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THE GROUND RULES FOR EFFECTIVE OBAs: PRINCIPLES FOR ADDRESSING CARBON-PRICING COMPETITIVENESS CONCERNS THROUGH THE USE OF OUTPUT-BASED ALLOCATIONS[†]

Sarah Dobson, G. Kent Fellows, Trevor Tombe and Jennifer Winter

SUMMARY

The federal government's decision to impose a minimum national price on carbon emissions has the potential to make certain businesses in the country less competitive. Specifically, there are emissions-intensive and trade-exposed industries across Canada that compete against producers from other jurisdictions where governments do not put a price on carbon. For these industries, the obligation to pay a carbon price creates a competitive disadvantage. Specifically, these businesses will face higher costs and may encounter a loss of market share to international competitors from jurisdictions that lack the same emission-control measures. That not only hurts Canadian businesses, it could also negate any emissions reductions that carbon pricing in Canada achieves on a global scale.

The federal government has opted to protect such emissions-intensive, trade-exposed businesses using subsidies called output-based allocations (OBAs). This is the same system that Alberta is introducing through its forthcoming Carbon Competiveness Regulation. It also shares certain similarities with cap-and-trade programs, such as those in Ontario and Quebec, which provide free allocations of emissions permits to certain firms.

OBAs are a desirable complementary policy to a carbon price as they maintain the incentive for producers to invest in production methods and facilities that are less emissions intensive. So while producers are still, nevertheless, subsidized to offset the tax burden of the carbon price, they will, under an OBA system, see greater benefits the more they work to reduce their emissions intensity. Still, to function most effectively and most efficiently, an OBA policy should follow certain key principles.

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The most critical principle in the design of an OBA policy is ensuring that OBAs are allocated to facilities independent of their individual emission levels, and allocated equally (on a per unit basis) to facilities producing the same product. One of the major flaws with Alberta's current Specified Gas Emitters Regulation (SGER) is that it does not follow this principle. Rather, subsidies under SGER are allocated based on a facility's historical emissions intensity. As a result, more generous subsidies are given to those facilities that are "dirtier" (that is, those with higher emissions intensities) than to "cleaner" facilities with lower emission intensities.

Secondly, it is important for a well-designed OBA policy to have transparent costs. Including a clear accounting of OBAs in government finance reports will ensure the public is fully aware of the revenues being directed to the subsidies.

Thirdly, OBAs for different facilities are best allocated using a classification system based on the product being produced, and not using more conventional industry-classification codes. Commonly used conventional industry classifications—for example, conventional oil and natural gas extraction—group together facilities that produce distinct products and compete in different markets. Consequently, this classification will not recognize the various levels of emissions intensity and trade exposure within an industry. This will result in some facilities receiving more OBAs than they should and others receiving less than they should.

Finally, a well-designed OBA system should seek to be as administratively efficient as possible with minimal implementation costs imposed on government and businesses.

It is important to recognize that the federal carbon price and OBAs are a new policy and that many large emitting facilities have been making investment decisions based on a previous regulatory environment. Therefore, a compromise approach may be to initially provide an output subsidy based on a facility's past emissions intensity (as Alberta has historically done under its SGER system) and then to transition gradually to the optimal OBA system over time.

INTRODUCTION

Canada is taking a leadership role in the world by implementing efficient environmental policies, such as carbon pricing. The federal government first announced in October 2016 its intention to implement a pan-Canadian carbon price (Environment and Climate Change Canada, 2016b). Starting in 2018, all provinces will be required to have a minimum carbon price of $10 per tonne. This minimum price will increase by $10 per year, reaching $50 per tonne in 2022. Provinces were given the option of designing their own system — in the form of either a carbon tax or a cap-and-trade program — to implement the price. For provinces opting not to go this route, the federal government will implement the carbon price through a federally designed system.

A technical paper released by Environment and Climate Change Canada (ECCC) in May 2017 provided initial details on the federally designed system. The proposed system will have two components: (1) a carbon tax on fossil fuel consumption (equal to the minimum prescribed level in each year); and (2) output subsidies (output-based allocations or OBAs) for large industrial facilities plus an opt-in option for smaller facilities.

Although not explicitly acknowledged in ECCC's technical paper, the proposed federal system strongly resembles Alberta's carbon-pricing system. Alberta's system was announced in November 2015, and was based on the recommendations provided by its climate change advisory panel. The panel, chaired by Andrew Leach of the University of Alberta, recommended in its Climate Leadership Report (hereafter referred to as the Leach report) that: " … the Government of Alberta broaden and improve its existing carbon pricing regime, and complement carbon pricing with additional policies to reduce the emissions intensity of our electricity supply and our oil and gas production, to promote energy efficiency, and to add value to our resources through investments in technological innovation" (Leach et al., 2015, 4).

The report also noted the concern that, in addition to their environmental benefits, these policies represent a cost to Alberta's economy. As a result, in the absence of matching policy from other jurisdictions, these policies can impede Alberta's competitiveness. This concern motivated the recommendation of output subsidies (also referred to as output-based allocations, or OBAs) to mitigate the effects of carbon pricing on trade-exposed industries.

OBAs, as a complement to emissions pricing via a carbon tax, have been recognized as an attractive and likely effective mechanism through which competitiveness interests can be balanced against the preservation of a strong incentive to reduce emissions intensities (Fischer and Fox, 2007). When compared to alternative approaches, such as corporate income tax reductions, OBAs are likely to better address competitiveness concerns within and between sectors. In particular, a conventional tax-credit system used to address competitiveness concerns would have limited or no benefit to firms with zero or negative tax liability, since these firms wouldn't be able to use these credits (Gray and Metcalf, 2017). There is a growing understanding of OBAs in general, thanks in part to accessible descriptions by the Ecofiscal Commission (Dion, 2017). We add to this, and go deeper into general principles that should guide OBA design.

While the Leach report offered in broad strokes what the OBAs should achieve and how they should be implemented in Alberta, it does not give much policy guidance in terms of designing the actual policy. The details of Alberta's OBAs will be outlined in a new Carbon

Competitiveness Regulation (CCR), due to be released sometime in 2017. Similarly, ECCC's technical paper provided only a broad overview of the federal government's proposed OBAs. Feedback is being gathered through to the end of June 2017 and will presumably inform the development of a more detailed policy that will be released at a later date.

The purpose of this paper is to describe principles of policy design that can help make the implementation of OBAs efficient, fair and effective. It is additionally worth noting that, because an OBA system provides emissions credits to firms, it shares significant similarities with a cap-and-trade system that provides free allocations of emissions permits. As such, the principles discussed in this paper apply not only to Alberta and the federal government, but also to those provinces that are implementing their carbon price through a cap-and-trade system.

The remainder of the paper proceeds as follows. We start with a backgrounder that introduces the economics of OBAs and discusses why they are a desirable complementary policy to a carbon price. We then introduce and describe four primary principles for the design of an OBA system. Using Alberta as an example, we next offer recommendations for transitioning from current policies to an optimal OBA system. Lastly we offer some brief concluding remarks.

BACKGROUND: POLICY AND ECONOMICS BEHIND OUTPUT SUBSIDIES

Let's begin with a brief, high-level overview of carbon pricing in Canada and of approaches to address competitiveness concerns.

Economists broadly find evidence that the most cost-effective approach to lowering greenhouse gas emissions (GHGs) is to price them. The logic is simple: each tonne of emissions has environmental consequences,[1] but individuals and businesses tend to neglect these consequences in their decisions. Economists call this an externality, and the result is too much emissions production. In the presence of an appropriately set carbon price, those consequences are no longer hidden and the full cost of individual decisions are seen. Some decisions will no longer make sense, and behaviour will change, thus lowering emissions.[2]

Though many discussions about carbon pricing focus on the effect it has on the fuel we buy to power our cars or to heat our homes, an important source of emissions are large industrial emitters, defined as those that emit more than 50,000 tonnes of GHGs per year. In 2015, for example, there were 563 such facilities in Canada and the largest 100 of them emitted nearly 200 million tonnes of carbon-dioxide equivalent (CO_2e) — or almost 30 per cent of Canada's total emissions.[3]

