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Executive Summary

In December 2016, the Government of Canada, along with most provinces and territories agreed to the Pan-Canadian Framework on Clean Growth and Climate Change to use a Pricing carbon as the central mechanism to reduce the greenhouse gas (GHG) emissions.[1]

On 20 March 2017, Mark Warawa, MP, introduced a private member's bill, Bill C-342. The bill amends the *Excise Tax Act* to provide that any tax, duty or fee imposed in respect of carbon is excluded from the total purchase price for the purpose of calculating the goods and services tax. On 25 October 2017 the bill was defeated at second reading in the House of Commons. The analysis in this report may be useful in determining the impact of a Canada-wide carbon pricing policy on revenue from the goods and services tax.

The two primary carbon pricing systems that have been implemented at a provincial level are, a) direct pricing (such as a carbon tax like British Columbia or a carbon levy in Alberta), and b) cap-and-trade (C&T) system (e.g., Ontario and Quebec). These two mechanisms are the models that could be followed by the other provinces.[2]

The federal government has stated that carbon pricing systems will be revenue neutral, with any revenues generated under the system staying in the province or territory where they are generated.[3] However, some provinces, such as Alberta and British Columbia, have argued that the federal government gets benefits from the carbon prices through the good and service tax (GST).[4] The latter is a 5% tax that is charged in the final amount of a good or service.

The carbon tax or levy is a direct pricing mechanism which is applied at downstream levels and is included in the final price of products, such as diesel, gasoline, natural gas and propane. Taking into account the fact that the carbon tax affects the final price directly, the GST portion of the projected tax/levy revenues could be an approximation of the federal financial benefits from these carbon prices in B.C. and Alberta.

A carbon pricing system based on the C&T system in Ontario and Quebec is applied at the upstream level of the production of goods and services. In general, the provincial government creates and distributes emission quotas through an auction. Numerous industrial and commercial companies are required to purchase certain emission rights to continue the supply of their goods and services. Hence, the unit production cost for these companies will likely increase. The cost of the pollution right (the auction price) fee could be "passed through" to the final consumer of the product through an increase in the sale price.

We consider these two systems to estimate the cost of excluding tax, duty or fee imposed by a province in respect of carbon from the calculation of the GST. The PBO has also used various methodologies to estimate a range of carbon pricing deduction amounts from GST for two fiscal years (Summary Table 1).

The total amount of GST collected on carbon pricing in the four provinces is anticipated to be between $236 million and $267 million in 2017-18 and between $265 million and $313 million in 2018-19.

The range of the estimated GST collected on carbon taxes in B.C. and Alberta is between $121 million and $131 million in 2017-18 and between $142 million and $169 million in 2018-19.

The GST collected on C&T system in Ontario and Quebec could be between $115 million and $136 million in 2017-18 and between $123 million and $143 million in 2018-19.

Summary Table 1 Range of C-342- cost of carbon pricing deductions from GST in British Columbia, Alberta, Ontario and Quebec

Province	Period	Potential GST range ($ million)
B.C.	2017-18	62.6-69.5
	2018-19	63.8-69.5
Alberta	2017-18	58.4-61.7
	2018-19	78.0-99.7
Ontario	2017-18	79.6-96.3
	2018-19	84.9-101.8
Quebec	2017-18	35.7-39.8
	2018-19	37.9-41.6
Total	2017-18	236.3-267.3
	2018-19	264.6-312.6

Source: PBO calculations.

The estimates of GST in Alberta, Ontario and Quebec assume that businesses in the industrial sector will not pass the carbon taxes on to customers and that only the emitters in residential, commercial and transport sectors pass-through the full-cost.

Many facilities in the industrial sector, such as aluminum, chemical and petrochemical industry, metallurgy, mining and pelletizing, pulp and paper and petroleum refining, use energy-intensive inputs and are highly exposed to international competition. Provinces applying GHG regulations as Alberta and Quebec argue that carbon pricing applied to these trade-exposed businesses may increase their trade costs and decrease their competitiveness if their international competitors do not undergo comparable GHG

policies.[5, 6] Hence, many of these manufacturers could relocate to countries with less or without GHG restrictions. To avoid this phenomenon, known as "carbon leakage," each province uses some less stringent GHG standards in the industrial sector.

Regarding C&T systems, the trade-exposed businesses in Quebec and Ontario receive assistance in the form of emission allowances distributed free of charge. Also, Alberta's businesses that emit more than 100,000 tonnes of CO_2eq per year, including electricity producers, are subject to the Specified Gas Emitters Regulation (SGER) rather than the carbon levy. Under the SGER, many facilities will be allowed to emit a certain amount of greenhouse gases, free of charge from the carbon levy.[7]

Regarding British Columbia, the industrial sector is included in our calculations because many businesses in the oil and gas industry have to pay a carbon tax for their GHG emission.[8]

However, the portion of the carbon tax/levy paid by businesses in Alberta and British Columbia is restored through corporate income tax reductions. PBO considers an alternative scenario in which all or some of businesses exposed to the carbon tax (levy) in B.C. and Alberta could benefit from this income tax cut. The latter could be an incentive for these businesses to not or partially pass through the carbon cost to the final price of their product.

1. Background

Carbon pricing is one of the most popular environmental policies to reduce Greenhouse Gas (GHG) emissions at the local, national and continental levels.[9] The Congressional Budget Office suggests that putting a price on GHG emissions is the most effective approach to reducing emissions of CO_2 because it involves giving businesses and households an economic incentive for such reductions.[10] According to the World Bank, the two most commonly discussed methods of pricing carbon are carbon taxation and Cap &Trade, sometimes referred to emission trading systems (ETS).[11]

Carbon Pricing Leadership Coalition (CPLC)

According to the World Bank, the CPLC is a voluntary partnership of national and sub-national governments, businesses, and civil society organizations that agree to advance the carbon pricing agenda by working with each other towards the long-term objective of a carbon price applied throughout the global economy.

The Carbon pricing Leadership Coalition defines a carbon tax as a price directly imposed on carbon through a tax rate on greenhouse gas emissions or – more commonly – on the carbon content of fossil fuels. [12] British Columbia and Alberta have used a carbon tax to reduce GHG emissions since 2008 and 2015, respectively.[13]

Cap-and-trade systems set a firm limit or cap on GHGs and aim to minimize the compliance costs of reducing GHG emissions.[14] In general, the government creates and distributes emission quotas through an auction. The cap declines each year requiring polluters that exceed their emissions quota to buy unused allowances from the government and/or other companies. Thus, the emissions market determines the price of allowances under this system and the cap creates incentives to reduce GHGs below allowable levels through investments in clean technologies.[12] Quebec implemented a cap-and-trade system in 2013 through the Western Climate Initiative (WCI). Ontario joined the WCI, which included Quebec and California, in 2017.

