

The Greenhouse Gas Emissions Coverage of Carbon Pricing Instruments for Canadian Provinces^{*}

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July 2018

Abstract

In this paper we provide a comparison of the coverage of Canadian carbon pricing systems. We define coverage as the proportion and types of emissions priced under the various systems, by emissions source. We compare provincially announced pricing systems to the federal benchmark (the minimum coverage provinces must meet) and the federal backstop, the pricing system that will be imposed on provinces with insufficient coverage or who opt to not develop their own policies. For those provinces that have not yet introduced a carbon price we look only at coverage under the federal benchmark and the federal backstop. We find the majority of provincial pricing systems meet or exceed the federal benchmark. Our results also point to the importance of additional complementary policies to address significant sources of unpriced emissions, primarily in agriculture and fugitive sources.

Keywords: carbon pricing, emissions pricing, Canadian climate policy

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Introduction

In a parliamentary speech in October 2016 Prime Minister Justin Trudeau introduced the federal government’s carbon pricing plan, announcing that “. . . all Canadian jurisdictions will have put a price on carbon pollution by 2018” (Trudeau 2016).^{1,2} Provinces were given the option of implementing the price through a federal backstop system or designing their own pricing system that meets minimum thresholds – referred to by the federal government as “benchmarks” – for the level of the carbon price and the types of emissions to which the carbon price applies. If a provincially designed system falls short of these benchmarks then the federal backstop system will supplement or top up the provincial system by raising the carbon price or expanding its coverage (Environment and Climate Change Canada 2017c).

In this paper we provide a comparison between provincially announced pricing systems, the federal backstop and the federal benchmark, with a particular focus on coverage of the carbon price.³ We define coverage as the proportion and types of emissions priced under the various systems, by emissions source. For those provinces that have not yet introduced a carbon price we look only at coverage under the federal benchmark and the federal backstop. Notably, coverage of the federal backstop exceeds the minimum threshold – the federal benchmark – for the types of emissions to which the carbon price must apply. Therefore, in some provinces, there is a gap between emissions that are covered by a provincial policy, and those that would be covered under the federal backstop. Where relevant, we also comment on other considerations which cause divergence between provincial policies and the federal benchmark, and implications for coverage and potential actions by the federal government.

Variation in coverage across the provinces will be further driven by differences in a province’s emissions sources. These variations have important policy implications as provinces with a higher share of unpriced emissions are more likely to require additional complementary emissions reduction policies that specifically target these sources. This variation will be important in federal-provincial relations and policy development moving forward and may be a source of future tension.

The results presented here are informative for policy development, as provinces decide on the relative merits of various options in implementing carbon pricing schemes. Part of our contribution is the calculation of estimated pricing coverage of different carbon pricing plans using currently accessible data on emissions; our methodology is described in Appendix B. We note that the

¹ We note that the colloquial reference to a carbon price (or carbon tax) typically means a price (or tax) on greenhouse gas emissions, not just carbon. For ease of exposition, we will also use this term, unless additional precision is required.

² Although Prime Minister Trudeau’s speech clearly stated that a nationwide carbon price would be in place “by 2018,” the federal legislation making provincial prices a legal requirement was introduced only in spring 2018 (as part of the budget 2018 budget omnibus bill). Additionally, provinces now have until September 1, 2018 to submit provincial carbon pricing plans for review by the federal government (McKenna and Morneau 2017). Despite Prime Minister Trudeau’s initial wording, Environment and Climate Change Canada is stating that the requirement has always been “in 2018” (Campbell 2017).

³ We do not discuss the territories as media reports suggest the federal government is examining them separately and a different backstop system may apply (Forrest 2017, Thomson 2017).

different datasets used do not always align in their reported estimates of emissions, so our results may differ from coverage estimates presented by governments.

The remainder of this paper proceeds as follows. First, we outline Canada's classification system for greenhouse gas emissions. Second, we present the details (current to July 2018) of the federal government's carbon pricing backstop and benchmark, and then compare coverage under these systems to current, announced or potential systems in each of the provinces. We conclude with a brief discussion of other considerations provinces may face as they move forward with implementation of a carbon pricing system.

Types of Greenhouse Gas Emissions

Canada reports its greenhouse gas emissions in Environment and Climate Change Canada's National Inventory Report (NIR). The NIR is issued in the spring of each year, with estimates of greenhouse gas emissions current to two years prior (that is, the 2017 NIR includes emissions estimates current to 2015). Canada's categorization of greenhouse gas emissions follows the United Nation's Framework Convention on Climate Change (UNFCCC). Readers familiar with the UNFCCC categorization system and Canada's greenhouse gas emissions as reported in its annual NIR may wish to skip this section and proceed immediately to the discussion of the federal government's carbon pricing backstop.

Greenhouse gas emissions can broadly be divided into combustion and non-combustion sources. Combustion emissions are the emissions that are released from the burning of fossil fuels, including crude oil and refined petroleum products, natural gas and coal. This is the largest source of greenhouse gas emissions in Canada, accounting for 74 per cent of total emissions from 2000 to 2015. The UNFCCC classifies all combustion emissions in the Energy category (Figure 1), with most of these emissions falling in the stationary combustion and transportation subcategories. The stationary combustion subcategory accounts for combustion emissions from all fixed locations in Canada (for example, emissions from a natural gas fired electricity plant). In contrast, the transportation subcategory accounts for combustion emissions from all mobile sources including road and off-road vehicles, rail, air, marine and pipelines.⁴

Also included in the UNFCCC Energy category are fugitive emissions from oil and gas production and coal mining, which includes combustion and non-combustion emissions. These are emissions that are released during the fossil fuel extraction process, most notably due to flaring, venting, coal mining, and oil and natural gas well or pipeline leakages.⁵ Fugitive emissions from flaring are combustion emissions, while the remaining sources of fugitive emissions are primarily non-combustion.

⁴ Although pipelines are included in the transportation category, the majority of greenhouse gas emissions associated with their operation are from fixed location compressor stations.

⁵ Flaring and venting are both part of regular oil and gas operations. Specifically, flaring is the controlled burning of natural gas during operations and venting is the controlled release of gases to the atmosphere. Gases released during venting may include natural gas or other hydrocarbon vapours, water vapour and other gases such as carbon dioxide (Alberta Energy Regulator 2018).

Figure 1: 2015 Canadian Greenhouse Gas Emissions by UNFCCC Reporting Category



Source: Environment and Climate Change Canada (2017b)

Note: All numbers are emissions reported in kilotonnes of CO₂e. Sections shaded in blue are combustion emissions while those in grey are non-combustion emissions. The “Other” category for Stationary Combustion Sources includes petroleum refining industries, construction and agriculture and forestry while the “Other” category for Fugitive Sources includes emissions associated with coal mining, oil and natural gas operations. A table with the full listing of emissions, including all subcategories is provided in Appendix A.

In addition to the Energy category, the UNFCCC reporting framework also includes the following emissions categories: Industrial Processes and Product Use (IPPU); Agriculture; Waste; and Land Use, Land Use Change and Forestry (LULUCF). All greenhouse gas emissions in these categories are non-combustion emissions. Emissions in the IPPU category are primarily attributable to the manufacturing and oil and gas sectors, with a smaller share generated by transportation and residential and service sector buildings.

Emissions in the Agriculture and Waste categories are entirely attributable to the agriculture and waste sectors respectively. Lastly, the LULUCF category reports the GHG emissions flows between the atmosphere and Canada's managed lands. It includes both categories that are carbon sinks and those that are sources of greenhouse gas emissions, either as a result of biomass emissions or land conversions that reduced a carbon sink. LULUCF emissions are not tracked at the provincial level. Additionally, although Environment and Climate Change Canada reports a national estimate to the UNFCCC each year, this estimate is not included in the summation of Canada's total greenhouse gas emissions. Greenhouse gas emissions in the LULUCF category are also not subject to any existing emissions pricing policy in Canada. As a result, we do not include emissions from this category in our discussion of provincial coverage.

The Federal Carbon Pricing Backstop and the Coverage Benchmark

The Government of Canada has introduced a coverage benchmark – minimum emissions pricing coverage that provinces must achieve – and a pricing backstop. The coverage benchmark is defined as “. . . substantively the same sources as British Columbia's carbon tax” (Government of Canada 2016). Provinces can meet the benchmark via a price-based system such as B.C.'s tax or Alberta's hybrid system, or via a cap and trade system (Government of Canada 2016). The benchmark also includes a requirement for increases in stringency, via minimum pricing increases for pricing systems, and for cap and trade systems, declining annual caps in emissions that correspond to projected reductions resulting from pricing systems. Notably, the cap and trade systems also need a 2030 emissions reduction target at least as ambitious as Canada's 2030 target, whereas pricing systems only need the annual increases in price. The backstop will be imposed on provinces whose pricing plans do not meet the benchmark, and there is some indication that this will include provinces whose *stringency* does not meet the benchmark. Provinces may also opt in to the backstop, which will be administered by the Government of Canada.

The federal carbon pricing backstop consists of two components: (1) a carbon tax that will apply to emissions from combustion and controlled (measured) flaring and venting in a province; and (2) an output-based pricing system (OBPS)⁶ that applies to industrial facilities that emit 50 kt of CO₂e or greater per year. Smaller industrial facilities that emit less than 50 kt of CO₂e will also be given the option of participating in the OBPS. The carbon tax will be implemented between fall 2018 and January 1, 2019 while the OBPS is scheduled to take effect in 2019.

As of July 2018, regulation for the OBPS has yet to be released, though a general framework for consultation and comment was published in January 2018. As a result, specific details of the system are still lacking. As a high-level overview, however, industrial facilities participating in the system will have an emissions limit that is equal to an output-based emissions standard, expressed in tonnes of CO₂e emissions per unit of output, multiplied by their total output. Emissions standards will generally be set for individual industries. The currently proposed starting point is

⁶ Output-based pricing systems generally price emissions from facilities designated as large emitters and provide a per unit subsidy based on a benchmark emissions intensity (tonnes per unit or dollar value of output). For details on principles behind output-based pricing systems, see Dobson et al (2017).

70 per cent of the national production weighted emissions intensity of the industry (Government of Canada 2018a).

If a facility produces more than one product then its emissions limit will be equal to the sum of its output-based emissions allocation across all products. A facility's emissions limit will apply to both combustion and non-combustion emissions. Non-combustion emissions will generally include IPPU emissions, fugitive emissions and emissions from venting. The only significant exception to this is fugitive and venting emissions of methane from oil and gas facilities (Government of Canada 2018a). These are excluded from the OBPS as they are separately covered under the Government of Canada's forthcoming methane regulations for the oil and gas sector.

A facility faces no charge on greenhouse gas emissions up to its emissions limit. Additionally, if a facility's emissions fall below its emissions limit then it will receive surplus credits that it can bank for future use, or which it can sell to other facilities participating in the system. Alternatively, if a facility's emissions exceed its limit then on its excess emissions it must pay the prevailing carbon tax to the federal government or cover these emissions by purchasing surplus credits from other industrial facilities or offset credits from non-participants in the OBPS that achieve voluntary (non-regulated) and certified greenhouse gas emissions reductions.

A key characteristic of a well-designed OBPS is that it allows a facility to emit a certain amount of greenhouse gas emissions at zero charge while maintaining the incentive for it to reduce its emissions intensity per unit of output.⁷ In other words, the OBPS will provide the same emissions reduction incentive while costing less than a carbon price that applies to all of a facility's emissions. For the purposes of discussing coverage, we therefore classify all emissions covered by the OBPS as being covered by a carbon price.

The carbon tax component of the federal government's carbon pricing backstop will apply to stationary and non-stationary combustion emissions that are not covered by the OBPS. As most stationary combustion emissions are generated by industrial facilities, this leaves emissions associated with the heating of residential and commercial buildings as the largest source of stationary combustion emissions that will be subject to the carbon tax. The carbon tax will also apply to all combustion emissions from passenger and freight transport within a province.

The federal government has also identified a limited number of domestic emissions sources that will be exempt from the tax. Most of these sources are unlikely to be significant, and are not reported separately in the NIR. As a result, we generally include these sources in the coverage estimates presented below, resulting in what is likely to be a small overestimate of true coverage. The one exception is emissions from gasoline and diesel used by registered farmers in certain farming activities. This is a notable emissions source in the Prairie provinces and Prince Edward Island, and one that we can approximate using available data.⁸ As a result, we exclude on-farm transportation emissions from our coverage estimates. A second notable emissions source that will

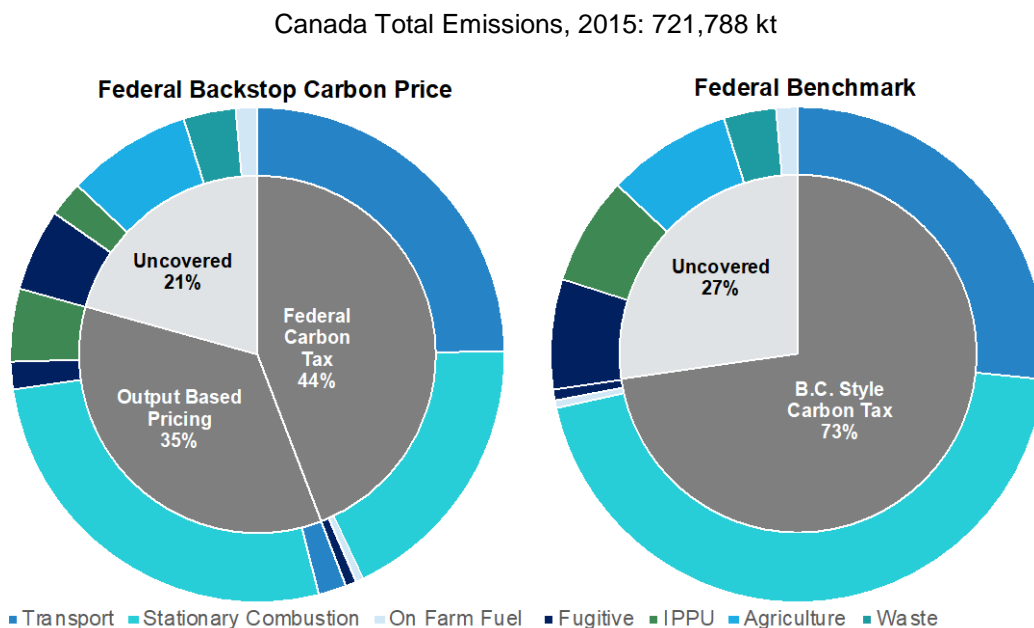
⁷ For a more complete description of the economics of output-based pricing systems, as well as recommendations for the design of the federal government's system, see Dobson et al (2017).

⁸ See Appendix B for a description of the methodology for generating this estimate.

be exempt from the carbon tax to start is fuel used for interprovincial airline travel.⁹ The federal government, however, has announced its intention to extend coverage to this source. As airline fuel used for intra-provincial travel will be immediately subject to the federal backstop carbon tax, and the NIR does not allow us to distinguish between domestic aviation emissions from inter- and intra-provincial travel, we include all domestic aviation emissions in our coverage estimates.

As shown in Figure 2, based on 2015 emissions data, if the federal backstop were to be applied across the country then it would cover 79 per cent of national emissions. More specifically, 44 per cent of emissions would be subject to the federal carbon tax while 35 per cent would be covered by the OBPS. The largest source of uncovered emissions is non-combustion emissions from the agricultural sector (eight per cent of total emissions).

