)[d]	$91	71 Mt	-0.6%
Total impact in 2030	**$211**	**167 Mt**	**-1.4%**

Source: Office of the Parliamentary Budget Officer.

Note: (a) Beyond the $50 per tonne over 2022-2030. Nominal dollars: to convert to 2019 dollars, divide by 1.258.

(b) Not including LULUCF, WCI and NBS.

(c) The impact is measured as the percentage difference between the level of real GDP in 2030 (under the Reference Scenario) and the level of real GDP in 2030 projected under HEHE and Budget 2021 measures.

(d) Minimum cost is achieved by using an equivalent price instrument.

On a sectoral basis, the additional carbon levy and OBPS will have the largest impact on the transportation and oil and gas sectors. By contrast, real GDP in heavy industry is projected to increase as it is sheltered from full carbon pricing under the OBPS system and can substitute its energy and production inputs for relatively lower cost.

Sectoral economic impacts with additional carbon pricing and OBPS

Real GDP, percentage difference from Reference Scenario

	2023	**2024-2026**	**2027-2029**	**2030**
Electricity	0.7	1.3	2.2	2.7
Oil and Gas	-2.6	-5.6	-9.2	-10.8
Heavy Industry	-0.1	0.7	1.5	1.7
Transportation	-3.1	-8.1	-13.5	-16.2
Agriculture and Fishing	0.2	0.7	1.5	2.1
Buildings	-0.1	-0.1	-0.2	-0.2
Waste and others	0.2	0.3	0.3	0.3
Total	**-0.1**	**-0.3**	**-0.6**	**-0.8**

Source: Office of the Parliamentary Budget Officer.

Note: Increasing the carbon levy from $50 per tonne over 2022-2030 to $170 per tonne in 2030 and tightening OBPS standards.

We also estimate that the carbon levy and OBPS alone will reduce economy-wide real labour income by 1.2 per cent, primarily in the oil and gas and transportation sectors. In addition, we project that workers with lower levels of education will see larger income losses than higher educated workers.

This report does not provide detailed analysis of the Government's April announcement to further reduce emissions to between 40 and 45 per cent below 2005 levels (that is, 438 Mt and 402 Mt, respectively). While technologies to achieve this reduction are currently available, the scale and speed of the changes will make it challenging to achieve.

1. Introduction

In December of 2020 and in Budget 2021 the Government announced a series of measures titled *A Healthy Environment and a Healthy Economy* (HEHE) that aim to exceed Canada's 2030 GHG reduction target under the Paris Agreement.[2]

HEHE and Budget 2021 measures are projected to reduce emissions in 2030 to 36 per cent below those of 2005 (or 468 Mt).[3] In April, the Government announced that it would further reduce emissions to between 40 and 45 per cent below 2005 levels (that is, 438 Mt and 402 Mt respectively).[4] However, this announcement was not accompanied by any new measures.

Even though technologies already exist that could allow Canada to meet its targets, whether by actual emission reductions (for example, Melton, *et al*, 2020) or by removing them after they are generated (for example, Omoregbe, *et al*, 2020), the required economic changes are nonetheless quite ambitious.

A Reference Case helps to make clear the level of that ambition. Based on existing trends and implemented policies—such as the rise in the carbon levy to $50 by 2022 and maintained at this level through 2030[5]—ECCC (2020) projects that emissions will decline to 674 Mt by 2030. This is already a significant reduction from 729 Mt in 2018 (excluding LULUCF, WCI and NBS).[6]

The announced HEHE measures—including those in Budget 2021—are intended to reduce emissions further to 468 Mt in 2030—including LULUCF, WCI and NBS.[7] HEHE measures include previously announced, but not yet implemented measures, and augments them to achieve a combined reduction of 167 Mt in 2030 (or 26 per cent, excluding LULUCF, NBS and WCI). The HEHE measures have five components:

1) Building retrofits;
2) Transportation policies for higher fuel efficiencies and electric vehicles;
3) Pricing GHG emissions at $170 per tonne;
4) Regulations/incentives/subsidies; and,
5) Lands, forestry, and agriculture.

After the Government's December 2020 announcement, much attention focussed on the carbon levy rising annually to $170 per tonne in 2030 (item 3).[8] But the other components are also important for reducing emissions. For this analysis, they will be grouped into an overarching "non-price" category of measures.

Our objective is two-fold. First, estimate how much of the 167 Mt reduction will come from increasing the carbon levy to $170 per tonne in 2030 (from $50 in 2022) and tightening the OBPS standard. This will serve to highlight how much of the projected reductions will be done by the non-price HEHE and Budget 2021 measures.

Second, we estimate the economic impact of the HEHE and Budget 2021 measures. For this, we optimistically conjecture that the non-price-based measures will be implemented by the Government with sufficient care that the actions they induce by firms and consumers are no more costly than specific price-based measures.

For example, if a price-based measure such as a levy is set at $170 per tonne of emissions from fuels, then we extend the non-price measures such that they induce actions by firms and consumers elsewhere in the economy that cost no more than $170 per tonne. This is optimistic because non-price-based measures such as regulations are often more costly than price-based measures to achieve the same objective (Box 1).[9]

Box 1 Price-based versus regulatory instruments

Economists generally view price-based instruments like the federal carbon levy as effective tools to reduce emissions while minimizing disruption to the economy. They allow policymakers to cap the costs of carbon abatement since that price itself represents the maximum cost. This provides important cost certainty with which firms and consumers can make economic decisions.

Price-based instruments harness the ability of markets to aggregate information and ensure costs imposed on firms and consumers are proportional to the pollution created by their actions.