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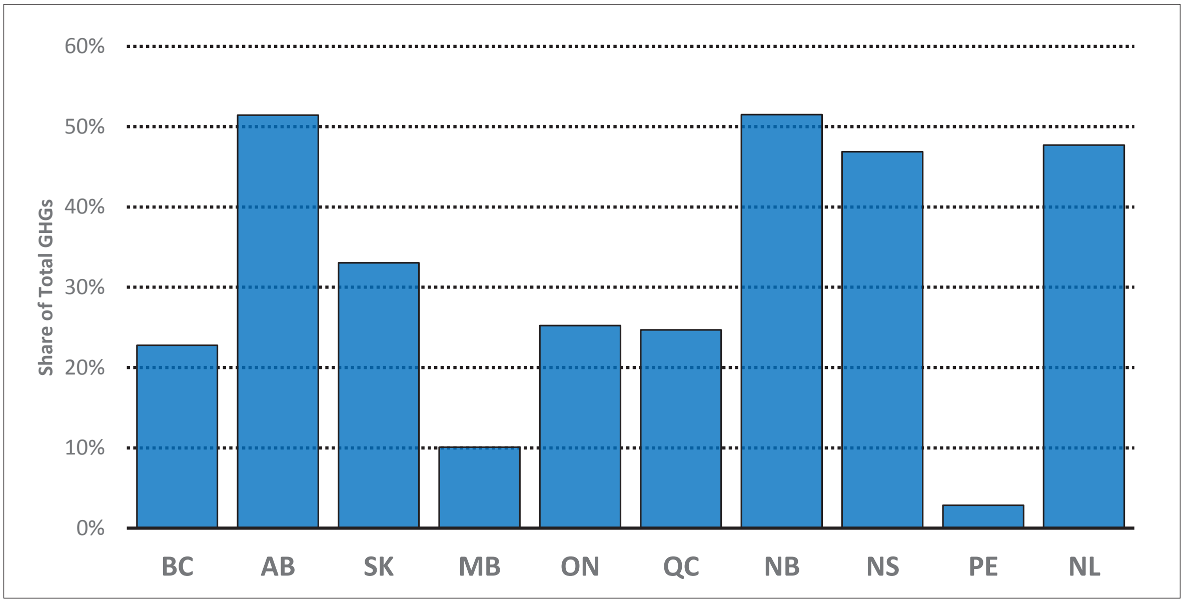
1 For a discussion of the latest evidence, see NASA (2017).

2 To be sure, this argument requires that we know where the appropriate carbon-price level is. There is uncertainty here, just as there is uncertainty about the socially optimal path of future global emissions levels. For details around how Environment and Climate Change Canada, among others, summarizes the magnitude of the environmental externality from GHG emissions, see its Social Cost of Carbon estimates in Environment and Climate Change Canada (2016a).

3 A list of large-emitting facilities is available online from Environment and Climate Change Canada at http://www.ec.gc.ca/ges-ghg/default.asp?lang=En&n=8044859A-1.

And not all provinces are the same. The majority of Alberta and New Brunswick emissions, for example, are accounted for by facilities emitting more than 50,000 tonnes of GHGs per year. Alberta and Saskatchewan, both of whom have many coal-fired power plants and oil and gas facilities, together account for nearly two-thirds of Canada's total large-emitter emissions. We plot all provinces in Figure 1. Given Canada's somewhat decentralized approach to climate change policy, this provincial variation is important.

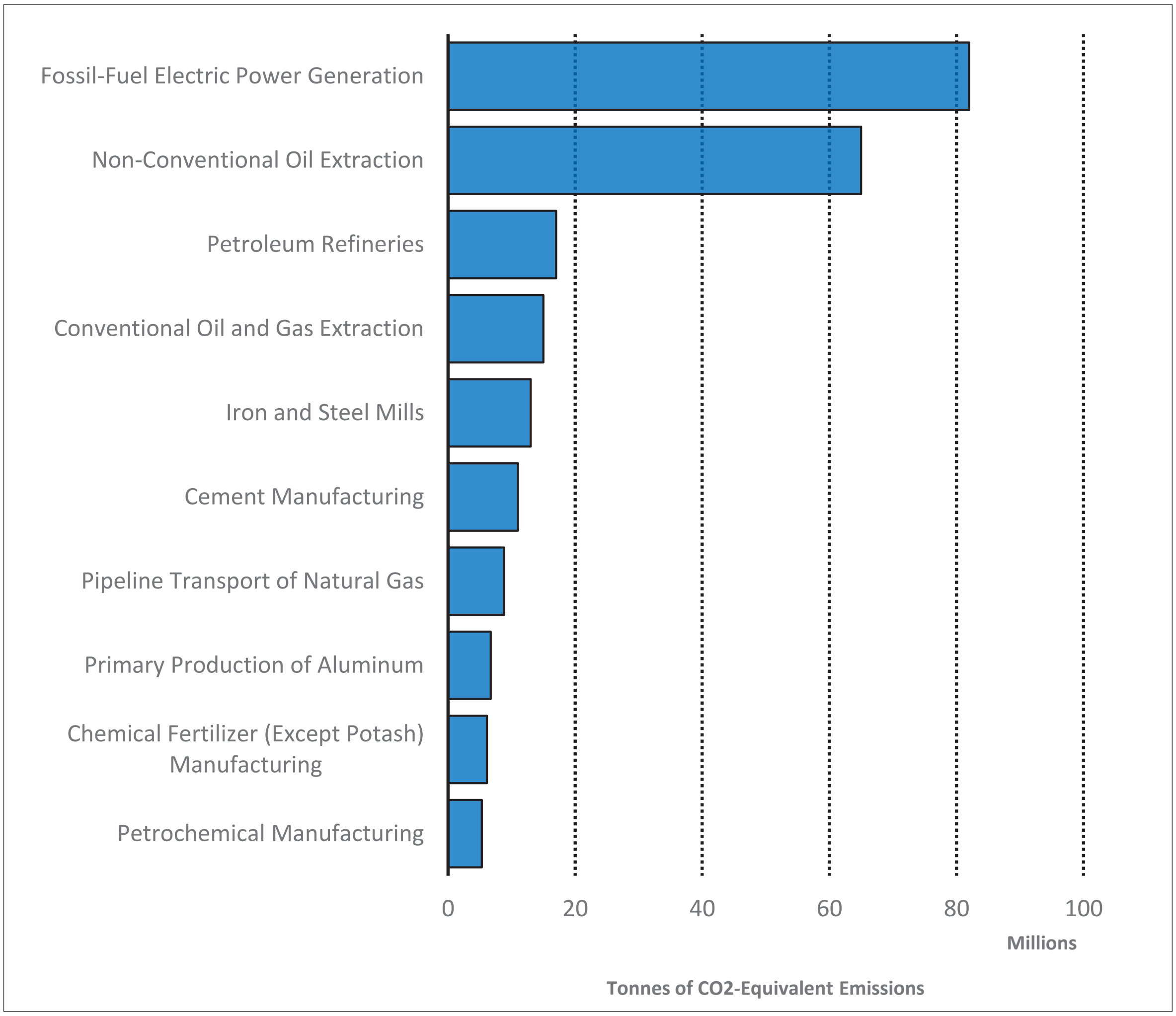
FIGURE 1 LARGE EMITTERS AS SHARE OF TOTAL PROVINCIAL GHGs (2015)



Source: Canada's Greenhouse Gas Emissions Reporting Program (Environment and Climate Change Canada, 2017a), and Canada's 2017 National Inventory Report (Environment and Climate Change Canada, 2017b).

There are also large differences across sectors. In Figure 2, we show 2015 emissions by Canada's 10 largest sectors. The dominance of fossil fuel power generation and non-conventional oil extraction (such as Alberta's oil sands) is evident.

FIGURE 2 LARGE EMITTER EMISSIONS IN CANADA BY SECTOR (2015)



Source: Canada's Facility Greenhouse Gas Emissions Reporting Program (Environment and Climate Change Canada, 2017a).

Given the importance of large emitters for certain sectors and for certain provinces, carbon pricing here requires careful consideration. In principle, pricing emissions from large industrial sources is as straightforward as it is for the fuel everyday households and smaller businesses buy. But for a variety of reasons we discuss later, policy-makers may opt to treat large emitters differently than other emission sources. In particular, they may provide firms with free emissions allowances.

In the case of cap-and-trade systems, the allowances take the form of free permits that governments distribute. Less widely known is that through the use of OBAs, carbon-tax systems can feature something equivalent to free permit allocations. To make this clear, we discuss key features of Alberta's pre-existing Specified Gas Emitters Regulation (SGER) system.

Alberta's SGER System

Through its Specified Gas Emitters Regulation (SGER), initially implemented in 2007, Alberta was the first jurisdiction in North America to implement a carbon price (McCrank and Ross, 2015). The SGER applies to large industrial emitters, and if a facility is subject to

SGER, it is required to report on production and emissions, and faces various requirements to lower emissions. Roughly speaking, each facility is given a "baseline" emissions intensity as well as a target for bringing its actual emissions intensity sufficiently below its baseline level. Facilities can choose whether to lower emissions to the target threshold or, alternatively, pay a charge for each tonne in excess of the threshold. When the program was first introduced in 2007, facilities were given targets of 12-per-cent below their baseline level and the price per tonne above the threshold was $15. In 2017, the target is 20-per-cent below a facility's baseline level and the price per tonne is $30.