Figure 2: Coverage Comparison of the Federal Benchmark and the Federal Carbon Pricing Backstop



In comparison, the Government of Canada’s benchmark for provincial carbon pricing coverage – that is, the minimum coverage that provincial carbon pricing plans must achieve – is lower than the federal carbon pricing backstop. British Columbia’s carbon tax applies to all combustion emissions in the province, meaning the federal benchmark does not include emissions from controlled venting, nor does it include industrial process and fugitive emissions from facilities that meet the criteria for participating in the federal government’s OBPS. Industrial process emissions from large industrial facilities account for five per cent of national emissions, while non-methane fugitive and controlled venting emissions from large facilities account for an additional one per

⁹ Emissions from fuel used in international airline travel is also exempt from the federal carbon tax. Notably, however, these emissions are not considered to be a domestic source and are therefore not included in the domestic aviation emissions reported in the NIR.

cent. Coverage of the federal benchmark is therefore six percentage points lower than the federal carbon pricing backstop, covering only 73 per cent of national emissions.

In the next section, we examine the coverage of the federal carbon pricing benchmark and backstop in each of the provinces, comparing these to the coverage of implemented or announced provincial pricing systems. We generally do not account for exemptions to provincial pricing systems unless they are from a significant source that we can identify or approximate with available data.

Carbon Pricing Coverage in the Provinces

British Columbia

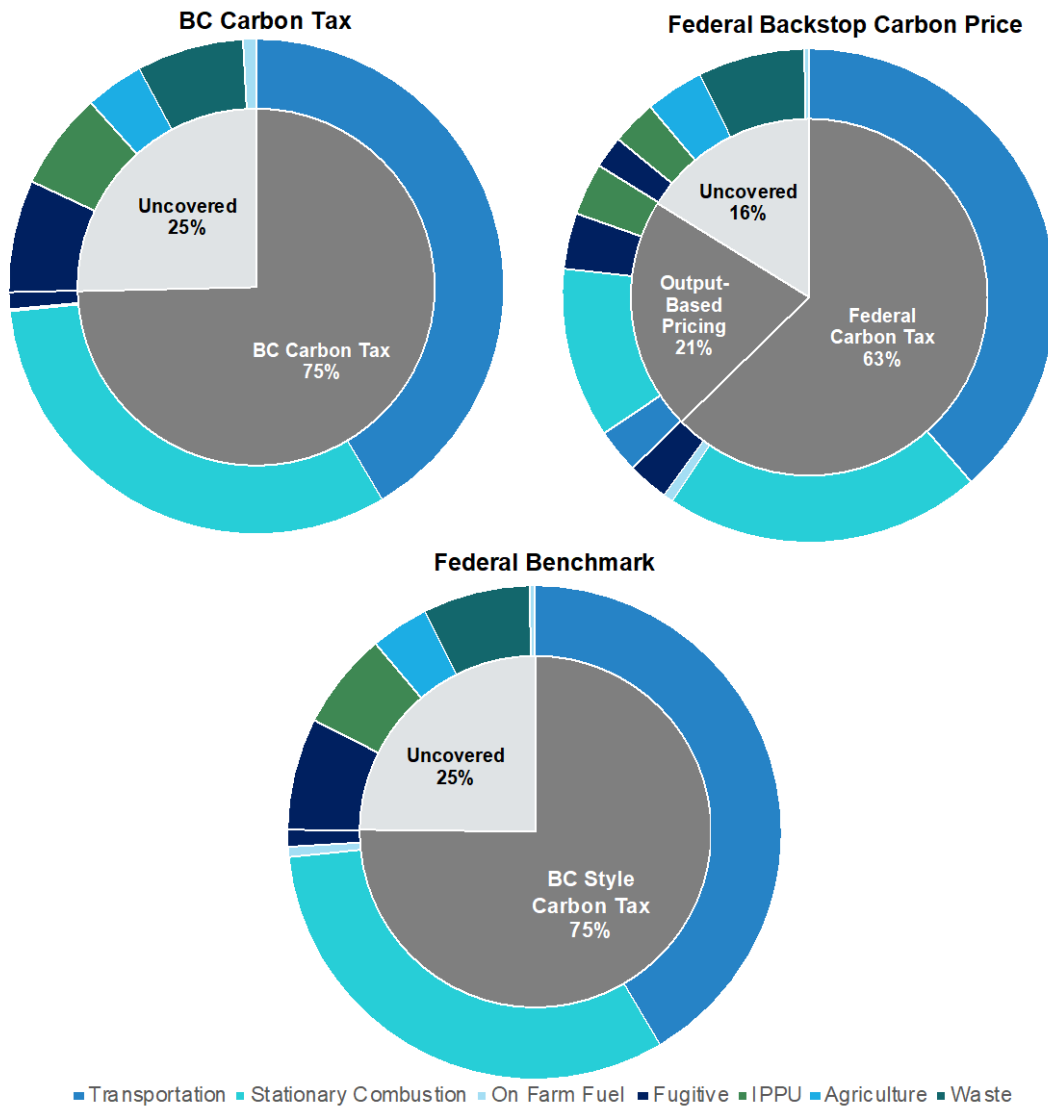
British Columbia introduced a carbon tax on all combustion emissions in the province in 2008. Using 2015 emissions data, we estimate coverage of the tax at 75 per cent of the province's emissions (Figure 3). This estimate accounts for an exemption to coloured fuel purchased by farmers and delivered to farm land as well as British Columbia's carbon-tax-relief grant program for commercial greenhouse growers that provides these facilities with a rebate of up to 80 per cent of the carbon tax paid on fuels that are used for heating in production greenhouses (Government of British Columbia 2018a, 2018b).

As noted in the previous section, British Columbia's carbon tax falls short of the federal government's backstop for coverage of the carbon price. Specifically, the tax does not apply to non-methane emissions from controlled venting, nor does it apply to industrial process and fugitive emissions from industrial facilities that meet the threshold for participating in the federal government's OBPS. As a result, coverage of the British Columbia carbon tax is nine percentage points lower than if the federal backstop were implemented in the province. The largest sources of uncovered emissions are controlled venting and fugitive emissions from coal mining and oil and natural gas production and distribution (seven per cent of total emissions), non-combustion emissions from the waste sector (seven per cent of total emissions) and industrial process emissions from all sources (six per cent of total emissions).

In comparison, the federal backstop system would result in 63 per cent of British Columbia's emissions being covered by a carbon tax and an additional 21 per cent of emissions covered by the OBPS. That is, fewer emissions would face a direct carbon price but as there is a market for emissions permits distributed through the OBPS, a larger share of total emissions would have a value attached to them. The largest source of uncovered emissions under the federal backstop is non-combustion emissions from the waste sector (still seven per cent of total emissions) and non-combustion emissions from the agriculture sector (four per cent of total emissions). Uncovered industrial process emissions fall to three per cent of total emissions while uncovered fugitive emissions fall to two per cent.

Figure 3: Coverage Comparison of the British Columbia Carbon Tax and Federal Carbon Pricing Backstop and Benchmark

British Columbia Total Emissions, 2015: 60,909 kt



Note: As the B.C. carbon tax forms the basis of the federal benchmark, the federal benchmark is virtually identical to B.C.'s coverage. The only difference is we account for the exemption to (agricultural) greenhouse producers (80 per cent of emissions from greenhouse heating are exempt) in the BC carbon tax figure and have not accounted for the same exemption in the federal benchmark graph.

Alberta

Alberta first introduced a carbon price in 2007 through the *Specified Gas Emitters Regulation* (SGER). SGER applied to combustion emissions, fugitive emissions and non-combustion waste and wastewater emissions from large industrial facilities with emissions of 100 kt CO₂e or greater in 2003 or any subsequent year (Government of Alberta 2012). The inclusion of non-combustion waste and wastewater emissions is notable as it makes landfills and landfill gases – facilities and

emissions that are typically excluded from carbon pricing – potentially subject to the regulation. In practice, however, the coverage of waste emissions is limited as there is only a single landfill in the province that is subject to the regulation (Government of Alberta n.d.).

In January 2017, the Government of Alberta expanded coverage of carbon pricing through the introduction of a carbon tax on combustion emissions and controlled flaring and venting emissions. Similar to the federal backstop, the carbon tax does not apply to combustion emissions from large facilities, which remained subject to SGER through to the end of 2017. In 2018, SGER was replaced by Alberta's *Carbon Competitiveness Incentive Regulation* (CCIR), an OBPS. Similar to SGER, the CCIR applies to industrial facilities emitting at least 100 kt of CO_{2e} per year. It covers the same emissions sources as SGER and additionally expands coverage to include industrial process emissions, indirect emissions associated with facility imports of heat, electricity and hydrogen, methane and nitrous oxide biomass emissions, and formation emissions (Government of Alberta 2017).

Using 2015 emissions data, we estimate coverage of Alberta's new carbon pricing system at between 69 and 77 per cent of the province's emissions (Figure 4). More specifically, 50 per cent of emissions are covered by the CCIR while 19 to 27 per cent of emissions are subject to the carbon tax. This estimate accounts for a carbon tax exemption for coloured fuel purchased by farmers and delivered to farm land, as well as a grant program for greenhouse growers that provides a rebate of up to 80 per cent of the carbon tax paid on heating fuels in production greenhouses (Government of Alberta 2018, Alberta Agriculture and Forestry 2018).

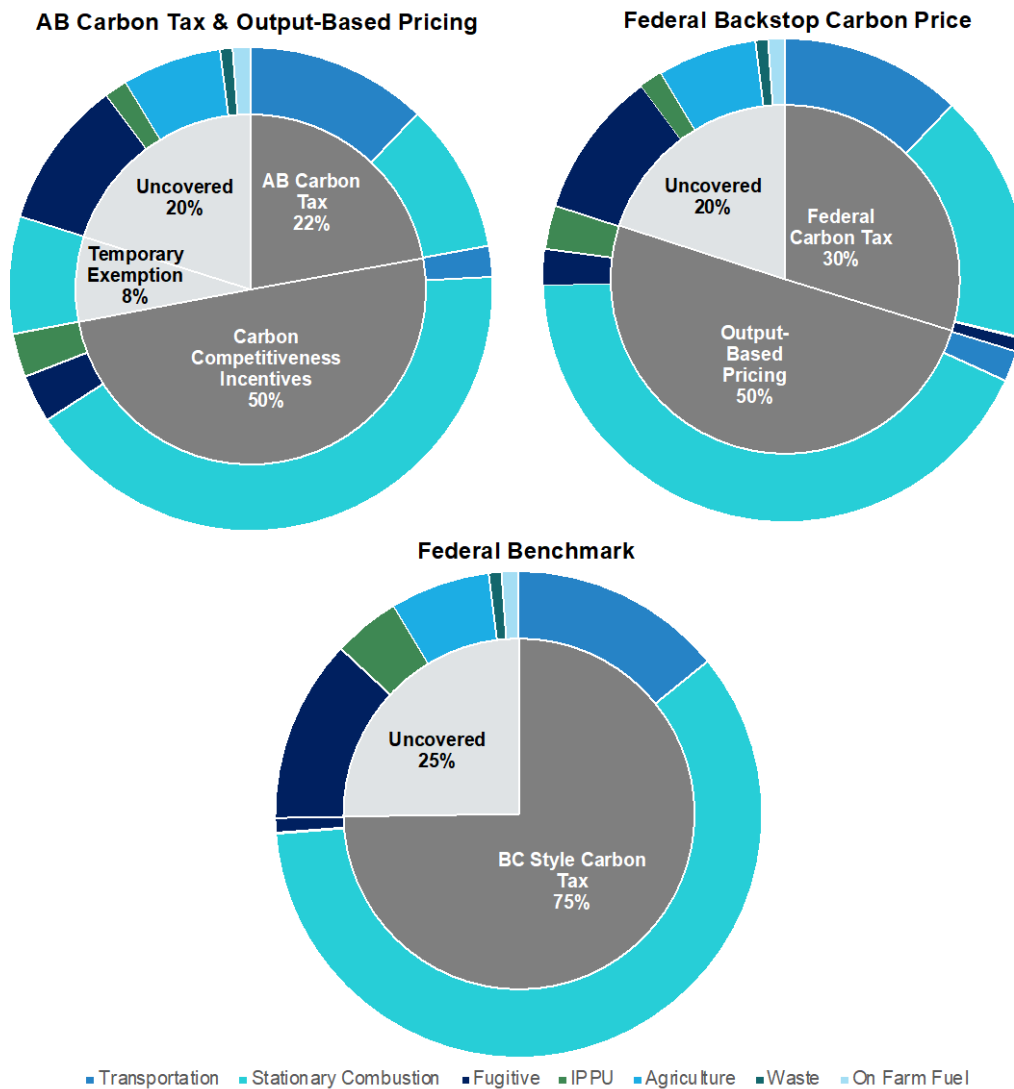
The uncertainty around the coverage of the carbon tax stems from a temporary exemption (until 2023) from the carbon tax for conventional oil and natural gas producers not subject to the CCIR. The exemption applies specifically to flared and vented emissions, as well as emissions that are generated during the production process from non-vehicular sources (unless the vehicle fuel is marked fuel) (Province of Alberta 2017). While we are able to approximate flared and vented emissions we do not have a measure of this latter emissions source. Based on NIR data that shows Alberta's emissions by economic sector and Environment and Climate Change Canada's large emitters database, we estimate these emissions at a maximum of eight per cent of Alberta's total emissions (Environment and Climate Change Canada 2017a,b). Until 2023, fugitive and production process emissions from Alberta's conventional oil and gas sector are therefore likely to be the largest source of unpriced emissions in the province, accounting for up to 18 per cent of the province's total emissions (10 per cent fugitive emissions and eight per cent production process). A second notable source of unpriced emissions is non-combustion and farm fuel emissions from the agricultural sector (eight per cent of total emissions).

Alberta's carbon pricing system is very similar to the federal backstop system. Although not explicitly acknowledged, the Alberta system – introduced 18 months prior to the federal backstop – is widely viewed as the model for the federal system. Environment and Climate Change Canada additionally identifies Alberta's system as an example of one that other provinces can adopt to meet the benchmark (Environment and Climate Change Canada 2016,2017c). A key difference between the systems in the short-term, however, is the temporary exemption Alberta is providing to non-vehicular emissions generated by conventional oil and natural gas producers. Strictly

speaking, as this exemption excludes a significant source of combustion emissions from carbon pricing, it causes Alberta’s pricing system to fall short of the federal coverage benchmark.

Figure 4: Coverage Comparison of the Alberta Carbon Pricing System and Federal Carbon Pricing Backstop and Benchmark

Alberta Total Emissions, 2015: 274,142 kt



Note: The ‘Temporary Exemption’ category is an estimate of combustion emissions from conventional oil and gas facilities. We estimate these emissions at up to eight per cent. See Appendix B for details on our methodology.

The Government of Canada has not yet indicated how it plans to address provincial exemptions that lower carbon pricing coverage. On the one hand, when first announcing the national carbon price in October 2016, the federal government outlined a number of principles that it supported, including a flexible approach, recognition of provincial policies already implemented or under development, and minimizing competitiveness impacts and carbon leakage (Government of

Canada 2016). All of these principles are consistent with the federal government accepting the Government of Alberta's decision and acknowledging the exemption as a transitional measure to help maintain competitiveness of conventional oil and gas producers. On the other hand, allowing the exemption creates inconsistency in what is supposed to be consistent coverage across the provinces. Conventional oil and gas producers in British Columbia, for example, do not – and have not – received a similar exemption (British Columbia Ministry of Finance 2018). In addition, comments by Catherine McKenna indicates lack of compliance will result in the federal backstop being imposed (Poitras 2018, Soloducha 2018).

