Commission on Carbon Competitiveness

Policies to Achieve Industrial Decarbonization in Sectors Facing Competitiveness Risks

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The **Commission on Carbon Competitiveness** (C3) is made up of leading Canadian and US experts in economics, climate policy, and trade law. C3 aims to help Canadian industry remain globally competitive as the world decarbonizes, reduce greenhouse gas emissions, attract new investment, and develop long-term competitive advantages in emerging low-carbon industries.

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Executive Summary

How can Canada protect and enhance its carbon competitiveness? As the country and its trading partners accelerate efforts to reduce greenhouse gas emissions, this question has high stakes for Canada's economic prosperity.

For Canada, as a small open economy, prosperity has always been closely linked to success on international markets. But success is a moving target; dynamic global change is reshaping supply chains, trading relationships, and geopolitics. Efforts worldwide to decarbonize existing industrial sectors and foster emerging low-carbon industries are ushering in a new era of economic competition and opportunity.

Achieving long-term carbon competitiveness requires addressing four interwoven policy objectives: 1) decarbonizing Canadian industry; 2) avoiding carbon leakage (i.e., Canadian industry losing market share because of higher carbon costs than competitors); 3) attracting low-carbon investment across the economy; and 4) fostering the development of green sectors with high growth potential.

In the first paper from the Carbon Competitiveness Commission (C3), we showed that there is a potential tension between objective 1 (decarbonizing Canadian industry) and objective 2 (avoiding carbon leakage). That's because climate policy needs to be strengthened to accelerate decarbonization, but doing so could increase the risk of leakage in some parts of Canada's industrial base without a complementary policy to address this leakage risk.

This paper focuses on addressing this tension by examining policies that can effectively reduce carbon leakage without compromising decarbonization. We examine three broad approaches: 1) adjusting the performance standards within existing large-emitter trading systems (LETS) to reduce leakage risk, 2) adopting a border carbon adjustment (BCA), or 3) adopting product emissions-intensity standards. These options are not mutually exclusive: they can be used in complementary ways and/or applied differentially to different sectors. Note that we do not consider direct subsidies to be a leakage prevention tool because performance standards within LETS are a better way to achieve that end. Below the performance standard, emissions are not subject to pricing—this partial exemption from industrial carbon pricing serves as an implicit subsidy without having a fiscal impact.

Regardless of which leakage prevention tool is used, LETS should remain the foundational policy for achieving industrial decarbonization. LETS are the lowest-cost and most flexible way to decarbonize heavy industry. Alternatives to LETS would, in most cases, make securing emissions reductions more expensive: regulations impose higher costs on industry, and broad subsidies impose higher costs on the public. Furthermore, industrial carbon pricing in the form of LETS has a long history of support across Canada from all parties and has been shown to be effective. These systems are working and should be maintained and strengthened.

A key question in this paper, then, is whether adjusting performance standards within LETS systems can be a sufficient response to addressing the risk of leakage or whether the two alternatives we present, BCAs and product emissions-intensity standards, are preferable.

We answer this question in two different ways. First, we evaluate the three tools conceptually based on a set of key criteria such as fiscal impact, diplomatic considerations, and administrative feasibility. Second, we assess four sectors—iron and steel, pulp and paper, nitrogenous fertilizers, and basic chemicals—that we showed to be at relatively higher risk of leakage in our first paper to evaluate the suitability of each of the three tools within these specific sectoral contexts.

Overall, our analysis points to adjusting the performance standards within LETS as the most attractive option for leakage prevention, in part because adopting the two alternatives presents significant challenges.

BCAs would be challenging for Canada primarily for two reasons: first, any unilateral Canadian BCA would be a critical source of trade friction with the United States—by far our biggest trading partner. A cooperative version of BCA would take time to conceptualize and negotiate and would require a workaround to the fact that the United States does not have national carbon pricing. But even if a cooperative BCA with the United States could be developed, there is a second challenge: a high percentage of our industrial production is exported, and a BCA that protected exports by rebating carbon costs at the point of export would reduce demand for credits and thus accelerate the need to tighten performance standards, as well as incentivizing the export of high-carbon goods. Export rebates might also be illegal under World Trade Organization rules and could spark countervailing retaliation from the United States and others.

Product emissions-intensity standards would also be challenging. They would only protect against leakage in Canada's significant export markets if those markets also adopted similar standards. Moreover, negotiating an agreement on standards would take time, especially in sectors other than steel and aluminum, where no such international efforts or standards have been proposed. Like BCAs, emissions-intensity standards would almost surely require agreement with the United States.

The challenges with BCAs and product emissions-intensity standards mean that we believe Canada should focus on strengthening LETS and adjusting performance standards to address leakage. However, we believe it is also prudent to develop options for implementing BCAs and product emissions-intensity standards in parallel to strengthening LETS for three key reasons.

First, while well-designed LETS can work to avoid leakage in the short term, that job will be more difficult in the longer term—i.e., as we approach net-zero—because performance standards must be tightened to keep credit markets in balance. As firms covered by LETS decarbonize, they will generate an increasing number of tradeable credits. This risk of oversupply weakens the signal to decarbonize (i.e., if firms can buy credits for CAD 20 per tonne, the marginal price becomes CAD 20 despite what the headline price is set at). Tightening performance standards avoids oversupply by reducing the share of emissions that are eligible for credits and/or raising demand for credits. However, results from our first report show that tightening performance standards will need to be done carefully to avoid leakage risks in some sectors even before 2030.

As decarbonization accelerates beyond 2030, the tension between emissions reductions and leakage risks may grow, though there are at least two factors that may help resolve this tension. Low-carbon technologies will continue to improve and become less expensive and more widely deployed, and as a result, both abatement costs and compliance costs will decrease, reducing competitiveness pressures. At the same time, Canada's trading partners are also likely to continue to strengthen their own climate policies, further reducing the risk of leakage.

Second, policy-makers faced with even a minor risk of leakage and loss of competitiveness may err on the side of caution by not tightening standards to levels that will drive sufficient decarbonization. Elected leaders may face pressure to be risk averse in avoiding any loss of competitiveness and accompanying job losses. Indeed, concern about the risk of leakage may already be constraining climate policy. Performance standards set by some provincial governments (and granted equivalency by the federal government) are not strong enough to ensure robust demand for credits and, thus, the full effectiveness of policy in reducing emissions. As decarbonization proceeds and performance standards must be tightened further, there is likely to be a growing concern about leakage risk, and that concern might compromise the achievement of the first objective: decarbonizing Canadian industry. Conversely, actively exploring alternative means of addressing leakage may make it easier for governments to maintain and strengthen LETS systems.

Third, other countries are increasingly considering or implementing other tools to prevent leakage and competitiveness impacts (e.g., the Carbon Border Adjustment Measure in the European Union and the United Kingdom, the proposed Foreign Pollution Fee Act in the United States). They are pursuing international cooperation on the goals of industrial decarbonization and leakage prevention (e.g., the G7+ Climate Club, the U.S.–European Union (EU) Global Arrangement on Sustainable Steel and Aluminum). Canadian policy-makers need to understand how these tools and potential modes of cooperation might interact with Canadian realities and priorities.

Key Findings

1. LETS are the most effective tool for leakage through at least 2030 and possibly much longer.
2. BCAs and product-intensity standards should still be pursued as possible complements to LETS over the longer term, although they will be challenging and complex to adopt.
3. Any use of BCAs or product-intensity standards will need to be closely coordinated with the United States.
4. The mix of policies needed for each of the focus sectors to decarbonize and avoid leakage will differ based on sectoral context, as explained below.

Sector-Specific Conclusions

The steel sector has a strong and time-sensitive case for emissions-intensity standards: The global steel sector is facing a particularly acute reckoning due to years of global oversupply of emissions-intensive Chinese steel, increasing the desirability of a BCA or emissions-intensity standard (though Canada's recently announced 25% tariffs on Chinese steel may remove some of that competitive pressure). Fortunately, there are already existing negotiations between the United States and the EU on an instrument to deal with leakage in steel and aluminum (though negotiations are reportedly stalled), and multiple efforts globally to agree on "green" steel standards, making the prospect for Canada reaching agreement with the United States (and EU) more likely. The importance of a cooperative approach is especially high since this sector has faced a history of trade action by the US.

Leakage risk from nitrogenous fertilizers is manageable with LETS for the foreseeable future: seven of the nine facilities in Canada are located in Alberta and Saskatchewan, where emissions from fertilizers comprise a relatively small share of total emissions in the industrial pricing systems of these two provinces. Consequently, adjusting performance standards to keep average costs manageable is a robust solution for the foreseeable future.

The chemicals sector will likely rely on LETS over the long term, given its complex downstream value chain. The chemicals sector is highly diverse and complex, with single facilities producing many different products and covering thousands of downstream goods, making it particularly complex to administer a BCA or emissions-intensity standard. Efforts to ensure LETS function effectively over the long term will be particularly important for this sector.

Pulp and paper will also require LETS, though it also has the most challenging decarbonization pathway, reinforcing the importance of carbon competitiveness strategies. Pulp and paper depend on technologies that lack an operating history in mills like those found in Canada or have yet to scale. Unlike the other sectors we examined, there are many mid-sized to small producers, and, in some cases, the costs of decarbonizing facilities would be much greater than the value of the facility's existing capital stock. Moreover, global market prospects for paper are not trending well, and there is growing competition from temperate producers of pulp. On the other hand, there is some promise in new technologies, such as biogas-fed mill production being rolled out in Europe. Given that context, perhaps more than any other sector, pulp and paper critically needs a sectoral carbon competitiveness strategy (as recommended for all sectors) to define what mix of decarbonization support and leakage protection is most appropriate.

Recommendations

Based on our findings, we make the following recommendations to the federal government. To be clear, while these recommendations are applicable to the four sectors on which we focus, they are applicable to other industrial sectors in Canada as well.

- create a high-level task force on carbon competitiveness with a focus on coordination with the United States: Canada needs a high-profile body within government to study and address issues of carbon competitiveness, similar to the Climate and Trade Task Force recently announced by the United States. This body would coordinate competitiveness analysis and policy response in partnership with domestic stakeholders (see the roadmaps recommendation below), while also being the primary interface between Canada and international allies in coordinating competitiveness responses. A key focus of this body would be coordination with the United States, as we will need to partner with our southern neighbour on any potential BCA or emissions-intensity standard for at-risk sectors. We imagine the body would include representatives from key departments, such as the Privy Council Office, Global Affairs, Environment and Climate Change, Natural Resources, Industry, and Finance. It should also establish an advisory council to ensure it is closely connected with non-governmental actors, including industry, labour groups, civil society, and Indigenous communities.
- use the G7 Presidency in 2025 to advance discussions on cooperative BCAs and emissions-intensity standards (i.e., climate clubs): Canada will take over the Presidency of the G7 next year and can use its influence to advance ongoing initiatives on these key carbon competitiveness topics, including through the existing G7+ Climate Club and the G7's industrial decarbonization agenda.
- work in partnership with provinces to ensure adjustments to performance standards for high-risk sectors go hand-in-hand with strengthened carbon market systems: As the federal government and provincial and territorial governments work on the rules for carbon regimes post-2027 (the next phase of carbon pricing), the federal government can set a helpful precedent by designing its LETS system to appropriately accommodate high-risk sectors with manageable performance standards while still ensuring that there is enough demand for credits to keep the market in balance. It can similarly offer advice to provinces and territories on ways to assess the appropriate standards for sectors at high risk of leakage. It must ensure that it carefully reviews the rules proposed by each province, including modelling multiple future market scenarios, to ensure that the carbon markets will remain in balance. There are additional important measures for the federal and provincial governments to take as part of a carbon market review, but those are outside the scope of this paper.
- facilitate sector-by-sector decarbonization roadmaps in partnership with key stakeholders: Our analysis has shown that each sector's competitiveness and decarbonization needs are different, and each requires a tailored plan that includes—and goes beyond—leakage prevention. Decarbonizing investment is dependent on sectorally appropriate leakage prevention tools but also on ensuring firms can access inputs such as low-carbon electricity and low-carbon hydrogen, and on policies such as green government procurement to create lead markets. The federal government should coordinate with other levels of government, the private sector, Indigenous Peoples, academia, and civil society to create roadmaps that identify the pathways forward for each sector and the policies needed to get there. Several other groups have called for similar roadmaps.

ONE

Introduction

Canadians rely on sustainable and competitive industrial sectors for our continued prosperity. As Canada and its trading partners accelerate efforts to reduce greenhouse gas emissions, decarbonizing heavy industry remains a thorny challenge. Heavy industries are important regional employers and drivers of economic prosperity that produce commodities essential to quality of life. New industries are emerging, and anchor investments continue to make headlines, including in electric vehicles, battery manufacturing, and low-carbon hydrogen. Decarbonized heavy industry can be a driver of future economic prosperity for Canada.

Heavy industrial sectors are also a major source of GHG emissions. Taken together, Canada's heavy industrial sectors accounted for almost 40% of Canada's emissions in 2021. This presents unique challenges and opportunities for Canada as an open trading nation in a global economy that is quickly orienting toward low-carbon production. Healthy economies naturally change over time in a process of creative destruction, and climate policies worldwide are accelerating that dynamic in new ways. Failing to adapt to the global context will be costly; Canadian policy-makers must account for and act to address the risks and seize the opportunities presented by a period of dynamic global change. To achieve long-run carbon competitiveness, we must address four interwoven policy objectives:

- decarbonizing Canadian industry
- avoiding carbon leakage (see Box 1)
- attracting low-carbon investment across the economy
- fostering the development of green sectors with high growth potential.

Box 1. Carbon leakage

Carbon leakage (often called simply "leakage") occurs when climate policies in one jurisdiction result in a shifting of GHG emissions from that jurisdiction to others, usually because those other jurisdictions have lower climate policy costs. It can occur through the relocation of productive facilities, through a diversion of greenfield investment, or through a loss of market share to foreign producers.

In this paper, the second from the Commission on Carbon Competitiveness (C3), we look specifically at options to avoid carbon leakage without compromising on the objective of decarbonizing Canadian industry

Of course, many other nations are similarly trying to achieve carbon competitiveness. The European Union (EU), for example, is accounting for the greenhouse gas emissions embodied in heavy industrial commodities (also called "embedded" carbon), demanding low-carbon goods and imposing penalties on high-carbon imports. Other countries, such as the United Kingdom, are following suit, implementing policies that would make it more difficult to sell highly emissions-intensive goods within their territory. The United States has made massive investments in subsidizing industrial decarbonization, principally through the 2022 Inflation Reduction Act (IRA). These investments—a mix of tax credits, loans, and grants—will accelerate decarbonization and help American firms compete more effectively in a world that will increasingly prioritize low-carbon goods. While there is risk that the IRA could be undermined by the executive branch of a future administration or fully repealed with the help of the House and the Senate, the momentum that it has built in just 2 years, paired with state-level action, means that the U.S. economy will continue to move steadily toward lower-carbon production regardless of what party is in power.

Despite this accelerated action on decarbonization from many of Canada's closest trading partners, when it comes to embedded carbon, the global playing field is still far from level. For at least the next decade, Canadian producers will continue to face competition from low-cost, emissions-intensive producers.

As the Commission's first paper showed, not all heavy industrial sectors are equally vulnerable to leakage risks. In this paper, we focus analysis on four sectors facing acute risk of lost market share in the near term: iron and steel, pulp and paper, nitrogenous fertilizer, and basic chemical sectors. As climate policies ramp up in the coming years, the results of the Commission's analysis in our first paper showed that these sectors are the most likely to face the prospect of lost market share and low profitability. Other heavy industrial sectors, including oil and gas, aluminum, and cement, are at somewhat lower risk due to high profitability, recent decarbonization investments, or relatively lower exposure to international competition.