In the following subsections, PBO presents a detailed description of the carbon pricing systems in B.C., Alberta, Quebec, and Ontario.

1.1. Carbon tax systems in B.C. and Alberta

British Columbia

B.C.'s carbon price has been in place since 2008 and covers approximately 75% of the province's economy.[15] The 2008 tax rates are based on $10 per tonne of CO_2 equivalent emissions, and increased by $5 per tonne each year for the next four years to $30 per tonne in 2012.[16]

Carbon pricing in B.C. is a broad-based tax that applies to the purchase or use of fuels, such as gasoline, diesel, natural gas, heating oil, propane, and coal unless specifically exempted.[17] The use of fuels includes all uses, even if

the fuel is not combusted. A carbon tax also applies to the use of combustibles, such as peat and tires, when used to produce heat or energy.[18]

According to the climate action plan of B.C., all carbon-price generated revenue is returned to taxpayers through tax reductions (Neutral revenue carbon price).[19] The potential additional costs paid by individuals and businesses is offset, in the aggregate, by reductions in their income tax. Additionally, a one-time $100 Climate Action Dividend is paid to all British Columbians each year.[20]

Alberta

The Alberta carbon pricing system is a hybrid system which contains two principal components:

1. **A carbon levy** similar to that in B.C., which is applied to the price of all fuels that emit greenhouse gases when combusted, including transportation and heating fuels such as diesel, gasoline, natural gas and propane. The levy has been applied at a rate of $20/tonne of CO_2 equivalent emissions since January 1, 2017, and will increase to $30/tonne in 2018.[21]
2. According to Alberta's climate leadership plan, Alberta's facilities that emit more than 100,000 tonnes of CO_2eq per year, including electricity producers, are subject to the **Specified Gas Emitters Regulation (SGER)** rather than the carbon levy. These facilities include Alberta's largest trade-exposed facilities,[22] such as oil and gas and industrial manufacturing facilities. The SGER for large trade-exposed industry, provides options that include offsets and payments into the Climate Change and Emissions Management Fund (CCEMF). The CCEMF price increased from $15 per tonne to $20 in 2016 and $30 in 2017.[23]

A portion of revenues generated from this system is returned to businesses and consumers through the small business tax cut and household rebates. The remainder is invested in programs that reduce emissions and diversify the economy such as large scale renewable energy, bioenergy and technology, and green infrastructure like transit.[24]

1.2. Cap-and-Trade system in Quebec and Ontario

Western Climate Initiative (WCI)

Western Climate Initiative, Inc. (WCI, Inc.) is a non-profit corporation formed to provide administrative and technical services to support the implementation of state and provincial greenhouse gas emissions trading programs. The Board of Directors for WCI, Inc. includes officials from the provinces of Quebec, British Columbia, Ontario, and the State of California. The services provided by WCI, Inc. can be expanded to support jurisdictions that join in the future.

In April 2008, Quebec joined the Western Climate Initiative (WCI) and has taken part of the WCI cap-and trade (C&T) system for greenhouse gas (GHG) emission allowances since 2013.[25] Quebec's system has been linked to California's system since 2014, and to that of Ontario since 2017.

The C&T mechanism in Quebec and Ontario is intended for companies in the industrial and electricity sectors that emit 25,000 metric tons of equivalent CO_2 annually (ex: aluminum smelters, cement factories, electricity producers, etc.), as well as fossil fuel distributors that must cover GHG emissions associated with all products they distribute (gasoline, diesel fuels, propane, natural gas and heating oil).[25,26]

C&T system for the fossil fuels and for the industrial sector

- According to Quebec and Ontario C&T programs, distributors of fuels and combustibles covered by the C&T system do not receive free GHG emission units. Rather, they are required to purchase all allowances needed to cover emissions attributable to the combustion of the fossil fuels they sell for consumption in Quebec and Ontario.
- According to the Sections 39 to 44 of the Quebec *Regulation respecting a cap-and-trade system for greenhouse gas emission allowances*, the emitters that are part of the following sectors will receive assistance in the form of emission allowances distributed free of charge in order to mitigate the impacts on the competitiveness of Quebec's industrial sector: aluminium; lime; cement; chemical and petrochemical industry; metallurgy; mining and pelletizing; pulp and paper; petroleum refining; glass containers, electrodes, gypsum products; and some agri-food establishments. Thermal power producers that signed long-term supply contracts before January 1st, 2008, under which pricing is predetermined and which have no cost-sharing clauses pertaining to GHG emission regulation will also benefits from free emission allowances.
- According to the Ontario C&T program, all emitters can apply for a distribution of emission allowances free of charge except those that are electricity generators or involved in electricity importation and transmission, producing or supplying petroleum, and distributing natural gas.

The government of Quebec may hold GHG emission unit auctions separately or jointly with other governments with which it has a carbon market linkage agreement in place, as is currently the case with California and Ontario. A minimum (reserve) auction price is set each year.[27] These prices may differ among partner jurisdictions due to differing annual rates of inflation.[28] For joint auctions, the minimum bid price will be the higher of Quebec and California minimum prices on auction day, based on the latest exchange rate.[29,30]

All revenue collected from auction sales are paid into the Quebec and Ontario Green Funds which are reserved to finance greenhouse gas reduction, fight climate change, grow the economy, create jobs, and in particular, to fund their Climate Change Action Plans.[30,31]

2. Cost of carbon pricing deduction from GST

PBO has constructed a range of estimates of the federal fiscal cost of exempting provincial carbon pricing from the application of the Goods and Services Tax (GST). PBO's baseline methodology uses three approaches based on three principal sources of data: the projected sectorial energy demand by province provided by the National Energy Board (NEB) (**1st approach**); the anticipated projected revenue of the carbon pricing that is included in the relevant provincial budget's fiscal plans of 2017 (**2nd approach**); and the actual and projected sectorial GHG emission by province as provided by Environment and Climate Change Canada (**3rd approach**).

The first approach is based on the estimate of the carbon prices contained within the sale price of consumer products. This approach is based on the assumption of full pass-through of any change in the price of fuel – due to GHG emission regulation and pricing – to the price of any downstream good and service.

Cost pass-through of GHG regulations

- The Cambridge dictionary defines cost pass-through as the increase in the price a customer pays because of an increase in a company's costs.
- Robust econometric evidence supports that fuel cost changes, because of GHG emission regulation, are fully transmitted downstream in the form of price changes. Therefore, any increase in a distributor's cost will be passed through and included in the price paid by the final consumer.

The second approach takes into account the provincial estimates of carbon pricing revenues in the fiscal years 2017-18 and 2018-19 as published in the budget of the relevant provinces for 2017. PBO estimates the federal fiscal impact as the GST fraction of these revenues.