A second small difference between the Alberta and federal OBPS is that Alberta's CCIR defines large emitters as those with emissions of 100 kt or greater while the federal OBPS applies to facilities with emissions of 50 kt or greater. This difference does not impact total coverage of the two pricing systems, but it does result in a small number of emissions shifting from coverage under a carbon tax to coverage under an output-based pricing system.

Implemented on its own, the federal backstop system would result in 30 per cent of Alberta emissions being covered by a carbon tax and an additional 50 per cent of emissions covered by the output-based pricing system. Relative to Alberta's system, this would increase total coverage of the carbon price in the short-term by up to 11 percentage points. The largest sources of unpriced emissions under the federal backstop are venting and uncontrolled fugitive emissions from the oil and gas sector, including methane emissions from large emitters (10 per cent of total emissions) and non-combustion and farm vehicle emissions from the agricultural sector (eight per cent of total emissions).

Saskatchewan

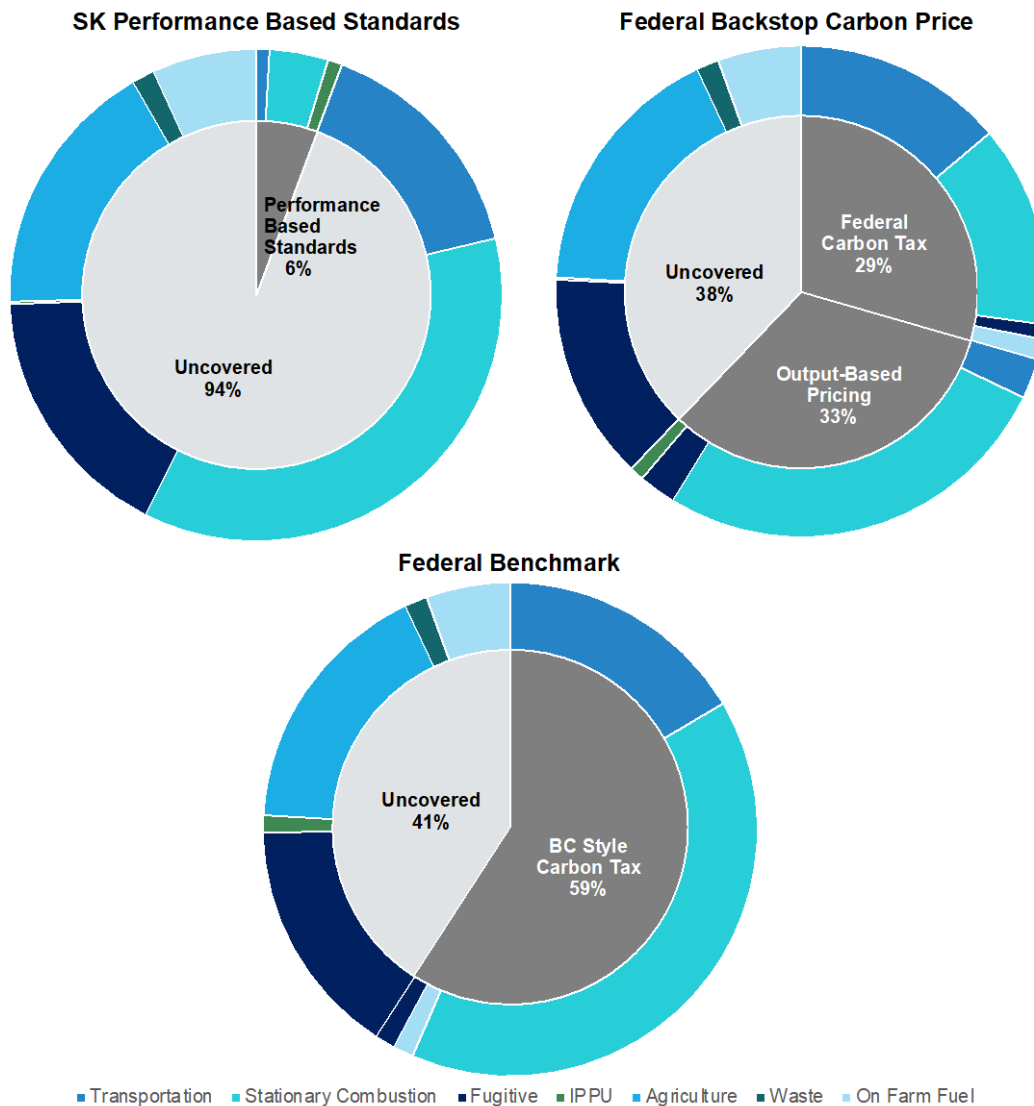
Saskatchewan has been the most vocal of the provinces in its opposition to a national carbon price. It released its climate change strategy in December 2017 and made only a single reference to carbon pricing, stating that “the conversation around climate change must be broader” (Government of Saskatchewan 2017). Although not calling it a carbon price, the province introduced a performance-standard system for large industrial emitters in the mining and manufacturing sectors. The system is similar to the OBPS component of the federal backstop. Specifically, facilities with emissions of 25 kt CO₂e or greater per year will be required to meet sector-specific performance-based standards for their emissions. Facilities emitting below this standard will receive ‘best performance’ credits, while those emitting above the standard will have to meet their compliance obligation by paying into a provincial technology fund, purchasing offset credits from non-regulated entities, purchasing best performance credits from regulated facilities or engaging under the Paris Agreement in “internationally transferred mitigation outcomes.”¹⁰

¹⁰ Internationally transferred mitigation outcomes are a provision in the Paris Agreement under the United Nations Framework Convention on Climate Change Paris Agreement. They allow a developed country (or sub-national jurisdiction) to finance inexpensive emissions reductions in another country as a means of lowering the cost of meeting its own emissions reduction target (Tolman and Kerr 2017).

Based on 2015 emissions data, we estimate coverage of Saskatchewan’s performance-based standards system at only six per cent of the province’s emissions. The plan leaves numerous significant sources of emissions largely unpriced including the majority of stationary combustion emissions (35 per cent of total emissions), transportation emissions (16 per cent of total emissions), all sources of fugitive emissions (17 per cent of total emissions) and non-combustion and farm fuel emissions in the agricultural sector (24 per cent of total emissions).

Figure 5: Saskatchewan Coverage of the Federal Carbon Pricing Backstop and Benchmark

Saskatchewan Total Emissions, 2015: 74,954 kt



By leaving large sources of combustion emissions unpriced, Saskatchewan’s carbon pricing plan falls far short of the federal government’s benchmark. It therefore appears likely that the federal backstop will be implemented in the province in some form. We estimate that implementation of

the federal backstop would expand coverage of the carbon price to 62 per cent of the province's emissions. Specifically, 29 per cent of Saskatchewan's emissions will be subject to the federal carbon tax and an additional 33 per cent of emissions will be covered by the output-based pricing system (Figure 5). This leaves 38 per cent of emissions in the province still unpriced. The largest source of unpriced emissions is the agricultural sector, including both non-combustion emissions (17 per cent of total emissions) and off-road combustion emissions from farm vehicles (six per cent of total emissions). Fugitive emissions (14 per cent of total emissions), the majority of which are methane emissions from small oil and gas producers, are also a significant source of unpriced emissions. However, the Government of Saskatchewan has indicated its opposition to the carbon tax numerous times and referred a constitutional reference case in the Saskatchewan Court of Appeal questioning whether the federal government has the authority to impose a carbon price on the province (Government of Saskatchewan 2018). This significant difference in coverage between the Saskatchewan policy and the benchmark and backstop underscores the potential benefits to Saskatchewan – avoided carbon tax costs – from contesting the federal policy.

It is additionally interesting to note that the federal benchmark requires only 59 per cent of the province's emissions to be priced. The difference is driven primarily by the exclusion from the federal benchmark of controlled venting emissions and fugitive coal mining and oil and gas production and distribution emissions from large facilities. That is, the federal benchmark does not require these emissions sources to be priced while the federal backstop includes these sources in its pricing system. These are not a significant emission sources in Saskatchewan, accounting for only three per cent of the province's total emissions. Still, by declining to implement a pricing system consistent with the benchmark Saskatchewan is exposing itself to having a higher share of emissions priced than the minimum required.

Manitoba

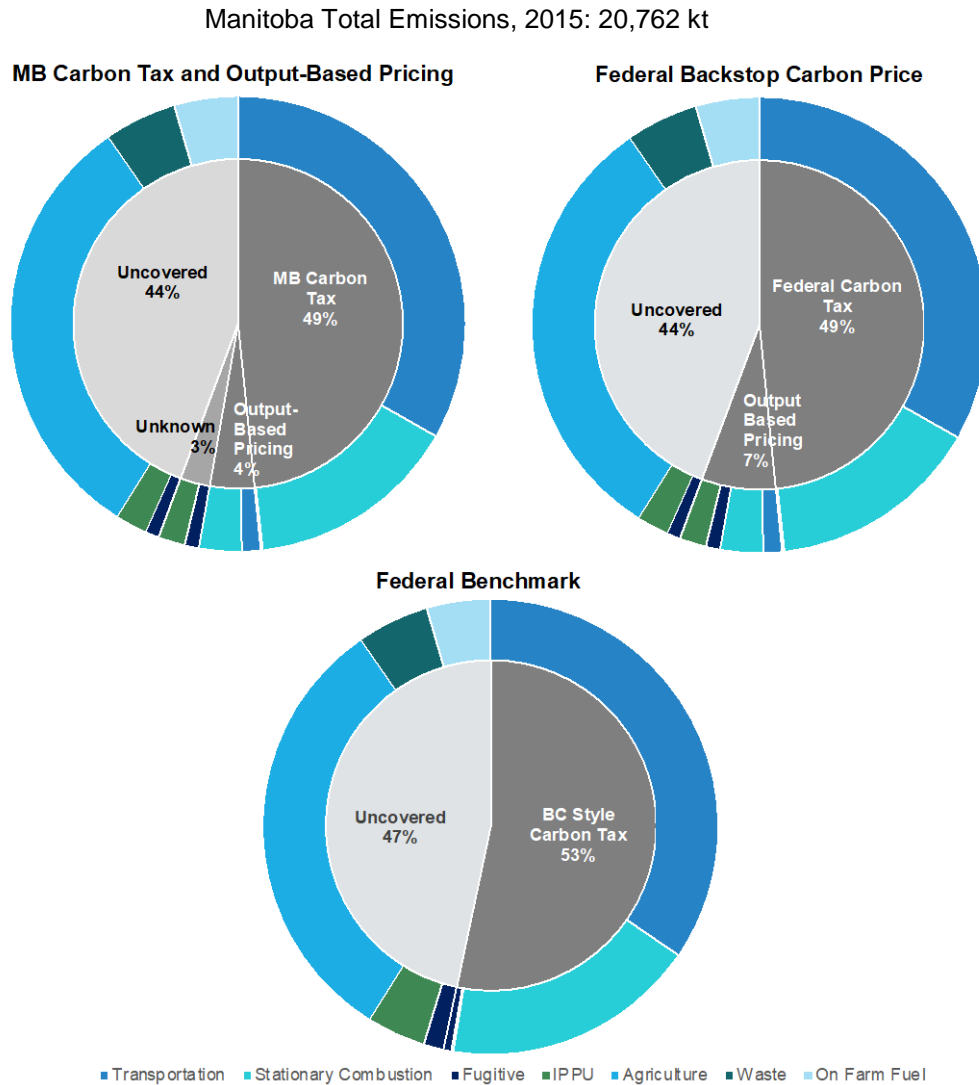
Manitoba introduced its carbon price system in October 2017. The system closely follows the federal backstop, consisting of a carbon tax that will be introduced in September 2018 and an OBPS for large industrial emitters that will be introduced in 2019 (Manitoba Sustainable Development, 2017). Similar to the federal backstop, Manitoba will exempt marked fuels used in farming operations from the carbon tax. The OBPS also follows the federal backstop in applying to large industrial emitters with emissions of 50 kt CO₂e or greater.

At the time of writing, Manitoba has not yet specified whether the emissions thresholds for large facilities will include industrial process emissions, nor has it provided any information on the treatment of fugitive emissions. Given this uncertainty, using 2015 emissions data we estimate coverage of the Manitoba carbon price at 53 to 56 per cent of the province's emissions (Figure 6). Fifty-three per cent equals coverage of the federal benchmark. In comparison, as the federal backstop includes industrial process and fugitive emissions from large emitters, it will cover 56 per cent of emissions in Manitoba.

Under both Manitoba's carbon pricing system and the federal backstop, the agricultural sector is the largest source of unpriced emissions. Agricultural emissions that will be exempt from the

carbon price accounted for 36 per cent of Manitoba’s emissions in 2015. This includes combustion emissions from farm vehicles (5 per cent of total emissions) and non-combustion emissions (31 per cent of total emissions).

Figure 6: Coverage Comparison of the Manitoba Carbon Pricing System and Federal Carbon Pricing Backstop and Benchmark



Of note for Manitoba, however, is that the province’s carbon price is \$25 per tonne between 2019 and 2022. The Government of Manitoba argues that its Made-In-Manitoba plan would result in greater emissions reductions than the federal backstop (Manitoba Sustainable Development 2017), and has indicated it would fight the federal government in court if the backstop were imposed (Lambert 2018).

Ontario

Ontario introduced a cap-and-trade program in January 2017. Mandatory participants in the program included industrial and institutional facilities with CO₂e emissions of 25 kt or greater each year, electricity importers, fuel suppliers that sell greater than 200 litres of fuel per year and natural gas distributors that sell natural gas that would emit at least 25 kt of CO₂e per year if consumed (Government of Ontario 2017). Through the inclusion of fuel distributors, Ontario's cap-and-trade program covered virtually all combustion emissions in the province. Notably, unlike the federal government and most other provinces, it did not provide an exemption to marked fuels used by farm vehicles (Lynch 2017). Also covered by the cap-and-trade program were industrial process emissions and fugitive emissions from refineries and oil and gas facilities.¹¹

In June 2018, Premier-designate Doug Ford announced that Ontario would dismantle its cap and trade system (Government of Ontario 2018a). The regulation implementing the cap-and-trade program was subsequently revoked on July 3. At the time of writing, no additional details on the timeline and process for withdrawal are available. Without the cap-and-trade program in place, Ontario will not have carbon pricing on any of its emissions. Accordingly, Justin Trudeau has stated the federal government will impose the backstop in the province (Jeffords 2018).

Using 2015 emissions data we estimate coverage of Ontario's former cap-and-trade program at 84 per cent of the province's emissions (Figure 7). This estimate can be further divided into emissions that required paid permits (66 per cent) versus those that were eligible for free allocations (18 per cent). Free allocations are primarily a transitional measure that the Ontario government was making available to institutions (most notably universities and hospitals) and facilities in the manufacturing and mining and quarrying sectors with emissions of at least 25 kt CO₂e per year (i.e., those that have a mandatory participation requirement in the cap-and-trade program). Under the program, institutions and facilities in the manufacturing and mining and quarrying sectors with emissions between 10 and 25 kt CO₂e per year could apply for voluntary participation in the cap-and-trade program and would then also be eligible to receive free allocations.¹² Most institutions and facilities eligible for free allocations were expected to receive sufficient permits to cover all of their emissions in 2017 (Reusing 2017). The number of free permits issued for combustion emissions was set to decline by 4.57 per cent annually from 2018 to 2020 while the number of free permits issued for industrial process emissions was to remain unchanged.