In this paper, we dive deeper into the main policy options to address leakage, examining the role they should play in Canada's climate policy mix, grounding our recommendations in a thorough analysis of the competitive circumstances facing the four most at-risk heavy industrial sectors.

When considering how best to foster carbon competitiveness in these industries, we argue that pricing-based mechanisms such as large-emitter trading systems (LETS) should remain at the forefront for reasons of both efficiency and fiscal prudence. Canada cannot afford to take a subsidy-driven policy approach, such as that contained in the IRA. Industrial carbon pricing is one of the most cost-effective climate policy tools available and should remain the foundation of Canada's approach to decarbonization.

Well-designed LETS can effectively prevent leakage in the short term. However, achieving industrial decarbonization and avoiding leakage may require a different approach over the longer term. LETS are specifically designed to address leakage in heavy industrial sectors by reducing average carbon costs. We evaluate the role that LETS with low average carbon costs should continue to play in Canada's policy mix. Given potential trade-offs between decarbonization and leakage prevention in the longer term, we consider two additional policy options: border carbon adjustments (BCAs) and product emissions-intensity standards. The question we seek to answer is how industrial carbon pricing should be best combined with these policies, considering their relative strengths and weaknesses.

In Section 2, we argue that industrial carbon pricing remains foundational to incentivizing decarbonization in these and other emissions-intensive and trade-exposed (EITE) sectors, accompanied by policies specifically designed to address leakage risks. In Section 3, we characterize three policy tools to address leakage—adjustment within LETS, BCAs, and product emissions-intensity standards—and compare them using seven criteria. Section 4 dives into the international competitiveness context facing the four decarbonizing sectors that we have identified as most likely to face near-term carbon competitiveness pressures arising from Canadian climate policy: iron and steel, pulp and paper, nitrogenous fertilizer, and basic chemicals. Section 5 synthesizes the policy tools and the deep dives and considers which policy mix responds best to the specific carbon competitiveness challenges facing each of the four sectors under examination. Finally, Section 6 offers conclusions, including cross-cutting recommendations for greater international collaboration.

TWO

Why Carbon Pricing Is Foundational

For Canadian climate policy to be effective over the long run, pricing-based policies should play an essential role. Well-designed carbon pricing systems that recycle their revenues back into the economy remain the most cost-effective option for emissions reductions (Aldy, 2015; Edenhofer et al., 2015; Kotlikoff et al., 2020; Schmalensee & Stavins, 2015), offering transparent financial incentives and broad coverage across different economic sectors without losing the flexibility to tailor the specifics for individual sectors or facilities.[1] Previous energy-economy modeling has shown that meeting Canada's 2030 targets with LETS would yield average annual GDP growth that is 40% to 70% higher between 2020 and 2030 when compared to other policy approaches (Beale et al., 2019).

Sectors covered by LETS operate in distinct competitiveness contexts. C3's previous analysis has made the case for tailoring Canada's industrial climate policies to account for these differences as climate policies become more stringent.

Well-designed carbon pricing systems can readily accommodate different competitiveness contexts, drive emissions reductions, and attract new low-carbon capital. These features have drawn the interest of provinces, many of which have adopted pricing-based policies as the backbone of their plans for industrial decarbonization. Starting in 2007, several provinces have taken the initiative to launch their own pricing-based policies for heavy industries, most notably their own LETS. These systems first emerged in Alberta (2007), Quebec (2013), and Ontario (2017), followed by a federal LETS equivalency test applying to all provinces (2019). All 13 provinces and territories now use LETS, including 12 output-based pricing systems (OBPS), as well as Quebec's cap-and-trade system.

LETS can drive significant emissions reductions. Recent modelling shows that LETS will drive the greatest emissions reductions of any individual policy in Canada between 2024 and 2030 (Beugin et al., 2024). Canada cannot meet its emissions targets without LETS, but LETS cannot do it alone. Even well-designed carbon markets have their limitations. As performance standards continue to tighten over time and the carbon price rises, some sectors will face competitiveness impacts while others may face market failures that frustrate the incentives offered by carbon pricing. A well-considered package of policies—with carbon pricing at its centre—can better position Canada to meet its climate targets while attracting investment in sectors that must decarbonize to thrive in a net-zero economy.

[1] Carbon pricing offers firms the flexibility and clear financial incentive to reduce emissions as cheaply as possible. Aggregate cost savings associated with carbon pricing are commonly estimated to be between 25%–75% compared to other instruments.

LETS can help the provinces turn themselves into more attractive investment destinations for low-carbon capital. The ability to offer policy-based incentives has become the crucial piece of Canada's competitive response to the generous incentives in the IRA. Mature markets in Canada, most notably Alberta's Technology Innovation Emissions Reduction (TIER) market, are an effective instrument to attract additional low-carbon capital. This mechanism, which allows firms to generate carbon credits with monetary value in the open market, will enable provinces to remain more competitive with the incentives available in the IRA (Allan & Bernstein, 2023).

THREE

Characterization of Policy Tools

In this section, we describe three policy options for addressing leakage. We believe that policy-makers have three broad options to address the risk of leakage sufficiently. While LETS remains foundational, the other options merit consideration as complements. They have the potential to better account for the unique and dynamic competitiveness context of different sectors over time. We evaluate each of their primary advantages and drawbacks in the Canadian policy context:

- adjusting performance standards within LETS
- BCAs
- product emissions-intensity standards

We compare these three approaches using seven key criteria, listed below, ultimately asking what they add to a policy package that includes industrial carbon pricing at its foundation. The comparison is designed to help inform the choice of policy mix for specific sectors.

- **environmental effectiveness:** To what extent does/could this policy instrument, when combined with strong carbon pricing, incentivize the type of innovation/investment needed to decarbonize Canadian industry in line with net-zero by 2050?
- **competitiveness:** How could this tool enhance or protect the global cost-competitiveness of heavy industry during the transition?
- **costs to households:** What is the incidence of policy costs to households vs. large emitters or others?
- **direct fiscal impact:** To what extent does the policy require additional public spending and/or generate additional government revenues?

- **diplomatic considerations and international obligations:** What impact could this policy have on Canada's diplomatic relations with its key allies and trading partners? Does it have important international legal implications?
- **administrative feasibility:** Will this policy be very difficult for the Canadian government to effectively design or administer?
- **policy interactions:** How would this policy interact with the LETS (or other policy tool in the policy mix)? What is the role of a given policy tool in either softening/mitigating risks and drawbacks identified for other tools or amplifying the benefits/effectiveness of the overall package?

3.1 Adjusting Performance Standards Within LETS

Mostly operating under provincial jurisdiction, LETS consist of two key components. First is a price on carbon, and second is an output-based subsidy for each unit of production (e.g., 1 tonne of steel, 1 litre of chemicals, one pallet of paper, etc.). In the literature, these output subsidies are known as output-based allocations (OBAs); Fischer & Fox, 2007; Quirion, 2009). In the federal OBPS, OBAs take the form of a sector-specific performance standard—a benchmark GHG intensity; if producers are above that standard, they pay only for those emissions above the standard. If they are below the standard, they receive carbon credits. All provinces use OBAs and output-based pricing, with the exception of Quebec's cap-and-trade system; its use of free allocations is analogous to the use of OBAs in other provincial systems. OBAs and other types of allocations are implicit subsidies, i.e., foregone revenue rather than new spending.

This aspect of LETS—the use of output-based subsidies or performance standards below which carbon is not priced—is a leakage prevention tool. One option for policy-makers is to simply continue to use this tool, making adjustments to the standards within LETS to respond to the risk of leakage.

Together, this one-two combination of pricing and performance standards ensures that LETS drive emissions reductions while shielding large emitters from carbon prices that might otherwise be high enough to induce leakage. It creates incentives for firms to reduce emissions by improving emissions performance, not by reducing production. LETS mitigate leakage risk while ensuring the marginal price of carbon is binding, providing large industrial facilities with a continuous incentive to reduce the emissions intensity of operations.

Different jurisdictions use different names for these performance standards. For instance, Alberta assigns performance benchmarks, while Ontario uses Total Annual Emissions Limits based on the sector and a facility's emissions intensity of production. Facilities that exceed their emissions limits can either pay the headline price or purchase carbon credits in the open market. Facilities that operate below their limit face no compliance costs, and in fact generate credits for every tonne of emissions they avoid below their maximum allowable limit. Firms can monetize these credits by selling them to facilities that have exceeded their allowable emissions and, therefore, face a compliance obligation.

This management of tightening performance standards and ensuring adequate supply and demand of credits is a continuous balancing act. Like all climate and competitiveness policies, LETS will require regular review and upkeep to ensure this balance is maintained. Most importantly, these systems must create increasing incentives for decarbonization over time while also remaining responsive to real-world operating conditions and global market dynamics. As carbon prices increase, so too will costs. But at the same time, as firms decarbonize and low-carbon technologies become cheaper, producers will need less leakage protection because their costs of compliance will be lower.

On the one hand, a previous analysis from C3 has shown that several sectors face a genuine risk of leakage as carbon prices rise. Many options to address leakage risk are already built into LETS. The use of performance standards helps ensure that the sectors at greater risk of leakage face relatively low average carbon costs, even if the marginal price of carbon is higher. This differentiation between marginal and average carbon costs remains the first-best defence at avoiding that leakage over the long run. Governments can also make use of the revenues that they collect through LETS to further offset leakage risk for the most vulnerable sectors. These built-in features ensure that policy-makers can use LETS to drive maximum emissions reductions while minimizing leakage.

On the other hand, LETS systems must also ensure robust credit markets. If performance standards—for all covered emitters, collectively—are too loose, credit markets will have too many sellers and too few buyers. The result will be a lower effective carbon price, undermining the policy's environmental performance.

For LETS to be an effective tool at driving industrial emissions toward net-zero over the long-term, the total share of industrial emissions facing a carbon price will need to rise over time. As firms decarbonize, they can expect to generate an increased number of carbon credits under most conditions. As the supply of carbon credits grows, demand must also grow to ensure the market stays in balance. Credit prices in the open market must trade close to the headline price of carbon and provide a sufficient incentive for additional firms to continue to invest in decarbonization.

However, as standards tighten, the costs faced by firms that are still emitting above their benchmarks will rise. While our modelling and that of other experts suggest that these costs will be largely manageable and are unlikely to lead to plant closures in Canada, it is also true that the risk of leakage will rise. Facilities facing higher carbon costs may also choose to operate at reduced capacity instead of ceasing production entirely. The possibility of this reduced economic activity typically leads to policy-makers making risk-averse decisions. Even a low risk of leakage could deter policy-makers from continuing to tighten standards and keep their systems in balance. Indeed, the risk of leakage constraining policy is arguably already occurring today. Clean Prosperity has shown that tightening rates set by provincial governments, and granted equivalency by the federal government, are not high enough to induce the emissions reductions that are explicitly targeted in the federal Emissions Reduction Plan, with credits trading well below the headline price of carbon (Dizon & Bishop, 2024).

In the short term, policy-makers will need to rely on policies already in place—most importantly, performance standards in LETS and subsidies like investment tax credits and grants. Alternative policies are speculative and would take years to implement.

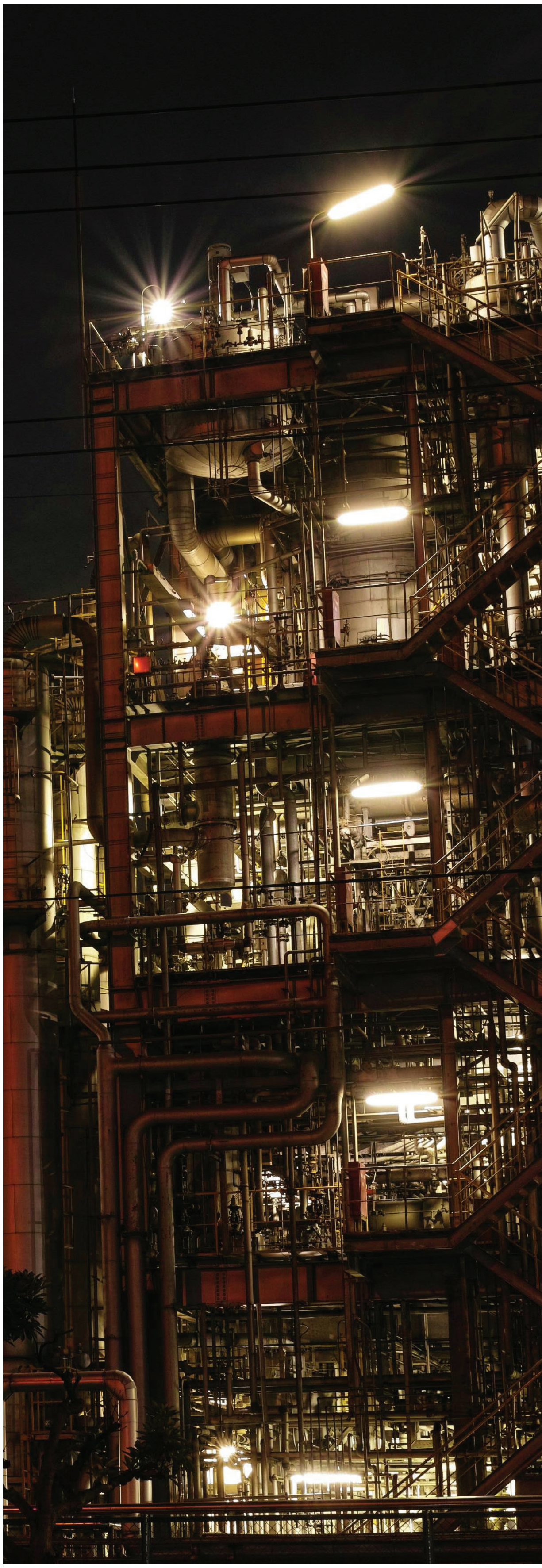
Box 2: Alternatives to OBAs

OBAs are just one form of subsidy that can be used to complement LETS. With OBAs, emitters receive a fixed sum for every unit of production. However, policy-makers can alter this formula to generate different outcomes. Alternatives include intensity-based allocations, abatement-based allocations, and lump-sum allocations (Böhringer et al., 2023).

Intensity-based allocations index the size of the allocation to the emissions intensity of production. In other words, the better a facility's emissions performance, the more intensity-based allocations it would receive. Facilities that are operating at higher emissions intensities would receive proportionately fewer allocations. This approach strengthens incentives to abate at the margin;
as firms receive more allocations, the more aggressively they cut emissions.

Whereas abatement-based allocations would likely need to be evaluated case by case, lump-sum allocations take the opposite approach. Facilities receive a fixed amount—based, for instance, on their size, sector, or region—that does not vary with production or emissions levels. Lump-sum rebates are the only option that does not have the potential to alter incentives at the margin (Böhringer et al., 2023).

Abatement-based allocation is a revenue-recycling approach that prioritizes additional emissions reductions. Unlike OBAs or intensity-based allocations, abatement-based allocations are not indexed to production levels. The revenues recycled toward each emitter may vary depending on the size, scope, and project readiness of their emissions reduction opportunities. Abatement-based allocations present several challenges, most notably that they may lead to depressed credit prices if stringency is inadequate, as well as increasing firms' opportunity cost of emissions reductions (Böhringer et al., 2023).



Box 3. LETS are not the end of the story

LETS is a foundational climate policy for achieving emission reductions and protecting against risk of leakage. But we need to be clear: LETS will require complementary policy to decarbonize Canadian industry, to induce innovation at the required speed, and to ensure Canada's long-term carbon competitiveness. While this report focuses on LETS as a tool for leakage prevention, it does not cover other reasons why LETS should be paired with complementary policy, including the following:

1. Some of the essential ingredients of decarbonization pathways for all four sectors lie beyond their direct control. Without policies to ensure there will be adequate supply of low-carbon electricity and hydrogen, for example, the incentives from a carbon price won't lead to emissions reductions in line with Canada's climate goals.