The third approach uses the GHG emissions of specific sectors in the four provinces and the carbon cost per unit of emission to calculate the total carbon revenues. In the second step, PBO approximates the GST revenue

from the carbon pricing as being equivalent to 5% of the total carbon revenues.

The three approaches are described in detail in Appendix A.

2.1. GST on carbon taxes in B.C. and Alberta

Based on these three approaches (Table 2-1), PBO estimates the federal fiscal cost of exempting provincial carbon pricing from the application of the GST in B.C. between $62.6 million and $69.5 million in 2017-18 and between $63.8 million and $69.5 million in 2018-2019. These estimates remain stable over the two fiscal years because PBO assumes that B.C. will keep the same carbon tax rate.

The cost in Alberta is in the range between $58.4 million and $61.7 million in the fiscal year 2017-18. This cost range will jump to a minimum value of $78 million and a maximum value of $99.7 million. This cost increase is due to the fact that Alberta will raise the carbon levy rate from $20/tonne of CO_2 equivalent emissions in 2017 to $30/tonne in 2018.

Table 2-1 C-342- cost of carbon taxes deductions from GST in B.C. and Alberta (millions)

($ millions)		B.C.		Alberta	
Period	**Approach**	**Carbon tax revenue**	**Potential GST**	**Carbon pricing revenue**	**Potential GST**
2017-18	1st approach	1,390.1	69.5	1,167.5	58.4
	2nd approach	1,252.0	62.6	1,234.0	61.7
	3rd approach	1,367.4	68.4	1,169.8	58.5
2018-19	1st approach	1,390.7	69.5	1,562.3	78.1
	2nd approach	1,275.0	63.8	1,993.0	99.7
	3rd approach	1,382.6	69.1	1,559.8	78.0

Source: PBO calculations. All spending in millions of dollars.

The baseline estimates of the second approach uses provincial projections of the GHG regulation revenues contained in the provincial fiscal plans for the next few years. This scenario assumes that businesses decide to pass the entire carbon costs to the consumer bills.

As mentioned in the background section, a portion of the carbon prices paid by businesses in B.C. and Alberta are restored through corporate income tax reductions. In alternative scenarios, PBO considers removing this tax cut from the aggregate carbon revenue to calculate the GST. These scenarios can be explained by the fact that some businesses who pay the carbon levy take advantage of the income tax reduction. This fact can incite them to reduce the carbon cost pass-through. Table 2-2 summarizes the results of different

scenarios of partially pass-through of carbon taxes into the final products prices in comparison with the first scenario of complete pass-through.

Table 2-2 C-342- cost of carbon taxes deductions from GST in B.C. and Alberta according to the 2017 provincial budgets and with various levels of income tax reduction pass-through

($ millions)		B.C.		Alberta	
Period	**Scenario**	**Carbon tax revenue**	**Potential GST**	**Carbon pricing revenue**	**Potential GST**
2017-18	Baseline scenario	1,252.0	62.6	1,234.0	61.7
	2nd scenario (pass-through of 50% of the income tax reduction)	999.0	50.0	1,146.5	57.3
	3rd scenario (pass-through of 100% of the income tax reduction)	746.0	37.3	1,059.0	53.0
2018-19	Baseline scenario	1,275.0	63.8	1,993.0	99.7
	2nd scenario (pass-through of 50% of the income tax reduction)	1,018.5	50.9	1,898.0	94.9
	3rd scenario (pass-through of 100% of the income tax reduction)	762.0	38.1	1,803.0	90.2

Source: PBO calculations. All spending in millions of dollars.

The GST revenue on Carbon tax in B.C. is almost reduced by 50% from the baseline scenario to the third scenario. In addition, the GST revenue on the carbon levy in Alberta slightly decreases.

2.2. GST on Cap-and-Trade in Quebec and Ontario

PBO estimates the federal fiscal cost of exempting provincial C&T system from the application of the GST in Quebec using the first and the third approaches. PBO is not able to use the Quebec fiscal plan (the second approach) because it does not contain the projected revenue from the auction of GHG emissions. Also, the proceeds from these auctions that are paid to the Green Fund and included in the Quebec-California joint auction reports cannot be considered as a reliable benchmark. This fund covers the transaction of the GHG allowances between the participants and Quebec government and does not include those between the emitters and the participants.

The fiscal plan of Ontario includes the projection of the carbon allowance proceeds of 2017-18 but not for 2018-19.

For the current fiscal period, PBO estimates the potential GST revenue from the C&T systems between $35.7 million and $39.8 million in Quebec and between $79.6 million and $96.3 million in Ontario (Table 2-3).

For the next fiscal year, the GST estimate range would be between $37.9 million and $41.6 million in Quebec and between $82.5 million and $101.8 million in Ontario (Table 2-3).

Table 2-3 C-342- cost of auction price deductions from GST in Quebec and Ontario

($ millions)		Ontario		Quebec	
Period	**Approach**	**C&T revenue**	**Potential GST**	**C&T revenue**	**Potential GST**
2017-18	1st approach	1,591.1	79.6	714.7	35.7
	2nd approach	1,778.0	88.9	-	-
	3rd approach	1,925.8	96.3	796.6	39.8
2018-19	1st approach	1,697.3	84.9	757.1	37.9
	2nd approach	-	-	-	-
	3rd approach	2,036.9	101.8	832.5	41.6

Source: PBO calculations. All spending in millions of dollars.

Appendix A: Costing Methodology

A.1 Calculation of the Goods and Services Tax

According to subsection 165(1) of the *Excise Tax Act*, every recipient of a taxable supply made in Canada shall pay a tax of 5% of the value of the consideration for that supply. Furthermore, according to section 154 of that Act, the consideration paid for a supply of property or a service includes any provincial levy payable by the recipient, or payable or collectible by the supplier, in respect of that supply or in respect of the consumption or use of the property or service.

Bill C-342, An Act to amend the Excise Tax Act (carbon levy), would exclude a tax, duty or fee imposed by a province in respect of carbon from the calculation of the consideration for a supply of property or a service.

PBO estimates the federal fiscal cost of exempting provincial carbon pricing from the application of the Goods and Services Tax (GST) by considering the 5% of the final price paid by the consumer as being equivalent to 5% of the total carbon regulation revenues. These considerations depend on the fiscal and environmental policies of each province. The subsections below represent the approaches used for the estimate of the carbon pricing revenues.