Price-based instruments are most effective when: (a) it doesn't matter which firm is reducing the (polluting) activity; and (b) the regulator does not have full knowledge regarding firms' costs (that is, technology). This is particularly relevant in climate policy where firms are so diverse that firm-specific information about the costs of reducing greenhouse-gas emissions would be prohibitively costly to collect.

Alternative "non-price" instruments require firms to comply with specific requirements, such as technology or performance standards. They can be effective when the regulator has: (a) high-quality information; (b) there are serious consequences to government failing to precisely meet the objective; and (c) when the desired objective is best achieved by imposing similar requirements upon different firms.

With that caveat, this report supplements the analysis of increasing the carbon levy to $170 per tonne in 2030 with what is essentially the best-case scenario for the non-price measures.

Given that regulations must be very well chosen to mimic what market price signals would achieve, an obvious question is why governments would choose them instead of price signals. Sometimes the best policy might not be feasible: for example, whereas Ecofiscal Commission, 2019, strongly endorsed carbon pricing, IMF, 2021, warned against over-reliance on it precisely on the grounds of feasibility. Indeed, EcoFiscal Commission (2016) echoed a well-established economic principle laid out in Goulder (1995) that using revenues from carbon pricing to reduce existing distortionary taxes could provide the best benefit from policies to address climate change. That the $170 carbon levy is instead being given back to households suggests that feasibility was an important consideration in revenue recycling.

The next section begins with an outline of the Government's Reference Case. It is followed by PBO's quantitative analysis of the emissions reduction achieved by increasing the carbon levy to $170 per tonne in 2030, and then by the additional carbon price-equivalent of measures that will close the gap to 468 Mt. The report closes with a discussion of the Government's April announcement to further reduce GHG emissions by 2030.

Like earlier PBO reports, we use the computable general equilibrium model ENVISAGE (Environmental Impact and Sustainability Applied General Equilibrium) to quantify the analysis reported here.

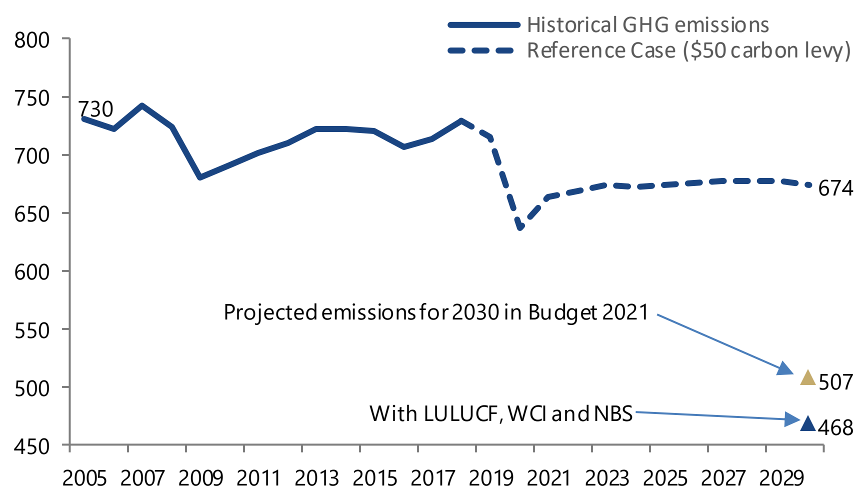
2. The Reference Case

Our analysis uses the 2020 Reference Case projection prepared by ECCC and published in the HEHE plan in December 2020 (ECCC, 2021). However, our use of the Reference Case does not imply an endorsement of its emissions projections through 2030. We simply use the Reference Case as a point of departure that emissions will go from 729 MT in 2018 to 674 Mt in 2030 (Figure 2-1).

ECCC notes that its Reference Case includes "all policies and measures funded, legislated and implemented by federal, provincial, and territorial governments as of September 2020". It does not include initiatives that have been announced but not yet "funded, legislated, or implemented". ECCC cites the announced Clean Fuel Standard (CFS)[10] and light-duty vehicle (LDV) regulations as examples of the latter.

Figure 2-1 Canada's GHG emissions projection – ECCC Reference Case

Megatonnes of CO_2 equivalent



Sources: Environment and Climate Change Canada and Office of the Parliamentary Budget Officer.

The effects of the 2020 COVID-19 pandemic are clearly visible in the projection. After a partial recovery during 2021, emissions are largely flat thereafter.

Among the noteworthy policies included in the ECCC Reference Case are the increased federal fuel charge to $50 per tonne in 2022, which remains at that level through to 2030. Also included are a basic implementation of the federal Output-Based Pricing System.

Those policies will impact on emissions across a broad range of activities. So, while emissions from transportation rose by 24 Mt between 2005 and 2018, they will fall by 8 Mt between 2018 and 2030 (Table 2-1). The rapid historical decline in emissions from electricity will continue as coal is phased out and natural gas plants become more efficient. At a very aggregated level, three of seven sectors would increase emission between 2018 and 2030 (oil and gas, heavy industry, and agriculture) while all others would fall with policies that had been implemented as of 2020.

Table 2-1 Sectoral emissions under ECCC Reference Case

Megatonnes of CO_2 equivalent	Historical		Reference Case (December 2020)	
	2005	2018	2020	2030
Electricity	119	64	38	21
Oil and gas	158	193	177	194
Heavy industry	87	78	65	82
Transportation	162	186	155	178
Agriculture	72	73	73	77
Buildings	86	92	90	82
Waste and others	47	42	39	41
Total (excl. LULUCF)	**730**	**729**	**637**	**674**

Source: Environment and Climate Change Canada.