2. Some decarbonization pathways are unclear, with new technology being untested at commercial scale. Policies will be needed to help de-risk these technologies, such as support for research and development, green procurement to establish lead markets, or other targeted subsidies to promote the commercialization of innovative solutions.

3. Maintaining the value of future carbon credits is critical to LETS' objective of incentivizing decarbonization; low credit prices lower both the rewards for effort and the cost of compliance, and they lead to underinvestment in low-carbon production. Tools like carbon contracts for difference, which guarantee the value of credits in future, are needed to support LETS' incentives. Other market reforms, including greater transparency around credit prices and sectorally appropriate strengthening of benchmarks within LETS, will also be necessary to ensure the future value of carbon credits.

The Commission's future work will explore the ways that some such policies can contribute to the broader objectives of carbon competitiveness in third country markets.

3.2 Border Carbon Adjustment plus LETS

BCA aims to neutralize any cost advantage foreign producers might gain as a result of the domestic government's carbon pricing. It imposes costs on imports equal to the carbon price imposed on domestically produced goods.

There are many possible variations of BCA, with many design choices in the process of elaboration that lead to different results. Evaluating this policy tool rigorously requires some assumptions about those design elements. In our analysis, we consider three variations of BCA, explained in more detail below:

- Carbon Border Adjustment Measure [CBAM] style: A BCA that, in many of its key design elements (described below), follows the lead of the EU CBAM, adjusted where necessary to reflect Canada's different underlying approach to carbon pricing.
- export coverage BCA: This is a variation on the EU CBAM-style BCA that also provides export coverage, i.e., that refunds the cost of carbon for exported goods.
- cooperative model BCA: This type of BCA does not actually adjust for a domestic carbon price, and thus, it might be cooperatively implemented with the United States. Rather, it charges for the difference between the import's average emissions intensity and the average domestic emissions intensity.

Cosbey et al. (2021) go into considerable depth assessing the need for and possible design elements of a Canadian BCA. The description here goes only into as much depth as is necessary to provide a basis for assessment against the other policies under consideration.

We assume that all three variations would cover those goods covered under the LETS that are most vulnerable to competitiveness impacts. The federal OBPS 38 covered activities are both emissions intensive (so a carbon price will increase their costs significantly) and trade exposed (so they can't pass along all those costs to their customers, or they will simply be undercut by foreign producers), but, as our first report showed, some are much more vulnerable than others. In the sectors it covered, a BCA would cover goods that are high on the value chain, like basic steel, rather than goods manufactured from steel, such as automobiles, for example.

The CBAM-style and export coverage BCAs would charge for direct emissions created in the production of the covered goods (Scope 1), and all emissions embodied in the purchased electricity, steam, heat, and hydrogen used to produce goods (Scope 2). Canada's LETS all cover electricity, so Canadian producers are paying a carbon price on any emissions generated in the production of the electricity they purchase; the BCA would ensure that the same conditions apply to imports.

For those two variations, the import charge would be based on the Canadian federal minimum carbon price but would be calculated to equal the average cost of carbon paid by each sector after accounting for the fact that Canadian producers don't pay for carbon up to their sectoral performance standards. It would be assumed that domestic producers, even if covered by a provincial scheme, face equivalent effective (average) carbon prices. While we know that this is not in fact the case, the federal regime assumes—and works to ensure—equivalency, and differential charges for different provinces would be unworkable as a national trade measure. The charge would be discounted to allow for any effective carbon price already paid by foreign producers.

For the export coverage BCA, firms would receive refunds at the point of export of the carbon price paid in Canada, as under the Goods and Services Tax regime. The purpose of the refund would be to try to protect against leakage in both the domestic market and in export markets. To avoid incentivizing high-carbon production for export, the rebates could be granted at default values rather than being based on actual carbon prices paid; otherwise, high-carbon producers would receive high-value rebates. The default could, for example, be equal to the performance standard (GHG intensity standard) for each sector, multiplied by the average cost of carbon as determined above.

For both variations, importers would need to submit third-party-verified data on actual direct emissions, with verifiers being accredited to the Canadian standard. Scope 2 emissions would be based on average grid GHG intensity in the country or region of export, with individual firms able to challenge that default under strict conditions, such as a power purchase agreement with a renewable energy provider.

The "cooperative" BCA would charge for any embodied carbon in excess of the Canadian sectoral averages. In other words, if the average sectoral GHG intensity of production for Indian steel is 50% greater than the Canadian average, the carbon price would only be charged on those "excess" emissions above the Canadian standard. Producers with emissions intensities at or below the Canadian level would pay nothing. The cooperative BCA model is considered because it offers the possibility of a regime that could be implemented in concert with the United States, which does not have a carbon price to adjust for.[2] "Cooperative" in this context doesn't necessarily mean the United States and Canada would have identical regimes. For one thing, the price might be different; Canada would probably charge its headline (minimum) national carbon price, and the United States would have to decide what it would charge. For another thing, neither country would necessarily be exempt from the other's charges, as there are differences in emissions intensity that would trigger such charges (though, for the most part, the differences are small). There are ways to address this last issue. For example, the two countries could state that any country's goods would be exempt under two conditions: if they were currently within a specified percentage of differential in emissions intensity, and if they had concluded an agreement committing to jointly reaching some improved level of GHG intensity over time. Canada and the United States could then conclude such an agreement.

BCAs would allow for increased stringency in Canada's carbon price (whether accomplished by increasing the headline (marginal) price or by tightening the GHG intensity standards above which payment is due); this enabling function is BCA's raison d'être. If it followed the EU example, BCA in Canada would replace OBAs, forcing firms to pay the full carbon price and transmitting the carbon price through the entire value chain while providing them with protection against foreign competitors that did not face the same carbon price.

2 In fact, this variant is modelled on a proposal currently before the U.S. Congress.

3.3 Product Emissions-Intensity Standards Plus LETS

Mandatory product emissions-intensity standards have been proposed as a promising mechanism for achieving greater international harmonization of trade and climate policy, including between countries such as Canada and the United States that have taken very different approaches to climate policy domestically (Shawkat & Cosbey, 2024). Unlike a BCA, product emissions-intensity standards account only for the emissions embedded in a good and not the carbon price paid on those emissions; therefore, the absence of a carbon price in the United States is not a barrier to cooperation on standards.

Collaboration with the United States on emissions-intensity standards would ultimately result either in the adoption of identical or slightly different standards for specific products. Either way, the risk of a trade dispute with the United States—and other participating countries if adopted as part of a larger climate club—would be greatly reduced or eliminated. The adoption of standards would not, however, be expected to completely level the playing field between producers in participating jurisdictions, nor would it completely eliminate leakage risk. The carbon costs faced in each participating country will still differ, and these differences may be significant enough to cause leakage even in the presence of a set of emissions-intensity standards.

Product emissions-intensity standards are a new policy tool, adopted in only a few settings in Canada or elsewhere, with a notable example being British Columbia's Low-Carbon Fuel Standard. That said, they are under consideration by several countries as a policy option to address carbon competitiveness. In this paper, we consider mandatory carbon intensity standards as a complement to Canada's industrial carbon pricing system rather than a stand-alone policy tool. We also assume that Canada would adopt these standards only in conjunction with another major trading partner, such as the United States, rather than unilaterally.

As envisioned in this paper, a product emissions-intensity standard is a requirement that all covered goods sold on the domestic market must be produced with an emissions intensity that is below a given threshold. The main purpose of these standards is similar to that of BCA: to prevent the undermining of Canada's carbon price by the importation of goods with high emissions intensities. While the standards would also be applied to goods produced domestically for sale domestically, they would be set at a level that ensures that the LETS, rather than the standard, would continue to drive emissions reductions in Canada. Goods destined for export would be exempt from product emissions-intensity requirements.

Product emissions-intensity standards would be set by the Government of Canada working jointly with one or more trading partners. They would have to be set at technically achievable levels and would be most effective if set on a schedule that started at easy levels of achievability and progressively became more stringent (though still in line with expected trends in technological innovation).

3.4 Evaluation of Policy Tools

Table 1 offers a brief summary of the results from our assessment of the three policy tools based on seven key criteria. A more detailed assessment of each tool against the criteria is presented in Appendix B.

Table 1. Summary evaluation of three policy tools

Criteria	Adjusting performance standards within LETS	BCAs	Product emissions-intensity standards
Environmental effectiveness	Well-calibrated performance standards in LETS can help maintain both environmental effectiveness and competitiveness. Overly lax standards can undermine environmental effectiveness by undermining credit markets.	Can reduce leakage risk, enabling higher average prices under LETS to transmit incentives down the full value chain.	Can reduce leakage risk, enabling higher average prices under LETS to drive emissions reductions.
Competitiveness	Improves competitiveness by reducing cost burden on firms.	Improves competitiveness by eliminating competition from high-carbon imports. Only the export coverage model of BCA also protects export markets.	Improves domestic competitiveness by eliminating high-carbon imports. If adopted by major trading partners, will also improve competitiveness on export markets.
Costs to households	No significant impacts to households.	Would increase costs for items made with covered goods as inputs.	Would increase costs for items made with covered goods as inputs.
Direct fiscal impact	Cost to governments is in terms of foregone revenue.	Would create a revenue stream for government from collected charges. The export coverage model would have a much-reduced revenue stream.	No direct fiscal impact other than cost of operating the standards regime.
Diplomatic considerations	No major diplomatic or trade considerations, but there is precedent for free allocation in the EU ETS being ruled a countervailable subsidy.	Would be highly contentious with the United States, which exports significant percentages of covered products to Canada. Possibly addressed by the cooperative BCA option. The export coverage model might be deemed an illegal subsidy under trade law.	Would be highly contentious for those countries (e.g., India, South Korea, China) whose products may be prohibited, but less so than BCA.

Criteria	Adjusting performance standards within LETS	BCAs	Product emissions-intensity standards
Administrative feasibility	Currently in use and therefore administratively feasible, but risk-averse decision making can lead to inadequate tightening of standards over time.	Technically challenging to administer, especially if asking for actual data from foreign producers.	Technically somewhat challenging to administer, including the challenge of setting standards at levels that are no more demanding than the existing carbon price.
Policy Interactions	Other subsidies can interact with LETS in a way that exacerbates risks of over-reliance on loose standards, undermining LETS markets and decreasing effectiveness.	Positive interaction with carbon pricing. No other important policy interactions, other than the case of the export coverage model of BCA, if rebates are returned fully and directly to covered firms, which would likely depress the price of carbon credits by lowering demand.	No important policy interactions, as long as standards are set at levels that are no more stringent than the existing carbon price.

Source: Authors.

The rest of this section offers key takeaways about each of the tools based on our analysis.

Adjusting Performance Standards Within LETS

LETS are a well-understood policy tool already being used in almost all Canadian jurisdictions, with the exception of Quebec. Tightening standards within LETS remains the most readily available, near-term solution that can ensure LETS remain environmentally effective while fostering competitiveness. Over the next decade, and perhaps longer, they will be an important tool for addressing leakage as the rest of the world develops more ambitious climate policy.

However, LETS face challenges in the medium to longer term. As firms decarbonize, performance standards will need to be tightened to keep the market in balance; decarbonized firms need fewer credits and will supply more, so without tighter standards, the price of credits will fall, and with them, the incentives for all firms to decarbonize. However, those same standards are being used to lower average costs and prevent leakage: the more they are tightened, the less effective they are at leakage prevention. Results from our first report show that the tightening of performance standards will need to be done carefully to avoid leakage risks in some sectors even before 2030.

As decarbonization accelerates beyond 2030, the tension between emissions reductions and leakage risks may grow, though there are at least two factors that may help resolve this tension. Low-carbon technologies will continue to improve and become less expensive and more widely deployed; as a result, both abatement costs and compliance costs will decrease, reducing competitiveness pressures. At the same time, Canada's trading partners are also likely to continue to strengthen their own climate policies, further reducing the risk of leakage.

While LETS may well be able to handle all those moving parts—tightening benchmarks just enough to keep the market in balance but also not increasing the risk of leakage—that final outcome is uncertain, and uncertainty is a problem. Policy-makers faced with even a minor risk of leakage and loss of competitiveness may err on the side of caution by not tightening standards to levels that will drive sufficient decarbonization. Elected leaders may face pressure to be risk averse in avoiding any loss of competitiveness and accompanying job losses. Indeed, concern about the risk of leakage may already be constraining climate policy. Performance standards benchmarks set by some provincial governments (and granted equivalency by the federal government) are not strong enough to ensure robust demand for credits and, thus, the full effectiveness of policy in reducing emissions. As decarbonization proceeds and performance standards, benchmarks must be tightened. As decarbonization proceeds and performance standards must be tightened further, there is likely to be a growing concern about leakage risk and that concern might compromise achievement of the first objective: decarbonizing Canadian industry. Conversely, actively exploring alternative means of addressing leakage may make it easier for governments to maintain and strengthen LETS systems.

Nonetheless, because those tensions are a longer-term problem and because LETS are central to Canadian climate policy, OBAs should be Canada's subsidy of first resort to address the risk of leakage. Unlike other forms of subsidies, they constitute foregone revenue rather than additional spending. An OBA-first approach allows policy-makers to minimize direct fiscal impacts and costs to households and avoid the free-rider problem by avoiding the funding of economic activity that would have happened anyway without a subsidy.

There are several principles that can help policy-makers ensure LETS with OBAs are environmentally effective (Dobson et al., 2017). Most importantly, OBAs should be distributed on a per-unit basis across all facilities producing the same type of product. However, some provinces are not using OBAs in this manner and are instead targeting individual facilities through the use of facility-specific standards (usually grounded in historical emissions). These facility-specific standards mean that higher-emitting facilities receive larger output subsidies relative to low-carbon facilities, creating more inertia for emissions-intensive production. To ensure environmental effectiveness over time, the distribution and use of OBAs should evolve toward a more standardized approach.

BCAs

BCAs offer the possibility of increasing the stringency of carbon pricing for those sectors that need it—either by increasing headline (marginal) cost or by tightening up performance standards and increasing average costs—while avoiding the competitiveness risks that would otherwise arise from foreign competition that does not face the same carbon costs.

Given the high share of production exported in most of the sectors—for example, 67% in pulp and paper and 74 in basic chemicals—a BCA that did not protect against leakage in foreign markets would be of limited use. Only the export coverage model, which would refund carbon costs at the point of export, would, in fact, preserve competitiveness in Canada's significant export markets, but that version has challenges. Rebate of carbon costs would be considered a prohibited subsidy under trade law if Canada's OBPS were deemed a regulatory regime rather than a tax (taxes can be legally refunded on export). Even if it were not taken to dispute resolution in forums such as the World Trade Organization (WTO), an export rebate might be challenged as a subsidy under national trade remedy law by the United States (a heavy user of such tools) and slapped with countervailing duties that would cancel out any leakage prevention. Finally, an export rebate would reduce the average costs of carbon for the recipients, potentially depressing the price of carbon credits and reducing incentives to decarbonize for all covered firms.

To the extent that BCAs allow for stronger carbon pricing, they would result in increased costs of emissions-intensive goods for Canadian consumers, but the incentives that implies are in fact the point of carbon pricing. Some of those impacts could be softened by some form of consumer rebates, though these would be challenging to design so as to keep the incentives created by the full carbon price. BCAs would create a stream of revenues that might be devoted to this or other purposes. By charging imports a carbon fee, BCAs also incentivize foreign producers to decarbonize their production or for foreign firms to apply their own carbon pricing schemes so that they, rather than the Canadian government, might receive the associated revenue.

The only existing BCA regime—the EU's CBAM—has been diplomatically controversial. Canada's intense trade relationship with the United States would make a Canadian version of a CBAM particularly controversial from the U.S. perspective. One option for avoiding this controversy is a cooperative version of BCA that the United States and Canada could jointly pursue, even in the absence of a U.S. carbon price. However, that option has several challenges, including trade law obligations and the need for the United States to specify the price it would charge for embodied carbon in imports.