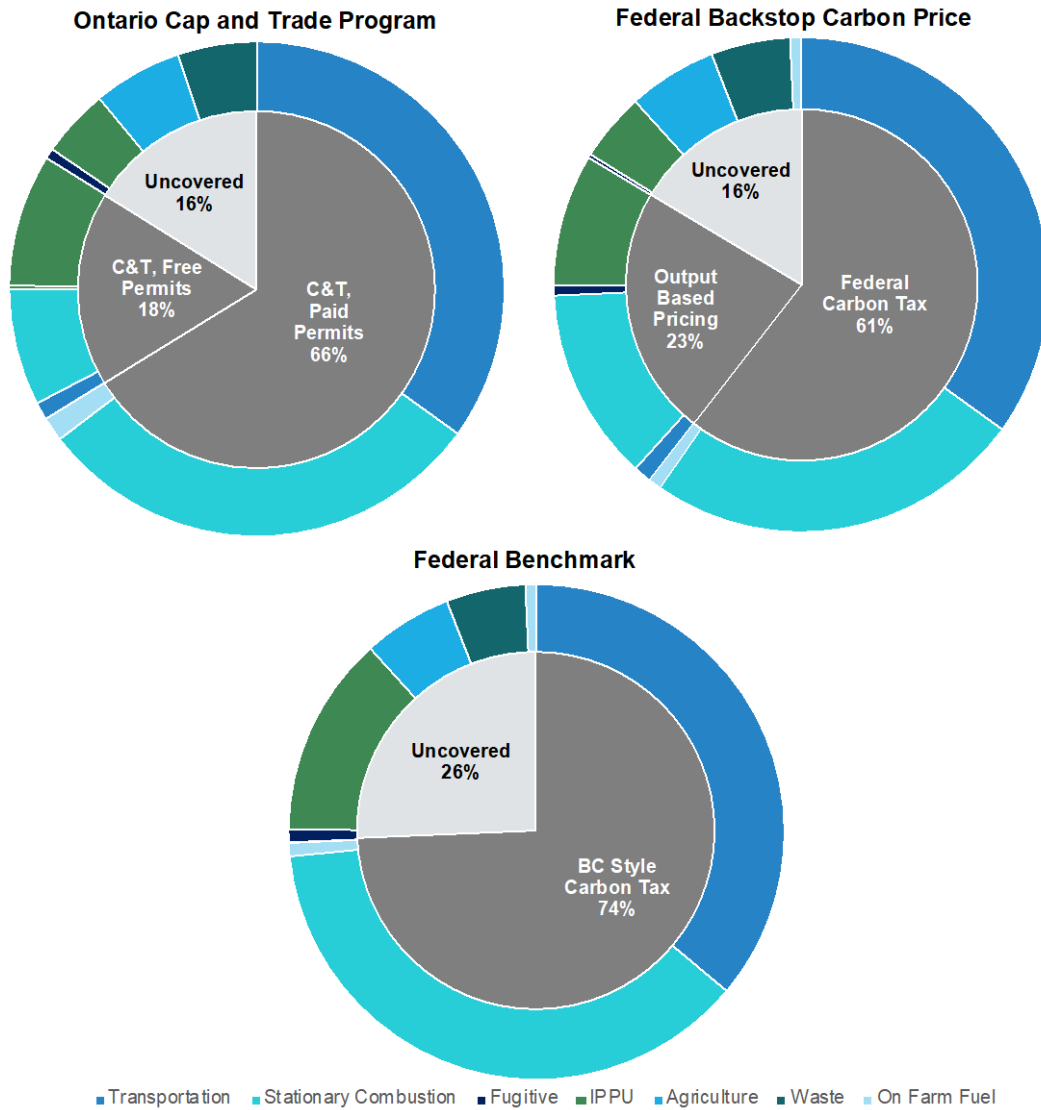
By including industrial process emissions, coverage of Ontario's cap-and-trade program exceeded coverage of the federal benchmark by 10 percentage points. That is, the program surpassed the minimum coverage requirements and there was no expectation of the federal government imposing the backstop in the province. Rather, Ontario was listed as an example province of acceptable pricing systems by Environment and Climate Change Canada (Environment and Climate Change Canada 2017c).

¹¹ Fugitive emissions from natural gas distribution pipelines are excluded from the cap-and-trade program.

¹² Emissions from potential voluntary participants in Ontario's cap and trade program are not included in the coverage estimate of emissions eligible for free allocations. As a result, it is likely that free allocations will be distributed to facilities and institutions accounting for greater than 18 per cent of Ontario's emissions.

Figure 7: Coverage Comparison of Ontario Cap and Trade and the Federal Carbon Pricing Backstop and Benchmark

Ontario Total Emissions, 2015: 166,168 kt



Note: The estimate of emissions eligible for free permits under Ontario’s cap-and-trade program does not include emissions from institutions and facilities that are eligible to opt-in to the program. As a result, the actual number of emissions eligible for free allocations is likely higher than the 18 per cent indicated above.

With the cap-and-trade regulation now revoked, the expectation is the federal government will implement the backstop in Ontario starting in January 2019. Coverage of the federal backstop will be virtually identical to coverage to the province’s cap and trade program. Specifically, the federal backstop will again cover 84 per cent of the province’s total emissions, with 61 per cent of emissions subject to the carbon tax and 23 per cent covered by the OBPS. Direct carbon price coverage is lower under the federal backstop system as electricity generators and natural gas transmission pipelines are eligible to participate in the OBPS. Despite covering a larger share of emissions, however, the OBPS will almost certainly distribute a lower number of free emissions

permits than Ontario's cap-and-trade system, which intended to provide sufficient permits to cover the majority of emissions from eligible facilities over the 2017 to 2020 period. In contrast, as noted early, the federal government will distribute permits based on output-based emissions standards set equal to 70 per cent of the national production weighted emissions intensity of an industry.

Other small differences in coverage between the Ontario cap-and-trade and federal backstop system is the aforementioned exemption that the federal system provides to fuel for farm vehicles, the inclusion of controlled venting emissions under the coverage of the federal carbon tax, and the inclusion of fugitive emissions from natural gas pipelines in the federal OBPS. Under both systems the largest source of uncovered emissions is non-combustion emissions from the agriculture sector (six per cent of total emissions), followed by emissions from the waste sector (five per cent of total emissions).

Of note in this situation is that the provincial government in Ontario is foregoing an opportunity to lower overall coverage of carbon pricing in the province. Specifically, by moving from the former cap-and-trade system to a system such as a B.C. carbon tax that only meets the federal benchmark, the government could lower carbon pricing coverage from 84 to 74 per cent. Most of this decrease would come from the removal of a carbon price on industrial process emissions from the manufacturing sector.

The overall cost on the Ontario economy of a B.C. style carbon tax would be potentially higher due to the removal of free allocations. However, given the use of free allocations within the federal backstop, it is not unreasonable to assume the federal government would provide some flexibility for Ontario to design and implement a similar or alternative support mechanism as part of a broad-based carbon tax on combustion emissions.

More significantly, under the federal benchmark a B.C. style carbon tax requires a higher carbon price than the prevailing market price that was expected under Ontario's former cap-and-trade program. We have not highlighted this detail as the focus of this paper is on coverage. It is worth noting, however, that Ontario residents and businesses will also face this higher price when the federal backstop is introduced. That is, by cancelling the province's cap-and-trade program, Premier Doug Ford has positioned the province to face a higher carbon price, with near identical coverage of the province's emissions sources. A key difference, however, is the federal government's commitment to return all revenues from the federal backstop back to the province. How the federal government opts to return these revenues will therefore play an important role in determining the overall cost of the federal backstop relative to the former cap-and-trade program. Ford has also stated that Ontario will join Saskatchewan in challenging the federal government (Government of Ontario 2018b).

Québec

Québec introduced its cap-and-trade program in January 2013. The program originally applied only to industrial facilities with annual CO₂e emissions of 25 kt or greater, including electricity importers. Facility emissions covered by the cap-and-trade program include combustion, industrial process (non-combustion) and fugitive emissions. Starting in January 2015 the cap-and-trade

program was expanded to include fuel distributors. Fuel distributors originally faced the same threshold for inclusion – CO₂e emissions of 25 kt or greater – but the calculation is based on the embedded emissions in the fuels they sell. Starting in January 2016, the threshold was lowered to include fuel suppliers that sell more than 200 litres of fuel per year (Vérificateur Général du Québec 2016). Québec’s cap-and-trade program now covers nearly all combustion emissions in the province. In contrast to the federal government and most other provinces, Québec does not appear to provide an exemption to marked fuels used by farm vehicles.

Using 2015 emissions data we estimate coverage of Québec’s cap-and-trade program at 81 per cent of the province’s emissions (Figure 8). As was the case in Ontario, this estimate can be further divided into emissions that will require paid permits (58 per cent) versus those that are eligible for free allocations (23 per cent). Free allocations are distributed to facilities in the manufacturing and mining and quarrying sectors, facilities supplying steam and air conditioning for industrial facilities, and electricity generation plants selling power under fixed price contracts signed prior to January 1, 2008. Institutions do not participate directly in the cap-and-trade program and therefore are not eligible for free allocations. Last, although Québec has a voluntary participation option in the program, free allocations are only distributed to mandatory participants.

In 2015, the number of free emissions permits distributed by the Quebec government exceeded the verified emissions of the facilities that received them.¹³ The quantity of free emissions permits issued annually is currently being reduced by only one to two per cent per year, suggesting that covered facilities will continue to receive the majority of their permits at zero cost.

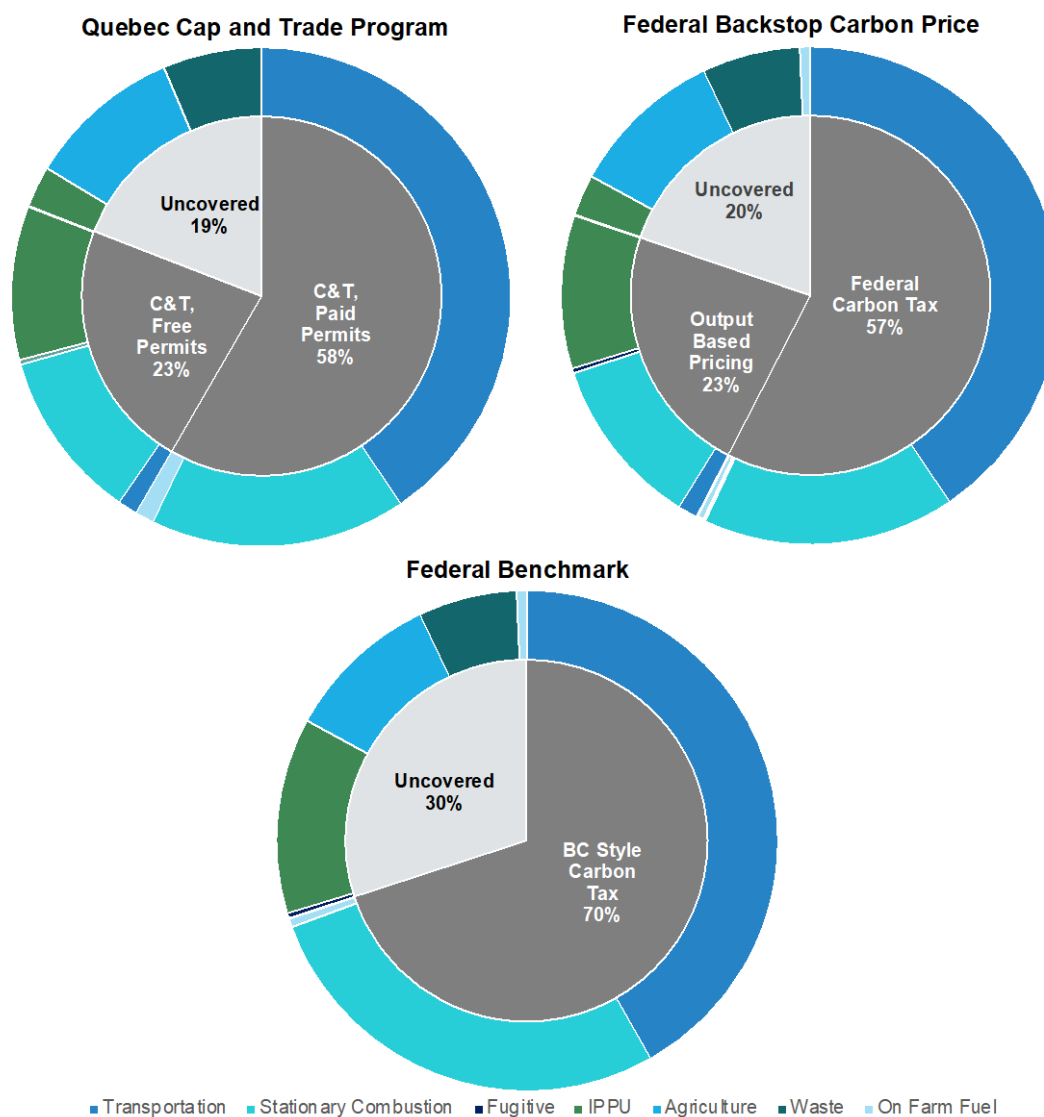
Through the inclusion of industrial process emissions, coverage of Quebec’s cap and trade program exceeds the federal benchmark by 11 percentage points. It additionally aligns closely with coverage of the federal backstop program. The only small differences are that the cap-and-trade program has a lower emissions threshold for mandatory participation by industrial facilities while under the federal OBPS natural gas distributors are eligible for free emissions permits. The federal backstop also provides an exemption to marked fuels used in farm vehicles. None of these differences are significant, however, and the federal backstop therefore covers nearly the same total number of emissions in Quebec (80 per cent), with a similar breakdown between those that are covered by a direct carbon price (57 per cent) and those that are eligible for support through the OBPS (23 per cent). The number of free permits distributed through the OBPS is likely to be smaller than those distributed through Québec’s cap-and-trade program.

Under both Québec’s cap-and-trade program and the federal backstop the largest source of uncovered emissions is non-combustion emissions from the agriculture sector (10 per cent of total emissions), followed by emissions from the waste sector (six per cent of total emissions).

¹³ Specifically, in 2015 Quebec distributed 18,823,184 emissions permits to 53 emitters with verified emissions of 17,234,077 (Développement durable, Environnement et Lutte contre les changements climatiques Québec, 2017a; Développement durable, Environnement et Lutte contre les changements climatiques Québec, 2017b).

Figure 8: Coverage Comparison of Québec Cap and Trade and the Federal Carbon Pricing Backstop and Benchmark

Québec Total Emissions, 2015: 80,133 kt



New Brunswick

Details of New Brunswick’s proposed carbon pricing plan were released in December 2017. In releasing the plan, the government indicated its primary goal was to reduce emissions, not to raise revenues (Government of New Brunswick 2017). As a result, rather than introducing a new carbon levy, the government announced that revenue from existing fuel taxes will be redirected towards a newly established Climate Change Fund (New Brunswick Department of Environment and Local Government 2017). Revenues from the fund will be restricted to use on climate change mitigation

and adaptation measures. In addition to the redirection of existing fuel taxes, the government also announced that the federal government's OBPS will be implemented in the province. Industrial facilities with emissions of 50 kt CO₂e or greater per year will be required to participate in the system.