To illustrate the basic principle, consider the Sundance coal power plant. In 2015, this facility emitted about 14.4 million tonnes of GHGs and produced nearly 13 TWh of electricity, giving it an emissions intensity of about 1.1 tonnes per MWh of electricity produced.[4] If Sundance continues to produce electricity at its baseline emissions intensity and a price of $30 per tonne were charged on all emissions, that would cost well over $400 million per year — equivalent to about three cents per kWh of electricity. But 80 per cent of its baseline emissions are provided to it for free, so the charge is only on the excess 20 per cent — lowering the cost substantially, to barely over half a cent per kWh. Essentially, 80 per cent of the baseline emissions are "allocated" to the facility for free.

It is interesting, but not immediately obvious, that the SGER system is equivalent to a facility being charged $30 per tonne on its total emissions but then simultaneously receiving a subsidy to offset most of the resulting costs. Each tonne a firm is permitted to emit for free is a tonne for which it need not pay the carbon tax. One would be willing to pay *up to, but not exceeding* the carbon tax to buy such a permit. Thus, in our example of the Sundance power plant, it is implicitly being charged $30 for each tonne it emits and simultaneously receiving $25.50 per MWh produced as a subsidy.[5]

The subsidies implicit in a system such as SGER need not represent actual cash flows from government to firms. That such permits are often provided for free by the government, rather than recorded as an explicit subsidy, is merely a choice of accounting rules and not a reflection of the underlying economics involved. Also, different firms will (under SGER) receive different subsidies per units of output.

The Economics of OBAs

Will such subsidies undermine the incentive effect of pricing carbon? Yes and no, but mostly no. To understand why, it's instructive to know some of the basic economics at work.

Firms produce output by using inputs. But there are countless ways in which different inputs may be combined with different methods and technologies to produce output. Critical for us: *how to produce* and *how much to produce* are, in a very important sense, separate decisions. Firms decide *how* to produce based on the relative prices of those various inputs or production technologies available. They then decide *how much* to produce to earn the largest profits, which itself depends on the scale of demand for their product, their costs of production, and the price they can therefore charge.

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4 Emissions data for TransAlta's Sundance Thermal Electric Power Generating Plant from ECCC's Facility Reporting Data (Environment and Climate Change Canada, 2017a), and power generation data from Leach and Tombe (2016).

5 From 1.1 t/MWh multiplied by the 80-per-cent allowance multiplied by the $30-per-tonne carbon tax.

In terms of environmental impacts, some alternative production methods will be dirtier than others. Putting a price on emissions will therefore give important incentives to firms to consider cleaner methods, different technologies, and so on. This will tend to lower the emissions *intensity* of their output — that is, the emissions *per unit of production*. But, it will also tend to increase their costs, necessitating they charge a higher price to consumers and this will shrink demand for their product. Thus, their total production — their *scale* — will also decline. To the extent that policy-makers wish to avoid this, a subsidy to output will dampen the cost increase faced by firms, so its price need not rise as much and the resulting scale of production will not fall as much.

Critically, this subsidy — which an OBA implicitly is — does not affect a firm's emissions intensity (Fischer and Fox, 2007; Adkins et al., 2012; Gray and Metcalf, 2017). That is, a subsidy on a firm's output will have no effect on whatever production mix a firm opts to use when producing that output. We illustrate the overall effect of GHG prices, an output subsidy, and both combined (an OBA system) in Table 1.

TABLE 1 STYLIZED REPRESENTATION OF HOW EMISSIONS AND OUTPUT RESPOND TO POLICY

	GHG Intensity	Total Output	Total GHGs
Price on GHGs	↓	↓	↓
Output Subsidy	No Effect	↑	↑
Both Combined — An OBA System	↓	↓*	↓*

* In practice, output subsidies in an OBA system are not likely to be so generous as to increase output above its pre-policy level. Thus, we note the overall effect of an OBA system is to shrink output. But, strictly speaking, the effect is ambiguous without explicit restrictions on the magnitude of the subsidy.

In short, putting a price on emissions gives incentives for firms to lower emissions, regardless of how much they produce. Providing a subsidy to output will tend to increase a firm's output more than otherwise. To be clear, this increases emissions — since each unit produced has associated emissions — but does not increase emissions intensity. The incentive to lower emissions, per unit of output, remains. In practice, output subsidies in an OBA system are not likely to be so generous as to increase output above its pre-policy level. Thus, we note the overall effect of an OBA system is to shrink output. But, the amount by which output shrinks is smaller than would be the case if only emissions were priced and no subsidies offered, perhaps substantially so.

With this background in policy and economics in hand, we turn to discussing the motivations behind OBAs and then move to principles for designing an efficient and effective system.

Why Subsidize Output? And for Which Sectors?

In an ideal world (what economists call "first best"), all countries would be meeting their climate change commitments with some form of uniform carbon pricing. This could be through a carbon tax, or a cap-and-trade system. In either scenario, firms face carbon pricing regardless of where they are located and where they sell to. This creates uniformity in the treatment of firms and, while their costs increase, a firm operating in Alberta is not adversely affected relative to a firm operating elsewhere, such as the United States.

However, this ideal situation is not the current state of the world. Relatively few countries have carbon pricing in place. Of significance for Canada is that in most of the U.S. — our most important trading partner — there is no carbon pricing. This means that firms here, as a result of Canadian carbon pricing, have their costs increase relative to their competitors in other jurisdictions. This has detrimental impacts on the Canadian economy and can also cause economic activity to leave for other jurisdictions with lower environmental standards, resulting in lower economic activity in Canada and no global reduction in emissions.

To illustrate the problem more concretely, consider where OBAs are particularly useful. In Alberta, the largest sector where carbon pricing may be of particular concern is oil and gas extraction. Together, large emitters within these sectors accounted for over 112 million tonnes of GHG emissions in 2014 (over 40 per cent of the province's total).[6] Carbon pricing will have substantial effects on production costs. For non-conventional oil, based on the average intensity of oil sands in-situ production, a $30-per-tonne carbon price adds $2 per barrel to costs. As the overwhelming majority of oil production is exported, and as oil prices are determined largely on a world market, producers will have little ability to pass these added costs onto consumers and their competitiveness may be challenged.

Oil and gas production provides a useful illustration, but it is by no means the only sector where carbon pricing may present competitiveness concerns. Any firm that faces competition from outside of Canada (in particular, competition from a firm located in a jurisdiction with a lower, or no carbon price) will face a competitive disadvantage resulting from a pan-Canadian carbon price (all other things being equal). This disadvantage is larger in sectors with high emissions intensity since these produce more GHG emissions (and therefore face a higher carbon-tax burden) per dollar of output. As such, the combination of emissions intensity and the share of production that is exported are of paramount concern in determining the sectors in which a carbon price will have the most significant negative impacts on competitiveness. These sectors of concern are referred to as "emissions intensive, trade exposed" or EITE, and they deserve particular attention when formulating the specifics of a formal OBA system.

Once again turning to Alberta as an example, Figure 3 indicates the overall emissions intensity for the six highest-intensity sectors in the Alberta economy.[7] Emissions intensity here is defined as the emissions generated per $1,000 of gross output from the sector, and is split into direct intensities (emissions produced by the sector) and indirect intensities (emissions produced by upstream sectors supplying inputs into the indicated sector).