BCA is an administratively difficult policy: among other things, it requires the implementing country to elaborate methodologies for emissions accounting at the product level. Some, but not all, of these challenges would be softened by Canada's ability to learn from the implementation of BCA by the EU and the United Kingdom.

Product Emissions-Intensity Standards

Like BCAs, product emissions-intensity standards can be effective at preventing competition from low-cost, high-carbon imports produced in jurisdictions with relatively lax climate policy. In this way, they help level the playing field and create policy room for Canadian governments to rely more heavily on industrial carbon pricing to drive emissions reductions.

The main advantage of standards over BCAs is the ability to pursue them cooperatively with the United States without the complications that would be involved in implementing a BCA in the absence of a U.S. carbon price. Given the relatively small size of Canada's domestic market and the dependence of Canadian facilities on sales in the United States, it makes sense for Canada to adopt these standards jointly with the United States (and other countries as well, if possible). Unlike BCAs, standards do not adjust for domestic carbon prices, and therefore, the lack of such a price in the United States is not a barrier to cooperation.

Like BCAs, product emissions-intensity standards would be complex to develop and administer, though less so because there is no need to account for carbon prices paid. They would also be opposed by countries whose exports are likely to be prohibited by them. These drawbacks may be at least partially alleviated through greater international cooperation that would result in a large number of countries collaborating on standards development and implementation. Finally, these standards have the potential to increase costs for domestic consumers of covered goods. Targeted subsidies can be used to partially offset the increased costs faced, but this would create a drain on the public purse, and, unlike BCAs, product emissions-intensity standards would not have revenue streams that could be directed toward such subsidies.

FOUR

Sector-by-Sector Competitiveness Overviews

In this section, we offer brief summaries of the competitiveness context for our four sectors of focus: iron and steel, pulp and paper, nitrogenous fertilizers, and basic chemicals. The summaries are informed by both interviews with industry experts and a review of online literature. We focus on factors influencing the international competitiveness of each sector, as well as the feasibility of border measures such as BCAs. These factors include global competitors, location of active facilities, emission intensities compared to the United States, the complexity of value chains, integration with the U.S. market, and available decarbonization technology solutions. A deeper dive into the sectors and their competitiveness context can be found in Appendix A.

4.1 Iron and Steel

Canada's iron and steel sector benefits from its access to the Labrador Trough, one of the world's largest sources of iron ore, as well as access to multimodal transportation networks and nearby markets, like the North American auto sector. Despite these advantages, Canada faces competitive pressures from China, which produces steel at lower prices due to its large-scale production and government support. While India and Japan are also top producers, China leads with 54% of global steel production (World Steel Association, 2023). In efforts to level the playing field, Canada has announced its plan to impose a 25% surtax on imports of steel and aluminum products from China—matching current U.S. tariffs—starting October 15, 2024, though this has been taken to the early stages of dispute settlement by China at the WTO (Reuters, 2024).

Canada has 19 iron and/or steel facilities, mostly located in Ontario and Quebec (Environment and Climate Change Canada, 2024b). These facilities produce primary and secondary steel and convert it to final products used in various commercial and industrial applications such as automotive, buildings and infrastructure, and mechanical equipment. Just five facilities generate more than 0.9 Mt CO_2 annually, which together account for 91% of Canada's total steel sector CO_2 emissions of 15 Mt (Environment and Climate Change Canada, 2024a; Khan et al., 2023). A large portion of these emissions are concentrated in Ontario (Stelco [Lake Erie], Algoma [Sault Ste. Marie] and ArcelorMittal [Hamilton]). Canada's carbon intensity is about 1.2 tCO_2 per tonne of crude steel, compared to the United States at just under 1 tCO_2 per tonne (Hasanbeigi, 2022).

In the past decade, Canada has consistently exported approximately 50% of its iron and steel production. The steel trade between the United States, Canada, and Mexico is particularly strong. The United States is the largest importer of Canadian steel, with Mexico a distant second (International Trade Administration, 2020). In 2023, 88% of Canada's iron and steel exports went to the United States (Innovation, Science and Economic Development Canada, n.d.). Canada and Mexico are also the largest buyers of American steel by a wide margin. There has been a history of trade disputes between the United States and Canada, such as Canada's objection to the U.S.'s 25% steel import duties in 2018, which Canada argued violated the WTO's General Agreement on Tariffs and Trade (GATT).

The iron and steel sector primarily emits carbon through the use of coking as a reductant in blast furnaces. There has been progress in transitioning from blast furnace-basic oxygen furnace processes to electric arc furnaces coupled with direct reduced iron (DRI) and shutting down coke ovens. Many promising decarbonization technologies, such as fluidized bed hydrogen DRI or aqueous or molten oxide electrolysis followed by an electric arc furnace, are still in the early stages of development and application in the iron and steel sector. Using hydrogen in direct reduction would see even more emission reductions (International Energy Agency [IEA], 2020).

The Government of Canada has made significant federal investments to support the iron and steel sector's decarbonization efforts. In 2021, Innovation, Science and Economic Development Canada announced CAD 400 million for ArcelorMittal's Dofasco plant and CAD 200 million for Algoma Sault Ste. Marie plant (Government of Canada, 2021; Innovation, Science and Economic Development Canada, 2021). Both hydrogen-ready DRI conversion projects are located in Ontario and are expected to cut emissions by 6 million tonnes, or 40% of the iron and steel sector's total (Government of Canada, 2021). These two projects alone will come close to achieving the sector's Emissions Reduction Plan 2030 objectives. These types of megatonne-scale projects have the potential to disrupt credit supply balances in LETS over the short term.

Large subsidies, combined with import tariffs (such as those on steel imports from China) work together to lessen competitiveness pressures. Given this policy interaction, LETS needs to adjust their rules to maintain effectiveness. Without adjustments to performance standards and tightening, there's a risk that too many credits could flood the market, making the headline carbon price less effective in driving down emissions and undermining the system's overall integrity.

4.2 Pulp and Paper

The global pulp and paper industry is seeing a shift in terms of the countries that are major producers. Pulp and paper exports from North America have declined, with countries in the southern hemisphere, particularly Brazil, steadily increasing their production. As of 2020, the world's largest pulp producers are the United States (27% of global production), Brazil (11%), and Canada (8%). The largest producers of paper are China (29%), the United States (17%), and Japan (6%) (Government of Brazil, 2022).

There are approximately 96 active pulp and paper facilities in Canada, mainly in British Columbia, Alberta, Ontario, and Quebec (Environment and Climate Change Canada, 2024b). These facilities include chemical and mechanical pulp, newsprint, paper, and paperboard mills, which produce a mix of products. The sector is responsible for an estimated 4.9 Mt of CO_2 emissions/year in Canada, with the major emissions sources in British Columbia (pulp and paper), north-central Alberta (chemical pulp mills), Ontario, southern-central Quebec (papermaking), and the Maritimes (Environment and Climate Change Canada, n.d.). Canada's carbon intensity of paper products is similar to that of the United States (Rorke & Bertelsen, 2020).

Canada's exports of pulp have remained relatively constant, but its exports of paper have declined (Statistics Canada, n.d.). In 2022, 67% of domestic paper production was exported (United Nations Economic Commission for Europe, 2023). In the last 5 years, Canada's main export markets for pulp have been the United States and China (Innovation, Science and Economic Development Canada, n.d.). The United States is the largest market; in 2023, 66% of Canada's pulp and paper exports went to the United States, totalling CAD 9.2 billion (Innovation, Science and Economic Development Canada, n.d.). U.S. exports of pulp and paper to Canada amounted to USD 5.81 billion in 2023 (Trading Economics, 2024). Again, there have previously been trade disputes between the two countries regarding inputs to pulp and paper production, notably over U.S. countervailing duties on Canadian softwood lumber. August 2024 saw an increase in U.S. countervailing and anti-dumping duties on most Canadian softwood lumber, rising from 8.05% to 14.54% (Jones, 2024).

By far the largest source of remaining emissions has to do with the operation of chemical pulp mills (21 reporting mills at 2.6 Mt of emissions in 2022, or 53% of sector emissions), and, in particular, lime kiln operation, which requires a great deal of heat (Government of Canada, 2024).

The main options for decarbonizing the sector include lime kiln fuel switching from natural gas and fuel oil to biomass-sourced syngas (IEA, 2023a). Although Sweden has shown tremendous success with decarbonizing its pulp and paper sector through bioenergy, adopting similar measures in Canadian mills may be challenging.[3] Currently, six Swedish mills use solid or gasified biomass from their feedstock as the primary fuel in lime kilns (Energiforsk, 2022). Sourcing enough biomass feedstock is one challenge facing Canadian pulp and paper producers. Moreover, retrofitting Canadian facilities for switched fuels could be prohibitively expensive. For instance, upgrading a CAD 5 million lime kiln to run on syngas might require a CAD 40 million investment (Industry representative, personal communication, May 2024).

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3 Since the 1970s, Sweden has actively pursued bioenergy research and biorefinery advancements, supported by policies such as a high carbon tax (amongst the highest in the world), tax exemptions for biofuels (for transport) and a national bioeconomy strategy to diversify energy sources (Mossberg & Erikson, 2020). Swedish mills that have switched to biofuels benefit from high production volumes, which provide ample feedstock that can be used as biofuel for the lime kilns (Energiforsk, 2022). Furthermore, Sweden's access to the North Sea facilitates effective carbon sequestration for mills, a resource not available to Canadian mills (IEA Bioenergy, 2021). Mills have also benefited from large amounts of financial support from the European Investment Bank, sometimes up to 40% of the total modernization and/or decarbonization costs (European Investment Bank, n.d.).

4.3 Nitrogenous Fertilizers

In 2022, Canada was the world's ninth largest ammonia producer (a foundational ingredient for nitrogenous fertilizers), producing 4.4 Mt, equivalent to 2.4% of total world production (International Fertilizer Association, 2024). In comparison, the top five ammonia-producing countries are China (54.7 Mt), Russia (16.9 Mt), the United States (16.8 Mt), India (16.6 Mt), and Indonesia (7.2 Mt) (International Fertilizer Association, 2024). Demand for nitrogenous fertilizers is projected to rise until 2030.

Canada has nine major nitrogen fertilizer production facilities, primarily in Alberta, with many operating for over 30 years (Environment and Climate Change Canada, 2024b). Each facility produces a diverse mix of nitrogen fertilizers. Emissions from the sector have remained relatively stable at around 6.1 Mt CO_2 per year over the past two decades (Environment and Climate Change Canada, 2024a). Canada's ammonia production has an emission intensity of 1.99 t CO_2 per tonne, comparable to the U.S.'s emission intensity of 1.98 t CO_2 per tonne (Vidovic et al., 2023).

Canadian producers of nitrogenous fertilizers export about 35% of total production [by volume] (Fertilizer Canada, 2023). Nearly all of Canada's nitrogenous fertilizer exports go to the U.S. (99.6%) (Innovation, Science and Economic Development Canada, n.d.). Canadian imports of nitrogenous fertilizers also come primarily from the United States, with exports to Canada making up 42% of total U.S. exports (United States International Trade Commission, n.d.). There have been no significant trade disputes between Canada and the United States in this sector.

The nitrogenous fertilizer sector has two main sources of emissions: combustion and process emissions. The sector is already capturing a significant portion of process emissions (61%) for other uses, such as urea production, use in greenhouses, and feeding into the Alberta Carbon Trunk Line (Fertilizer Canada, 2023). Adding carbon capture and storage (CCS) could cut remaining process emissions by up to 60%, as seen at Nutrien's Redwater facility, while the use of low-carbon hydrogen offers further reduction by removing natural gas as a feedstock in producing ammonia (CF, 2024a; Nutrien, 2024). Electrifying industrial heating and lowering the carbon footprint of electricity are also important pathways to decarbonization, as is the use of green hydrogen as an alternate feedstock. However, decarbonizing the nitrogenous fertilizer sector is challenging. The cost of converting to hydrogen feedstocks is high; there is no security of supply for low-carbon hydrogen or, often, low-carbon electricity; and the use of CCS demands facilities be near suitable storage sites, which are not evenly available across regions (IEA, 2021).

4.4 Basic Chemicals

Canada's basic chemical sector is made up of facilities involved in manufacturing petrochemicals from petroleum feedstocks and creating various organic and inorganic chemicals from industrial gas. The sector represents 3.3% of the global market, with China dominating at 40% for chemicals broadly, though primarily due to its leading role in basic chemicals (Atkinson, 2024; Chemistry Industry Association of Canada, 2023). Other major producers in order include the EU, the United States, and Japan. With global demand for ethylene, hydrogen, methanol, and sulfuric acid projected to rise through 2030, Canadian producers have opportunities to expand output and capture a larger market share (Bogdanova, 2024; DataBridge Market Research, 2024; Future Market Insights, 2023; Globe Newswire, 2023; PricewaterhouseCoopers, 2024; Research and Markets, 2024; ResearchDive, 2022; The Brainy Insights, 2021).

Canada has 54 large basic chemical manufacturing facilities, primarily located in Ontario (22), Alberta (15), and Quebec (11) (Environment and Climate Change Canada, 2024b). These facilities vary greatly in age, with both long-established plants and newer ones that have recently started or are planned to start soon to address growing demand for emerging chemicals like green hydrogen. The top 10 basic chemical sector facilities emitted 9.1 $MtCO_2$ in 2022 (Environmental and Climate Change Canada, 2024a). Four of the 10 produce ethylene and ethylene derivatives and three, owned by the same parent company, produce hydrogen. Broadly, Canada's chemical sector has been assessed as more carbon-intensive than that of the United States (Rorke & Bertelsen, 2020).

Exports in 2021 represented 74 % of Canadian production (by volume) in the basic chemical sector (Chemistry Industry Association of Canada, 2022). Almost three-quarters (72%) of Canada's basic chemical exports go to the United States, making it the primary destination (Innovation, Science and Economic Development Canada, n.d.). The United States is Canada's top supplier of basic chemicals, providing 47% of Canada's imports, while the Canadian market absorbs 11% of all U.S. basic chemical exports (Statistics Canada, n.d.; United States International Trade Commission, n.d.). The share of U.S. exports destined for Canada has been growing steadily since 2019, highlighting the strong trade relationship between the two countries in the chemical sector (Statistics Canada, n.d.).

The basic chemical sector could significantly reduce emissions by targeting combustion emissions, which are produced by burning fossil fuels to generate heat for chemical processes. In 2022, combustion emissions accounted for 83% of the sector's direct emissions, while process emissions were responsible for 9.2% (Environment and Climate Change Canada, 2024a). Decarbonization strategies include electrification (e.g., high-temperature thermal energy storage), waste-to-energy, fuel switching, and small modular reactors, many of which have been adopted in other sectors but not yet in the basic chemical sector (Innovation, Science and Economic Development Canada, 2018). It is also important to note that achieving emissions reductions is 15%–20% cheaper at new facilities compared to existing ones, and upfront capital costs in this sector are high (Industry expert, personal communication, 2024). This makes it hard to consider upgrading existing plants to lower-emission technologies outside of the usual investment cycle.

FIVE

Sector-Specific Policy Recommendations

5.1 Iron and Steel

The iron and steel sector, more than any other, faces serious challenges of competitiveness under the announced policies scenario, in large part due to many years of increasing Chinese over-capacity and the spillover effects in global markets. Given its vulnerability, we found that **this sector needs policies to protect against leakage and competitiveness impacts**, though Canada's recently announced tariffs on Chinese steel imports will reduce the pressure.

In the medium term, Canada should pursue product emissions-intensity standards for iron and steel. This sector has seen much more activity than any other in terms of identifying suitable global sustainability standards, which is a prerequisite to a standards approach. The United States and the EU are also formally in the process of negotiating an agreement on sustainably produced steel and aluminum (though progress is reportedly stalled), and they have shown a willingness to have other parties join.