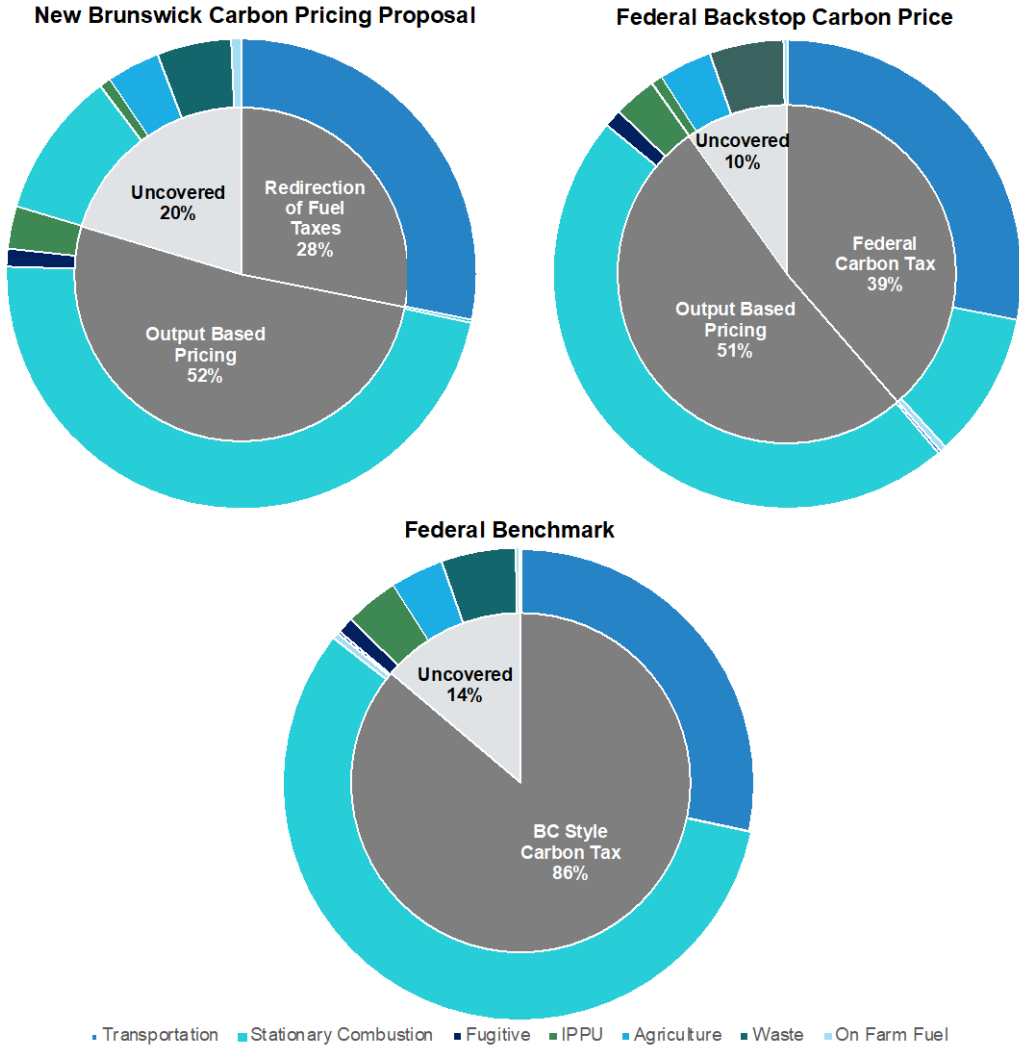
The Climate Change Act introduced in December 2017 identifies only gasoline and diesel fuel as the fuels for which a portion of the existing fuel tax will be redirected to the Climate Change Fund. This suggests coverage of the redirected tax will extend only to transportation emissions. Using 2015 emissions data we estimate this coverage at a maximum of 28 per cent of New Brunswick's emissions. This estimate accounts for the fuel tax exemption to farm vehicles but does not account for additional exemptions provided under the Fuel Tax Act, most notably for off road vehicles used in the fisheries, forestry, manufacturing and mining and quarrying sectors (Government of New Brunswick 2018). Our estimate of coverage of the federal government's OBPS is substantially higher at 52 per cent of New Brunswick's emissions (Figure 9). These emissions are primarily from stationary combustion and additionally cover small amounts of industrial process, fugitive and transportation emissions. Combined, New Brunswick's proposed carbon pricing system will therefore cover, at most, 80 per cent of emissions in the province.

The redirected fuel tax component of New Brunswick's carbon price is likely to face two challenges when compared against the federal benchmark. First, by only applying to fuels that are used for transportation, it does not ensure that a carbon price covers all sources of combustion emissions in the province. Most notably, 15 per cent of New Brunswick's stationary combustion emissions, corresponding largely to emissions associated with commercial, institutional and residential heating – and accounting for 10 per cent of the province's total emissions – are left unpriced. As a result, the province's plan falls short of the federal benchmark, which would cover 86 per cent of the province's emissions. In addition, in a post on her Facebook page, Environment and Climate Change Canada Minister Catherine McKenna suggested that a redirection of existing revenues was not sufficient to meet the federal requirements for carbon pricing, stating that “. . . New Brunswick proposes to take revenues from existing fuel taxes and invest them in climate action instead of putting a price on carbon across the economy, which does not create a new incentive to cut carbon pollution” (McKenna 2017).

If the federal government opts to impose the carbon tax component of its pricing system, then the share of emissions subject to a direct carbon price in New Brunswick will increase to 39 per cent. With 52 per cent of emissions still being covered by the OBPS, total carbon pricing coverage in New Brunswick would rise to 91 per cent of the province's emissions. The largest source of uncovered emissions in New Brunswick will be from the province's waste sector (five per cent of total emissions) and non-combustion emissions from the agricultural sector (four per cent of total emissions).

Figure 9: Coverage Comparison of a Potential New Brunswick Carbon Tax and the Federal Carbon Pricing Backstop and Benchmark

New Brunswick Total Emissions, 2015: 14,094 kt



Nova Scotia

Nova Scotia announced in December 2016 that it would implement a provincial carbon price through a cap-and-trade program starting in 2018. The threshold for mandatory participation in the program by industrial facilities is 50 kt CO₂e (Government of Nova Scotia 2017a). Other mandatory participants in the cap-and-trade program will include the electricity sector at the point of emissions, fuel suppliers that distribute greater than 200 litres of fuel in the Nova Scotia market each year and natural gas distributors with sales of natural gas equalling 10 kt CO₂e or more (Government of Nova Scotia 2017a).

As of July 2018, the regulation implementing Nova Scotia’s cap-and-trade program has not yet been released. However, preliminary documentation on the cap-and-trade program, as well as the

guidelines and regulation for reporting of greenhouse gas emissions, suggests the program will include combustion and industrial process emissions from mandatory participants (Government of Nova Scotia 2017b, Government of Nova Scotia 2018, Province of Nova Scotia 2018). Also included are fugitive emissions from oil and gas facilities. Based on 2015 emissions data, we therefore estimate coverage of the cap-and-trade program at 92 per cent of Nova Scotia's emissions, two percentage points higher than coverage under the federal benchmark (Figure 10).

The Government of Nova Scotia has additionally indicated that it will distribute the majority of emissions allocations for free. While exact details of the distribution have not been released, the government has stated that part of the motivation for the cap-and-trade program is to “minimize impacts to consumers” and to have Nova Scotians “. . . avoid a carbon tax or paying much more at the pumps or to heat their homes” (Government of Nova Scotia n.d.). This suggests that, unlike Ontario and Quebec, Nova Scotia is intending to include both electricity generators and fuel distributors in its allocation of free permits. On the surface this suggests that Nova Scotia may run into a similar challenge as New Brunswick in obtaining federal approval for its program. That is, if virtually all permits are being handed out for free with the objective of minimizing price increases, then the province exposes itself to the same criticism of failing to create a new incentive for reducing carbon emissions.¹⁴

In releasing its legislation enabling the creation of the cap-and-trade program in September 2017, however, Nova Scotia Environment Minister Iain Rankin stated that the province has been in discussions with the federal government and that the federal government is “onside” with the province's program (Laroche 2017). The key difference likely lies in the “cap” component of Nova Scotia's program, which has yet to be announced. In particular, even if the province does not charge a price for permits, it can meet the federal government's requirements by ensuring that its annual cap aligns with the emissions reductions that would have been achieved via implementation of the federal government's benchmark carbon price (Government of Canada 2018b).

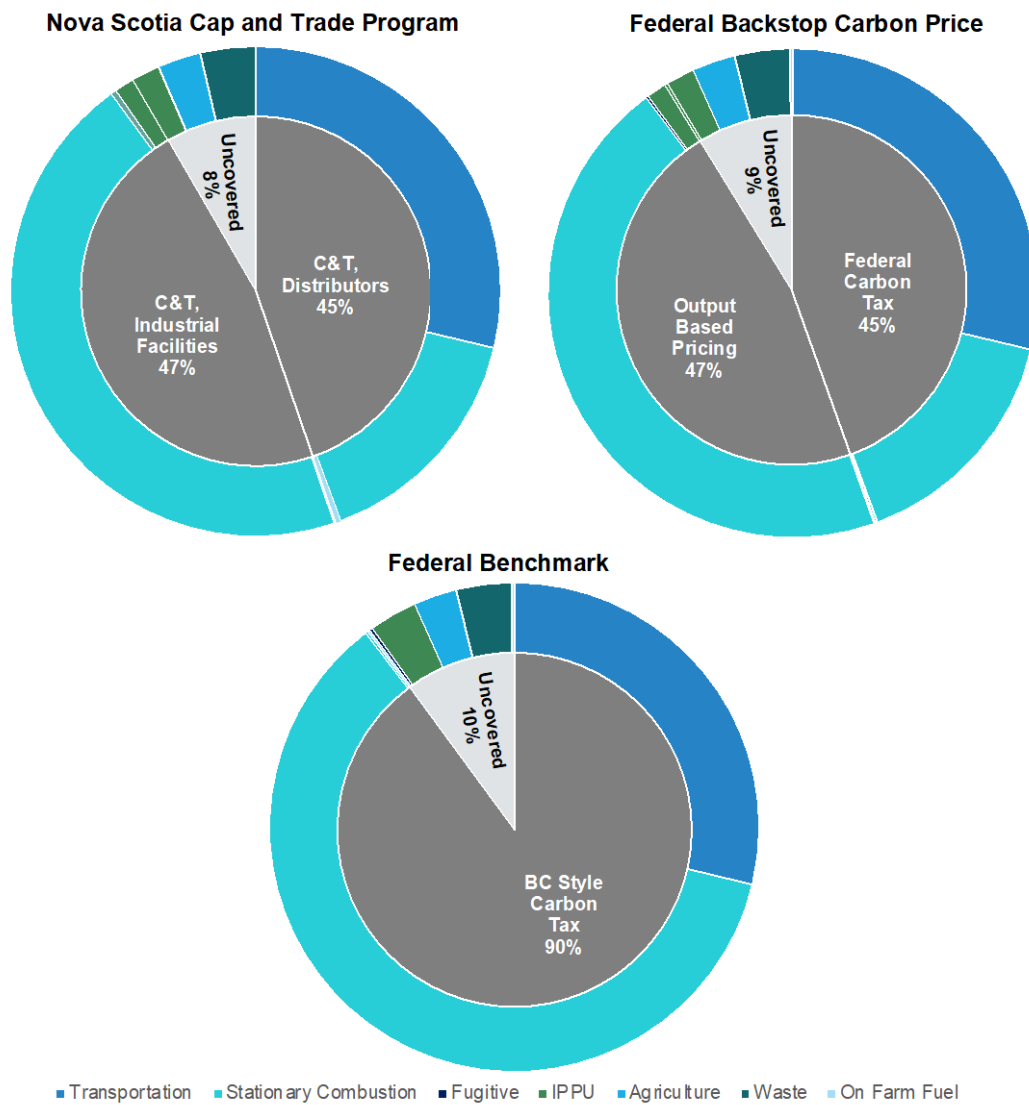
Coverage of Nova Scotia's cap-and-trade program aligns closely with the federal backstop, which would cover 91 per cent of the province's emissions. The federal backstop, however, would see a higher share of emissions – 44 per cent – facing a direct carbon price, with only 47 per cent of emissions eligible for free allocations. The federal backstop additionally provides an exemption to farm fuel and oil and gas methane emissions, which marginally lowers total carbon pricing coverage relative to Nova Scotia's cap-and-trade program.

Under both Nova Scotia's cap-and-trade program and the federal backstop the largest source of uncovered emissions is the waste sector (four per cent of total emissions), followed by non-combustion emissions from the agriculture sector (three per cent of total emissions).

¹⁴ As outlined in an Ecofiscal Commission blog post, it is interesting to note that providing emissions permits to electricity producers and fuel distributors at zero charge does not ensure that consumers will face only minimal price increases. As the permits have value in the cap-and-trade market there is an opportunity cost associated with them. This cost may be passed down to consumers through higher prices for electricity, natural gas and transportation fuel (gasoline/diesel), creating “windfall profits” for electricity generators and fuel distributors (Beugin 2017).

Figure 10: Coverage Comparison of Nova Scotia Cap and Trade and the Federal Carbon Pricing Backstop and Benchmark

Nova Scotia Total Emissions, 2015: 16,228 kt



Prince Edward Island

At the end of October 2016, shortly after the Government of Canada announced its intention to introduce a national carbon price, Prince Edward Island’s Environment Minister Robert Mitchell indicated that a cap-and-trade system would not work in the province due to its small share of industrial emissions. Prince Edward Island’s climate change secretariat has also issued a report recommending that the province implement a carbon tax (Campbell 2017). Early on, Premier Wade MacLauchlan indicated that it would be a “made-in-PEI” approach and “fiscally neutral” (Wright 2017). The province’s fall 2017 throne speech indicated a full Carbon Mitigation Strategy and Carbon Adaptation Plan would be released in early 2018.

The PEI Climate Change Action Plan was released in May 2018. Notably, it does not include a broad-based carbon tax. Instead, the province committed only to implementing the federal backstop for industrial emitters. The plan also commits to lower pricing on clean energy options, most explicitly electric heating for homes, which is significantly less carbon intensive than the traditional heating oil used widely across the province.¹⁵

Despite not implementing a carbon tax on fuels, PEI's climate plan also commits to providing exemptions for marked fuel in agriculture and fisheries (Government of Prince Edward Island 2018). This may be a nod towards the province's plan falling far short of the federal benchmark, and a recognition that the federal backstop – which includes the broad-based carbon tax the provincial plan is lacking – will likely be implemented in the province.

Specifically, the federal benchmark requires pricing all combustion emissions in the province, which would result in coverage of 68 per cent of the province's total emissions (Figure 11). In comparison, there is only a single industrial facility in PEI with emissions that exceed 50 kt of CO_{2e} per year and which therefore has a mandatory participation requirement in the federal government OBPS. Accordingly, PEI's climate plan prices only emissions from this facility, which are equal to three per cent of total emissions in the province. Significant sources of unpriced emission under PEI's climate plan include transportation (45 per cent of total emissions), stationary combustion (21 per cent) and non-combustion emissions from agriculture (20 per cent).