Note: Projected emission levels correspond to the Reference Case in ECCC (2021b). The total does not include Land Use, Land Use Change and Forestry (LULUCF) which contribute: -13Mt in 2018, -25 Mt in 2020, and -17 Mt in 2030. Totals may not add up due to rounding.

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	
	2017-2019	2020-2024	2025-2030
Real GDP growth	2.4	1.1	1.8
Population growth	1.4	1.1	1.0
Labour force growth	1.5	0.5	0.5
Consumer price inflation	1.9	1.7	2.0

Sources: Office of the Parliamentary Budget Officer, Environment and Climate Change Canada, Finance Canada, Canada Energy Regulator and Statistics Canada.

PBO inferred the assumptions in Table 2-2 based on descriptions and sources provided in HEHE documentation. As a result of the pandemic, ECCC's Reference Case assumes slower average real GDP and price growth over 2020-2024. Real GDP growth is projected to average 1.1 per cent over 2020 to 2024, then increase to an average 1.8 per cent over 2025 to 2030. Average real GDP growth is projected to remain below pre-pandemic levels reflecting the aging demographic profile of the Canadian labour force.

3. Exceeding the Paris Target

Under the Paris Agreement, Canada committed to reduce its GHG emissions to 30 per cent below its 2005 level of 730 Mt by 2030. This translates into a target of 511 Mt in 2030.

Based on measures announced in the HEHE plan and Budget 2021, the Government projects that the reduction in emissions will exceed the Paris target, with emissions falling to 468 Mt in 2030, which would be 36 per cent below the 2005 level.

Relative to the Reference Case in 2030, this represents a reduction of 206 Mt, including 39 Mt in contributions from LULUCF, WCI and NBS. Thus, 167 Mt of the emissions reduction is due to the direct impacts of measures announced in the HEHE plan and Budget 2021.

Included in those measures is an additional $120 carbon pricing – indeed, probably its most important component. To partially disentangle those components, we use a modified version of the ENVISAGE model (van der Mensbrugghe, 2019) and the GTAP database (Aguiar et al., 2019; see Appendix A of PBO, 2020).

We begin by calibrating the model so it reproduces the aggregate profile of emissions in the ECCC 2020 Reference Case, and approximately reproduces the sectoral profile. Some differences between PBO and ECCC exist in the definitions of sectors, and these lead to some minor, but not consequential, effects on the analysis. This calibration is termed our *Reference Scenario* – it includes the $50 carbon levy and some basic OBPS measures (to 2030). Onto this scenario we then introduce the additional carbon levy and OBPS under the Government's HEHE plan.

Once the reduction in emissions from additional carbon pricing and OBPS is identified, we then estimate the (minimum) cost of reducing the remaining emissions to achieve the 2030 GHG level of 468 Mt that the Government projected in Budget 2021.

3.1. Contribution of additional carbon pricing and OBPS

The Government's assumptions regarding OBPS is a change from previous ECCC projections. OBPS is intended to mitigate the impact on international competitiveness of carbon pricing and does that by encouraging firms to reduce emissions while limiting the negative impact on their competitiveness (see Dobson, *et al*, 2017). In previous ECCC projections, the sectors covered by OBPS were expected to face an emission standard that was unchanged, but a carbon levy on part of their emissions that rose to $50 in 2022 and remain unchanged thereafter.

Under the HEHE projections, firms face an increasing carbon levy on emissions above the standard, but that standard decreases by 2 per cent per year to encourage greater efficiency (Table 3-1). We have updated our OBPS modelling to account for this illustrative ECCC change, as well as the special treatment of fossil fuels used for generating electricity.[11]

Table 3-1 OBPS sectors and OBS fractions

Estimated fraction of historical emission intensity that will be exempt from the levy

OBPS sector	OBS fraction	
	2022	2030
Mining, Oil and gas, Pipelines, Food and tobacco, Lumber, Pulp and paper mills, Non-ferrous metals, Miscellaneous manufacturing, Transport equipment manufacturing	80%	66%
Fertiliser, Petrochemicals, Petroleum products	90%	77%
Electricity using solid fuels	74%	46%
Electricity using liquid fuels	95%	63%
Electricity using gaseous fuels	95%	46%
Cement, Gypsum and lime, Iron and steel	95%	81%

Sources: Environment and Climate Change Canada and Office of the Parliamentary Budget Officer.

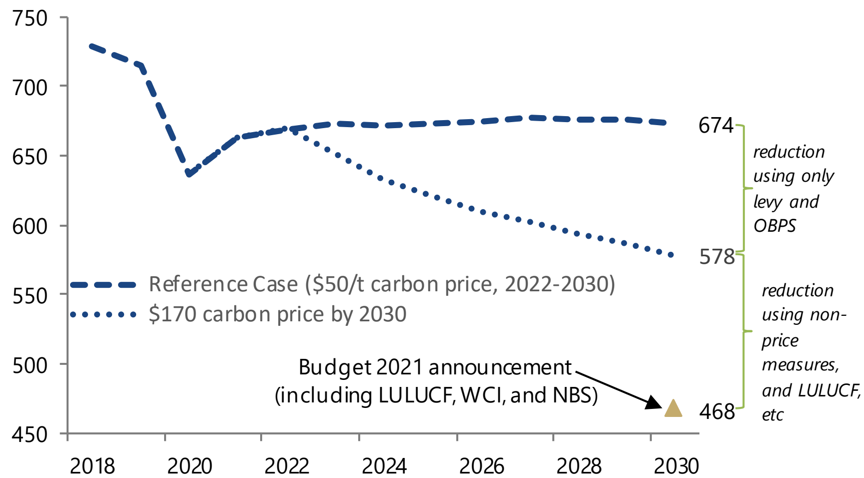
The partial change to the OBPS standard outlined in Table 3-1 places it between two earlier PBO scenarios (PBO, 2020).[12]

We estimate that the additional $120 carbon levy and enhanced OBPS will reduce emissions by 96 Mt by 2030 (Figure 3-1). The effect is weakest in agriculture, and waste and others (Table 3-2). Though the agriculture sector is subject to the levy on some of its activities, such as natural gas heating of buildings, the impact is small. The predominance of non-CO2 sources of emissions in waste and others also means that a carbon levy on fuels has little impact there.