A.2 GHG emissions and cost pass-through

Cost pass-through

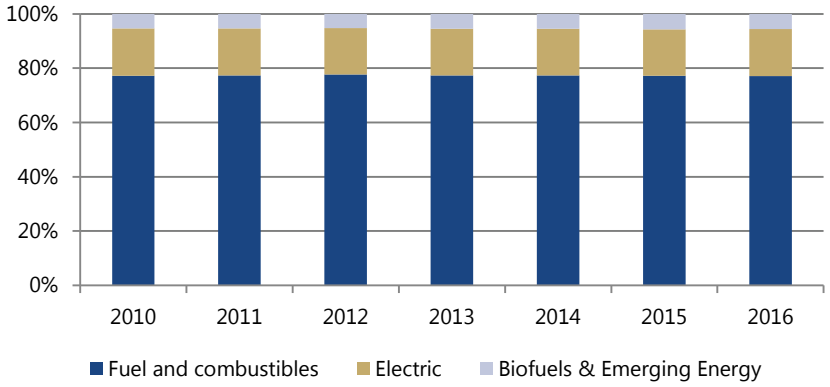
The Cambridge dictionary defines the cost pass-through as an increase in the price a customer pays because of an increase in a company's costs.

The pass-through degree is the magnitude of the response of the output prices to the input prices variations. The pass-through is complete when the cost change is fully transmitted to the final product price, and it is incomplete when it partially affects the consumer price.

Taxes, duties or fees imposed by a province in respect of carbon may be of two types: a) a tax based on consumption of a specific product; or b) a fee for the right to emit that is paid by a supplier and that is based on the level of the estimated greenhouse gas emissions (i.e., cap-and-trade). In both cases, the cost of the tax or fee is "passed through" to the final consumer of the product through an increase in the sale price of the products with the tax or of the goods and services of the supplier that paid the fee for the right to emit.

Fuels and combustibles[32] represent the most common energy use at the national level (more than 75%) by sector and by province in Canada (See Figure A-1 and Appendix B). Robust econometric evidence supports that fuel cost changes due to GHG emission regulation are fully transmitted downstream in the form of price changes.[33] Therefore, any increase in costs for distributors will be passed through and included in the price paid by the final consumer.

Figure A-1 Canadian Final Energy Demand



Sources: National Energy Board data, PBO calculations.

In B.C. and Alberta, carbon taxes are charged on the sale of fossil fuels that emit greenhouse gases. In most cases, the rates are based on the amount of carbon pollution released by the fuel when it is combusted, such as diesel, gasoline, natural gas and propane.

Taking into account this fact, PBO assumes that the carbon tax directly affects the consumer sale price. The change in the fuel prices are transmitted to the final prices of the goods and services that utilize such fuel in the production of the good and service.

Under the cap-and-trade system in place in Quebec and Ontario, numerous industrial and commercial companies are required to purchase certain emission rights to continue the supply of their goods and services. Hence, the unit production cost for these companies will likely increase. The emitters that could experience the largest increase in costs are the distributors of fuels and combustibles because they are the major contributors to greenhouse gas (GHG) emissions.[34] Specifically, the distributors of fuels and combustibles are required to purchase at government auctions, or on the WCI carbon market, all allowances needed to cover emissions attributable to the combustion of the fossil fuels they sell for consumption.[35]

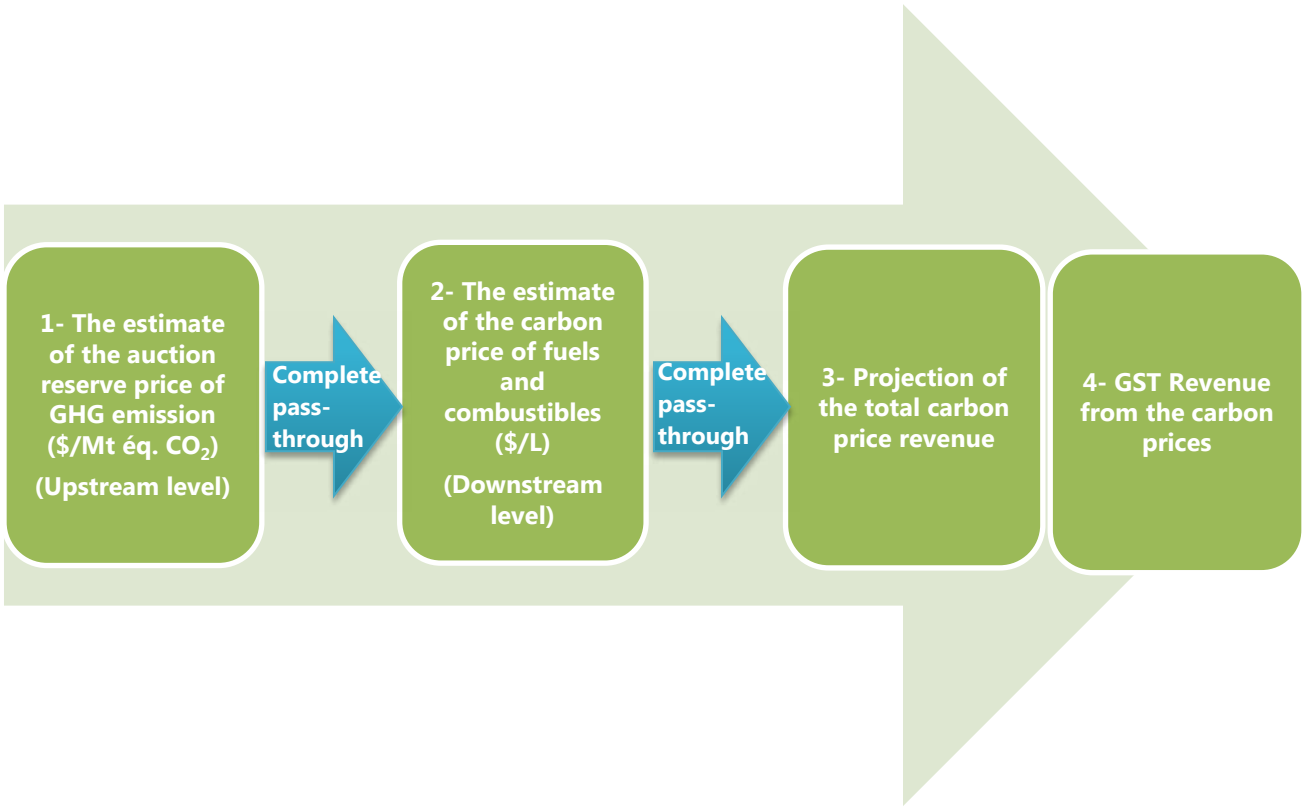
Based on these two facts, PBO uses the unit cost of the pollution rights associated with the fuels and combustibles as a measure of the carbon price of the final consumer products. PBO considers the latter as an equivalent of the carbon levy on goods and services as applied in Alberta and B.C.