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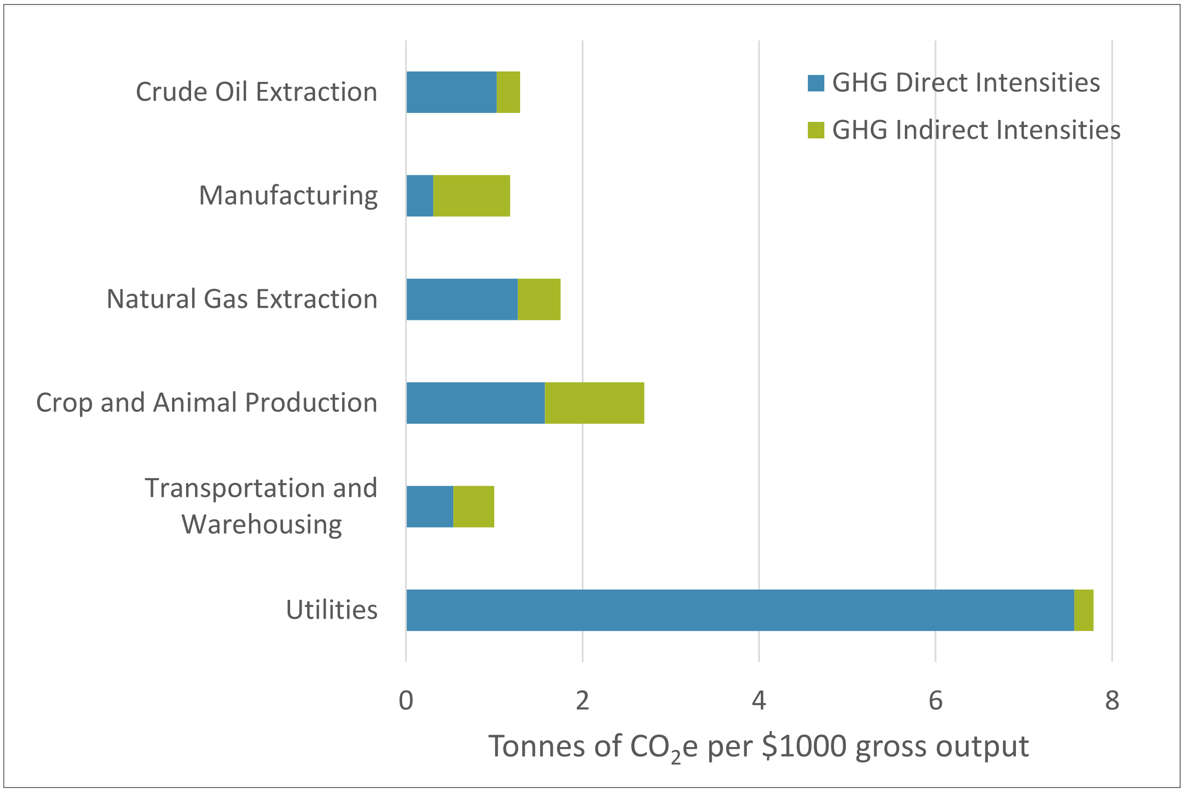
[6] Data: ECCC's Facility Reporting Data (Environment and Climate Change Canada, 2017a). The 2014 emissions by large emitters in that dataset were: 56.6 MT for non-conventional oil extraction emissions, 48.8 MT for fossil-fuel electric power generation, and 7.6 MT for conventional oil extraction. In 2014, total Alberta emissions were 274 MT.

[7] Sector definitions are based on the two-digit North American Industry Classification System (NAICS) definitions used by Statistics Canada in the S-Level provincial input-output tables produced as a component of the System of National Accounts (SNA) codes. They are modified somewhat here in that Natural Gas and Crude Oil Extraction have been disaggregated from the single "Mining, Quarrying and Oil and Gas Extraction sector" along with other mining and related support activities.

FIGURE 3 DIRECT AND INDIRECT EMISSIONS INTENSITIES FOR TOP SIX ALBERTA SECTORS (2011)



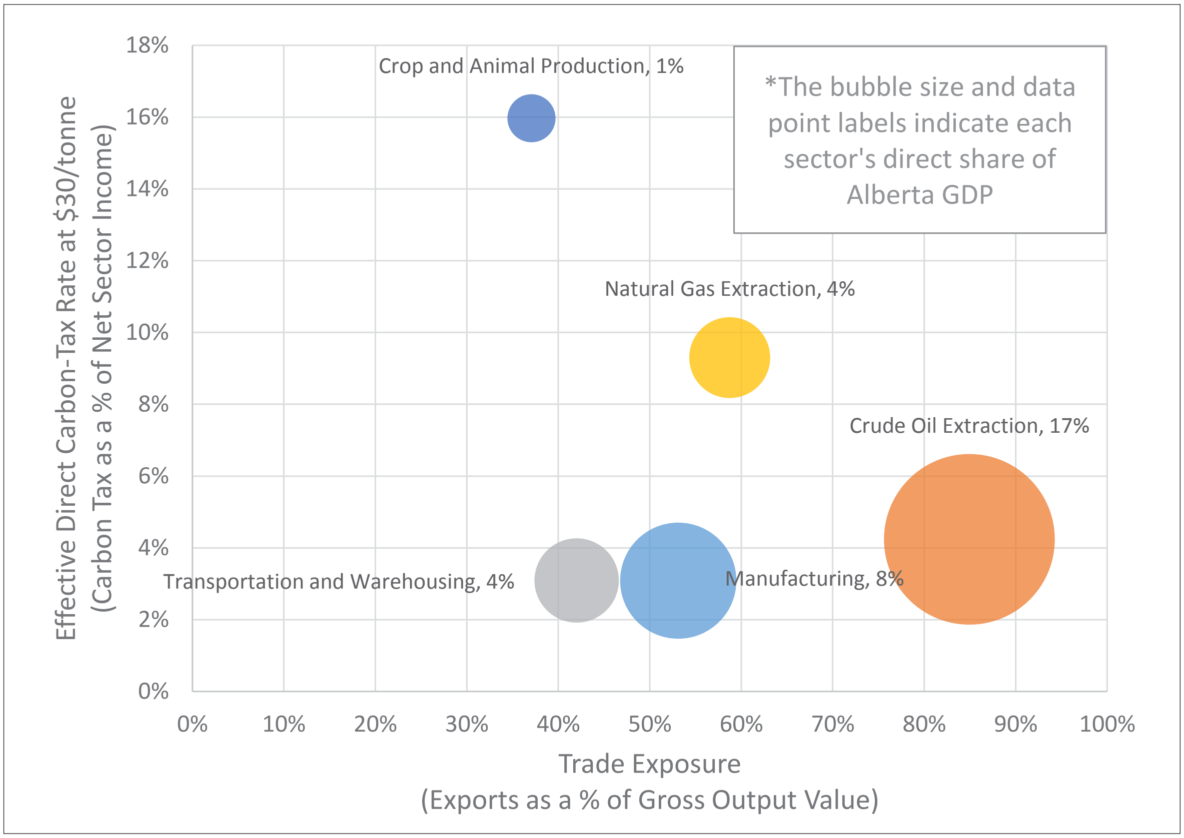
Source: Fellows and Dobson (2017) and authors' calculations.

As indicated under the EITE definition, the emissions intensities only tell part of the story since trade exposure is also a critical consideration for competitiveness. In Figure 4, we plot a measure of the trade exposure of Alberta sectors against the emissions-intensity data. We use a simple measure (exports as a percentage of gross production) to indicate the trade exposure of each sector. Additionally in Figure 4 we have converted the intensity measures given in Figure 3 into an equivalent tax rate based on the carbon tax paid per dollar of net income (assuming a carbon tax of $30/tonne of CO_2e).[8, 9]

8 This is essentially a rough measure of the extent to which a carbon tax would affect the bottom line of an average firm in each of these sectors, absent any price or behavioural changes.

9 In addition to the figures provided here, Canada's Ecofiscal Commission has undertaken a more detailed analysis of Canada's emissions-intensive and trade-exposed sectors (Beale et al., 2017). Their approach is to (1) measure a sector's trade exposure as imports plus exports relative to its GDP contribution, and (2) measure a sector's emissions intensity as the effect of pricing carbon on a sector's total cost. If trade exposure is 15 per cent or more, and if the effect of carbon pricing is to increase costs by five per cent or more, Beale et al. deem a sector to be emissions intensive and trade exposed. By this methodology, roughly 18 per cent of Alberta's economy falls into this category.

FIGURE 4 ALBERTA'S EMISSIONS-INTENSIVE, TRADE-EXPOSED SECTORS (2011)



Source: Fellows and Dobson (2017) and authors' calculations.

Note: The export measure under trade exposure includes inter-provincial exports as well as international exports.

Output subsidies are meant to cushion the effect of pricing carbon on those sectors towards the right and the top of the above graph. It should also be noted that the vertical placement of some of the bubbles on Figure 4 are highly sensitive to world movements in commodity prices. In particular, the data depicted in Figure 4 are from 2011, when the market price for crude oil generally averaged twice the current (post-2014) market average. If we were to perform the same calculation using the 2017 price, we would likely find an effective direct carbon tax in the crude oil extraction sector that is nearly double that indicated in the figure.[10]

The utilities sector is not pictured in Figure 4. If it were, it would be at the extreme left (very low exports as a proportion of gross production) but above the end of the y-axis (a 33-per-cent effective direct carbon-tax rate). While the utilities sector does not fit well within the EITE definition, it is still an important concern since we should not neglect input-output linkages across firms and sectors. Electricity is not itself typically exported from Alberta, so there are fewer competitiveness concerns there, but other sectors that do export (such as various manufacturing activities) can intensively use electricity. Higher electricity prices will increase costs in those export-oriented sectors, and their competitiveness may suffer.

[10] Since the data required to do this calculation for 2017 is not yet available, we made the same calculation using 2009 data as a close proxy. (In 2009, the average benchmark crude oil price was around US$60 per barrel, which is more in line with current pricing than the greater-than-US$100 per-barrel average from 2011.) Using 2009 data, the effective direct carbon tax would be approximately seven per cent versus the four per cent indicated for 2011.