Other sectors therefore have to contribute more to emissions reductions, including oil and gas, as well as transportation, with emissions in each of these two sectors falling by 30 Mt. Relative to our Reference Scenario, the levy would raise nominal gasoline prices in 2030 by about $0.27 per litre (for a total carbon levy of $0.38 per litre).

Figure 3-1 Projected GHG emissions with additional carbon pricing

Megatonnes of CO_2 equivalent



Sources: Environment and Climate Change Canada and Office of the Parliamentary Budget Officer.

Note: The reported reference emissions (674 Mt) and emissions with additional carbon pricing (578 Mt) do not include LULUCF, WCI and NBS, which reduce emissions by an additional 39 Mt.

Table 3-2 Sectoral GHG emissions with $120 additional carbon pricing and OBPS

	Reference Scenario levels in 2030*	Reductions in 2030	
	Mt	Mt	%
Electricity	28	-9	-31
Oil and gas	192	-30	-15
Heavy industry	64	-8	-13
Transportation	177	-30	-17
Agriculture	78	-0	-1
Buildings	75	-17	-23
Waste and others	61	-2	-4
Total	**674**	**-96**	**-14**

Source: Office of the Parliamentary Budget Officer.

Note: * Sectoral emissions in 2030 represent PBO's approximation of ECCC's Reference Case. Totals may not add up due to rounding.

3.2. Contribution of non-price measures

Based on the Government's estimates of reductions from LULUCF, WCI and NBS, non-price-based measures account for 71 Mt of additional abatement to achieve the emissions level of 468 Mt in 2030 projected in Budget 2021. That additional abatement is significant and will require effective measures.[13]

As announced, those measures span a wide range of policies: from building retrofits, to fuel standards, to transportation subsidies and even carbon capture. While it would be informative to outline a detailed description of each of the policies and their impacts, a more limited analysis could nonetheless serve to formulate some general conclusions. This could include, for example, their cost, both for the economy as a whole as well as for the cost (implicit and explicit) that firms and individuals will face for emissions.

Non-price measures impose costs on individuals and firms, for example by making them undertake expenditures, or change their operations to conform to the policy requirement. In principle, a price-based measure could achieve the same objective as a non-price measure. In such a case, the (implicit) cost of the non-price measure would be roughly the same as the price-based measure (though issues such as the treatment of revenues would still need to be dealt with).

This approach assigns an implicit carbon price to achieving a given reduction in GHG emissions. In this report, we assign an optimistic cost to the non-priced-based measures by using a price-based measure that achieves the same emission reduction. It is optimistic because it assumes that the Government has very detailed information concerning the operations of a large number of regulated firms (see Box 1).

However, like all scenarios where a levy is imposed, additional revenues are generated – whose use could engender important secondary effects. Here we deal with this issue by assuming these proceeds are refunded to households. Admittedly, this is itself not a completely neutral solution to the revenue-recycling question, but it engages fewer secondary effects such as the returns to government or private investment – or even the ability of green investments to generate super-normal returns.

Given the widespread nature of the non-price policies, we impose their price equivalent across the entire economy. Because extending the equivalent of a $170 (nominal) carbon price to all sectors is not sufficient to reach the target, we raise the carbon price and its equivalent throughout the economy until the 468 Mt level of emissions is achieved in 2030.

OBPS sectors also face the higher carbon price, but without additional changes to their performance standard. (Table 3-1). This may cause some upward bias in the carbon price since it implies some measure of protection to those sectors.

We thus estimate that the price and non-price policies needed to reach the Government's projection of 468 Mt in 2030 would have to be the equivalent of an additional $91 per tonne across all sources of emissions. This brings the combined measures to the equivalent of a carbon levy of $211 per tonne ($120+$91) (see endnote 5 for conversion of 2019 dollars) above the $50 per tonne in 2022. This price is only a little lower than Melton, et al, (2020) for a similar reduction (about $270 in constant 2019 dollars for a 200 Mt reduction in 2030).

Across sectors, there is now a more even proportional distribution of reductions except for agriculture (Table 3-3). All sectors are impacted, with electricity again showing the biggest proportionate decline relative to the Reference Scenario. The magnitude of these changes, particularly for oil and gas, imply substantial change. Without a more rapid development and implementation of technologies to reduce emissions, the scenario implies that output will have to be lower if exports cannot be increased.

Table 3-3 Sectoral emissions with measures

	Reference Scenario	Additional carbon pricing	Additional price and non-price measures	Total reduction
Electricity	28	19	16	-12
Oil and gas	192	163	139	-54
Heavy industry	64	56	51	-13
Transportation	177	147	132	-45
Agriculture	78	78	77	-1
Buildings	75	58	50	-25
Waste and others	61	59	43	-18
Total	**674**	**540***	**468***	**-168**

Source: Office of the Parliamentary Budget Officer.