A.3 GST revenue estimates based on provincial energy (fuel and combustible) demands (1st approach)

As mentioned above, the carbon tax (levy) rates of B.C. and Alberta are applied directly to the combustible fuels. Based on the assumption of complete pass-through of these rates into the final product prices, PBO considers the emission value that would be equivalent to the energy demand in some sectors as the total charge on consumer bills. PBO uses the 5% of this energy value as an approximation of the cost of carbon tax deduction from GST in Alberta and B.C.

The estimate of GST revenue on C&T system in Quebec and Ontario is more complex because carbon pricing is applied at the upstream level of the production of goods and services. PBO estimates the effect of the C&T system on downstream level pricing. The following diagram and paragraphs describe the steps needed to calculate the GST revenue from the C&T GHG regulation in Quebec and Ontario in 2017 and 2018. This methodology is based on the assumption of complete pass-through of the GHG auction cost into fuel and combustible prices and also the full pass-through of the latter into the prices of the final good and services, as described above.[36]

Figure A-2 Descriptive diagram of the steps to estimate the GST revenue from the GHG cap-and-trade regulation



First Step

In the first step, PBO forecasts the reserve price of the unit pollution right ($/Mt *eq*. CO_2) established jointly by California and Quebec in 2018.[37,38,39] PBO considers this price as the minimum GHG emission cost that can be applied at the "upstream" (Wholesale) level. PBO uses the reserve price of 2017 to project the value of 2018 based on the joint auction model.

Annual Auction Reserve Price

The Annual Auction Reserve Price is a predetermined minimum price at which allowances will be sold to auction participants in jurisdiction specific auctions (Quebec & California). Each jurisdiction provides an Annual Auction Reserve Price that conforms to its Regulation.

Annual Auction Reserve Price model

- Section 95911 of the California Cap-and-Trade Regulation stipulates that the "Auction Reserve Price in U.S. dollars shall be the U.S. dollar Auction Reserve Price for the previous calendar year increased annually by 5 percent plus the rate of inflation as measured by the most recently available twelve months of the Consumer Price Index for All Urban Consumers."
- Article 49 of the Quebec *Regulation respecting a cap-and-trade system for greenhouse gas emission allowances* stipulates that "The minimum price of the emission units is set at:
    1) $10 per emission unit, for auctions conducted in 2012;
    2) for auctions conducted in any year after 2012, the price set in subparagraph 1 increased annually by 5% and adjusted in the manner provided for in section 83.3 of the Financial Administration Act (chapter A-6.001).
- The Auction Reserve Price will be determined as the higher of the California or Quebec Announced Reserve Prices after applying the established Auction Exchange Rate (USD to CAD).

Second Step

In the second step, PBO calculates the Carbon prices of the fuels and combustibles ("downstream" or retail level). PBO converts the reserve price of 2017 and 2018 to carbon price using this formula:[40]

$$P_{carbon,t,i}\left(\$/_{L}\right) = P_{reserve,t}\left(\$/_{Mt\ eq.CO_2}\right) * Emission_i\left(Mt\ eq.CO_2/_{L}\right) \quad (1)$$

$$Emission_i\left(Mt\ eq.CO_2/_{L}\right) = \frac{P_{carbon,BC,i}\left(\$/_{L}\right)}{Tax_{carbon,BC}\left(\$/_{Mt\ eq.CO_2}\right)} \quad (2)$$

With $i \in \{Gasoline, Diesel, Natural\ Gas, Heavy\ Fuel\ Oil, Aviation\ Fuel\}$

$P_{carbon,t,i}$ is the carbon price by fuel.

$P_{reserve,t}$ is the auction reserve price cited on the base of the eq. CO_2 units.

$Emission_i$ is the carbon production by a unit of fuel regarding Mt eq. CO_2. PBO uses the GHG emission of the fuels and combustible gases in British Columbia to calculate $Emission_i$ in Quebec and Ontario because of the availability of data. This approach implicitly assumes that the carbon production of each combustible product is equal across provinces. This assumption is based on the free mobility of the technology (Capital) of the petroleum refiners and natural gas between provinces. Also, it considers that the energy industry is already in the long-run equilibrium.[41]

The carbon production is merely the ratio between the carbon prices of combustible products ($P_{carbon,BC,i}$) and the carbon tax rate by a unit of emission ($Tax_{carbon,BC}$) in B.C. The latter is fixed at $30 per tonne since 2012.[42] Table A-1 shows the carbon price by fuel/combustible gas applied in B.C ($P_{carbon,BC,i}$).

Table A-1 B.C.-Wide Carbon Tax Rates per Liter

Carbon Tax Act	Carbon Tax Rate (¢/Litre)
Gasoline	6.67
Diesel	7.67
Heavy Fuel Oil	9.45
Aviation Fuel	7.38
Natural Gas	5.70¢ per cubic meter or $1.4898 per gigajoule

Source: Ministry of Finance Tax Bulletin, Motor Fuel Tax Act and Carbon Tax Act (revised in August 2016).

Alberta also fixes a carbon price by fuel type.[43] PBO applies the same method (eq.(2)) to estimate the carbon production by fuel in Alberta and compares them with those of B.C. (See Table A-2). The comparative analysis leads to test if the two provinces use the same technology and if they are at the same point of their long-run equilibrium as assumed above. Table A-2 shows that the carbon production by combustible product is almost the same in both provinces, which is in line with our assumption.

Table A-2 Fuel Carbon production in Alberta and B.C.

Fuel	B.C. (Kg/L)	Alberta (Kg/L)
Diesel	2.56	2.68
Gasoline	2.22	2.24
Natural Gas (1)	49.66	50.57

Sources: Ministry of Finance Tax Bulletin, Motor Fuel Tax Act and Carbon Tax Act (revised in August 2016), Alberta's fiscal plan 2017-20, PBO calculations.

(1): The unit used for natural gas is Kg/GJ

Third Step

In a third step, PBO calculates the total revenue of the C&T system in Quebec and Ontario by multiplying the combustible carbon price estimated in the second phase by the final energy demand in the residential, commercial, and transport sectors.[44] PBO does not include industrial sector because most emitters in this sector benefit from free GHG emission allowances.[45]

The National Energy Board calculates the final demand energy as a function of joules. However, the carbon price is calculated on the base of the liter of

the fuel/combustible. To standardize the measure, PBO converts the energy unit (joule) to the metric system unit (litre) using the energy conversion calculators given by U.S. Energy Information Administration (EIA):

Table A-3 Energy Conversion Calculators

Diesel	1 megajoule	0.02978 litres
Gasoline	1 megajoule	0.0263 litres
Natural Gas (1)	1 megajoule	0.2388 cubic meters

Source: U.S. Energy Information Administration.

(1): The unit used to calculate the carbon price of the natural gas is $/joule or cubic meter.