This concept is illustrated in Figure 3 which indicates the split of direct emissions (those produced in the sector indicated) and indirect emissions (those produced by upstream sectors selling inputs to the sector indicated). The figure shows that indirect emissions are a concern to most sectors and that, in particular, the manufacturing sector faces a particularly high burden (in the form of increased input costs) from indirect emissions relative to direct emissions. Effective OBA design should take into account upstream linkages as well as the EITE characteristics of each sector.

The above also speaks to a concept known as "leakage." If Canada introduces stringent environmental policies, emissions-intensive operations here may move elsewhere. A good example may be iron and steel production. It is both a tradable commodity with an energy- and emissions-intensive production process. If such production facilities were to expand elsewhere and contract in Canada as a result of stringent environmental policy here, Canada would bear economic costs for little global environmental gain. Indeed, if steel production elsewhere is even dirtier than here, global emissions could in principle rise. By providing subsidies to such sectors, such leakage can be mitigated.

This is an ongoing area of research, and recent work indeed suggests that as Canada's trading partners introduce more stringent policies, the optimal OBA rate is lower as the leakage concern declines (Bohringer et al., 2017). To complicate matters, though, it depends on the type of policies Canada's trading partners introduce. Europe, for example, has a cap-and-trade system and its aggregate emissions are therefore fixed. There is little concern of leakage from Canada to Europe, since any pressure for that to occur will automatically lead to higher emission-permit prices in Europe (and thus more stringent policy there).[11] Thus, trade exposure itself is not sufficient to claim leakage is an important concern. Careful analysis and examination is required.

Moving beyond trade and competitiveness concerns, there are a number of other considerations that should influence the design and targeting of output subsidies.

First is the issue of investment returns. Even if a sector does not export a carbon-intensive product, pricing carbon may result in lower investment returns. The resulting reduction in capital spending has implications for a province's overall GDP, for jobs, wages, and so on.

Second, there may be fairness considerations. To the extent that past investment decisions were made with an implicit understanding of the nature of a province's policy environment, changing policy can lead to windfall losses that we may wish to avoid. OBAs can serve as a buffer to the bottom line of such firms without undermining the incentive effect of carbon pricing (if, that is, the OBA system is well designed). Another element of fairness is the aspect of treatment of large and small firms. Often, the initial structure of OBA systems is framed around large emitters (with good reason). However, because OBAs represent an effective subsidy or benefit, smaller firms that are not afforded allocations under an OBA system may be presented with a perverse incentive to increase emissions in order to obtain OBA benefits afforded to larger firms. Given this, it is important to allow smaller firms to

11 For more discussion of this point, see Goulder and Schein (2013).

opt in to the OBA system at their own discretion. With that said, once a small firm has chosen to opt in, the same design principles discussed should apply to all firms receiving OBAs.[12]

Finally, there is also the issue of impacts on households. As the end-use demanders of goods and services, households pay the majority of the costs of a carbon price. The carbon price increases the price of goods and services proportional to their emissions intensity. While provincial governments can implement rebates for lower-income residents to cushion that group against these price increases, as is the case with carbon tax regimes in Alberta and British Columbia, output subsidies can also be used to reduce the price impact on certain goods and services. In Alberta, for example, electricity generation has been included in the sectors eligible for OBAs precisely for this reason.

Based on an average emissions intensity in Alberta of 0.79 kilograms of CO_2e per MWh,[13] a $30-per-tonne carbon price would add just over $0.024 per kWh produced — enough to add roughly $170 to the average household's electricity bill (and substantially more for commercial and industrial users). Given the politically sensitive nature of electricity prices, OBAs can serve to limit the extent to which consumer electricity prices rise. If structured properly, carbon pricing will still incentivize electricity producers to opt for less emissions-intensive generation technologies, though in this case OBAs come at the cost of a lower incentive for consumers to limit electricity consumption.

The issues identified above create the scope for complementary policy to a carbon price. For example, attempting to address competitiveness concerns through a lower carbon price would negate the emissions-reduction incentive while failing to address the root cause of the concerns: low or no carbon pricing in competitor jurisdictions. Below, we flesh out in more detail appropriate policies for designing an OBA system.

PRINCIPLES FOR DESIGN

We offer four primary design principles for consideration in the design and implementation of an OBA system: independence and uniformity, transparency, output-product-based market and sector definition, and minimization of administrative costs.

Independence and Uniformity

The allocations offered by a government to firms and their facilities should be independent of each facility's emissions, and the same for otherwise identical activities. This is the most critical design element, by far. To illustrate this in practice, consider Alberta's oil sands.

In Figure 5 we plot the oil sands in-situ facilities subject to Alberta's SGER system. In blue, we illustrate the cost per barrel if each facility had to pay a $30-per-tonne tax on its emissions. The amount of GHGs emitted in the process of producing a barrel of oil varies

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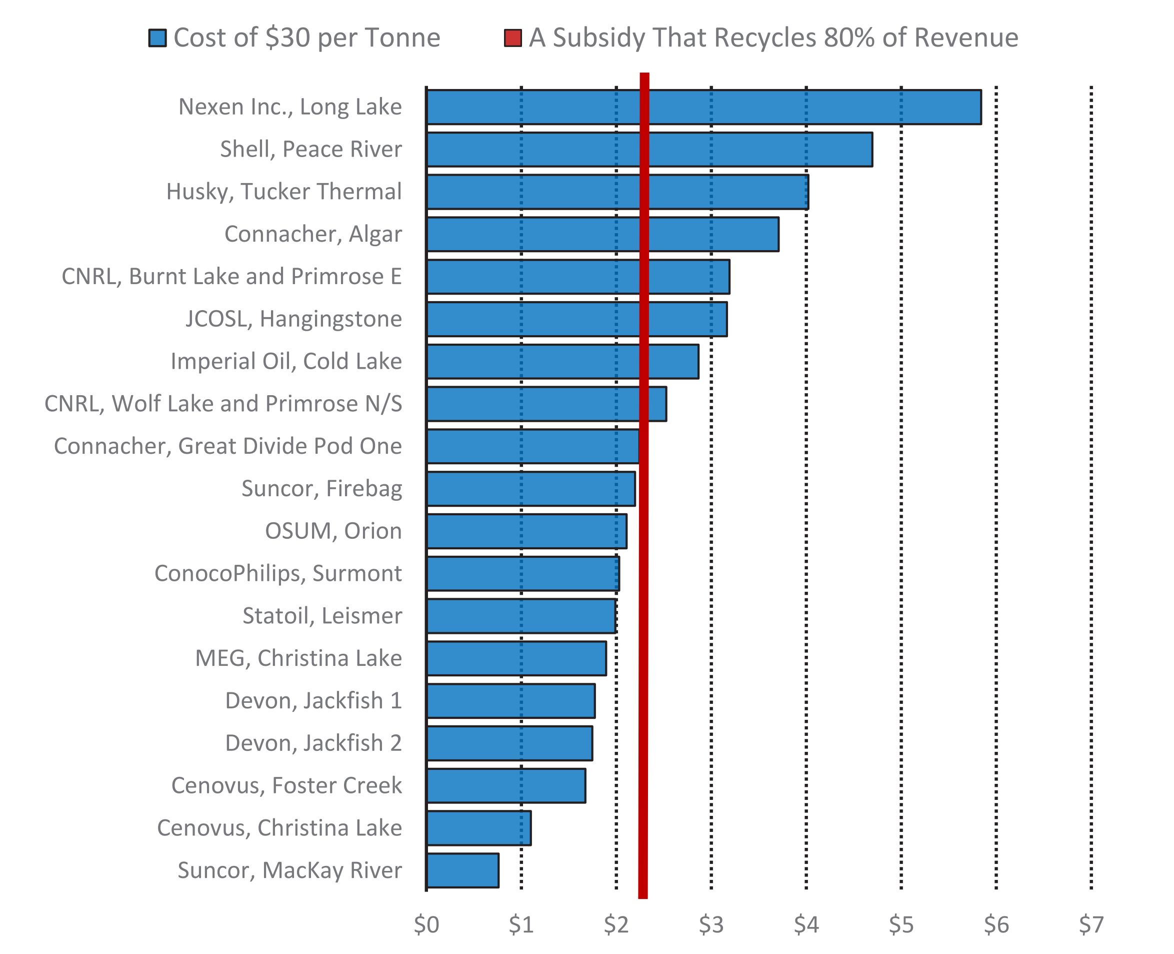
[12] At present, both the Alberta government's announced OBA strategy (Government of Alberta, n.d.) and the Canadian federal government's announced carbon-pricing backstop strategy (Environment and Climate Change Canada, 2017c) have indicated that smaller firms (those below the high-emitter cut off for direct inclusion in the respective policies) will be allowed to opt in to the OBA system at their own discretion.