Note: PBO's Reference Scenario approximates ECCC's Reference Case but differences persist due to sectoral definitions and other issues. Additional pricing includes increasing the carbon levy by $120/t and increasing OBPS stringency. The total reduction represents the difference between emissions under the additional price and non-price measures scenario relative to the Reference Scenario.

(*) including LULUCF, WCI and NBS.

4. Economic Impacts

As HEHE and Budget 2021 measures discourage the use of existing emission-causing technologies, they will impact on Canada's economy—even after accounting for investment and employment in alternative technologies. This is inevitable in a competitive economy, unless unusual economic conditions exist that could mitigate or even offset the cost of policies that address climate change.[14]

PBO's previous analysis treated the federal carbon price as applying nationally since provinces are required to adopt policies that are roughly equivalent to the federal carbon pricing backstop. But now that the Government has been more explicit about how revenues from the increased carbon price and OBPS will be dealt with, we can refine our analysis to consider the differences in policies. Given the sensitivity of the economic impacts to revenue recycling, this is an improvement on our earlier work.

In our October 2020 report, we assumed—for lack of indications otherwise—that all federal fuel charge and OBPS revenues were returned to households. Based on our review of current provincial plans, we now infer that 80 per cent of the additional federal fuel charge proceeds will be returned to households, with the remainder being used for government spending.[15] By contrast, we infer that 100 per cent of OBPS proceeds are used for government spending.[16] Consequently, this increases the negative impact on GDP relative to the case where all the revenues were given back to consumers.[17]

The secondary effects of the policy on government revenues cause a long-term deterioration in government savings (similar to McKitrick and Aliakbari, 2021).

We estimate that increasing the carbon levy from $50 per tonne in 2022 to $170 per tonne in 2030 and tightening OBPS standards would reduce Canada's real GDP by 0.8 per cent in 2030. Furthermore, if the HEHE and Budget 2021 non-price policies are achieved at the optimistic cost (that is, equivalent to carbon pricing), we estimate that non-price policies would reduce Canada's GDP by an additional 0.6 per cent.

Of course, that GDP loss is not intended to be viewed in isolation. Climate change itself will have potential costs, and unforeseen breakthrough technologies could reduce that loss. Indeed, there is a nascent literature that suggests carbon pricing may have less of a negative economic impact.[18] Nonetheless, we provide the estimate as a point of reference for projecting future economic growth and government balances.

Overall, we estimate that reaching the projected emissions level of 468 Mt in 2030 would reduce Canada's real GDP by 1.4 per cent by 2030 (Table 4-1). This is higher than the Government's estimate of the economic impact of HEHE measures (no impact was provided for the measures in Budget 2021).[19]

Table 4-1 Economic impact of HEHE and Budget 2021 to 2030

	Additional carbon price (per tonne)[a]	Emissions reduction[b]	GDP impact in 2030[c]
HEHE carbon levy and OBPS	$120	96 Mt	-0.8%
Non-price policies (implicit price)[d]	$91	71 Mt	-0.6%
Total impact in 2030	**$211**	**167 Mt**	**-1.4%**

Source: Office of the Parliamentary Budget Officer.

Note: (a) Beyond the $50 per tonne over 2022-2030. Nominal dollars: to convert to 2019 dollars, divide by 1.258.

(b) Not including LULUCF, WCI and NBS.

(c) The impact is measured as the percentage difference between the level of real GDP in 2030 (under the Reference Scenario) and the level of real GDP in 2030 projected under HEHE and Budget 2021 measures.

(d) Minimum cost is achieved by using an equivalent price instrument.

Budget 2021 also proposes a border price adjustment to ensure that imports coming into Canada are priced for the carbon emissions that they induced in production. In principle, the border price adjustment and OBPS are substitutes since they both seek to level the playing field between Canada and the rest of the world. In practice, however, they are both complements and substitutes, and using both creates significant complications (Box 2).

Box 2 OBPS, BPA and levelling the playing field

Higher cost for emissions translates to higher operating costs for Canadian firms. This is particularly a concern for those that are so-called energy-intensive trade-exposed (EITE). Such firms could be put at a competitive disadvantage vis-à-vis their international counterparts.

The inclusion of a proposal for border price adjustment (BPA) in Budget 2021 means that such a policy will supplement OBPS – if BPA is permitted under World Trade Organisation rules. This creates some risks to a level playing field. Output-based pricing (OBS – a more generic term for Canada's OBPS) and BPA can be duplicative or complementary.

OBS works by having firms face the full carbon levy, but only pay it on a portion of their emissions. They then respond as if all emissions were levied (see Dobson, et al, 2017; Sawyer and Stiebert, 2017). BPA, on the other hand, works by adjusting prices at the border, so goods coming into Canada are not exempt when their production was associated with substantial untaxed emissions abroad (Droege and Fischer, 2020).

If firms that are covered by OBS also have a BPA applied to competitive goods coming from abroad, then those firms will gain an extra measure of protection in their domestic markets. So a policy that was meant to mitigate the carbon levy will give them a competitive advantage (at a cost to consumers).

As outlined in previous PBO publications, if other countries implement carbon pricing to reduce emissions in their industrial sectors, the case for OBS and BPA becomes less clear.

4.1. Sectoral impacts

We provide estimates of the sectoral and labour market impacts from increasing the carbon levy from $50 per tonne in 2022 to $170 per tonne in 2030 and tightening OBPS standards. We do not include a sectoral economic impact of non-pricing measures as our "minimum cost" assumption of the cost of these measures is less precise at the sectoral level.