Fourth Step

In the last step, PBO estimates the GST imposed on the Goods and Services under the C&T systems to be equivalent to 5% of the total revenue estimated at the previous step.

A.4 Carbon regulation revenues according to the 2017 provincial budgets (2nd approach)

B.C., Alberta and Ontario have published their fiscal plans for the next few years. The latter contain provincial projections of the GHG regulation revenues.

2017 B.C. Budget:

In B.C., carbon tax is applied on the purchase or use of fuels, even if they are not combusted. The tax is also applied on combustibles, such as peat and tires that are used to produce heat or energy.

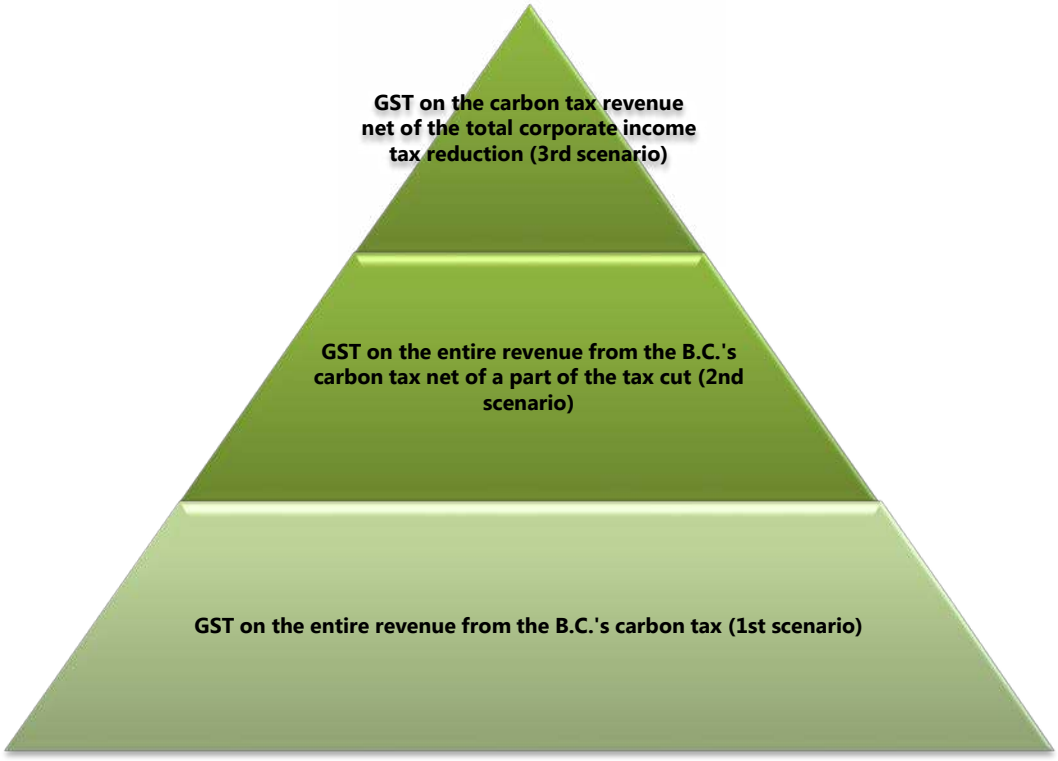
In the first scenario (Baseline scenario), PBO assumes that the transmission of the carbon cost into the final price is complete. Thus, the GST on the entire projected carbon tax revenues could be used as an approximation of the federal cost of Bill C-342 in B.C.

As mentioned in the background section, a portion of the carbon price paid by businesses is restored through corporate income tax reductions. In the second scenario, PBO assumes that some of businesses that endure the GHG regulation may benefit from the corporate income tax reduction and these businesses choose not to pass through the carbon cost to the final price of their product.

In a third scenario, PBO considers removing the total corporate income tax reduction from the entire carbon revenue to calculate the GST. This scenario assumes that it is the same businesses receiving the income tax cut that are

paying the additional carbon tax. The projected tax cuts are included in the revenue-neutral carbon tax plan for 2016/17 to 2018/19.

Figure A-3 Descriptive diagram of the three scenarios



2017 Alberta Budget:

In Alberta, the carbon levy is charged on sales of fossil fuels that emit greenhouse gases, at a rate of $20 per tonne, rising to $30 per tonne in 2018. The rate is based on the amount of carbon pollution released by the fuel when it is combusted, not on the mass of fuel itself.[46] Thus, this levy is applied at downstream levels by adding this rate to the final price of the products, such as diesel, gasoline, natural gas and propane.

Taking into account the fact that the carbon levy affects the final price directly, PBO assumes that the GST on the projected levy revenues could be used as an approximation of the federal cost of Bill C-342 in Alberta for the carbon levy.

In addition, the Alberta facilities that emit more than 100,000 tonnes of CO_2 per year, including electricity producers, are subject to the Specified Gas Emitters Regulation (SGER) rather than the carbon levy. These facilities include Alberta's largest trade-exposed facilities, such as oil and gas and industrial manufacturing facilities. Under the SGER, large trade-exposed facilities have compliance options that include offsets and payments into the Climate Change and Emissions Management Fund (CCEMF). The CCEMF rate

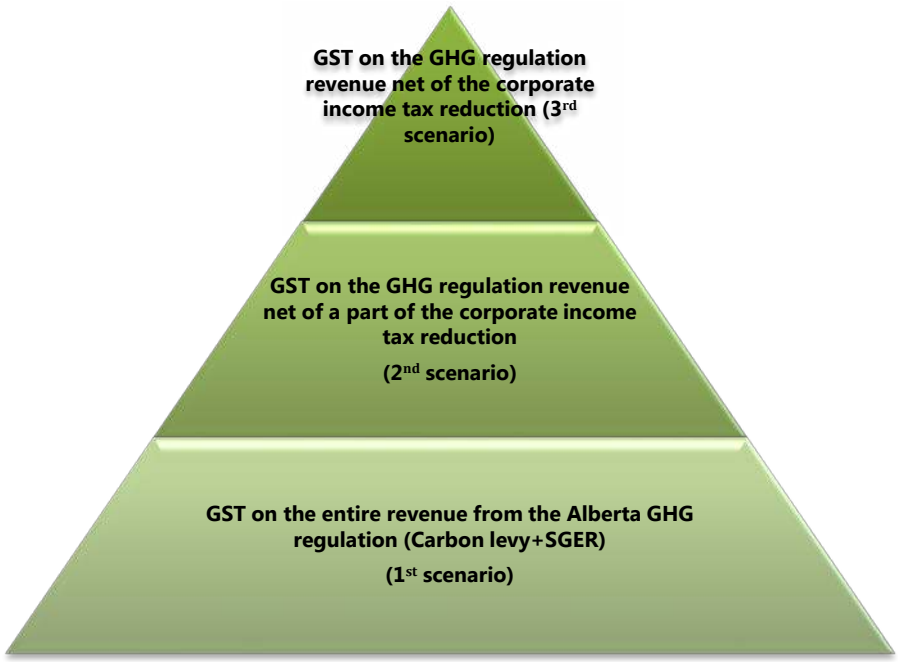
increased from $15 per tonne to $20 in 2016 and $30 in 2017. PBO considers the SGER as an upstream level pricing system. PBO assumes that the businesses that must comply with the SGER pass this upstream cost changes to the consumer prices. In this case, the GST is estimated by adding the large Emitters Revenue to the total amount of Alberta's GHG regulation (First scenario).