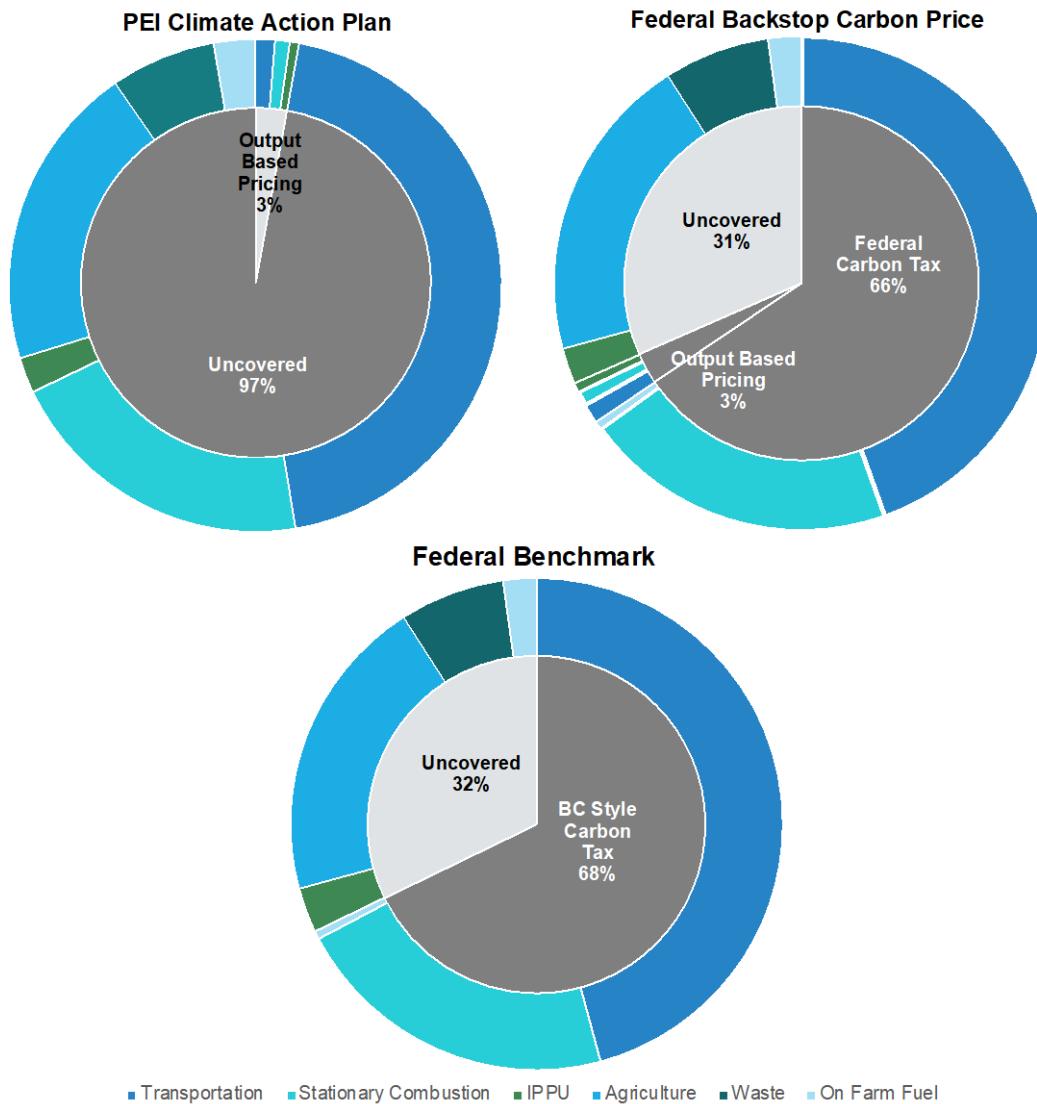
Implementation of the federal backstop in PEI would result in the same coverage as the federal benchmark. The OBPS would continue to cover the same facility as PEI's climate plan (three per cent of total emissions) while the carbon tax would apply to the remaining 65 per cent of combustion emissions in the provinces. Notably, however, included in this 65 per cent is a small number of emissions from lower emitting industrial facilities that are eligible to opt in to the federal OBPS. When faced with paying a direct carbon tax on all of their combustion emissions, versus participating in the OBPS and receiving free allocations for a share of their emissions, it seems likely that some number of these facilities will opt in to the OBPS. Accordingly, coverage of the OBPS may be slightly greater than three per cent while coverage of the carbon tax may be slightly less than 65 per cent.¹⁶

¹⁵ In 2011, for example, 76 per cent of households in Prince Edward Island used oil as their primary heat source (Statistics Canada 2011). More recent data specific to heat sources does not appear to be available. However, 2015 data on total household energy use indicates that heating oil accounts for 63 per cent of total energy use and that 78 per cent of Prince Edward Island households use heating oil (Statistics Canada 2018). Moreover, heating oil accounted for 56 per cent of residential home heating energy use and 82 per cent of installed residential heating systems (Natural Resources Canada 2018). This suggests it continues to be a significant source of household heating.

¹⁶ Industrial facilities with emissions between 10 and 50 kt of CO_{2e} per year did not have a mandatory reporting requirement prior to 2017. As a result, we cannot obtain a direct estimate of the quantity of emissions from facilities in PEI that are eligible to opt-in to the OBPS. The NIR provincial emissions summary for PEI indicates that in 2015, however, PEI had 80 kt of total stationary combustion emissions from electricity and manufacturing sources. Approximately 50 kt of emissions are attributable to the large emitter that is a mandatory participant in the OBPS. This leaves a maximum of 30 kt of stationary combustion emissions – or an additional 1.7 per cent of total provincial emissions – that may be eligible to opt in to the OBPS.

Figure 11: Coverage Comparison of a Potential Prince Edward Island Carbon Tax and the Federal Carbon Pricing Backstop

Prince Edward Island Total Emissions, 2015: 1,765 kt



Under the federal backstop the largest source of uncovered emissions in Prince Edward Island will be from the agricultural sector, including both non-combustion emissions (20 per cent of total emissions) and combustion emissions from farm vehicles (two per cent of total emissions). Unpriced emissions in the waste sector account for an additional seven per cent of total emissions.

Given PEI’s announced policy, it seems likely the federal backstop will be imposed. However, the Government of PEI’s plan does explicitly include a commitment to reduce provincial emissions 30 per cent below 2005 levels by 2030, the federal benchmark’s required target. While unlikely, it

is possible the federal government will accept the PEI plan as sufficient for meeting the benchmark.¹⁷

Newfoundland and Labrador

At the end of October 2017 Newfoundland and Labrador Premier Dwight Ball announced that his province's carbon pricing plan would be released in spring 2018 (The Telegram 2017). He stated that the province was working with the federal government on a "made-in-Newfoundland-and-Labrador" plan but declined to say whether it is a carbon tax or a cap-and-trade system that is under development. In the 2018 Budget speech in late March, Finance Minister Tom Osborne noted the government is finalizing the made-in-Newfoundland-and-Labrador plan (Government of Newfoundland and Labrador 2018). Of note in the speech is the implication that the Temporary Gas Tax would be phased out as carbon pricing is phased in. At the time of writing, no additional details are available.

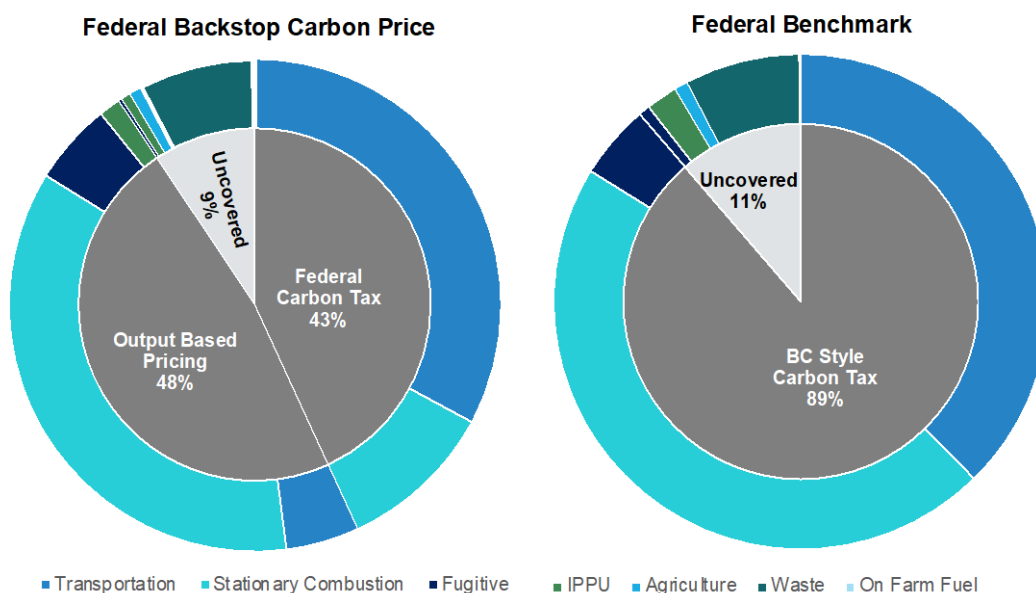
If Newfoundland and Labrador opts for a carbon tax similar to the federal benchmark then 89 per cent of the province's emissions will be covered by a carbon price (Figure 12). Implementation of the federal backstop will increase total emissions coverage only slightly, rising to 90 per cent as a result of the inclusion of large facility industrial process and fugitive emissions. Under the federal backstop 42 per cent of emissions in Newfoundland and Labrador would face a direct carbon tax while 48 per cent would be covered by the OBPS. A provincially implemented cap-and-trade program is likely to have similar coverage to the federal backstop. As was the case in Prince Edward Island, however, the breakdown between emissions covered by a direct price and those eligible for free allocations could vary significantly and will depend on whether free allocations are distributed following a model similar to Ontario and Quebec, or a model similar to Nova Scotia.

Under both the federal benchmark and the federal backstop only 10 to 11 per cent of Newfoundland and Labrador's emissions are not covered by a carbon price. The largest source of uncovered emissions is the waste sector (eight per cent of total emissions).

¹⁷ PEI's plan notes the province has the second-lowest per capita emissions in Canada and promotes the predominantly renewable nature of in-province electricity generation. Electrification of home heating and transportation is cited as a major source of action. However, recent research suggests PEI's imports of electricity are significant and also emissions-intensive, putting pause to the notion that electrification will result in substantial emissions reductions on net (Dobson and Fellows 2017).

Figure 12: Coverage Comparison of a Potential Newfoundland and Labrador Carbon Tax and the Federal Carbon Pricing Backstop

Newfoundland and Labrador Total Emissions, 2015: 10,323 t



Comparison and Summary of Carbon Pricing Coverage across the Provinces

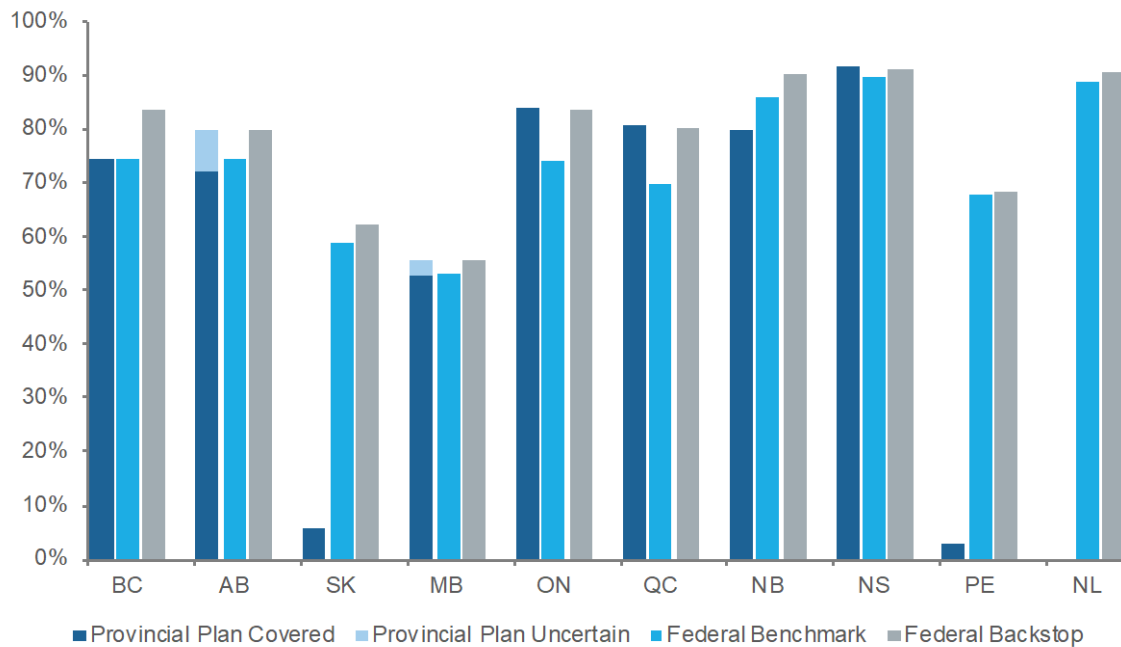
Figure 13 summarizes the coverage of proposed provincial carbon pricing plans across Canada and compares them to coverage of the federal benchmark and the federal backstop. Currently the provincial pricing plans in British Columbia, Manitoba, Québec and Nova Scotia all meet the benchmark.

Alberta’s hybrid system will also exceed the federal benchmark once the carbon price is fully implemented across the province, covering 86 per cent of emissions. The temporary exemption provided to conventional oil and gas producers, however, will decrease coverage by up to eight percentage points, causing the system to fall short of the coverage benchmark through to 2023. It remains to be seen whether the Government of Canada will accept the exemption or if it will impose some form of the federal backstop as a top-up measure. In comparison, Saskatchewan, New Brunswick and Prince Edward Island have each announced pricing systems that explicitly fall short of the federal benchmark. (New Brunswick’s plan is insufficient, even without the additional lack of effective coverage from the re-directed fuel tax.) In all three provinces, therefore, the federal backstop is likely to be implemented in some form. In Saskatchewan carbon pricing coverage will increase from only six per cent under the provincial plan to 73 per cent under the federal benchmark. In New Brunswick coverage will increase from 80 per cent to 90 per cent while in Prince Edward Island coverage will increase from three per cent to 68 per cent. Ontario’s choice to eliminate its cap and trade system also makes it delinquent relative to the federal benchmark. As noted above, by cancelling the province’s cap-and-trade program, Premier Doug Ford has

positioned the province to face a higher carbon price, with essentially identical coverage of the province’s emissions sources (84 per cent).

Last, as of July 2018, Newfoundland and Labrador is the only province that has not announced a provincial carbon pricing plan. The federal benchmark and the federal backstop, however, results in similar levels of emissions coverage. This is primarily due to the lack of industrial emitters – and thereby a relatively small number of industrial process emissions – in the province. As a result, regardless of the carbon pricing system that is adopted, coverage of a carbon price in Newfoundland and Labrador will be 89 to 90 per cent.