We estimate that increasing the carbon levy and tightening OBPS standards will have the largest negative economic impact on the transportation, and oil and gas sectors (Table 4-2). By contrast, real GDP in heavy industry and agriculture are projected to increase as these industries are sheltered from full carbon pricing due to OBPS and other exemptions and therefore benefit from a reallocation of resources.[20]

Electricity generation is also projected to increase and to lead to significant compositional changes within the sector. Electricity generated by renewables is projected to replace generation by fossil fuel sources over time.

Table 4-2 Sectoral impacts of additional carbon pricing and OBPS

Real GDP, percentage difference from Reference Scenario

	2023	2024-2026	2027-2029	2030
Electricity	0.7	1.3	2.2	2.7
Oil and Gas	-2.6	-5.6	-9.2	-10.8
Heavy Industry	-0.1	0.7	1.5	1.7
Transportation	-3.1	-8.1	-13.5	-16.2
Agriculture and Fishing	0.2	0.7	1.5	2.1
Buildings	-0.1	-0.1	-0.2	-0.2
Waste and others	0.2	0.3	0.3	0.3
Total	**-0.1**	**-0.3**	**-0.6**	**-0.8**

Source: Office of the Parliamentary Budget Officer.

Our estimate of the total impact on Canada's real GDP is driven primarily by a contraction in the oil and gas sector (Table 4-3).

These results illustrate the notion that some sectors (green) will gain as a result of climate policy. That gain, however, is not enough to overcome the adverse impact on existing carbon-based activities.

Table 4-3 Sectoral contribution to aggregate economic impact of additional carbon pricing and OBPS

Contribution to real GDP impact, percentage points

	2023	2024-2026	2027-2029	2030
Electricity	0.0	0.0	0.0	0.0
Oil and Gas	-0.2	-0.4	-0.7	-0.8
Heavy Industry	0.0	0.1	0.1	0.2
Transportation	0.0	-0.1	-0.2	-0.3
Agriculture and Fishing	0.0	0.0	0.0	0.0
Buildings	0.0	0.0	0.0	0.0
Waste and others	0.1	0.2	0.2	0.2
Total	**-0.1**	**-0.3**	**-0.6**	**-0.8**

Source: Office of the Parliamentary Budget Officer.

4.2. Labour market impacts

We also provide estimates of increasing the carbon levy and tightening OBPS standards on workers in affected sectors of the economy. PBO's model (ENVISAGE) gives a result from policy that is all-encompassing. That is, it looks beyond the short- to medium-term repercussions. This means that labour will respond to the policy and find a new equilibrium. Since these policies are not expected to impact on structural factors that determine the long-term rate of unemployment,[21] there may be (significant) job turnover, but it will not be permanent.[22]

When long-term unemployment is not affected, there will instead be an impact on wages as workers have to make their way into other sectors. We estimate that increasing the carbon levy and tightening OBPS will reduce total real labour income by 1.2 per cent by 2030 which is higher than the estimated impact on real GDP (Table 4-4). Our modelling suggests that the reallocation of employment between sectors explains the majority of the change in real labour income.

Table 4-4 Impact of additional carbon pricing and OBPS on real labour income

Real labour income, percentage difference from Reference Scenario

	2023	2024-2026	2027-2029	2030
Electricity	0.4	0.9	1.5	1.9
Oil and Gas	-2.1	-5.0	-8.7	-10.6
Heavy Industry	-0.1	-0.1	-0.1	-0.3
Transportation	-0.8	-2.0	-3.3	-4.0
Agriculture and Fishing	-0.2	0.1	0.5	0.6
Buildings	-0.1	-0.5	-1.1	-1.5
Waste and others	0.2	0.0	-0.5	-0.8
Total	**0.0**	**-0.3**	**-0.8**	**-1.2**

Source: Office of the Parliamentary Budget Officer.

Workers in the oil and gas sector and transportation industries are projected to see the largest aggregate income losses (Table 4-5). By contrast, real labour income is projected to rise modestly for workers in electricity and agriculture sectors.

Table 4-5 Impact of additional carbon pricing and OBPS on workers with less than a high school diploma

Real labour income, percentage difference from Reference Scenario

	2023	2024-2026	2027-2029	2030
Electricity	0.2	0.6	1.3	1.6
Oil and Gas	-2.4	-5.1	-8.8	-10.7
Heavy Industry	-0.3	-0.2	-0.2	-0.3
Transportation	-0.9	-1.8	-2.8	-3.2
Agriculture and Fishing	-0.2	0.1	0.5	0.7
Buildings	-0.3	-0.7	-1.3	-1.8
Waste and others	-0.1	-0.4	-0.9	-1.3
Total	**-0.3**	**-0.6**	**-1.2**	**-1.6**

Source: Office of the Parliamentary Budget Officer.

We estimate that real labour income will fall by 1.6 per cent for workers with less than a high school diploma and by 1.0 per cent for workers with a high school diploma or higher level of education (Table 4-6).[23]

Table 4-6 Impact of additional carbon pricing and OBPS on workers with a high school diploma or higher

Real labour income, percentage difference from Reference Scenario

	2023	2024-2026	2027-2029	2030
Electricity	0.6	1.1	1.8	2.1
Oil and Gas	-2.0	-4.8	-8.6	-10.5
Heavy Industry	0.0	0.0	-0.1	-0.3
Transportation	-0.7	-2.2	-3.8	-4.6
Agriculture and Fishing	0.1	0.3	0.5	0.5
Buildings	0.0	-0.3	-0.9	-1.4
Waste and others	0.4	0.2	-0.2	-0.5
Total	**0.2**	**-0.1**	**-0.6**	**-1.0**

Source: Office of the Parliamentary Budget Officer.