[13] Source: Table A11-10 in Canada's National Inventory Report (Environment and Climate Change Canada, 2017b). Data is available online at http://donnees.ec.gc.ca/data/substances/monitor/national-and-provincial-territorial-greenhouse-gas-emission-tables/E-Tables-Electricity-Canada-Provinces-Territories/?lang=en.

substantially across facilities. Pricing carbon at $30 per tonne will therefore increase costs at emissions-intensive facilities more than at less-intensive ones. At the high end, Nexen's Long Lake facility would see cost increases of nearly $6 per barrel while Suncor's MacKay River facility would see less than $1.

FIGURE 5 IN-SITU CARBON COSTS VERSUS UNIFORM OBA (OUTPUT SUBSIDY), 2015

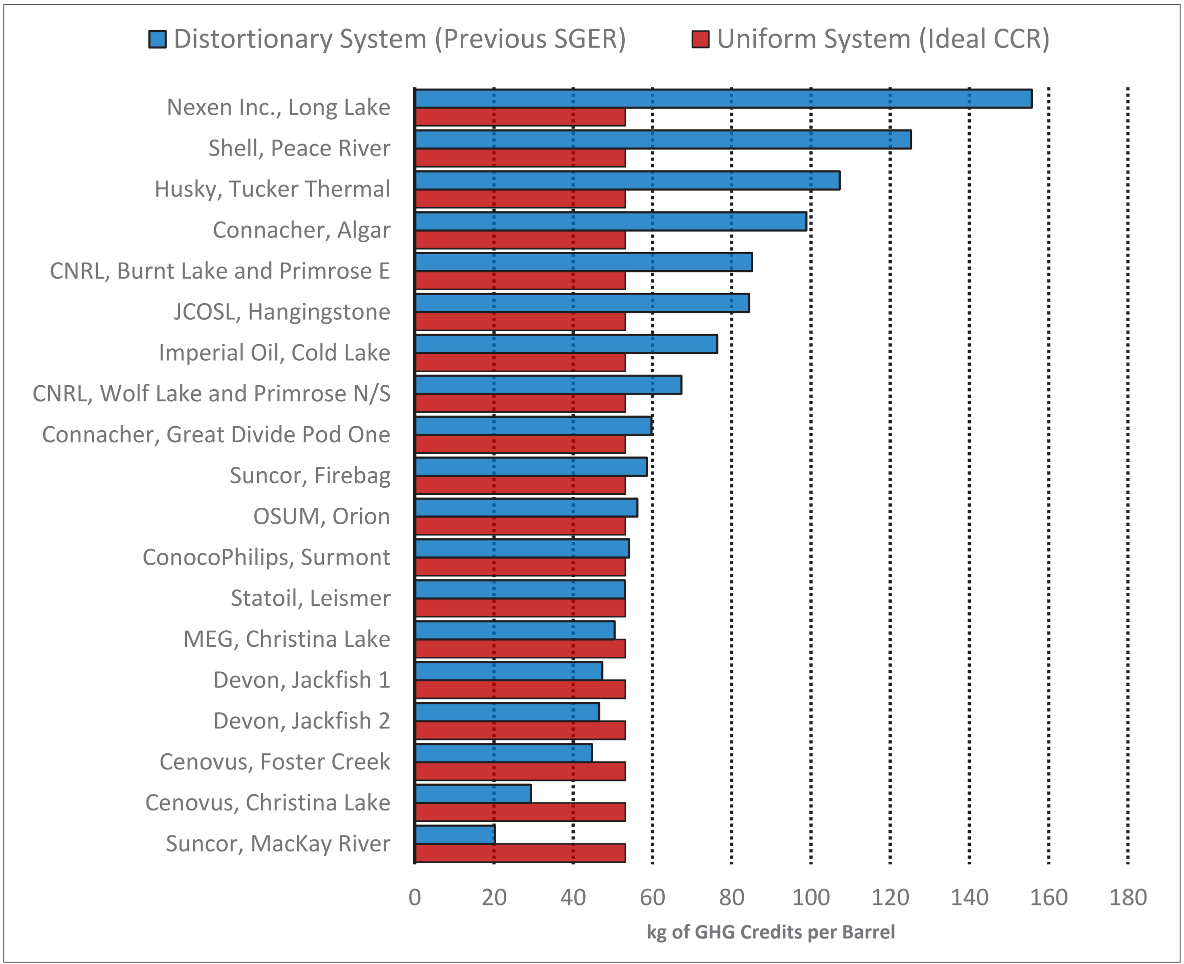


Source: Authors' calculations based on SGER 2015 compliance data.

We illustrate in red the implied per barrel subsidy if 80 per cent of revenue raised from a carbon price is to be returned. This is also roughly consistent with the "top-quartile" performance recommendation of the Leach report. Under that recommendation, the 25 per cent of facilities with the best emissions-intensity performance would receive output subsidies in excess of their carbon costs while the remaining 75 per cent of facilities would not.

Why are uniform output subsidies per unit important? Consider another way of thinking about the subsidy: in terms of free emissions permits allocated to firms. In Figure 6 — for the same set of Alberta oil sands facilities — we show the allocations roughly consistent with SGER (though, in practice, the allocations may differ) relative to a uniform system. Illustrated in blue, SGER allocates more free permits to emissions-intensive facilities like Nexen, and less to those with lower emissions intensity. Essentially, SGER allows Nexen to emit nearly 160 kilograms of GHGs per barrel for free but only allows Cenovus' Christina Lake facility to emit less than 30 kilograms. Since such permits have value, this is in effect providing a larger subsidy to dirty facilities relative to cleaner ones.

FIGURE 6 GHG CREDIT ALLOCATION OPTIONS, PER BARREL PRODUCED, 2015



Source: Authors' calculations based on SGER compliance data for 2015.

By contrast, the red bars represent allocations that are independent of a facility's actual emissions and consistent with the uniform output subsidy described earlier. Notice that relative to the SGER system, allocating credits in a way that is independent of a facility's emissions tends to benefit low-intensity facilities and harm high-intensity ones. This will incentivize greater expansion of low-intensity facilities relative to high-intensity ones. That is, it incentivizes an efficient reallocation of production across facilities in a way that lowers the overall GHG footprint of the oil sands sector as a whole.

The principle of independence and uniformity not only implies all firms should receive the same subsidy per unit of output, but also demands allocations do not depend on whether a facility adopts an efficiency-enhancing innovation. Current SGER rules, for example, allow for a facility's baseline level of emissions to be re-established for a variety of reasons, including major modifications to facilities, expansions, decommissionings, and so on. The rules further note that the government "will work with facilities to determine appropriate recognition of facility improvements during baseline restatements" (Government of Alberta, 2012).

If allocations fall following a reduction in a facility's emissions, then the willingness of a firm to invest in emissions-reducing technologies will fall and this weakens the fundamental goal of emissions pricing. Put another way, tying allocations to a facility's own emissions creates incentives akin to taxing efforts to lower emissions. A better approach is to ensure that facility-level allocations are not a function of the facility's own emissions, present or historic. To the extent that they are historically determined, they should ideally evolve in an independent pre-set manner — perhaps tied to industrywide improvements, or some fixed tightening rate.

We note that the level of funding provided to output subsidies, and how these subsidies are allocated across industries, are important questions, deserving of additional work. In this paper, we attempt to provide general principles guiding the design of an OBA structure. In contrast, Bohringer et al. (2017) examine the optimal level of OBAs in a variety of scenarios, but say little about optimal design structure.

Transparency and Government Revenue

There is no free lunch, and output subsidies are no exception. The scope to which the government can compensate emissions-intensive and trade-exposed firms depends on the revenue available. While this is an obvious point, using government revenues on these output subsidies means this revenue is not available for other, equally worthy policy objectives.

The government can and should report OBA valuations as tax-expenditure items. The magnitudes in question are substantial. Environment and Climate Change Canada data reports large emitters in Alberta emitted roughly 135 million tonnes of GHGs in 2014. If all were priced at $30 per tonne, this would generate over $4 billion in government revenue — which the government could put towards other objectives, from lowering other taxes to spending on various initiatives. Instead, the 2017/18 provincial budget reports only $800–$900 million in compliance payments by large emitters. Implicitly, this recognizes that OBAs will come at a cost of over $3 billion. This may indeed satisfy a worthy public policy objective — as described earlier — but transparency will become increasingly important going forward.

It also underscores the importance of the rate at which allocations shrink over time — the so-called tightening rate. As allocations fall, the government reduces the implicit output subsidy and this frees up revenue for other purposes. In Alberta, with each two-per-cent reduction in the magnitude of the OBAs, carbon tax revenue increases by $60 million as that amount is no longer provided as a subsidy in the form of foregone taxes paid. In addition, as emissions are reduced due to the incentive provided by the carbon tax, carbon-tax revenues will decline, making output subsidies more difficult to support.[14] Of course, whether or how quickly allocations tighten depends crucially on the competitive environment in which firms operate, and the stringency of environmental policies elsewhere. Transparent and full reporting will ensure the stability, effectiveness, efficiency, and fairness of the system can be maintained/improved in the future.