5.2 Pulp and Paper

In the medium term, Canada should work toward a product emissions-intensity standard with the United States in pulp and paper. U.S. and Canadian GHG intensities are similar in this sector and are lower than other major global producers.

This sector's decarbonization pathways are challenging. They depend on technologies that lack an operating history in mills like those found in Canada (e.g., use of high-temperature industrial heat pumps) or have yet to scale (e.g., biomass coupled with CCS to create syngas). Unlike the other sectors we examined, there are many producers, and they are mid-sized to small. In some cases, the costs of decarbonizing facilities would be multiples of the value of existing capital stock, and this is a sector with relatively low levels of investment. Moreover, global market prospects for paper are not trending well, and though prospects for pulp seem strong, there is growing competition from temperate producers. Given that context, perhaps more than any other sector, pulp and paper critically needs a sectoral carbon competitiveness strategy (as recommended below for all sectors) to define what types of support are most appropriate.

5.3 Nitrogenous Fertilizers

Leakage risk from nitrogenous fertilizers is manageable with LETS for the foreseeable future. Seven of the nine facilities in Canada are located in Alberta and Saskatchewan, where emissions from fertilizer comprise a relatively small share of total emissions in the industrial pricing systems of these two provinces. Consequently, adjusting performance standards to keep average costs manageable is a robust medium-term solution.

Canada should work toward a set of emissions-intensity standards in the medium term. U.S.-Canadian cooperation is possible and helped by the fact that the two countries' average GHG intensity is similar in this sector and lower than other major global producers.

5.4 Basic Chemicals

Basic chemicals are the most diverse and heterogeneous of any heavy industry covered by industrial pricing, with many distinct end products; major production is spread between Alberta, Ontario, and Quebec and among facilities of vastly different ages, sizes, and emissions profiles. To an even greater extent than the other sectors analyzed, a one-size-fits-all policy approach is insufficient to protect the sector's carbon competitiveness.

BCA and product emissions-intensity standards are not good near-term options. They would be technically challenging to implement for basic chemicals, more so than other sectors, for two reasons. First, the downstream sector is extremely complex, with thousands of goods, and it would be difficult to decide at what point downstream to stop coverage. Second, many facilities produce more than one good, and it would be methodologically difficult to split up the total facility emissions and attribute them to the various goods. These are not insurmountable challenges, but they mean that these policy options are probably not available in the near term to address competitiveness and leakage impacts.

As such, **it is critical that LETS be employed in this sector in ways that both drive emissions reductions and protect against leakage**, at least in the near term.

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Conclusions and Other Cross-Cutting Recommendations

This report has focused on the four sectors that our previous report identified as at the most risk of leakage and competitiveness impacts. To identify policy solutions, we surveyed three policies that might be able to address those risks: adjustment of performance standards under LETS, BCA, and product emissions-intensity standards. We also explored each of the sectors in detail—an exercise that confirmed for us the imperative of tailored approaches to address carbon competitiveness in Canada's industrial sectors.

Our analysis allowed us to make sector-specific recommendations, summarized above. It also yielded conclusions that are valid across all four sectors (as well as being relevant to those sectors on which we did not focus in this report):

1. **OBAs are the best policy option in the short term; other instruments may be needed in the medium term**. The cost pressures facing all of the sectors are material enough to merit an anti-leakage policy in the short and long term. In the short term, adjustment of performance standards within LETS is likely to be the tool of choice because it is already in place, whereas a BCA or product emissions-intensity standard will take years to develop and implement (longer in some cases than in others). However, LETS require a careful balance that becomes more difficult as firms decarbonize in the longer term. Performance standards might need to be tightened to maintain carbon credit prices, increasing risk of leakage, though that might be offset by falling costs of compliance as emissions drop and technology becomes cheaper. The risk of leakage inherent in that dynamic makes it prudent to explore other instruments, especially since policy-makers tend to be risk averse when it comes to leakage and loss of competitiveness.

2. **BCA and product emissions-intensity standards should be explored as medium-term options, but they present challenges**. All of these sectors export an atypically large share of their production, meaning that a BCA on imports alone is insufficient to address leakage that would be experienced in global markets. However, rebating carbon costs at the point of export (the export coverage BCA model) may be illegal under international trade rules, might spark countervailing duties, and could incentivize high-carbon production for export. BCA enacted unilaterally would likely cause diplomatic friction with the United States, so a cooperative model should be explored. Product emissions-intensity standards offer the advantage of being less distasteful for the United States, as they don't require a domestic carbon price, but negotiation would likely be difficult and prolonged.

3. **U.S. cooperation is essential over the medium term:** All four sectors are highly integrated across the Canada-U.S. border—with significant trade flows in both directions—which makes it challenging to impose a BCA or product emissions-intensity standard unilaterally without risking a damaging U.S. response. Instead, a cooperative Canada-U.S. BCA or emissions-intensity standards regime is the only one that appears practical. As well, to be effective, any product emissions-intensity standard would need to be operated cooperatively with key Canadian export markets such as the United States in order to lower (but not eliminate) the risk of leakage in foreign markets.

Based on our findings and analysis, we make the following recommendations to the federal government. To be clear, while these recommendations are drawn from our assessment of the four most vulnerable industrial sectors in Canada, they are applicable to other industrial sectors as well, in particular, those we assessed in our first report.

1. **Create a high-level task force on carbon competitiveness with a focus on coordination with the United States:** Canada needs a high-profile body within government to study and address issues of carbon competitiveness, similar to the recent Climate and Trade Task Force announced by the United States. This body would coordinate competitiveness analysis and policy response in partnership with domestic stakeholders (see the roadmaps recommendation below), while also being the key interface between Canada and international allies in an effort to coordinate competitiveness responses. A key focus of this body would be coordination with the United States on potential BCA or product emissions-intensity standards for at-risk sectors. We imagine the body would include representatives from key departments such as Privy Council Office, Global Affairs, Environment and Climate Change, Natural Resources, Industry, and Finance. It should also establish a private sector advisory council to ensure it is closely connected with non-governmental stakeholders including industry, labour groups, civil society, and Indigenous communities.

2. **Use the G7 Presidency in 2025 to advance discussions on cooperative BCAs and emissions-intensity standards (i.e., climate clubs):** Canada will take over the Presidency of the G7 next year and can use its influence to advance ongoing initiatives on these key carbon competitiveness topics including through the existing G7+ Climate Club and the industrial decarbonization agenda.

3. **Work in partnership with provinces to ensure adjustments of LETS performance standards for high-risk sectors go hand-in-hand with strengthened carbon market systems:** As the federal government and provincial and territorial governments work on the rules for carbon regimes post 2027 (the next phase of carbon pricing), the federal government can set a helpful precedent by designing its LETS system to appropriately accommodate high-risk sectors with OBAs while still ensuring that stringency in the rest of the system is sufficiently strong to keep the market in balance. It can similarly offer advice to provinces and territories on ways to assess the appropriate stringency level for sectors at high risk of leakage. There are additional important measures for the federal and provincial governments to take as part of a carbon market review, but those are outside the scope of this paper.

4. **Facilitate sector-by-sector decarbonization roadmaps** in partnership with key stakeholders: As our analysis has shown, each sector's competitiveness and decarbonization needs are different, and each requires a tailored plan that includes—and goes beyond—leakage prevention. Decarbonizing investment is dependent on sectorally appropriate leakage prevention tools but also on ensuring firms can access inputs such as low-carbon electricity and low-carbon hydrogen, as well as on policies such as green government procurement to create lead markets. The federal government should coordinate with other levels of government, the private sector, Indigenous Peoples, academia, and civil society to create roadmaps that identify the pathways forward for each sector and the policies needed to get there. Several other groups have called for similar roadmaps.

We cannot stress strongly enough that government should act quickly. These sectors and others are already being buffeted by a maelstrom of dynamic global forces and are making investment decisions now that will have significant impacts on Canada's emissions and economy. They need long-term assurances that Canadian policy-makers will find ways to avoid the economic impacts of loss of competitiveness and set them up to be able to attract significant investment and take advantage of growing green market opportunities.

References

Agriculture and Agri-Food Canada. (2021). *Nitrogen indicator*. https://agriculture.canada.ca/en/agricultural-production/water/nitrogen-indicator

Alberta Pacific. (n.d.). *Our roots*. https://alpac.ca/our-roots/

Aldy, J. E. (2015). Pricing climate risk mitigation. *Nature Climate Change, 5*(5), 396–398. https://econpapers.repec.org/scripts/redir.pf?u=http%3A%2F%2Fdash.harvard.edu%2Fbitstream%2Fhandle%2F1%2F21150339%2FAldy%2520Pricing_climate_risk.pdf;h=repec:hrv:hksfac:21150339

Allan, B. & Bernstein, M. (2023). *Creating a Canadian advantage: Policies to help Canada compete for low-carbon investment*. Clean Prosperity and the Transition Accelerator. https://cleanprosperity.ca/new-data-shows-what-canada-can-do-to-compete-for-low-carbon-investment-feb23/

Atkinson, R. (2024). *How innovative is China in the chemicals industry?* Information Technology and Innovation Foundation. https://itif.org/publications/2024/04/15/how-innovative-is-china-in-the-chemicals-industry/

Arcelor Mittal. (2022). *ArcelorMittal successfully tests partial replacement of natural gas with green hydrogen to produce DRI* [Press release]. https://corporate.arcelormittal.com/media/news-articles/arcelormittal-successfully-tests-partial-replacement-of-natural-gas-with-green-hydrogen-to-produce-dri#

Bastani, S. (2023). *The marginal cost of public funds: A brief guide*. CESifo. https://www.cesifo.org/DocDL/cesifo1_wp10322.pdf

Bataille, C., Steibert, S., & Li, G.N. (2024). *Facility level global net-zero pathways under varying trade and geopolitical scenarios*. https://netzeroindustry.org/wp-content/uploads/pdf/net_zero_steel_report_ii.pdf

Beale, E., Boothe, P., Cappe, M., Dahlby, B., Drummond, D., Elgie, S., Hodgson, G., Leroux, J., Lipsey, R., Olewiler, Ragan, C., N., St-Hilaire, F., & Tedds, L. (2019). *Bridging the gap: Real options for meeting Canada's 2030 GHG target*. Ecofiscal Commission. https://ecofiscal.ca/reports/bridging-gap-real-options-meeting-canadas-2030-ghg-target/

Beugin, D., Kanduth, A. Sawyer, D., & Smith, R. (2024). *Which Canadian climate policies will have the biggest impact by 2030?* Canadian Climate Institute. https://440megatonnes.ca/insight/industrial-carbon-pricing-systems-driver-emissions-reductions/

Bogdanova, K. (2024, May 30). *Five things investors should know about hydrogen's global potential*. RBC Wealth Management. https://www.rbcwealthmanagement.com/en-ca/insights/five-things-investors-should-know-about-hydrogens-global-potential

Böhringer, C., Fischer, C., Rivers, N. (2023). Intensity-based rebating of emissions pricing revenues. *Journal of the Association of Environmental and Resource Economists, 10*(4). https://doi.org/10.1086/723645

Cosbey, A., Bernstein, M. & Stiebert, S. (2021). *Enabling climate ambition: Border carbon adjustment in Canada and abroad*. International Institute for Sustainable Development. https://www.iisd.org/publications/enabling-climate-ambition-border-carbon-adjustment-canada.

CF Industries. (2022, February 18). *Key questions about fertilizer and its price answered*. https://www.cfindustries.com/newsroom/2022/fertilizerpricefaq

CF Industries. (2024a). *Carbon capture & sequestration: The safe, proven pathway to rapid reduction of CO_2 emissions*. https://www.cfindustries.com/globalassets/cf-industries/media/documents/ccs-factsheet.pdf

CF Industries. (2024b). *CF Industries signs engineering and procurement contract with thyssenkrupp for green ammonia project* [Press release]. https://www.cfindustries.com/newsroom/2021/donaldsonville-electrolyzer

Chartech. (2023). *C$6.6M Strategic Investment by ArcelorMittal and Annual Biocarbon Purchase Agreement* [Press release]. https://www.chartechnologies.com/post/char-technologies-announces-c-6-6m-strategic-investment-by-arcelormittal-and-annual-biocarbon-pur

Cheminfo Services Inc. (2019). *Economic assessment of the integrated steel industry final report*. Report submitted to the Canadian Steel Producers Association. https://canadiansteel.ca/files/resources/Final-Report-Economic-Assessment-of-the-Integrated-Steel-Industry.pdf

Chemistry Industry Association of Canada. (2022). *2022 economic outlook for industrial chemicals*. https://canadianchemistry.ca/wp-content/uploads/2022/01/2022-Outlook-for-Industrial-Chemicals.pdf

Chemistry Industry Association of Canada. (2023). *2023 economic outlook for industrial chemicals*. https://canadianchemistry.ca/wp-content/uploads/2023/02/2023-Outlook-for-Industrial-Chemicals-FINAL.pdf.

Climate Leadership Council. (2020). *America's carbon advantage*. https://clcouncil.org/reports/americas-carbon-advantage.pdf

Confederation of European Paper Industries. (2023). *A collaboration between the paper industry & heat pump producers could halve its energy needs & help decarbonise the sector* [Press release]. https://www.cepi.org/press-release-a-collaboration-between-the-paper-industry-heat-pump-producers-could-halve-its-energy-needs-help-decarbonise-the-sector/

DataBridge Market Research. (2024). *Methanol market size, demand insights, outlook & forecast by 2031*. https://www.databridgemarketresearch.com/reports/global-methanol-market

Delphi & Forest Products Association of Canada. (2023). C*limate change mitigation in Canada's forest products sector: Roadmap toward net-zero*. https://www.fpac.ca/reports/climate-change-mitigation-in-canadas-forest-products-sector-roadmap-toward-net-zero

Dion, J. (2017). *Explaining output-based allocations (OBAs)*. Ecofiscal Commission. https://ecofiscal.ca/2017/05/24/explaining-output-based-allocations-obas/

Dion, J. (2019). *Introducing TIER – Alberta's new approach to pricing industrial GHG emissions*. Ecofiscal Commission. https://ecofiscal.ca/2019/10/30/introducing-tier/

Dizon, E. & Bishop, G. (2024). *Strengthening TIER for Alberta's low-carbon growth: Measuring credit oversupply risks in Alberta's carbon market*. Clean Prosperity. https://cleanprosperity.ca/wp-content/uploads/2024/07/Strengthening-TIER-for-Albertas-Low-Carbon-Growth.pdf

Dobson, S., Fellows, G., Tombe, T., Winter, J. (2017). *The ground rules for effective OBAs: Principles for addressing carbon-pricing competitiveness concerns through the use of output-based allocations*. The School of Public Policy Publications. https://www.policyschool.ca/wp-content/uploads/2017/06/Effective-OBAs-Dobson-Fellows-Tombe-Winter.pdf

Domtar. (2021). *Biomass from wood byproducts fuels mills with renewable energy*. https://newsroom.domtar.com/fueling-mills-renewable-energy/

Edenhofer, O., Jakob, M., Creutzig, F., Flachsland, C., Fuss, S., Kowarsch, M., Lessmann, K., Mattauch, K., Siegmeier, J., & Steckel, J. C. (2015). Closing the emission price gap. *Global Environmental Change, 31*, 132–143. https://www.mcc-berlin.net/~creutzig/EdenhoferJakob2015.pdf

Energiforsk. (2022). *Biofuels in lime kilns*. https://energiforsk.se/media/30995/biofuels-in-lime-kilns-energiforskrapport-2022-847.pdf

Environment and Climate Change Canada. (2024a). *National inventory report, 1990-2022: Greenhouse gas sources and sinks in Canada*. https://publications.gc.ca/collections/collection_2024/eccc/En81-4-2022-1-eng.pdfhttps://publications.gc.ca/collections/collection_2024/eccc/En81-4-2022-1-eng.pdf

Environment and Climate Change Canada. (2024b). *Greenhouse gas reporting program (GHGRP)—Facility greenhouse gas (GHG) data*. https://data-donnees.az.ec.gc.ca/data/substances/monitor/greenhouse-gas-reporting-program-ghgrp-facility-greenhouse-gas-ghg-data/

Espa, I., Francois, J., & van Asselt, H. (2022, November). *The EU Proposal for a Carbon Border Adjustment Mechanism (CBAM): An analysis under WTO and climate change law* (Vol. 06/2022). World Trade Institute. https://www.wti.org/research/publications/1375/the-eu-proposal-for-a-carbon-border-adjustment-mechanism-cbam-an-analysis-under-wto-and-climate-change-law/

European Chemical Industry Council. (2023). *Facts and figures 2023*. https://cefic.org/app/uploads/2023/12/2023_Facts_and_Figures_The_Leaflet.pdf

European Investment Bank. (n.d). *All projects*. https://www.eib.org/en/projects/all/

Felder, M., Hervas, A., & Noyahr, C. (2024). *Evaluation of carbon capture and storage potential in Canada*. Clean Prosperity. https://cleanprosperity.ca/wp-content/uploads/2024/04/Evaluation_of_carbon_capture_and_storage_potential_in_Canada.pdf

Fellows, K., & Tombe, T. (2023). *Indirect carbon tax costs reduced by policy design*. The School of Public Policy. https://www.policyschool.ca/wp-content/uploads/2023/04/EE-Policy-Trends-April.pdf

Fertilizer Canada. (2023). *Technology roadmap study report: GHG emissions reductions in the Canadian fertilizer production sector*. https://fertilizercanada.ca/wp-content/uploads/2023/10/Technology-Roadmap-Study-Final.pdf

Fischer, C., & Fox, A. K. (2007). Output-based allocation of emissions permits for mitigating tax and trade interactions. *Land Economics, 83*(4), 575–599.