5. Beyond HEHE and Budget 2021

On April 22, 2021, the Government announced its intention to reduce Canada's GHG emissions below the 468 Mt projected in Budget 2021 to 40 to 45 per cent below 2005 levels (Figure 5-1).

Since there are no policy details yet available supporting this announcement, it creates an additional gap that is at least 30 Mt (and potentially 66 Mt) that will need to be closed.

Figure 5-1 **Announcements and projected GHG emissions in 2030**

• **Reference Case emissions in 2030**	674 MtCO2e	
		With $120 additional carbon pricing and other policies
• ***Paris target***	*511 MtCO2e**	
• **December 2020 HEHE policy scenario emissions**	503 MtCO2e*	
		Additional non-price policies (some unspecified)
• **Budget 2021 announcement**	468 MtCO2e*	
		Gap
• **April 2021 announcement of 40 to 45 % below 2005**	438 to 402 MtCO2e*	

Sources: Environment and Climate Change Canada and Office of the Parliamentary Budget Officer.

Note: (*) Including LULUCF, WCI and NBS which reduce reported emissions by 39 Mt under HEHE and 29 Mt in the Reference Case.

Even the less aggressive 40 per cent objective would require a reduction from the Reference Case of 236 Mt.

Given the carbon pricing noted above (implicit or explicit) required for reaching the less ambitious level of 468 Mt, it is clear that it will take extraordinary measures to achieve that objective. Examples of the scale of changes that would be needed for an additional 30 Mt reduction include (these are already partially achieved under the Budget 2021 projection):

(1) An *additional* 6 million passenger vehicles are zero-emission vehicles by 2030, or

(2) oil sands improve emission efficiency by an *additional* 50 per cent over what is already achieved in the Reference Case, or

(3) *additional* 50 per cent reduction in combined natural gas and oil use-based CO2 for heating all buildings.

The needed technologies are already available. Respectively, (1) electric cars and light trucks; (2) small modular nuclear reactors; and, (3) heat pumps. Each would make it possible to reduce emissions by the 30 Mt. Moreover, the technologies outlined in Melton, *et al*, (2020) could be further incentivised to come online more rapidly.

The challenge, however, is in the speed and scale of their implementation. For example, annual sales in Canada of cars and light trucks were just under 2 million units before the COVID-19 pandemic. The total stock of such vehicles in Canada is about 23 million. So, to change Canada's vehicle fleet to contribute meaningfully to the revised goal, roughly half of new vehicle sales starting in 2022 would have to be zero-emission (and be charged with zero-emission electricity). Only a prohibitively high subsidy could achieve that objective. Similar considerations enter into the rapid deployment of heat pumps in buildings, and small modular reactors in oil sands and other industrial activity. A combination of such changes would spread the cost across more of the economy, but also risks undermining some of the large fixed capital costs that may be needed, for example to upgrade the electricity generating capacity that would be necessary for large numbers of electric vehicles.

Thus, the main obstacle that must be overcome in each case is the need to replace existing equipment on a large scale. The private sector will not replace existing capital on its own unless there is a significant incentive to do so. If the Government were to provide subsidies rather than carbon pricing to reach the objective, the costs of achieving the last 30 Mt reduction could reach prohibitive levels for public finances. Getting the right public/private strategy is likely to become one of loss minimisation for the economy as a whole—that will have to consider feasibility at all levels.

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Notes

1. In this report we distinguish between ECCC's Reference Case and PBO's Reference Scenario. The difference between the two is only seen at the sectoral level, and is caused by some differences in definition of sectors. The results reported in the paper are not sensitive to that distinction.
2. Canada's target as negotiated under the Paris Agreement is 511 Mt of carbon dioxide equivalent emissions in 2030. It also made a long-term commitment to contribute to a global commitment to limit global temperature changes to between 1.5 and 2 degrees Celsius. The Government's net-zero target for 2050 is part of its attempt to fulfil that longer-term commitment.
3. This includes 39 Mt from LULUCF, WCI and NBS. LULUCF (Land-use and land-use change; https://unfccc.int/topics/land-use/workstreams/land-use--land-use-change-and-forestry-lulucf), WCI (Western Climate Initiative; https://wci-inc.org/) and NBS (nature-based solutions; ECCC, 2020b). Projected reductions: LULUCF, 17 Mt; WCI, 12 Mt; NBS, 10 Mt.
4. See the Prime Minister's April 22 announcement: https://pm.gc.ca/en/news/news-releases/2021/04/22/prime-minister-trudeau-announces-increased-climate-ambition.
5. Since the Government's carbon levy has been set in nominal terms, unless otherwise stated, all dollar figures in this report are nominal. To obtain the equivalent value in constant 2019 dollars they should be divided by 1.258. So, in 2030: nominal $50, $120, and $170 will be $40, $95, and $135 in 2019 dollars, respectively.
6. Prior to this announcement, the Government had projected that its policies under the Pan-Canadian framework would not achieve the Paris Agreement target (see PBO, 2020). For example, in the Fourth Biennial Report (ECCC, 2019), it had outlined a best case (with all announced and not-yet-implemented policies) would have lowered emissions to 588 Mt, or still some 77 Mt above the 511 Mt target in 2030.
7. Well below Canada's Paris Agreement target for 2030, but more in line with the Agreement's primary objective to limit the global average temperature increase of no more than 2 degrees (Celsius) above pre-industrial levels. Canada's nationally determined contributions (NDCs) for emissions in 2030 was to reduce them by 25 per cent below their levels in 2005 (that is, to 511 Mt).
8. Since the Government's carbon levy has been set in nominal terms, unless otherwise stated, all dollar figures in this report are nominal. To obtain the equivalent value in constant 2019 dollars in 2030, nominal amounts should be divided by 1.258. So, in 2030: nominal $50, $120, and $170 will be $40, $95, and $135 in 2019 dollars, respectively.
9. See Hepburn (2006) for a broader discussion but there is a large literature that followed Weitzman (1974).