[14] It is worth noting that a long-term decline in carbon-tax revenues is a desired result of the policy. That is, the carbon price is not intended to be a revenue-generation tool for government but rather to incent a reduction in emissions.

We stop short of recommending either a specific subsidy rate or a specific tightening rate as this will depend on the characteristics of industries in each jurisdiction. However, it is worth noting that care should be taken to ensure the chosen rate does not result in a net subsidy to industry. This overshoots the objective of the policy, which is to compensate for no more than the competitiveness impact of the carbon price, and also risks a violation of World Trade Organization rules.

Product-Based Market and Sector Definitions

As indicated, the primary function of the OBA system is to maintain competitiveness in industries that would otherwise be adversely affected by the imposition of a carbon tax. In the example above, we have used a loose definition of the oil sands as the industry to which a specific OBA rate would be applied. However, the complete design of an OBA system will require specific definitions for sets of firms with a shared industry or market to which a single OBA rate should be applied.

Datasets for the national and provincial economies often include industry definitions based on existing classifications (for example, the North American Industry Classification System, or NAICS, is often used). However, the primary functions of these classification systems are data collection and organization. We assert that they are not always useful and should not be relied upon too heavily for the purpose of defining OBA industries. As a simple initial example, the NAICS classifies conventional oil and natural gas extraction as a single sector. Basing an OBA system on this classification would mean that all of the items in the following list would receive the same OBA rate:

- coal gasification and pyrolysis at the mine site
- crude oil, conventional extraction
- fractionating natural gas liquids
- liquefied petroleum gases (LPG) from natural gas production and mining
- natural butane, ethane, isobutane and propane production
- natural gas cleaning and preparation plants
- natural gas liquids recovering and mining
- oil and gas exploration

Note that different items on the above list compete in different markets. In addition, a single item here may compete in multiple markets. As such, basing an OBA system — which is intended to maintain competitiveness in individual industries — on the above classification system would be ineffective relative to an industrial or market definition tailored to the goal of the OBA system.[15]

Because a core goal of an effective OBA system is to maintain competitiveness, we advocate for an industry/market definition similar to the one employed by competition

[15] Recent academic work has relied on six-digit NAICS categories to define sectors for OBA purposes (Gray and Metcalf, 2017). While the six-digit NAICS classification has been viewed in this existing work as an appropriate classification scheme, Gray and Metcalf and related studies of OBA design have focused on the U.S. economy where oil and gas extraction in particular constitutes a far smaller proportion of overall economic activity compared to the Canadian case. Even at the six-digit level, conventional oil and gas are still grouped as a single NAICS sector, suggesting that in applying an OBA system to Canada, the NAICS classification system should not be too heavily relied upon.

authorities such as Canada's Competition Bureau. A core tenet of most competition policy is that *it should exist and be enforced for the purpose of protecting competition, not for the purpose of protecting competitors*. This distinction is important. Designing a policy to protect individual competitors (i.e., individual firms) can and will lead to situations where inefficient firms are supported and protected. The protection of inefficient firms limits economic growth and paradoxically harms competition. Any policy protecting inefficient firms limits the growth of efficient firms and removes the incentive for individual firms (and by extension the incentive for whole industries) to become more efficient.

Under a typical competition policy application, a "product-based" industry or market-definition system is used. Under a product-based system, if firms produce identical — or very similar — products, they are classified as being in the same industry or market. Such a definition completely divorces a firm's costs and related efficiency from its association with a specific industry or market. All that matters in classifying a firm into a particular industry or market are the characteristics of the good or service being provided by the firm. Under this type of industry or market classification, any support (such as a specific OBA rate) given to a specific firm is afforded to all of that firm's direct competitors as well. This maintains a level playing field for all competitors. In the context of our oil sands example from above, oil sands facilities producing non-upgraded bitumen should receive the same OBA rate regardless of the costs of production, and regardless of whether the facility is in situ or a mine, or of the specific quality of the producing reservoir.[16]

The definition of specific OBA rates based on product (rather than the characteristics of the firm producing it) is also easily extended to the case of multiproduct firms. Where a firm produces multiple products it is a simple matter to associate specific OBA rates with each product being produced, which would define the firm's total received subsidy. However, that being said, the principle of product-based market and sector definitions should be directly superseded by the principle of minimizing administrative costs if the two principles come into conflict. Efficiency gains from better market and sector definitions should not come at the expense of a dramatic increase in administrative costs.

In addition to the Leach report's stated concerns about competitiveness, the report also comments on the issue of carbon leakage: "Carbon leakage occurs when there is an increase in emissions in one jurisdiction as a result of an emissions reduction in a jurisdiction with a strict climate policy. Carbon leakage may occur if an emissions policy raises local costs thereby giving another jurisdiction with a more relaxed policy a trading advantage."

With respect to the carbon leakage issue, an OBA system with OBA rates based on specific products is the best suited to address the issue of carbon leakage. By protecting the competitiveness of an industry, as defined by the set of firms producing a specific product, a product-based OBA system will significantly reduce or eliminate the trading advantage that might otherwise be afforded to firms producing the same product in other jurisdictions.

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16 A technical market definition based on these principles would ideally rely on some "critical" minimum elasticity of substitution between any two goods defined to be in the same market. Due to the administrative costs of identifying a wide enough set of elasticity estimates, a formalized technical set of market definitions is likely infeasible. However, the same basic logic can apply to the market-definition principle even in the absence of formal elasticity estimates.

Minimizing Administrative Costs

The OBA system will have an administrative burden on the government and the firms participating in it. Keeping the number of special cases and different products included in the system low will reduce this administrative cost. If the cost of implementing a special case is greater than the expected competitiveness benefit, it should be avoided.

This design principle is aided by following the other principles outlined above. For example, if OBAs are the same amount per unit produced by any firm or facility producing the same output, then all the information that is needed to assign the OBA is a firm's total output of the product. No information on its emissions intensity is, strictly speaking, necessary.

Another consideration in minimizing administrative costs is the cost of alternative policy measures to address the same competitiveness concerns. One policy option that immediately comes to mind is border carbon-tax adjustments, which levy a tariff on imports from a jurisdiction based on their carbon content (and potentially provides a credit to exports). An OBA system is less administratively complex, as the "optimal" system we are describing does not require firm- or facility-level data, as all firms/facilities receive the same allocation of output credits. In contrast, a system involving a border-tax adjustment requires information on the emissions content of each product.

A POTENTIAL COMPROMISE: TRANSITION PERIOD TO EFFICIENT OBAS

As noted earlier, the specifics of the OBAs that will be a part of the federal carbon-pricing system, and Alberta's carbon-pricing system, have yet to be announced. As the OBAs will be a new policy, an important consideration is how "old" large emitters should be transitioned to the new system, given they made their investment decision in a different policy environment from today. In Alberta's case, large emitters are subject to the SGER until the end of 2017, at which point they will be transitioned to the CCR.[17] In provinces that may be subject to the federal government's OBAs, large facilities may not have faced any prior carbon-pricing regulation.

In both scenarios, a useful way to transition is to start with a facility's past emissions intensity to determine its allocation of the output subsidy and transition to a system where allocations are uniform according to facility-specific tightening rates. We once again turn to Alberta's oil sands as an example of how such a system might be functionally implemented.