Figure 13: Coverage Comparison of Carbon Pricing Policies across the Provinces



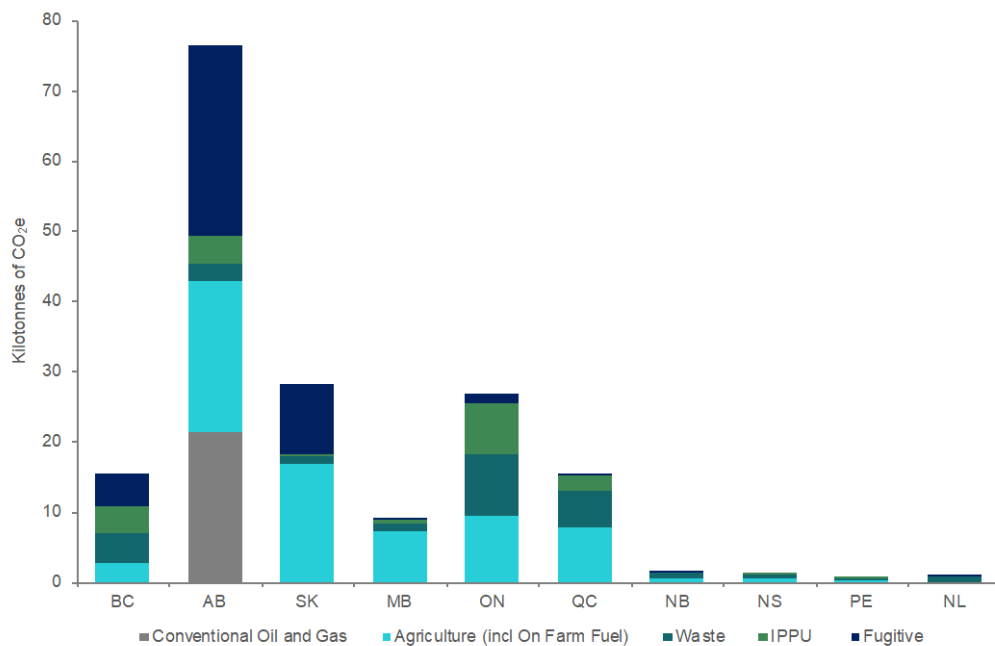
Comparing coverage of carbon pricing across the provinces, the highest rates of coverage are in New Brunswick (including coverage from the re-directed fuel tax) (80 per cent), Newfoundland and Labrador (89 to 90 per cent) and Nova Scotia (92 per cent). These high rates are driven by these provinces having relatively few sources of non-combustion emissions and therefore lower levels of these emissions. This in turn is a result of agriculture not being a major industry in any of these provinces, and these provinces also having smaller populations which results in fewer emissions from the waste sector, as well as fewer industrial process emissions from the service sector and individuals.

In the middle of the pack for coverage is Alberta (86 per cent) (assuming coverage of combustion emissions from conventional oil and gas), Ontario (84 per cent) and Quebec (81 per cent). These are all more diversified provinces that have large quantities of covered emissions, typically in the manufacturing and oil and gas sectors, as well as notable quantities of uncovered emissions, typically in the agricultural and waste sectors. British Columbia (75 per cent) falls below the

middle of the pack due to the fact that it is the only province that does not price non-combustion industrial process emissions. If these emissions were included under British Columbia’s carbon tax then its coverage would rise to a comparable 85 per cent.

Last, carbon pricing coverage is lowest in Saskatchewan (73 per cent), Prince Edward Island (68 per cent) and Manitoba (53 per cent). In all three provinces the relative importance of the agricultural sector – which correspondingly accounts for a significant share of provincial emissions – dampens carbon pricing coverage. It is important to note, however, that although these provinces have the highest shares of uncovered emissions, they are not the largest sources of uncovered emissions on a national basis. This is because these provinces do not have the highest absolute number of emissions. Rather, the largest source of uncovered emissions in Canada through to 2023 will likely be uncovered fugitive emissions (primarily methane) from Alberta’s oil and gas sector, followed closely by combustion emissions from conventional oil and gas producers not covered by Alberta’s CCIR (Figure 14).¹⁸ In Alberta, unpriced agriculture emissions are roughly equal to emissions from conventional oil and gas. Other significant sources nationally of uncovered emissions are agricultural emissions and fugitive emissions from the oil and gas sector in Saskatchewan.

Figure 14: Unpriced CO₂e Emissions Sources by Province



¹⁸ We say “likely” here because we do not have an exact measure of combustion emissions from the conventional oil and gas sector in Alberta. As noted in the main text, we estimate this amount at a maximum of eight per cent of Alberta’s emissions in 2015.

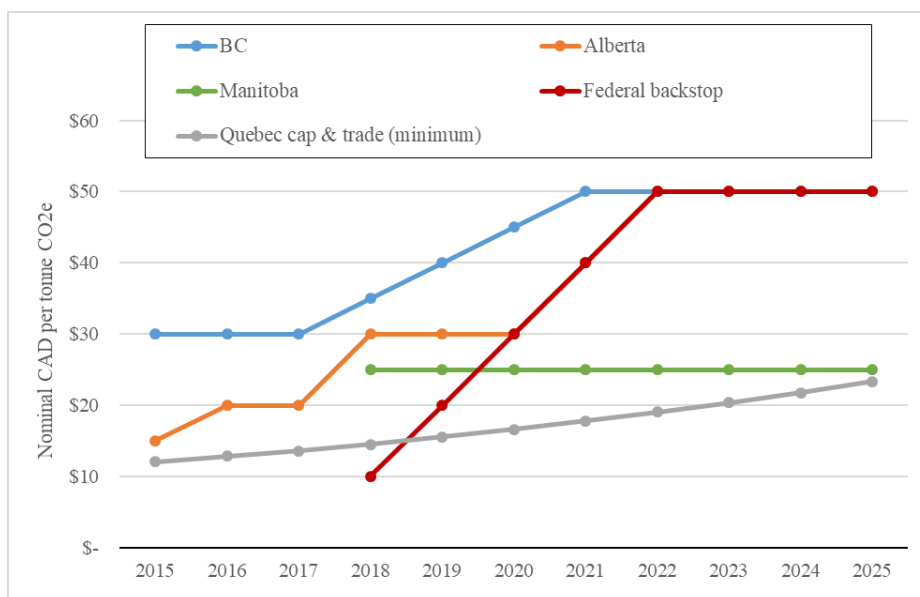
Discussion and Conclusions

We have demonstrated the differences in emissions coverage from the federal benchmark and backstop, and where applicable, provincial pricing plans. Comparing the coverage of different carbon pricing instruments can inform provincial decision-making. Of course, this is only one part of the decision-making process in developing emissions pricing plans. Other considerations include the overall stringency of the instruments, cost-effectiveness, transparency, the role of complementary policies and the role of the federal government in enforcing broad-based carbon pricing.

Overall stringency of the instruments.

Regardless of the instrument chosen, where the actual price is set will also determine its efficacy. While the federal backstop and the Pan-Canadian Framework ensures a price floor, free allocations within an OBPS or a cap and trade system reduce costs to large emitters. The PCF indicates that provinces choosing to implement cap-and-trade must set a cap that equals projected emission reductions from the benchmark price, rather than the price itself. Comparing the price of carbon across different jurisdictions with different systems is complicated and should include whether free allocation of permits occurs within a cap-and-trade system, as well as whether permits¹⁹ can be purchased from outside domestic borders.

Figure 15: Current Canadian Carbon Pricing Policies, 2015 – 2025



As noted above, part of the federal benchmark is increasing stringency, either through an increased price in carbon tax systems, or a tightened cap in cap-and-trade systems. However, provinces with

¹⁹ When cap-and-trade systems are linked across jurisdictions, as Quebec's is with California's, emitters can purchase permits from outside their own systems to meet their obligations. This means the carbon price achieves greater reductions at a lower price, even though some of these reductions will occur in another jurisdiction, because more low-cost options are available. For more details, see Beugin et al (2016).

a carbon tax and provinces with a cap and trade system have thus far seen a divergence in prices, which is projected to continue (Figure 15). In 2020 and onward, Quebec and Manitoba's prices are likely to be lower than most other provinces. While the Quebec and Manitoba plans may have equivalent stringency in terms of overall emissions reductions, the difference in price level will be contentious as provinces speak to the distribution of burden and economic impact. This is likely to be an important point of discussion in 2020 when the federal government is scheduled to review the equivalency of provincial pricing systems.

The cost-effectiveness of the instruments

A cap-and-trade system may provide more emissions coverage than a carbon tax. But if that increase is relatively small and the costs of developing and operating the system are high, it may be more cost-effective to institute a carbon tax.²⁰ This may be particularly pertinent for small jurisdictions like Manitoba, Nova Scotia, Newfoundland and Labrador, and PEI that have a small number of large final emitters and less bureaucratic capacity compared to larger provinces like Ontario and Quebec.

Transparency

By its very nature, a carbon tax is transparent – households and businesses know exactly the cost associated with the tax, and where there are exemptions. By contrast, a cap-and-trade system is more complex and opaque, both in terms of sectors potentially subject to the system and how permits are allocated. An explicit system like a tax can be more politically costly because of the transparency of costs imposed on voters. The complexity of a cap and trade system can also be more sensitive to lobbying, as it is more difficult for voters to see and police special treatment of certain types of firms.

Complementary policies

Many provinces in announcing their climate change strategies also included regulations in specific sectors that place an implicit price on emissions, in addition to that already created by a tax or cap-and-trade. Jaccard (2016) argues that governments should consider complementary regulations that would reduce emissions in areas like coal-fired electricity generation, vehicles and fuel. These policies place an implicit price on carbon, rather than an explicit price of a tax or trading system. Combining pricing and regulations, Jaccard argues, is more politically viable approach to achieving the reductions required to meet government-established targets. However, these policies often have a higher implicit price, imposing further costs on provincial economies, and do not always result in additional emissions reductions (Ragan et al. 2017). That said, there is a role for complementary non-pricing policies to improve coverage and when other market failures are present (Keohane and Olmstead 2016).

²⁰ While there are administrative costs associated with a carbon tax as well, these are likely to be less than a cap-and-trade system, because a tax can be implemented through existing infrastructure, such as motor fuel taxes, while cap-and-trade requires capacity for allocating permits, monitoring compliance and verifying emission reductions inside the system as well as emission offsets sold into the system (Frank 2014).

This issue is of particular importance for Saskatchewan, Manitoba and PEI with the highest proportion of uncovered emissions within-province. It also matters for B.C., Alberta and Saskatchewan as oil and gas producers and large sources of fugitive emissions.

The federal backstop

Those provinces that have yet to introduce carbon pricing or that do not meet the federal benchmark must consider the road ahead. The federal government has announced that it will impose the backstop on any provinces that does not meet its benchmark. This creates the potential for provinces to work with the federal government, reducing their administrative burden. However, as noted earlier, Saskatchewan has launched a reference case in the courts asking whether the federal government has the authority to impose a system on recalcitrant provinces. Under Ford, Ontario has joined Saskatchewan in their fight against Ottawa, while in Alberta UCP leader Jason Kenney has indicated he will do the same if elected in 2019. A legal opinion requested by the Manitoba Government indicates that imposing a tax is likely within federal jurisdiction, unless an equivalent provincial system is in place. Manitoba is therefore arguing that its approach meets and exceeds the federal backstop. Regardless of the outcome, the legal challenges could slow implementation of the PCF and create political challenges for the Trudeau government leading into the next federal election.

Concluding Thoughts

Provinces have a unique opportunity at this point in time to assess the coverage, stringency and efficacy of their climate strategies. The analysis presented above provides a starting point which allows provincial decision-makers to balance coverage concerns with additional policy considerations. It also highlights the need for additional policies to address the remaining unpriced emissions. Future research can aid provincial decision-making in developing these policies, and include aspects of climate policy broader than the strict coverage of the pricing instruments.

Appendix A

Table 1: 2015 Greenhouse Gas Emissions Estimates by National Inventory Report Emissions Category

Emissions Categories	2015 Emissions (t of CO₂e)	Share of 2015 Emissions
Energy	587,072	81.3%
Stationary Combustion	327,951	45.4%
Transport	202,235	28.0%
Fugitive Sources	56,886	7.9%
Industrial Processes and Product Use (IPPU)	51,067	7.1%
Mineral Products	8,036	1.1%
Chemical Industry	6,506	0.9%
Metal Production	14,230	2.0%
Production and Consumption of Halocarbons	11,016	1.5%
Non-Energy Products from Fuels and Solvent Use	10,798	1.5%
Other Product Manufacture and Use	481	0.1%
Agriculture	58,952	8.2%
Enteric Fermentation	25,005	3.5%
Manure Management	8,513	1.2%
Agriculture Soils	22,703	3.1%
Field Burning of Agricultural Residues	55	0.0%
Liming, Urea Application and Other Carbon-containing Fertilizer	2,676	0.4%
Waste	24,699	3.4%
Solid Waste Disposal	22,147	3.1%
Biological Treatment of Solid Waste	929	0.1%
Wastewater Treatment and Discharge	1,061	0.1%
Incineration and Open Burning of Waste	552	0.1%
Land Use, Land Use Change and Forestry	-33,544	N/A
Forest Land	-164,499	
Cropland	-10,907	
Grassland	681	
Wetlands	2,720	
Settlements	3,584	
Harvested wood products	134,877	

Note: This table also includes emissions in the Land Use, Land Use Change and Forestry sector. These emissions are not represented in the Figure 1 as they are not included in the annual total of Canada's greenhouse gas emissions.

Appendix B: Methodology

The primary data set we use to derive our estimates of coverage is the 2017 National Inventory Report (NIR). The NIR provides national- and provincial-level estimates of CO₂e emissions by greenhouse gas type and IPCC category, and of total CO₂e emissions by economic sector in 2015. Nationally, a mapping of emissions from IPCC category to economic sector is also available. The NIR data was supplemented by a dataset provided on request from Environment and Climate Change Canada (ECCC) that provides provincial level breakdowns of fugitive emissions by the coal, oil, natural gas, flaring and venting subcategories. Last, we also use ECCC's facility greenhouse gas reporting database from 2015.

We refer to these five datasets hereafter as the IPCC, economic sector (ES), mapping (MAP), supplementary fugitive (SF) and facility reporting (FR) datasets. The abbreviations of each dataset are used in the formulas presented below to identify data sources. We also make use of the following indices: f (facilities reporting to ECCC's greenhouse gas reporting database and covered by the OBPS), i (Canadian provinces), j (industrial economic sectors from the economic sector dataset)²¹ and k (subcategories of IPPU emissions from the IPCC dataset).²²

Benchmark Coverage Estimates

Coverage estimates of the federal benchmark are largely straightforward as combustion emissions are the only emissions that are priced. These emissions are reported in the IPCC Stationary Combustion (SC), Transportation and Fugitive Emissions-Flaring subcategories. They are therefore taken directly from the IPCC and the supplementary fugitive datasets. The only significant change we make from the IPCC categorization is separating out the estimate of farm transportation fuel emissions. We separate these emissions as combustion emissions from coloured fuel used in off-road farm vehicles are excluded from the federal benchmark.