Future Market Insights. (2023). *Sulfuric acid market*. https://www.futuremarketinsights.com/reports/sulfuric-acid-market

Globe Newswire. (2023, March 13). *Sulfuric acid market size ($ 29.4 billion by 2032 at 8.3% CAGR) global analysis by Market.us*. GlobeNewswire. https://www.globenewswire.com/en/news-release/2023/03/13/2625518/0/en/Sulfuric-Acid-Market-Size-29-4-Billion-by-2032-at-8-3-CAGR-Global-Analysis-by-Market-us.html

Government of Alberta. (2023). *TIER regulation fact sheet*. https://www.alberta.ca/system/files/custom_downloaded_images/ep-fact-sheet-tier-regulation.pdf

Government of Canada. (n.d.). *Bioenergy from biomass*. https://natural-resources.canada.ca/our-natural-resources/forests/industry-and-trade/forest-bioeconomy-bioenergy-bioproducts/bioenergy-biomass/13323

Government of Canada. (n.d.). *What are the clean fuel regulations?* https://www.canada.ca/en/environment-climate-change/services/managing-pollution/energy-production/fuel-regulations/clean-fuel-regulations/about.html

Government of Canada. (2018). *Canada stands up for our steel and aluminum workers and industry*. https://www.canada.ca/en/global-affairs/news/2018/06/canada-stands-up-for-our-steel-and-aluminum-workers-and-industry.html

Government of Canada. (2021). *Grants and contributions: Algoma Steel EAF transformation*. https://search.open.canada.ca/grants/record/ic,230-2021-2022-Q2-0241,current

Government of Canada. (2023). *Industrial summary - Paper manufacturing*. https://occupations.esdc.gc.ca/sppc-cops/l.3bd.2t.1ils@-eng.jsp?lid=34

Government of Canada. (2024). *Interactive indicator maps*. https://indicators-map.canada.ca/

Hasanbeigi, A. (2022). *Steel climate impact: An international benchmarking of energy and CO_2 intensities*. Global Efficiency Intelligence. https://www.globalefficiencyintel.com/steel-climate-impact-international-benchmarking-energy-co2-intensities

Innovation, Science and Economic Development Canada. (n.d.). *Trade data online*. https://ised-isde.canada.ca/site/trade-data-online/en

Innovation, Science and Economic Development Canada. (2018, January 23). *Technology readiness levels*. https://ised-isde.canada.ca/site/innovation-canada/en/technology-readiness-levels

Innovation, Science and Economic Development Canada. (2021). *Government investing in Hamilton's steel industry to support good jobs and significantly reduce emissions*. https://www.canada.ca/en/innovation-science-economic-development/news/2021/07/government-investing-in-hamiltons-steel-industry-to-support-good-jobs-and-significantly-reduce-emissions.html

International Energy Agency. (2020). *Iron and Steel Technology Roadmap*. https://www.iea.org/reports/iron-and-steel-technology-roadmap

International Energy Agency. (2021). *Ammonia technology roadmap*. https://www.iea.org/reports/ammonia-technology-roadmap

International Energy Agency. (2022). *Pulp and paper industry in Brazil and in the world*. https://www.epe.gov.br/sites-en/publicacoes-dados-abertos/publicacoes/PublicacoesArquivos/publicacao-234/Pulp%20and%20paper_EPE+IEA_ENGLISH_2022_01_25_IBA.pdf

International Energy Agency. (2023a). *Tracking pulp and paper*. https://www.iea.org/energy-system/industry/paper

International Energy Agency. (2023b). *Tracking chemicals*. https://www.iea.org/energy-system/industry/chemicals

International Energy Agency Bioenergy. (2021). *Country reports: Implementation of bioenergy in Sweden – 2021 update*. https://www.ieabioenergy.com/wp-content/uploads/2021/11/CountryReport2021_Sweden_final.pdf

International Fertilizer Association. (2024). *World ammonia production by country* [dataset].

International Trade Administration. (2020). *Steel exports report: Canada*. Global Steel Trade Monitor. https://legacy.trade.gov/steel/countries/pdfs/exports-Canada.pdf

Jones, J. (2024). Ottawa, B.C. criticize increased U.S. duties on softwood lumber. *Globe and Mail*. https://www.theglobeandmail.com/business/article-ottawa-bc-criticize-increased-us-duties-on-softwood-lumber/

Khan, M.A., Powell, M., Tampier, M., Thorn, E. and Layzell, D. (2023). Hydrogen and the decarbonization of steel production in Canada: Reaching economies of scale. *Transition Accelerator Reports, 5*(2), 1–145. https://transitionaccelerator.ca/wp-content/uploads/2023/09/hydrogen-and-the-decarbonization-of-steel-production-in-Canada-v2.pdf

Kotlikoff, L. J., Kubler, F., Polbin, A. & Scheidegger, S. (2020). *Pareto-improving carbon-risk taxation* [NBER working paper series]. https://www.nber.org/system/files/working_papers/w26919/w26919.pdf

Leal-Arcas, R., Faktaufon, M., & Kyprianou, A. (2022). A legal exploration of the European Union's Carbon Border Adjustment Mechanism. *European Energy and Environmental Law Review, 31*(4). https://kluwerlawonline.com/api/Product/CitationPDFURL?file=Journals\EELR\EELR2022016.pdf

Ministry of Forest, Lands and Natural Resource Operations. (2016). B*ritish Columbia pulp and paper sector sustainability: Sector challenges and future opportunities*. https://www2.gov.bc.ca/assets/gov/farming-natural-resources-and-industry/forestry/competitive-forest-industry/pulp_and_paper_sept_2016.pdf

Monahan, K., & Beck, M. (2023). *Hydrogen tax credits in the U.S. Inflation Reduction Act*. Canadian Climate Institute. https://climateinstitute.ca/publications/hydrogen-tax-credits-in-the-u-s-inflation-reduction-act/

Mossberg, J., & Eriksson, L. (2020). *Country report Sweden*. IEA Bioenergy. https://task42.ieabioenergy.com/wp-content/uploads/sites/10/2020/04/IEA-Bioenergy-T42-Country-Report-Sweden-April-2020_final.pdf

Nielsen, M. (2022). *The forest lives:" Biomass plant to be known as Arbios Biotech Chuntoh Ghuna*. Prince George Citizen. https://www.princegeorgecitizen.com/local-news/name-bestowed-on-biomass-plant-5725807

Northern Ontario Business. (2023). *Paper Excellence completes acquisition of Resolute Forest Products*. https://www.northernontariobusiness.com/industry-news/forestry/paper-excellence-completes-acquisition-of-resolute-forest-products-6631067

Nutrien. (2024). *Advancing carbon solutions and reducing emissions at Redwater*. https://www.nutrien.com/what-we-do/stories/advancing-carbon-solutions-and-reducing-emissions-redwater

Paper Age. (2019). *Paper Excellence Canada closes acquisition of Catalyst Paper*. http://www.paperage.com/2019news/03_19_2019paper_excellence_catalyst_paper.html

PricewaterhouseCoopers. (2024, May 30). *Green hydrogen economy—Predicted development of tomorrow*. https://www.pwc.com/gx/en/industries/energy-utilities-resources/future-energy/green-hydrogen-cost.html

Prime Minister of Canada. (2023). *Backgrounder: Canada and the United States advance work to grow our clean economies and create good, middle-class jobs on both sides of our border*. https://www.pm.gc.ca/en/news/backgrounders/2023/03/24/backgrounder-canada-and-united-states-advance-work-grow-our-clean

Province of British Columbia. (2024). *Getting started with the B.C. output-based pricing system: Technical background and general program guidance for industrial operators*. https://www2.gov.bc.ca/assets/gov/environment/climate-change/ind/obps/guidance/bc_obps_guidance.pdf

Pulp and Paper Canada. (2010). *Kruger's biomass-to-syngas venture pays off*. https://www.pulpandpapercanada.com/kruger-s-biomass-to-syngas-venture-pays-off-1000373238/

Quirion, P. (2009). Historic versus output-based allocation of GHG tradable allowances: a comparison. *Climate Policy, 9*(6), 575–592. https://www.researchgate.net/publication/233606262_Historic_versus_output-based_allocation_of_GHG_tradable_allowances_A_comparison

Ragan, C., Beale, E., Boothe, P., Cappe, M., Dahlby, B., Drummond, D., Elgie, S., Hodgson, G., Lanoie, P., Lipsey, R., Olewiler, N., & St-Hilaire, F. (2016). *Choose wisely: Options and trade-offs in recycling carbon pricing revenues*. Ecofiscal Commission. https://ecofiscal.ca/wp-content/uploads/2016/04/Ecofiscal-Commission-Choose-Wisely-Carbon-Pricing-Revenue-Recycling-Report-April-2016.pdf

Research and Markets. (2024). *Global ethylene market (by production capacity & demand): Insights & forecast with potential impact of COVID-19 (2024-2028)*.

ResearchDive. (2022). *Methanol market size, value & trends (2022–2030)*. https://www.researchdive.com/8500/methanol-market

Reuters. (2024). *China requests consultations with Canada at WTO over tariffs*. https://www.reuters.com/world/china-says-it-submits-request-canada-wto-consultation-over-tariffs-2024-09-06/

Richardson, J. (2024, January 15). *Global ethylene capacity growth would need to be 90% lower than the ICIS base case for healthy 2024-2030 operating rates*. Asian Chemical Connections. https://www.icis.com/asian-chemical-connections/2024/01/global-ethylene-capacity-growth-would-need-to-be-90-lower-than-the-icis-base-case-for-healthy-2024-2030-operating-rates/

Rio Tinto. (2023). *Rio Tinto starts BlueSmelting demonstration plant to validate decarbonisation technology* [Press release]. https://www.riotinto.com/en/can/news/releases/2023/rio-tinto-starts-bluesmelting-demonstration-plant-to-validate-decarbonisation-technology

Rocky Mountain Carbon. (n.d.). *Rocky Mountain Carbon*. https://www.rockymountaincarbon.com/

Rorke, C., & Bertelsen, G. (2020). *America's carbon advantage*. Climate Leadership Council. https://clcouncil.org/media/2024/04/americas-carbon-advantage.pdf

Schmalensee, R., & Stavins, R. (2015). *Lessons learned from three decades of experience with cap-and-trade* (No. w21742). National Bureau of Economic Research. https://www.rff.org/publications/working-papers/lessons-learned-from-three-decades-of-experience-with-cap-and-trade/

Shawkat, A., & Cosbey, A. (2024). *A vision for international trade in CO_2-intensive materials: The role of carbon product requirements*. Agora Industry. https://www.agora-industry.org/publications/a-vision-for-international-trade-in-co2-intensive-materials

Standing Committee on Finance. (2023). *FINA Committee Meeting, February 16, 2023*. Government of Canada. https://www.ourcommons.ca/DocumentViewer/en/44-1/FINA/meeting-77/evidence

Statista. (2024). *Retail e-commerce sales worldwide from 2014 to 2027*. https://www.statista.com/statistics/379046/worldwide-retail-e-commerce-sales/

Statistics Canada. (n.d.). *Canadian international merchandise trade web application*. https://www150.statcan.gc.ca/n1/pub/71-607-x/71-607-x2021004-eng.htm

Stiglitz, J., Stern, N., Duan, H., Edenhofer, O., Giraud, G., Heal, G.M., La Rovere, E. L., Morris, A., Moyer, E., Pangestu, M., Shukla, P. R., Sokona, Y., & Winkler, H. (2017). *Report of the High-Level Commission on Carbon Prices*. https://academiccommons.columbia.edu/doi/10.7916/d8-w2nc-4103

Sunfire GmbH (2022). *Green hydrogen for green steel - Successful project completion with record production rates of highly efficient electrolyzer*. https://www.sunfire.de/en/news/detail/green-hydrogen-for-green-steel-successful-project-completion-with-record-production-rates-of-highly-efficient-electrolyzer

The Brainy Insights. (2021). *Methanol market research report*. https://www.thebrainyinsights.com/report/methanol-market-12495

Tombe, T. and Winter, J. (2023). *Carbon pricing is not to blame for Canada's affordability challenges*. Policy Options. https://policyoptions.irpp.org/magazines/december-2023/carbon-price-affordability/

Trading Economics. (2024). U*nited States imports from Canada of paper and paperboard, articles of pulp, paper and board*. https://tradingeconomics.com/united-states/imports/canada/paper-paperboard-articles-pulp-paper-board

Tvinnereim, E., & Mehling, M. (2018). Carbon pricing and deep decarbonisation. *Energy Policy, 121*, 185–189. https://doi.org/10.1016/j.enpol.2018.06.020

United Nations Economic Commission for Europe. (2023). *Forest products annual market review 2022-2023*. https://unece.org/forests/publications/forest-products-annual-market-review-2022-2023

United States Department of Commerce. (2020, December 7). *Issues and decision memorandum for the final affirmative determination of the countervailing duty investigation of forged steel fluid end blocks from the Federal Republic of Germany* [Memorandum]. https://access.trade.gov/Resources/frn/summary/germany/2020-27335-1.pdf

United States International Trade Commission. (n.d.) *DataWeb*. Retrieved May 15, 2024, from https://dataweb.usitc.gov/

University of Oxford. (2024, June 26). *Green ammonia demonstration programme: Siemens and Professor Edman Tsang*. https://www.chem.ox.ac.uk/green-ammonia-siemens-and-prof-edman-tsang

Van den Bergh, J., & Savin, I. (2021). Impact of carbon pricing on low-carbon innovation and deep decarbonisation: controversies and path forward. *Environmental and Resource Economics, 80*(4), 705–715.