10. 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.

11. The OBPS assigns different standards to electricity generation according to the type of fuel used. We assume that by 2030 electricity generated by solid fuels converges to the 2019 standard for gaseous fuels, the standard for gaseous fuels converges to zero. See: https://www.canada.ca/en/environment-climate-change/services/climate-change/pricing-pollution-how-it-will-work/industry/pricing-carbon-pollution.html and: https://laws-lois.justice.gc.ca/eng/regulations/SOR-2019-266/page-15.html#h-1185036

12. In PBO (2020), two OBPS cases were examined. The first was with a "dynamic" OBPS structure that updated the emissions standard over time so that firms always faced the equivalent of the carbon levy on a fixed portion of their emissions. This is different from the profile in Table 3-1, where the standard is declining at a fixed rate. In the current scenario, the proportion of emissions that are levied can change from year to year.

    The second case in the earlier PBO analysis was where the OBPS structure was "static" such that the emissions standard was fixed over time and OBPS firms never paid more $50 per tonne even while the rest of the economy faced levies substantially higher. A justification for that scenario was to avoid continued deterioration of competitiveness by Canadian firms.

    In that work, PBO pointed out that since the OBPS sectors represented some 35 per cent of emissions, shielding them from the carbon levy (the Static scenario) would cause the price of emissions to increase substantially in the rest of the economy.

13. An important part is covered by the Clean Fuel Standard. Based on ECCC estimates, the CFS will reduce emissions by 20 Mt, leaving a 51 Mt reduction to be done with other non-price policies.

14. Such conditions include: (a) large-scale market failures such that emission reductions can be achieved at a negative cost (some of which were identified in McKinsey (2009), or (b) large-scale opportunities for low-cost alternative technologies (as in Shapiro and Metcalf, 2021), or (c) behavioural biases that create sufficiently large economic distortions (Schleifer, 2012). But while all three might exist to some extent, the scale necessary to achieve a macro-economic net gain in aggressive climate change policy seems implausible.

15. In Quebec and Nova Scotia, for example, carbon pricing proceeds are earmarked for government funding for environmental initiatives. See: https://novascotia.ca/news/release/?id=20210202004 and https://www.environnement.gouv.qc.ca/changementsclimatiques/index-en.htm.

16. The federal government has indicated that for provinces without their own pricing mechanism, the recycling approach "will be guided by a number of considerations, including ensuring the proceeds remain in the jurisdiction where they were collected, ensuring transparency, driving further emission reductions, and supporting innovation and the transition to a low-carbon economy." See: https://www.canada.ca/en/environment-climate-change/services/climate-change/pricing-pollution-how-it-will-work/output-based-pricing-system/use-of-proceeds.html.

17. When the funds used by government are very well invested in highly productive assets and technologies, the effect can be positive (Ecofiscal, 2016). This report does not make that assumption.

18. That literature notes a potential positive impact of carbon pricing (for example, Shapiro and Metcalf, 2021 and Acemoglu, *et al*, 2016). It relies on endogenous technological change where new technologies appear – in response to carbon taxes – that are more productive than existing technologies. If so, PBO's results may overstate the negative effects of those policies.

    While such a scenario is possible (numerous past technological changes have transformed economies – and societies – because they were so much cheaper than their predecessors), it is not predictable. This is evidenced by the longstanding promise of nuclear fusion, or hydrogen fuel cells, among others. They have taken a very long time to develop and are still not competitive with alternatives. So the negative impact of a policy relying on them could persist for a long time before gains are realised. PBO's modelling – and the negative impact it illustrates – is thus an anchor on expectations, rather than a forecast *per se*.

19. ECCC modelling estimates that HEHE policies would reduce Canada's annual real GDP growth by 0.05 per cent. See: https://www.canada.ca/en/services/environment/weather/climatechange/climate-plan/climate-plan-overview/healthy-environment-healthy-economy/annex-modelling-analysis.html#toc9.

20. Biological emissions from animal production are exempt from carbon pricing. Farm fuel use may be subject to pricing but rebates are available in some jurisdictions. See: https://www.agr.gc.ca/eng/canadas-agriculture-sectors/agriculture-and-climate-change-policy-financial-impacts-of-carbon-pricing-on-canadian-farms-2018/?id=1589401385043.

    Our modelling suggests that it is less costly for heavy industry to substitute to cleaner energy sources and lower its overall energy inputs to production than for other activities.

21. Or what economists term the non-accelerating inflation rate of unemployment (NAIRU). For more discussion of factors that influence the NAIRU see Gianella, et al, (2008). OECD (2018) also found a neutral impact on employment when policies are well chosen.

22. Recent studies such as Caranci and Fong (2021) are thus more focused on the economic transition to lower emissions. Indeed, the more rapid is that transition, the more likely it is for a stronger disruption and labour dislocation.

23. Our labour market data is based on Shared Socioeconomic Pathways (SSP) database 2.0. We use Scenario 2 (SSP2). We define skilled labour as workers with a high school diploma or higher level of education and unskilled labour as workers without a high school diploma. See: https://tntcat.iiasa.ac.at/SspDb/dsd?Action=htmlpage&page=10.