A portion of revenues generated from this system is returned to businesses through the small business tax cut. For example, the small business corporate income tax rate was reduced from 3% to 2%, effective January 1, 2017, to help small businesses deal with higher costs resulting from the carbon levy.[47] In an alternative scenario, PBO subtracts a part or the entire tax cut from the total amount of the carbon pricing system (Carbon levy+SGER) to calculate the GST. This scenario assumes that the businesses receiving the tax cut will reduce the pass-through of the change in fuel costs into the final product price in responding to this tax return if they are paying the additional carbon levy.

If these businesses decide to consider a part of the corporate income tax reduction in their pricing then the cost pass-through is incomplete (2nd scenario).

If the small business decides to transmit the entire corporate income tax cut to customers, the GST on the total carbon levy revenues net of the entire tax cut is a good approximation of the C-342- cost in Alberta (3rd scenario).

Figure A-4 Descriptive diagram of the three scenarios



2017 Ontario Budget:

Ontario recently passed the *Climate Change Mitigation and Low-carbon Economy Act, 2016*, which established the Province's targets for reducing GHG emissions. The first compliance period began on January 1, 2017, and program participants took part in the first auction of emissions allowances in March 2017.[48]

The auction generated revenues will be invested in programs for gas reduction and to fund the Ontario Climate Change Action Plans. No money will be given back to businesses in the form of a tax cut.[49] Hence, PBO assumes that the GST on the entire projected revenues of emissions allowances' auctions could be used as an approximation of the federal cost of Bill C-342 in Ontario.

A.5 Carbon pricing revenues based on sectoral GHG emissions (3rd approach)

Environment Canada provides data on the actual and projected GHG emissions in the four provinces (B.C., Alberta, Ontario, and Quebec) and in Canada by sector or industry.

PBO estimates the carbon pricing revenues in each province by multiplying the projected GHG emission by the carbon price per MT CO_2 eq. PBO applies this approach for certain sectors that are currently under the GHG regulation.

The provincial data is given for the two years 2015 and 2020.[50] PBO applies a constant annual growth rate formula to calculate the GHG emission in years 2017, 2018, and 2019.

PBO uses the portion of 5% of these revenues as an estimate of the potential federal fiscal cost of exempting provincial carbon taxes from the application of the Goods and Services Tax (GST).

Appendix B: Actual and projected energy demand by sector and province in Canada (% share)

Table B-1 Final national energy demand by sector

		Energy shares in final demand by sector								
Sector	**Energy product**	**2010**	**2011**	**2012**	**2013**	**2014**	**2015**	**2016**	**2017**	**2018**
Residential sector	Fuels and combustibles	51.5%	52.9%	50.8%	51.1%	51.7%	51.2%	49.5%	51.8%	52.1%
	Electric	36.6%	35.7%	37.2%	36.9%	36.4%	37.3%	38.4%	36.6%	36.5%
	Biofuels & Emerging Energy	11.9%	11.4%	12.1%	12.0%	12.0%	11.6%	12.1%	11.5%	11.5%
	Total	**100.0%**	**100.0%**	**100.0%**	**100.0%**	**100.0%**	**100.0%**	**100.0%**	**100.0%**	**100.0%**
Commercial sector	Fuels and combustibles	61.1%	61.6%	63.3%	61.7%	61.7%	62.4%	61.8%	61.7%	61.6%
	Electric	38.9%	38.4%	36.7%	38.2%	38.3%	37.6%	38.2%	38.2%	38.4%
	Biofuels & Emerging Energy	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%	0.1%
	Total	**100.0%**	**100.0%**	**100.0%**	**100.0%**	**100.0%**	**100.0%**	**100.0%**	**100.0%**	**100.0%**
Industrial sector	Fuels and combustibles	77.9%	78.6%	79.5%	79.1%	79.4%	79.1%	79.1%	79.9%	80.0%
	Electric	15.6%	15.4%	14.9%	14.7%	14.5%	14.4%	14.7%	14.0%	14.0%
	Biofuels & Emerging Energy	6.5%	6.0%	5.6%	6.2%	6.1%	6.5%	6.3%	6.1%	6.0%
	Total	**100.0%**	**100.0%**	**100.0%**	**100.0%**	**100.0%**	**100.0%**	**100.0%**	**100.0%**	**100.0%**
Transportation sector	Fuels and combustibles	97.7%	96.7%	96.5%	96.6%	96.5%	96.4%	96.3%	96.3%	96.3%
	Electric	0.1%	0.1%	0.1%	0.2%	0.2%	0.2%	0.1%	0.2%	0.2%
	Biofuels & Emerging Energy	2.2%	3.2%	3.4%	3.2%	3.4%	3.4%	3.5%	3.5%	3.6%
	Total	**100.0%**	**100.0%**	**100.0%**	**100.0%**	**100.0%**	**100.0%**	**100.0%**	**100.0%**	**100.0%**
Total Canada	Fuels and combustibles	77.2%	77.3%	77.7%	77.4%	77.3%	77.2%	77.1%	77.7%	77.8%
	Electric	17.5%	17.4%	17.1%	17.1%	17.2%	17.1%	17.3%	16.8%	16.8%
	Biofuels & Emerging Energy	5.4%	5.3%	5.2%	5.5%	5.5%	5.6%	5.6%	5.4%	5.4%
	Total	**100.0%**	**100.0%**	**100.0%**	**100.0%**	**100.0%**	**100.0%**	**100.0%**	**100.0%**	**100.0%**

Sources: National Energy Board data, PBO calculations.