Vidovic, D., Marmier, A., Zore, L. & Moya, J. (2023). *Greenhouse gas emission intensities of the steel, fertilisers, aluminium and cement industries in the EU and its main trading partners*, Publications Office of the European Union. https://doi.org/10.2760/359533

Wang, Y., Liu, S., Liu, X., Wu, L., Wang, Q., & Ji, X. (2020). Biological pretreatment of biomass to decrease energy consumption in mechanical defiberization process. *BioRes, 15*(4). 9882–9893. https://bioresources.cnr.ncsu.edu/resources/biological-pretreatment-of-biomass-to-decrease-energy-consumption-in-mechanical-defiberization-process/

World Economic Forum. (2022). *The net-zero industry tracker*. https://www.weforum.org/publications/the-net-zero-industry-tracker/in-full/steel-industry/

World Steel Association. (2024). *World steel in figures*. https://worldsteel.org/data/world-steel-in-figures-2024/

Yankovitz, D., Hardin, K., Kumpf, R., & Christian, A. (2023). *2024 chemical industry outlook*. Deloitte Research Centre for Energy and Industrials. https://www2.deloitte.com/us/en/insights/industry/oil-and-gas/chemical-industry-outlook.html

Ye, J. (2024, April 16). *U.S. takes another important step towards improved climate and trade policy*. Center for Climate and Energy Solutions: https://www.c2es.org/2024/04/u-s-takes-another-important-step-towards-improved-climate-and-trade-policy/

Appendix A. Sectoral Deep Dives

Iron and Steel

Global Context

Iron and steel manufacturing is one of the most energy-intensive industries worldwide. The traditional use of coal as the primary fuel for iron and steel production means the sector has the highest emissions of any other global industry, at 11% of total CO_2 emissions globally (Hasanbeigi, 2022). Ironmaking in blast furnaces is by far the most energy and GHG-intensive step due to the amount and type of fuel used (largely metallurgical coal used as coke).

Worldwide, iron and steel industry production is continuing to grow and provide foundational materials for many sectors of the global economy, from building and infrastructure to automotive and metal products. Demand for iron and steel is expected only to increase with economic expansion in Southeast Asia and Africa (Bataille et al., 2024; World Economic Forum, 2022).

In recent decades, international capacity in steelmaking has ballooned, particularly in China, which has resulted in the global overproduction of steel. China has been accused of dumping steel into other markets, a practice that suppresses prices and affects steelmaker profitability. The top steel-producing countries are China, India, and Japan (World Steel Association, 2024). Of these, China produces by far the most steel at 54% of the global total or 1,019 Mt in 2023. The next highest production was by India at 140 Mt in 2023 (World Steel Association, 2024). These regions have benefited from government support. The industry in those countries also benefits from the use of lower-cost and highly emissions-intensive energy inputs like coal.

Canadian Industry Profile

Canada's industry benefits from its access to the Labrador Trough, one of the world's largest sources of iron ore, which is used to make steel, as well as access to multimodal networks and nearby markets, particularly the North American auto sector. There are 19 steel and/or iron facilities in Canada, largely situated in Ontario and Quebec (Environment and Climate Change Canada, 2024b). The major companies are all foreign-owned: ArcelorMittal with five facilities (headquartered in Luxembourg), Algoma Steel with one facility (United States), Gerdau Ameristeel with three facilities (Brazil), Stelco with two facilities (Argentina-Italy) and
Rio Tinto with one facility (United Kingdom-Australia).

In terms of emissions, this sector emitted a total of 15.2 Mt CO_2e in 2021 (Government of Canada 2024). Five facilities generate >0.9 Mt CO_2 annually that, when combined, make up 91% of steel CO_2 emissions in Canada (Government of Canada 2024). The most significant emission point sources are concentrated in Ontario and associated with the operation of blast furnaces and blast oxygen furnaces (Stelco [Lake Erie], Algoma [Sault Ste. Marie], and ArcelorMittal [Hamilton]). Smaller point sources exist near Montreal at facilities that operate direct reduced iron (DRI)/electric arc furnaces.

Canada's trade

Canada's iron and steel exports have significantly increased since 2000. From 2019 to 2023, the monthly trade value nearly doubled, from an average of CAD 660M/month to an average of CAD 1.1B/month (Statistics Canada, n.d.). The United States is the main export destination of steel from Canada (Innovation, Science and Economic Development Canada, n.d.). Total exports to the United States have increased by an average of CAD 540M/month in 2019 to an average of CAD 960M/month in 2023 (Statistics Canada, n.d.). From 2019 to January 2024, Canada also exported a total of CAD 2 billion of steel to Mexico, its next largest trade partner (Statistics Canada, n.d.). These statistics reflect the integrated nature of the iron and steel sector with auto manufacturing in North America.

The United States is the major exporter of iron and steel to Canada, accounting for 60% of Canada's total imports (Innovation, Science and Economic Development Canada, n.d.). Canada buys more American steel than any other country in the world, and in 2018 accounted for 50% of total U.S. exports (Government of Canada, 2018). Import volumes from the United States have increased from an average of CAD 500 million/month in 2019 to CAD ~790 million/month in 2023, for a total of CAD 27 billion over the last 5 years (Statistics Canada, n.d.). Canada's next largest trade partner is South Korea, with a total import volume of CAD 3.2 billion over the last 5 years, followed closely by China at CAD 3 billion over the study period (Statistics Canada, n.d.). From 2000 to 2007, Canada was generally a net importer of steel; however, this trade gap narrows after 2008 (Statistics Canada, n.d.). Imports are important to the Canadian market as they help supply the broader spectrum of steel products consumed in the country.

Decarbonization Prospects

Significant decarbonization investments have already been made in the Canadian iron and steel sector, with some support from Canadian governments. Notably, Algoma is converting its blast furnaces to DRI and ArcelorMittal is breaking ground on a hydrogen-ready DRI plant in Hamilton. These project announcements are anticipated to result in a combined emissions reduction impact of 6 million tonnes (-6 Mt), which would account for 40% of total sector emissions (Innovation, Science and Economic Development Canada, 2021). ArcelorMittal is also exploring the use of biochar in a new research arrangement with the startup CHAR Technologies (Chartech, 2023). Sorel-Tracy, Rio Tinto's ilmenite mine, has also piloted ilmenite reduction technology that cuts greenhouse gas emissions by 95% compared to traditional methods (Rio Tinto, 2023).

Despite the progress that has been made toward reducing emissions in Canada's iron and steel industry, more aggressive decarbonization pathways must be undertaken to achieve the scale of reductions required for net-zero. For Canada (and for many other jurisdictions), many of the most promising decarbonization pathways are in the early research stage or pilot or demonstration phases. For many of these applications, significant additional research is required.

Further, many of the directions (e.g., hydrogen, carbon capture, utilization, and storage [CCUS]) are dependent on new infrastructure and supply chains that are not yet in place. For example, the exploration of hydrogen at Arcelor's Contrecoeur, Quebec facility required the road transport of green hydrogen from elsewhere in the province and was only applied for a 24-hour period (ArcelorMittal, 2022). The potential use of electrolyzers to produce green hydrogen at Contrecoeur or other plants would depend on the availability of sufficient renewable electricity). ArcelorMittal's Hamilton DRI plant is planned to be hydrogen-ready; however, questions as to where and how this hydrogen is to be produced remain to be addressed. The Hamilton site does not overlay storage geology, nor is there available CCUS infrastructure that could otherwise be leveraged for blue hydrogen. Plans to build renewable-powered electrolysis plants to provide green hydrogen, as has been done by Salzgitter Flachstahl in Germany, have not been announced (Sunfire GmbH, 2022).

Decarbonizing steel production faces challenges beyond the facility level, including the availability of incentives, coordination difficulties, and import competition. First, the availability of incentives and access to low-cost, clean, and renewable electricity, like those offered in the United States, can give companies a competitive advantage in exploring green hydrogen-based DRI (Monahan & Beck, 2023). Second, achieving green steelmaking relies on various technologies—such as green and blue hydrogen, renewable electricity, biochar, and CCUS—that need the coordination of many players and entities beyond the sector itself. Lastly, the sector needs to navigate the complex challenge of tight profit margins combined with competition posed by cheaper, higher-carbon steel imports into Canada (Cheminfo Services Inc., 2019). Whether imported as a primary commodity or embedded in finished products, these cheaper imports make it difficult for firms to allocate funds to often costly decarbonization efforts.

Pulp and Paper

Global Context

The pulp and paper industry specializes in processing wood into a wide variety of pulp, paper, and paperboard products, such as newsprint, printing paper, tissue, corrugated cardboard, and more. While the energy efficiency of the sector has increased over the last few decades, largely due to the increased use of bioenergy onsite, the sector remains a large contributor of direct industrial CO_2 emissions, at 2% of the global total (International Energy Agency [IEA], 2023a).

Globally, electronic media is anticipated to continue reducing the demand for traditional paper, particularly newsprint. However, this trend is somewhat counterbalanced by the growing need for retail packaging driven by e-commerce, which supports the production of paperboard and paperboard containers (Government of Canada, 2023; Statista, 2024). This shift is reflected in production trends: while there is an overall decline in global newsprint, printing, and writing papers, there is an increase in packaging materials, recovered paper, and chemical wood pulp (IEA, 2022).

Geographically, shifts are also occurring in terms of which countries are now the major producers and consumers of pulp and paper. Pulp and paper exports have declined in North America and Europe, whereas Brazil has increased its pulp and paper production since 2016, especially in cellulose pulp (Statistics Canada, n.d.). The sector in Brazil, among other countries in the southern hemisphere, benefits from a longer growing season and a focus on fast-growing biomass supply, which is leading to increased market share (Industry expert, personal communication, 2024). The development of large new mill facilities in regions like Brazil and Scandinavia is also enabling economies of scale as well as the use of best-in-class technologies for the industries in those regions (Ministry of Forest, Lands and Natural Resource Operations, 2016). China's pulp and paper exports have grown significantly. As of 2020, the world's largest pulp producers are the United States (27% of global production), Brazil (11%), and Canada (8%). The largest producers of paper are China (29%), the United States (17%), and Japan (6%) (IEA, 2022).

Canadian Industry Profile

There are approximately 96 active pulp and paper facilities in Canada, mainly situated in British Columbia, Alberta, Ontario, and Quebec (Environment and Climate Change Canada, 2024b). Several major companies (Paper Excellence, Canfor, Cascades) dominate the industry; however, a number of smaller players remain active (n=30). The last new pulp mill in Canada was built in 1993 (Alberta Pacific, n.d.).

In recent years, there have been many pulp mill closures across Canada and relatively limited investment into the sector compared to that occurring in other countries. There also have been several acquisitions and mergers, most notably by Paper Excellence, which has acquired Domtar, Catalyst Paper, and Resolute Forest Products and is now the largest pulp mill operator and forestry company in Canada (Northern Ontario Business, 2023; Paper Age, 2019). Modernization investment has been modest in comparison with regions like Scandinavia and Brazil, where billions of dollars are being invested into building new mills and expanding capacity, including major production lines for softwood pulp, one of Canada's main exports (Ministry of Forest, Lands and Natural Resource Operations, 2016).

The pulp and paper sector is responsible for an estimated 4.9 Mt of CO_2 emissions in Canada, based on available reporting from 64 facilities (Environment and Climate Change Canada, 2024a). The major emission point sources are concentrated in British Columbia (pulp and paper), north-central Alberta (chemical pulp mills), Ontario (various mill types), southern-central Quebec (papermaking), and in the Maritimes (various mill types). By far the largest source of remaining emissions has to do with the operation of chemical pulp mills (21 reporting mills at 2.6 Mt of emissions in 2022, or 53% of sector emissions), and in particular, lime kiln operation (Environment and Climate Change Canada, 2024a).

Canada's Trade

Canada remains one of the world's top producers of bleached coniferous pulp, which is a highly valued softwood commodity (Statistics Canada, n.d.). This product is in high demand, particularly with the growth of retail packaging and hygiene products like tissue, though, as noted, other countries have been investing significantly to expand their production lines for this product. Conversely, exports of paper have fallen dramatically in the last 20 years, particularly for newsprint (Statistics Canada, n.d.). Over the last 5 years, Canada's main export markets for pulp have been the United States and China, while the main export market for paper is the United States (Statistics Canada, n.d.).

Imports of pulp have remained largely steady over the last 5 years; however, paper imports have increased, particularly for products such as hygienic tissue and corrugated material (Statistics Canada, n.d.). The main exporters of pulp to Canada are the United States and, increasingly, Brazil, which is approaching the United States in terms of value of total pulp exports to Canada (Statistics Canada, n.d.).

Decarbonization Prospects

In Canada, the sector has already gathered much of the low-hanging fruit in terms of employing cogeneration for heat and running most processes on wood, particularly for its chemical pulp mills (which mostly use thermal energy).[4] Lime kiln operation remains the largest remaining source of unabated emissions in the sector due to the use of natural gas or fuel oil. This is a difficult area to decarbonize as the kilns are used for thermochemical conversion and thus cannot easily be electrified (Industry expert, personal communication, May 2024). The main options for decarbonization[5] include the production and use of bio-based syngas or solid fuels such as sawdust. Bio-based fuels have been deployed successfully in Sweden, where six mills currently use solid or gasified biomass from their feedstock as the primary fuel in lime kilns (Energiforsk, 2022). Deploying this technology in Canada requires securing appropriate biomass feedstock supply and retrofitting plants. Canadian lime kilns tend to be older and have smaller capacity than newer best-in-class models, which greatly complicates the use of newer fuels like syngas due to capacity considerations (Industry expert, personal communication, May 2024). Further, the economics of retrofitting a CAD 5 million pulp mill with CAD 40 million gasifiers are questionable, especially given the current investment climate for this sector in Canada (Industry expert, personal communication, May 2024).

Other options proposed for chemical pulp mills include using bioenergy with carbon capture and storage (Delphi & Forest Products Association of Canada, 2023). However, the spatial location of mills does not widely coincide with identified available permanent storage geology, which brings into question the value of a widespread CCUS-focused decarbonization strategy for this sector (though this does not preclude CO_2 use other than permanent storage) (Felder et al., 2024). There have been some project announcements made around CCUS (most notably the Hinton site in Alberta), and the clustering of facilities in north-central Alberta could offer some co-location opportunities with existing carbon capture and storage infrastructure (Rocky Mountain Carbon, n.d.). In addition to CCS projects, biomass-to-biofuel conversions at Arbios Biotech's Prince George plant and syngas gasification at Kruger's New Westminster plant also highlight the sector's varied decarbonization strategies (Nielsen, 2022; Pulp and Paper Canada, 2010).[6]

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4 Despite efficiency progress to date, there may still be step changes available with bringing up facilities to best-in-class levels through modernizing mills to account for commercially available best-available technologies. For kraft pulping, options to use steam over water (steam cycle washing) can offer energy savings on the order of 30%–40%, as well as options for black liquor gasification to recover energy from the organic content, among other opportunities.

5 Some other earlier technologies applicable to chemical pulping include microwave pre-treatment to increase permeability of the wood to the chemicals, as well as utilization of green liquor, which involves pre-cooking the wood without the lime reaction. This latter opportunity can reduce the lime kiln load as well as offer energy savings of 25%.

6 Arbios Biotech's plant will use new technology to turn sawmill waste (largely bark) into renewable biocrude. This biocrude can then be refined into low-carbon fuels and chemicals as alternatives to crude oil. Kruger's New Westminster plant reduces emissions by replacing an old boiler with a new system that uses synthetic gas from wood residues, which burns more cleanly and efficiently. This upgrade significantly lowers the emissions compared to the conventional boiler that previously burned wood residues directly.

Options for mechanical pulp mills, which are net importers of electricity from the grid, include the use of combined heat and power to supply electricity on site, which would allow for the more optimal use of excess wood by-products, as well as options such as biological pre-treatment to reduce energy consumption (Domtar, 2021; Wang et al., 2020). Global demand for the products of mechanical pulp mills (newsprint) is declining, which may impact the willingness to invest. European countries are currently exploring the application of heat pumps to papermaking; it is anticipated that they will reduce the energy draw of drying by 50% (Confederation of European Paper Industries, 2023). These could be viable to explore in the Canadian context, among other options that can reduce the energy consumption involved with drying.