To separate out off-road farm fuel transportation emissions we utilize the following steps:

1. Estimate the national share of forestry combustion emissions attributable to transportation:

$$\begin{aligned} & \textit{Transportation Share, Forestry} \\ &= \frac{\textit{Forest Resources Transport}^{MAP}}{\textit{Forest Resources Transport}^{MAP} + \textit{Forest Resources SC}^{MAP}} \end{aligned}$$

2. Estimate provincial forestry sector emissions attributable to transportation:

$$\textit{Transportation, Forestry}_i = \textit{Transportation Share, Forestry} \times \textit{Forest Resources}_i^{ES}$$

3. Estimate provincial transportation emissions from off-road farm vehicles:

²¹ Industrial economic sectors include the following (from the economic sector dataset): Natural Gas Production and Processing, Conventional Oil Extraction, Oil Sands Mining and Extraction, Oil Sands In Situ, Oil Sands Upgrading, Petroleum Refining, Oil and Natural Gas Transmission, Natural Gas Distribution, Electricity, Mining, Smelting and Refining (Non-Ferrous Metals), Pulp and Paper, Iron and Steel, Cement, Lime and Gypsum, Chemicals and Fertilizers, Coal Production and Light Manufacturing.

²² IPPU emissions have the following six subcategories (from the IPCC dataset): Mineral Production, Chemical Industry, Metal Production, Consumption of Halocarbons, SF₆ and NF₃, Non-Energy Products from Fuels and Solvent Use and Other Product Manufacture and Use.

$$\begin{aligned}
& \text{Transportation, Agriculture}_i \\
& = \text{Other Transportation, OffRoad Agriculture \& Forestry}_i^{IPCC} \\
& - \text{Transportation Emissions, Forestry}_i
\end{aligned}$$

Our estimates of covered and uncovered emissions under the federal benchmark are then calculated as:

$$\begin{aligned}
\text{Covered}_i^{\text{Benchmark}} & = SC_i^{IPCC} + (\text{Transportation}_i^{IPCC} - \text{Transportation, Agriculture}_i) + \text{Flare}_i^{SF} \\
\text{Uncovered}_i^{\text{Benchmark}} & = \text{Transportation, Agriculture}_i + (\text{Fugitive}_i^{IPCC} - \text{Flare}_i^{SF}) + IPPU_i^{IPCC} \\
& + \text{Agriculture}_i^{IPCC} + \text{Waste}_i^{IPCC}
\end{aligned}$$

Backstop Coverage Estimates

Coverage estimates of the federal backstop are more complex as they require separating out emissions that are covered by a carbon tax and those that are covered by the federal government’s output-based pricing system (OBPS), which applies to industrial facilities with annual emissions of 50 kt of CO₂e and above (though facilities can opt in to the OBPS, we abstract from this in our estimation of coverage as we don’t have complete data for facilities eligible to opt-in, nor do we know how many will choose to opt in).

Output-based Pricing System

To approximate total emissions covered by the OBPS in each province we use the following formula:

$$OBPS \text{ Emissions}_i = \sum_f \text{Reported Emissions}_{i,f}^{FR}$$

We exclude emissions from facilities in the following NAICS sectors as they are not covered by the OBPS: Sewage Treatment Facilities; Waste Treatment and Disposal; All Other Waste Management Services; Other Federal Government Public Administration; Community Colleges and CEGEPS; Universities; and Other Support Activities for Air Transportation.

Industrial Emissions

The next step is breaking the total industrial emissions estimates down by the IPCC categories of SC, transportation, total fugitive (including venting, flaring and uncontrolled fugitive sources) and IPPU. Facilities report emissions by these categories to ECCC but this information is not made public at either the facility or the provincial level. Rather, ECCC only releases the shares of emissions by IPCC category at the national level. Specifically, the 2015 summary report indicates that 77 per cent of reported emissions are from SC, 14 per cent are from IPPU, 2 per cent are from venting, 2 per cent are from flaring, 2 per cent are from uncontrolled fugitive sources and 2 per cent are from on-site transportation. Estimates of national emissions by IPCC category are calculated by multiplying these shares by total reported emissions from large emitters (263,256 kt

of CO₂e). We refer to these amounts as SC^{OBPS} , $IPPU^{OBPS}$, $Vent^{OBPS}$, $Flare^{OBPS}$, $Fugitive^{OBPS}$ and $Transport^{OBPS}$ in the discussion that follows.

The next step is to distribute the estimates of national emissions by IPCC categories across the provinces. For IPPU emissions we follow the below steps for each subcategory of emissions.

1. Calculate the national share of IPPU subcategory emissions attributable to industrial economic sectors:

$$National\ Industrial\ Share, IPPU_k = \frac{\sum_j IPPU_{k,j}^{MAP}}{IPPU_k^{IPCC}}$$

2. Estimate provincial IPPU subcategory emissions attributable to industrial economic sectors:

- (a) If $National\ Industrial\ Share, IPPU_k = 1.0$ then:

$$IPPU_{i,k}^{Ind} = IPPU_{i,k}^{IPCC}$$

- (b) If $National\ Industrial\ Share, IPPU_k < 1.0$ then:

$$IPPU_{i,k}^{Ind} = \sum_j \left(\frac{\sum_f Reported\ Emissions_{i,f,j}^{FR}}{\sum_{i,f} Reported\ Emissions_{i,f,j}^{FR}} \times IPPU_{k,j}^{MAP} \right)$$

where the first term in the summation is a province's share of total large facility emissions in an industrial economic sector.²³

3. Estimate total provincial IPPU subcategory emissions attributable to industrial economic sectors:

$$IPPU_i^{Ind} = \sum_k IPPU_{i,k}^{Ind}$$

4. Estimate total provincial IPPU subcategory emissions subject to the OBPS:

$$IPPU_i^{OBPS} = \frac{IPPU^{OBPS}}{\sum_j IPPU_j^{MAP}} \times IPPU_i^{Ind}$$

Transportation Emissions

For transportation emissions we follow a similar process to IPPU emissions but without the subcategories. Specifically, we follow the below steps:

1. Estimate provincial transportation emissions attributable to industrial economic sectors:

$$Transport_i^{Ind} = \sum_j \left(\frac{\sum_f Reported\ Emissions_{i,f,j}^{FR}}{\sum_{i,f} Reported\ Emissions_{i,f,j}^{FR}} \times Transport_j^{MAP} \right)$$

where the first term in the summation is a province's share of total large facility emissions in an industrial economic sector.

2. Estimate total provincial transport emissions subject to the OBPS:

$$Transport_i^{OBPS} = \frac{Transport^{OBPS}}{\sum_j Transport_j^{MAP}} \times Transport_i^{Ind}$$

²³ Industrial economic sectors from the facility reporting dataset do not map directly to the industrial economic sectors in the NIR as ECCC classifies facilities according to NAICS. As a result, we must map the NAICS economic sectors to the NIR economic sectors. This mapping is available upon request.

Fugitive Emissions

Coverage of total fugitive emissions under the OBPS is equal to the sum of emissions coverage across the subcategories of flaring, venting and uncontrolled fugitive emissions. The allocation of flaring emissions is the most straight forward as the estimate of flaring emissions in the facility reporting dataset is greater than the estimate of flaring emissions in the IPCC dataset. This suggests that large industrial facilities account for 100 per cent of flaring emissions. Provincial estimates of flaring emissions covered by the federal backstop can therefore be taken directly from the supplementary fugitive dataset. That is:

$$Flare_i^{OBPS} = Flare_i^{SF}$$

The final two categories of emissions that we must allocate across the provinces are venting and uncontrolled fugitive emissions from solid fuel (coal), oil and natural gas. This is complicated by the federal government's announcement in January 2018 that methane emissions from oil and gas facilities are exempt from carbon pricing. As a result, we must separate oil and gas venting and fugitive methane emissions from venting and fugitive emissions of all other large emitters.

The mapping dataset indicates there are only four industrial sectors with venting and uncontrolled fugitive emissions – oil and gas (*OG*), petroleum refining (*R*), coal mining (*C*) and pipelines (*P*) (including oil and natural gas transmission and natural gas distribution). For simplicity we assume all venting and uncontrolled fugitive emissions from the latter three sectors are attributable to large emitters and therefore subject to the OBPS.

The coal mining sector only has uncontrolled fugitive emissions, which are directly reported at the provincial level in the supplementary fugitive dataset in the solid fuel subcategory. That is:

$$Fugitive_{i,C} = Solid\ Fuels_i^{SF}$$

For the petroleum refining and pipeline sector we calculate provincial venting and uncontrolled fugitive emissions as:

$$(Vent_{i,R} + Fugitive_{i,R}) = \frac{\sum_f Reported\ Emissions_{i,f,R}^{FR}}{\sum_{i,f} Reported\ Emissions_{i,f,R}^{FR}} \times (Vent_R^{MAP} + Fugitive_R^{MAP})$$

$$(Vent_{i,P} + Fugitive_{i,P}) = \frac{\sum_f Reported\ Emissions_{i,f,P}^{FR}}{\sum_{i,f} Reported\ Emissions_{i,f,P}^{FR}} \times (Vent_P^{MAP} + Fugitive_P^{MAP})$$

We next take the following steps to calculate an estimate of non-methane venting and uncontrolled fugitive emissions from large oil and gas facilities subject to the OBPS.

1. Estimate national venting and uncontrolled fugitive emissions from large oil and gas (*LgOG*) facilities subject to the OBPS:

$$\begin{aligned} &Vent_{LgOG} + Fugitive_{LgOG} \\ &= Vent^{OBPS} + Fugitive^{OBPS} \\ &- (Fugitive_C^{MAP} + (Vent_R^{MAP} + Fugitive_R^{MAP}) + (Vent_P^{MAP} + Fugitive_P^{MAP})) \end{aligned}$$

2. Estimate provincial venting and uncontrolled fugitive emissions from large oil and gas facilities:

$$\begin{aligned} & \text{Vent}_{i,LgOG} + \text{Fugitive}_{i,LgOG} \\ &= \frac{\sum_f \text{Reported Emissions}_{i,f,LgOG}^{FR}}{\sum_{i,f} \text{Reported Emissions}_{i,f,LgOG}^{FR}} \times (\text{Vent}_{LgOG} + \text{Fugitive}_{LgOG}) \end{aligned}$$

3. Calculate methane emissions from large oil and gas facilities in each province (as reported by each facility in the facility reporting dataset):

$$\text{Methane}_{i,LgOG} = \sum_f \text{Methane}_{f,i,LgOG}^{FR}$$

4. Calculate the estimate of non-methane venting and uncontrolled fugitive emissions from large oil and gas facilities covered by the OBPS:

$$(\text{Vent}_{i,LgOG}^{OBPS} + \text{Fugitive}_{i,LgOG}^{OBPS}) = (\text{Vent}_{i,LgOG} + \text{Fugitive}_{i,LgOG}) - \text{Methane}_{i,LgOG}$$

Last, our estimate of total fugitive emissions covered by the OBPS in each province is equal to the following:

$$\begin{aligned} & \text{Total Fugitive}_i^{OBPS} \\ &= \text{Flare}_i^{OBPS} + \text{Fugitive}_{i,C} + (\text{Vent}_{i,R} + \text{Fugitive}_{i,R}) + (\text{Vent}_{i,P} + \text{Fugitive}_{i,P}) \\ &+ (\text{Vent}_{i,LgOG}^{OBPS} + \text{Fugitive}_{i,LgOG}^{OBPS}) \end{aligned}$$

Last, we calculate provincial SC emissions covered by the OBPS as:

$$\begin{aligned} \text{SC}_i^{OBPS} &= \sum_f \text{Reported Emissions}_{i,f}^{FR} - \text{IPPU}_i^{OBPS} - \text{Transport}_i^{OBPS} - \text{Total Fugitive}_i^{OBPS} \\ &- \text{Methane}_{i,LgOG} \end{aligned}$$

Carbon Tax

Calculating emissions covered by the carbon tax in the federal backstop is generally more straightforward than calculating those covered by the OBPS. Coverage of stationary combustion and transportation emissions is equal to the following:

$$\text{SC}_i^{\text{Tax}} = \text{SC}_i^{\text{IPCC}} - \text{SC}_i^{\text{OBPS}}$$

$$\begin{aligned} \text{Transport}_i^{\text{Tax}} &= \text{Transport}_i^{\text{IPCC}} - \text{Transport}_i^{\text{OBPS}} - \text{Transportation Emissions, Agriculture}_i \end{aligned}$$

The last step is estimating non-methane venting emissions from small oil and gas facilities as these are the only source of fugitive emissions subject to the federal carbon tax. We back out this estimate through the following steps:

1. Calculate methane shares of uncontrolled fugitive oil and natural gas emissions, and venting emissions in each province:

$$\begin{aligned} & \text{Uncontrolled Fugitive Methane Share}_i \\ &= \frac{\text{Fugitive Oil Methane}_i^{\text{SF}} + \text{Fugitive Natural Gas Methane}_i^{\text{SF}}}{\text{Fugitive Oil}_i^{\text{SF}} + \text{Fugitive Natural Gas}_i^{\text{SF}}} \end{aligned}$$

$$\text{Venting Methane Share}_i = \frac{\text{Venting Methane}_i^{SF}}{\text{Venting}_i^{SF}}$$

2. Estimate provincial methane emissions attributable to pipelines and refineries:

$$\text{Methane}_{i,P+R} = \text{Uncontrolled Fugitive Methane Share}_i \times (\text{Fugitive}_{i,R} + \text{Fugitive}_{i,P}) + \text{Fugitive Venting Share}_i \times (\text{Vent}_{i,R} + \text{Vent}_{i,P})$$

3. Estimate provincial methane emissions attributable to small oil and gas producers (*SmOG*):

$$\begin{aligned} \text{Methane}_{i,SmOG} &= \text{Total Methane}_i^{SF} - \text{Flaring Methane}_i^{SF} - \text{Solid Fuels Methane}_i^{SF} \\ &\quad - \text{Methane}_{i,P+R} - \text{Methane}_{i,LgOG} \end{aligned}$$

4. Estimate provincial non-methane venting emissions attributable to small oil and gas producers and covered by the carbon tax:

$$\begin{aligned} \text{Non Methane Venting}_{i,SmOG}^{Tax} &= (\text{Fugitive Oil}_i^{SF} + \text{Fugitive Natural Gas}_i^{SF} + \text{Venting}_i^{SF}) \\ &\quad - (\text{Vent}_{i,R} + \text{Fugitive}_{i,R}) - (\text{Vent}_{i,P} + \text{Fugitive}_{i,P}) \\ &\quad - (\text{Vent}_{i,LgOG} + \text{Fugitive}_{i,LgOG}) - \text{Methane}_{i,SmOG} \end{aligned}$$

Note this method assumes there are no non-methane uncontrolled fugitive emissions from small oil and gas facilities. This assumption is grounded in the fact that nationally, 98 per cent of uncontrolled fugitive emissions from oil and natural gas sources are methane.

Uncovered Emissions

Finally, uncovered emissions under the federal backstop are equal to all agriculture and waste emissions (as reported in the IPCC dataset), IPPU emissions minus the estimate of those covered by the OBPS and fugitive emissions minus the estimate of those covered by the OBPS and those covered by the carbon tax. Specifically, we calculate these emission as:

$$\begin{aligned} \text{Uncovered}_i^{Backstop} &= \text{Transportation Emissions, Agriculture}_i + \text{Agriculture}_i^{IPCC} + \text{Waste}_i^{IPCC} \\ &\quad + (\text{IPPU}_i^{IPCC} - \text{IPPU}_i^{OBPS}) + \text{Methane}_{i,SmOG} + \text{Methane}_{i,LgOG} \end{aligned}$$

We do not go into detail on the methodology for coverage estimates of each individual provincial pricing program. The approach is generally similar to the methodologies described above, with small changes made to adjust for attributes specific to each provincial program. Specific details are available upon request.

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