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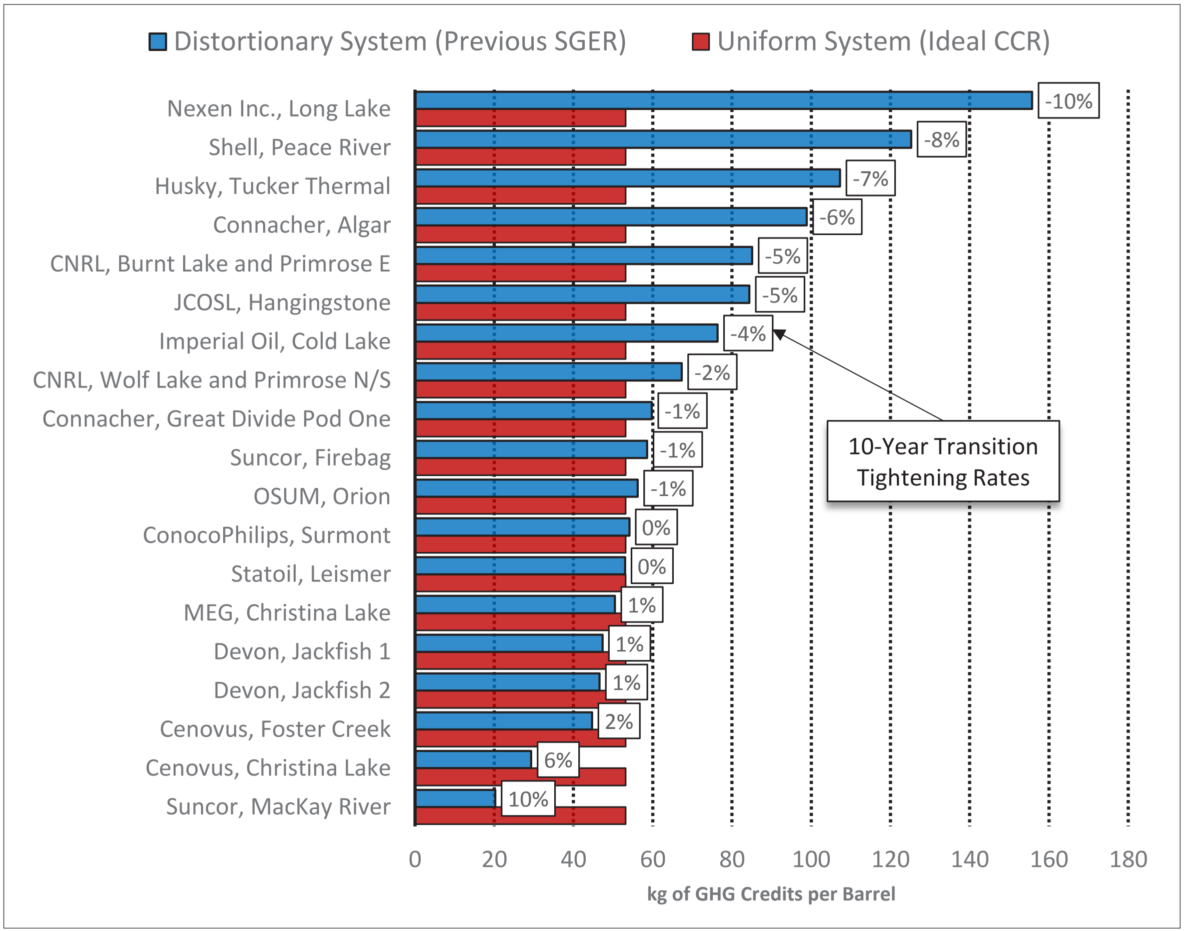
[17] It seems likely the government will push the adoption date of CCR to Jan. 1, 2019. The federal government's backstop policy for large emitters is also set to begin on Jan. 1, 2019.

FIGURE 7 GHG CREDIT-ALLOCATION OPTIONS, PER BARREL PRODUCED, 2015



Source: Authors' calculations based on SGER compliance data for 2015

As demonstrated in Figure 7, one could gradually move GHG allocations per barrel from the distortionary SGER system to the uniform allocation system under an ideal CCR by choosing facility-specific tightening rates that are maintained through time until uniformity is achieved. High-emissions-intensity facilities are tightened at a relatively faster rate, while low-intensity facilities experience increases. Note that the figure above is for illustrative purposes only and is not meant to imply that all of the facilities should be treated similarly. If facilities produce sufficiently different products then there is a strong case for differential treatment as noted above. As long as tightening rates are independent of a facility's own emissions, now or in the future, and the eventual allocations to which all facilities converge are uniform, then this phased-in approach represents a compromise between fairness (for historically high-emissions-intensity facilities) and efficiency (which demands uniformity and independence in allocations).

ADDITIONAL CONSIDERATIONS

There are a few other considerations for policy-makers in addition to the principles we identified above.

Pipelines

Pipelines do not necessarily fall into the category of "emissions intensive, trade exposed." However, there are fairness considerations because the users of the pipelines are trade exposed. For that reason, it may be desirable to include pipelines in the OBA system.

If pipelines are included, then each pipeline should be treated as a separate market, as they each offer a different service. That is, using the product-based principle for industrial classification, each pipeline is in its own market/industry: transportation of oil from Edmonton to Burnaby is not the same product as transportation of oil from Edmonton to the U.S. Gulf Coast. For that reason, the allocation provided should be pipeline-specific.[18] The tightening rate should be independent of historical emissions to ensure the incentive to reduce emissions is present.

Upgrading and Petrochemical Processing

The government of Alberta has indicated its intention to introduce policies to incentivize increased upgrading and petrochemical processing in the province. In developing these policies and designing the OBA system, the government should carefully evaluate potential interactions. For example, if both sets of policies involve government subsidies, then there is the possibility of overly subsidizing these sectors.

CONCLUSION

To conclude, we have outlined key principles for building a fair, effective and efficient policy to address Canada's competitiveness concerns regarding carbon pricing. Though there are many details we have glossed over, this paper provides important considerations for designing large-emitter OBAs. These principles are:

1. Independence and Uniformity

OBAs should be provided at the same per-unit level of output across all firms within a given market or sector. As a corollary, the allocations shouldn't depend on changes in a specific facility's own emissions over time. Providing OBAs inevitably increases emissions (relative to a scenario with carbon pricing only) as it prevents a contraction in the scale of a firm's operations. However, if allocated uniformly across firms and independently of a facility's own emissions then it need not undermine the carbon-pricing incentive to lower emissions intensity.

2. Transparency of Subsidies

OBAs cost money. Government budgets should account for the value of the implied subsidies to firm output as tax-expenditure items. Doing this ensures full and open debate about the appropriate role and size of subsidies provided to large industrial emitters.

[18] For Alberta, the initial OBA rate should be based on an allocation equivalent to what each pipeline receives under the Specified Gas Emitters Regulation.

3. Product-Based Classifications

All firms producing similar products should be treated similarly. To avoid treating different firms similarly that happen to be within the same NAICS code, governments should look to a product-based classification scheme.

4. Minimizing Administrative Costs

An important reason why carbon taxes may dominate cap-and-trade systems, and why both tend to dominate non-pricing regulatory approaches to lowering emissions, is that they are administratively simple and cheap to implement. Treating large emitters differently will necessarily entail added costs to governments. Some ways of designing an OBA system, however, are more administratively burdensome than others. Governments should, all else equal, pursue simple systems that minimize administrative costs.

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About the Authors

Sarah Dobson (PhD) is a Research Associate in the Energy and Environmental Policy area at The School of Public Policy. Her research interests are focused on studying the design, implementation and evaluation of energy and environmental regulatory policy. In prior work Sarah has considered such issues as the welfare implications of climate change policy, and the optimal design of regulatory policy to take into account the tradeoff between the economic benefits of resource development and the ecological consequences of management decisions. Sarah holds a PhD and MSc in Agricultural and Resource Economics from the University of California, Berkeley.

G. Kent Fellows (PhD, Calgary) is a Research Associate at The School of Public Policy, University of Calgary. Kent has previously worked as a researcher for the University of Alberta's School of Public Health and as an intern at the National Energy Board. He has published articles on the effects of price regulation and bargaining power on the Canadian pipeline and pharmaceutical industries as well as the integration of renewable generation capacity in the Alberta electricity market. His current research agenda focuses on the area of computational economics as applied to the construction and use of large scale quantitative models of inter-sector and inter-provincial trade within Canada. Kent is also involved in forwarding The School of Public Policy's Canadian Northern Corridor research program, which is aimed at studying the concept of a multi-modal linear infrastructure right of way through Canada's North and Near North.

Trevor Tombe (PhD) is an Assistant Professor of Economics at the University of Calgary and a Research Fellow at The School of Public Policy. Prior to joining the University of Calgary in 2012, he was an Assistant Professor of Economics at Wilfrid Laurier University in Waterloo, Ontario. He received his PhD and MA from the University of Toronto. His research focuses on the intersection of international trade and macroeconomics, with a particular focus on the factors influencing productivity within and between countries. He has published in a variety of leading economics journals, has written various policy papers through the University of Calgary's School of Public Policy, and is an occasional contributor to *Maclean's* and the *Financial Post*.

Jennifer Winter (PhD, Calgary) is an Assistant Professor and Scientific Director of the Energy and Environmental Policy research division at The School of Public Policy, University of Calgary. Her research is focused on the effects of government regulation and policy on energy development and the associated consequences and trade-offs. Current research projects are the prospects for Canadian LNG exports to Europe, social impacts of hydraulic fracturing, and comparing provincial emission-reduction policies. Dr. Winter is actively engaged in increasing public understanding of energy and environmental policy issues; recognition of her efforts include a 2014 Young Women in Energy Award and being named one of *Alberta Oil Magazine's* Top 35 Under 35 in 2016. Dr. Winter serves on the Future Leaders Board of Directors, World Petroleum Council Canada.

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University of Calgary, Downtown Campus
906 8th Avenue S.W., 5th Floor
Calgary, Alberta T2P 1H9
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