Table B-2 Total final energy demand by province

		Energy shares in final demand by sector								
Province	**Energy product**	**2010**	**2011**	**2012**	**2013**	**2014**	**2015**	**2016**	**2017**	**2018**
Alberta	Fuels and combustibles	90.0%	89.9%	90.3%	90.1%	89.6%	89.9%	90.0%	90.3%	90.3%
	Electric	7.7%	7.7%	7.4%	7.3%	7.5%	7.5%	7.5%	7.2%	7.3%
	Biofuels & Emerging Energy	2.3%	2.4%	2.3%	2.6%	2.9%	2.6%	2.6%	2.5%	2.4%
	Total	**100.0%**	**100.0%**	**100.0%**	**100.0%**	**100.0%**	**100.0%**	**100.0%**	**100.0%**	**100.0%**
B.C.	Fuels and combustibles	66.7%	68.3%	67.4%	68.0%	68.4%	67.3%	67.9%	67.7%	67.5%
	Electric	18.4%	18.4%	18.8%	17.9%	18.1%	17.5%	17.5%	17.5%	17.5%
	Biofuels & Emerging Energy	14.9%	13.4%	13.7%	14.1%	13.6%	15.2%	14.6%	14.8%	15.0%
	Total	**100.0%**	**100.0%**	**100.0%**	**100.0%**	**100.0%**	**100.0%**	**100.0%**	**100.0%**	**100.0%**
Ontario	Fuels and combustibles	79.8%	79.5%	79.6%	79.4%	79.9%	79.7%	78.8%	79.3%	79.4%
	Electric	16.2%	16.4%	16.6%	16.2%	15.6%	15.6%	16.3%	16.1%	16.0%
	Biofuels & Emerging Energy	4.1%	4.1%	3.8%	4.4%	4.4%	4.7%	4.8%	4.6%	4.6%
	Total	**100.0%**	**100.0%**	**100.0%**	**100.0%**	**100.0%**	**100.0%**	**100.0%**	**100.0%**	**100.0%**
Quebec	Fuels and combustibles	56.5%	55.9%	56.0%	55.4%	54.1%	54.9%	54.6%	55.4%	55.4%
	Electric	35.7%	35.8%	35.6%	36.4%	37.6%	36.9%	37.5%	36.8%	36.9%
	Biofuels & Emerging Energy	7.8%	8.4%	8.4%	8.3%	8.3%	8.1%	8.0%	7.8%	7.7%
	Total	**100.0%**	**100.0%**	**100.0%**	**100.0%**	**100.0%**	**100.0%**	**100.0%**	**100.0%**	**100.0%**
Total of the four provinces	Fuels and combustibles	77.0%	77.0%	77.6%	77.4%	77.3%	77.3%	77.1%	77.8%	77.9%
	Electric	17.4%	17.5%	17.1%	16.9%	17.0%	16.8%	17.1%	16.5%	16.5%
	Biofuels & Emerging Energy	5.6%	5.5%	5.3%	5.6%	5.7%	5.9%	5.8%	5.6%	5.6%
	Total	**100.0%**	**100.0%**	**100.0%**	**100.0%**	**100.0%**	**100.0%**	**100.0%**	**100.0%**	**100.0%**
Total Canada	Fuels and combustibles	77.2%	77.3%	77.7%	77.4%	77.3%	77.2%	77.1%	77.7%	77.8%
	Electric	17.5%	17.4%	17.1%	17.1%	17.2%	17.1%	17.3%	16.8%	16.8%
	Biofuels & Emerging Energy	5.4%	5.3%	5.2%	5.5%	5.5%	5.6%	5.6%	5.4%	5.4%
	Total	**100.0%**	**100.0%**	**100.0%**	**100.0%**	**100.0%**	**100.0%**	**100.0%**	**100.0%**	**100.0%**

Sources: National Energy Board data, PBO calculations.

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27. The "reserve price" is the term used by California and Ontario to define the "minimum price" as defined in the Quebec regulation.
28. For more details about the reserve price setting in each partner jurisdiction, see the Appendix A.3 in the Methodology section.
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33. Alexeeva-Talebi (2011) measures the pass-through of the carbon allowance costs on unleaded petrol retail prices during the trial phase of the EU ETS from 2005 to 2007. Their estimates are consistent with the complete pass-through potential. Fabra and Reguant (2014) use data from the Spanish wholesale electricity market covering the period in which the European cap-and-trade program for carbon emissions was introduced. They found that emission costs are almost fully passed through to electricity prices. Miller et al. (2017) study the effect of the market-based CO2 regulation on Portland cement industry. The latter accounts for roughly 5% of global anthropogenic CO2 emissions. They found that the fuel cost changes, because of the regulations, are more than completely passed through to cement prices.
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35. Bibliothèque et Archives nationales du Québec (2014). Québec's cap-and-trade system - Technical overview. Retrieved from Minister of Sustainable Development, Environment and the Fight against Climate Change: http://www.mddelcc.gouv.qc.ca/changements/carbone/documents-spede/technical-overview.pdf
36. PBO also considers a different scenario of the cost pass-through in which the rise in the fuel costs is partially transmitted to the consumer product prices. This scenario is developed in the sensitivity analysis subsection.
37. The California Air Resources Board. (2016). *2017 Annual Auction Reserve Price Notice*. Retrieved from https://www.arb.ca.gov/cc/capandtrade/auction/2017_annual_reserve_price_notice_joint_auction.pdf
38. California Air Resources Board. (2017). Unofficial electronic version of the Regulation for the California Cap on Greenhouse Gas Emissions and Market-Based Compliance Mechanisms. Retrieved from https://www.arb.ca.gov/cc/reporting/ghg-rep/regulation/mrr-2016-unofficial-2017-10-10.pdf
39. Ibid. note 5.
40. This formula assumes a complete pass-through of the auction reserve price into the fuel carbon price as mentioned before.
41. The long-run equilibrium is characterized by the optimal exploitation of exhaustible resources (oil, natural gas, coal, etc.)
42. Ibid. note 19.
43. Ibid. note 23.

44. This estimate assumes a full pass-through of the carbon price into the final demand by sector. PBO does not adjust the carbon price in the final energy demand.

45. According to a Bibliothèque et Archives nationales du Québec, (2014) report, emitters in Quebec that are part of the following sectors receive assistance in the form of free GHG emission allowances: Aluminium; Lime; Cement; Chemical and petrochemical industry; Metallurgy; Mining and pelletizing; Pulp and paper; Petroleum refining; Glass containers, electrodes, gypsum products; Some agri-food establishments; Thermal power producers that signed long-term supply contracts before January 1st, 2008, under which pricing is predetermined and which have no cost-sharing clauses pertaining to GHG emission regulation.

46. Ibid. note 21.

47. Ibid. note 23.

48. Ontario Ministry of Finance. (2017). A Stronger, Healthier Ontario. Retrieved from https://www.fin.gov.on.ca/en/budget/ontariobudgets/2017/budget2017.pdf

49. See page 94 of Ontario's 2017 budget for the description of the planned use of carbon allowance proceeds.

50. Environment Canada provides this data upon request to the PBO (Information Request IR0298).