The international picture, taken in combination with the current state of the sector, makes for a very challenging competitive outlook in terms of decarbonization. While markets for Canadian products like northern softwood remain strong, maintaining Canada's market position will require much more effort and attention to be able to compete with the more highly capitalized industries abroad. Furthermore, the continuing trend in mill closures may foreclose some decarbonization directions that depend on a robust biomass supply chain.

Nitrogenous Fertilizers

Global Context

Nitrogen is among the most essential nutrients for plant growth, ensuring high yields, quality, disease resistance, and nutritional value of crops (Agriculture and Agrifood Canada, 2021). Nitrogen fertilizer is made by extracting nitrogen from the air and combining it with hydrogen to create ammonia. This ammonia can be directly applied to crops or used as a key ingredient in manufacturing other nitrogen-based fertilizers (Fertilizer Canada, 2023). The nitrogenous fertilizer industry has two main emission sources: the combustion emissions that result from the combustion of natural gas to produce heat for the ammonia production (Haber-Bosch) process, and industrial process emissions—a relatively pure (99%) stream of carbon dioxide that is produced by chemical reaction during the Haber-Bosch process (Fertilizer Canada, 2023).

In 2022, Canada was the ninth largest ammonia producer in the world, producing 4.4 Mt, equivalent to 2.4% of total world production (International Fertilizer Association, 2024). The top five ammonia-producing countries as a share of total world production are China (54.7 Mt), Russia (16.9 Mt), the United States (16.8 Mt), India (16.6 Mt), and Indonesia (7.2 Mt) (International Fertilizer Association, 2024). Global production has remained relatively stable over time, with only minor fluctuations in the production amounts from these top five countries.

Global demand for nitrogenous fertilizers is expected to grow until 2030. This growth is driven by high crop prices and the need to replenish global coarse grain stocks, lower fertilizer prices due to cheaper feedstock, increasing food demand from a growing population, and subsidy programs ensuring sufficient fertilizer availability (CF Industries, 2022; Quin, 2024; Research and Markets, 2024). However, the rate of growth is expected to slow in response to an increased focus in many countries on use-efficiency to both reduce costs and limit nitrous oxide emissions from agriculture (International Fertilizer Association, 2024).

Canadian Industry Profile

There are nine major nitrogen fertilizer production facilities in Canada (Environment and Climate Change Canada, 2024b). These are located in Alberta (six), Saskatchewan (one), Manitoba (one) and Ontario (one). All the facilities have been operating for more than 30 years. The number of facilities in operation has fluctuated slightly between 8 and 10 plants since 2004 (Environment and Climate Change Canada, 2024b). All Canadian chemical facilities are owned by multinational companies.

Eight of the facilities produce ammonia from natural gas feedstock using steam methane reforming. One facility does not use steam methane reforming but receives hydrogen and nitrogen from nearby facilities. Each facility is unique and produces a varying mix and quantities of different nitrogen fertilizers.

Process emissions account for 64% of sector-wide emissions in Canada (Fertilizer Canada, 2023). The sector already captures 61% of all process emissions for other uses, including urea (a type of nitrogenous fertilizer) production, use in a greenhouse, and fed into the Alberta Carbon Trunk Line (Fertilizer Canada, 2023; Nutrien, 2024).

Canada's Trade

Domestic use of nitrogen fertilizer is approximately 8.2 Mt, approximately 2 Mt of which are exported to the United States and a much smaller volume (<0.1 Mt) exported to other countries (Fertilizer Canada, 2023). Canada's exports of nitrogen fertilizer in 2023 were valued at CAD 1.12 billion, with imports at a similar level, valued at CAD 1.15 billion (Statistics Canada, n.d.).

The United States dominates Canada's export market, importing CAD 935 million of Canadian nitrogen fertilizers (99.6% of exports), followed by Australia as a distant second, receiving CAD 0.94 million (0.1% of exports) (Statistics Canada, n.d.). Urea is the most traded product, valued at approximately 50% of both imports and exports (Statistics Canada, n.d.).

Over the last 20 years, Canadian imports of nitrogenous fertilizers have grown significantly, while exports have not grown at the same pace. Imports into Canada are also primarily sourced from the United States (CAD 486 million [46%]), with Russia as the second largest source of Canadian imports (CAD 219 million [21%]) (Statistics Canada, n.d.). Canada is a significant market for U.S. exports. Over the last 5 years, the proportion of total U.S. exports sent to Canada ranged from 34% to 46% (USD 240 to 674 million) (Statistics Canada, n.d.).

Decarbonization Prospects

Ammonia production in Canada is currently heavily dependent on natural gas as both a feedstock and a combustion fuel. The most promising approaches to decarbonization of the sector are the use of CCS, fuel switching, electrification, and small modular reactors (Clean Energy Canada, 2023).

The potential for using CCS to reduce process and combustion emissions varies depending on the facility. Many facilities already capture a portion of their process emissions for other uses, which can limit the availability of emissions for CCS. However, when CCS is implemented, it can lead to a 60% reduction in total emissions compared to the traditional manufacturing process (CF Industries, 2024a). For example, the recent expansion of the Nutrien Redwater Facility has increased its process CO_2 sequestration capacity by

40%, allowing it to export 800 tonnes of CO_2 daily to the Alberta Carbon Trunk Line (Nutrien, 2024). Despite these advancements in reducing process emissions, there are currently no significant CCS projects targeting combustion emissions in the nitrogenous fertilizer industry, highlighting an area for policy support to drive technology development.

Green hydrogen offers a promising path for decarbonizing the nitrogenous fertilizer industry. By using hydrogen produced through electrolysis in the Haber-Bosch process, the industry can eliminate the need for natural gas feedstock and steam methane reforming, thereby reducing process and combustion emissions. Notable projects—including CF Industries' electrolyzer in the United States and Yara's in Norway—are already producing thousands of tons of green ammonia annually (CF Industries, 2024b; Yara International, 2024). No similar projects have yet been announced in Canada. To support green hydrogen production, there is a need for further investment toward expanded renewable electricity supply in Ontario, Alberta, and Saskatchewan.

Electrification and small modular reactors can also help the nitrogenous fertilizer industry decarbonize, again by eliminating the use of fossil fuels in the production process. Siemens, in partnership with the University of Oxford and Cardiff University, is already using wind-generated electricity for ammonia in the United Kingdom (University of Oxford, 2024).

It is important to keep in mind that ammonia facilities have a long lifespan, between 20 and 50 years. Canadian facilities are older and more expensive to decarbonize than newer operating facilities or new greenfield production (Industry expert, personal communication, 2024). All Canadian facilities are owned by multinationals, and they compete for investment capital with facilities operating in other jurisdictions. Support offered in other jurisdictions, particularly support available under the IRA in the United States, has an impact on investment decisions (Industry expert, personal communication, 2024). There are very high capital requirements for all the most promising decarbonization technologies in this sector, as well as some increase in operating costs. Some decarbonization pathways may also face regulatory hurdles to implementation, particularly for CCS, where there is a lack of clarity regarding ownership and use of pore space outside of Western Canada (Industry expert, personal communication, 2024).

Basic Chemicals

Global Context

The Canadian industrial chemical sector recorded CAD 30.7 billion in shipments in 2022 (Chemistry Industry Association of Canada, 2023). Major global producers and their sales are as follows: China at CAD 3,600 billion (roughly 40% of global sales), EU27 at CAD 1,100 billion, United States at CAD 907 billion, and Japan at CAD 339 billion (European Chemical Industry Council, 2023).

In 2023, the global chemical industry faced sluggish demand due to an economic recession in the EU, inflation in the United States, and high inventory levels stemming from overordering in 2021 and 2021 (Yankovitz et al., 2023). However, demand for chemical products, including plastics, is picking up. Global demand for primary chemicals, an indication of overall activity in the sector, has increased significantly in recent years. Global demand forecasts for four key commodities show positive compound annual growth rates (CAGR) leading into 2030:

- Ethylene (petrochemicals) demand is expecting a CAGR of 3.14% for the 2024–2028 period (Research and Markets, 2024). Analysts are warning that production capacity is consistently outstripping demand, which is likely to result in decreased operating rates for facilities (Richardson, 2024).
- Hydrogen (industrial gases) demand is expected to grow to within the range of 150 to 600 Mt/year by 2050 (Bogdanova, 2024; European Chemical Industry Council, 2023).
- Methanol (other basic organic chemical) demand is projecting a CAGR of 4.8% to 5.53% from now until 2030 (DataBridge Market Research, 2024; ResearchDive, 2022; The Brainy Insights, 2021).
- Sulfuric acid (other basic inorganic chemicals) demand is expecting a CAGR of between 3.4% and 8.3% from now until 2030 (Future Market Insights, 2023; Globe Newswire, 2023).

Canadian Industry Profile

There are 54 large basic chemical manufacturing facilities in Canada: 15 in Alberta, 4 in Saskatchewan, 1 in Manitoba, 22 in Ontario, 11 in Quebec, and 1 in Newfoundland and Labrador (Environment and Climate Change Canada, 2024b). The petrochemical and industrial gas manufacturing subsectors are responsible for more than 75% of total sector emissions and are composed of 19 large facilities (Environment and Climate Change Canada, 2024).

Facility ages vary considerably: well-established plants continue to operate while many newer facilities have come online in recent years and have been announced for the near future, particularly to meet emerging demand for new chemicals (e.g., increasing demand for green hydrogen).

The two largest source types of total direct facility GHG emissions in the Canadian basic chemical manufacturing sector are stationary fuel combustion for heat production (83.8%) and emissions from industrial processes, corresponding to greenhouse gases (mostly CO_2) that result directly from the chemical reactions used in production (9.2%) (Environment and Climate Change Canada, 2024a). Decarbonization efforts in the sector are focusing on these two emission source types.

Canada's Trade

Canadian exports of basic chemicals were valued at CAD 14.8 billion in 2023, up 4% from 2022 and 57% from 2020 (Statistics Canada, n.d.). The United States is Canada's main destination for exports (CAD 8.6 billion [72%]), followed by China (CAD 780 million [7%]) (Statistics Canada, n.d.). Canadian imports of basic chemicals were valued at CAD 10.9 billion, down 3% from 2022 but up 49% from 2020 (Statistics Canada, n.d.). The United States was Canada's main source of imports (CAD 4.3 billion [47%]), followed by Brazil (CAD 1.7 billion [19%]) (Statistics Canada, n.d.). Canada's imports of basic chemicals from the United States represented 11% of American exports of basic chemicals in 2023 and have shown a generally growing trend since 2019 (United States International Trade Commission, n.d.).

Decarbonization Prospects

The International Energy Agency [IEA] has identified the main decarbonization pathways for the chemical sector as CCUS and the use of electrolytic hydrogen, as well as direct electrification technologies, such as high-temperature heat pumps (IEA, 2023b). Globally, these technologies are not at an advanced stage of readiness—most are at the first-of-a-kind or demonstration project phase. The IEA has also identified a need for supporting infrastructure, especially CO_2 storage capacity and hydrogen pipelines (IEA, 2023b).

The chemical industry will face challenges maintaining competitiveness during decarbonization that are similar to those faced by the other EITE sectors.

The challenges associated with process substitution relate directly to the age of the facility. Existing facilities represent a very large capital investment and are highly specialized toward the process they are operating (Industry expert, personal communication, 2024). As a result, if lower-emitting production pathways are developed, they are not readily applied until new facilities are constructed or there is sufficient incentive to undertake major facility upgrades (Industry expert, personal communication, 2024).

Canadian facilities are also owned by multinationals, and they compete for investment capital with facilities operating in other jurisdictions—i.e., there is internal competition between Canadian facilities and facilities in other countries for decarbonization funding. Canadian policies need to consider funding mechanisms available in other jurisdictions that apply to new facilities, particularly support available under the Inflation Reduction Act in the United States. There are very high capital expenditure requirements for all the most promising decarbonization technologies, and it may cost more to achieve the same emissions reduction at an existing (brownfield) facility as opposed to a new facility (greenfield) (Industry expert, personal communication, 2024).

Appendix B. Detailed Evaluation of Each Complementary Policy Tool Against Seven Key Criteria

Adjusting Performance Standard Under Large-Emitter Trading Systems

1. Environmental Effectiveness

By keeping the marginal cost of carbon relatively high and the average cost of carbon relatively low for large emitters, adjustments of performance benchmarks in existing large-emitter trading systems (LETS) (i.e., adjustments that recalibrate the use of output-based allocations [OBAs]) can help strike a balance between environmental effectiveness and competitiveness considerations. To be environmentally effective, LETS systems must maintain robust credit markets, with the total share of industrial emissions facing a carbon price rising over time. As firms decarbonize, they can expect to generate an increased number of carbon credits under most conditions. As the supply of carbon credits grows, demand must also grow to ensure the market stays in balance. Credit prices in the open market must trade close to the headline price of carbon and provide a sufficient incentive for additional firms to continue to invest in decarbonization.

Several principles can help ensure environmentally effective and fair LETS. Most critical is the allocation of OBAs on the same per-unit basis across all facilities producing the same product (Dobson et al., 2017). Not all provincial LETS follow this principle. For example, Alberta's Technology Innovation Emissions Reduction (TIER) system uses two methods to create benchmarks: facility-specific benchmarks and high-performance benchmarks (Government of Alberta, 2023). The use of facility-specific benchmarks undermines environmental effectiveness because these benchmarks are based on a facility's historical performance rather than the performance of top industry performers. This approach favours high-emitting or poor-performing facilities at the expense of lower-emitting facilities with stronger emissions performance (Dion, 2019).

The environmental effectiveness of LETS does have some natural limitations. Notably, they do not transmit the price signal down the supply chain in a way that encourages the consumption of lower-carbon substitutes, and they do not encourage circularity. The temptation to insufficiently tighten performance standards can also undermine environmental effectiveness by depressing credit prices and reducing average carbon costs to levels that are effectively negligible. Well-calibrated standards can increase the overall effectiveness of the system, keeping costs low and strengthening incentives to decarbonize without being undercut by jurisdictions with weaker or no carbon pricing—but their downstream impact is limited.

While these design choices and natural limitations can undermine environmental effectiveness, LETS also have several intrinsic features that can improve the environmental effectiveness of climate policy overall. For example, OBAs represent foregone revenue rather than new money and therefore avoid many of the challenges policy-makers face with other subsidies. This includes fully avoiding free ridership, where firms benefit financially from a subsidy without making meaningful contributions to emission reductions because they are undertaking new business activities that would have happened even without a subsidy. In contrast, OBAs are allocated based on actual production output relative to emissions, ensuring only those who genuinely reduce emission intensity will have the opportunity to generate and sell more credits over time. In these ways, OBAs can improve the overall environmental effectiveness of LETS by rendering the use of additional, less effective, subsidies unnecessary.

2. Competitiveness Impacts

The future design of performance standards in LETS will carry significant implications for competitiveness impacts across regulated sectors. Different provinces have different industrial profiles, and have designed their LETS accordingly, but competitiveness impacts may still emerge unevenly across the provinces over the medium term. Alberta's TIER market covers most of the oilsands, which C3's previous research shows will face relatively fewer competitiveness pressures as the carbon price rises. On the other hand, several highly emissions-intensive and trade-exposed (EITE) sectors are important regional economic drivers in Ontario, including notably iron and steel and chemical manufacturing.

Under existing federal and provincial legislation, policy-makers are empowered to adjust OBA distribution to address new competitiveness pressures as they emerge. The federal OBPS identifies different thresholds of EITE risk: low, medium, high and very high. Each threshold corresponds with a stringency rate that the Government of Canada uses when developing or revising performance standards. Provinces all have similar approaches for setting performance standards. Facilities calculated to be high risk have less tight benchmarks and, therefore, less exposure to the carbon price. This system is dynamic and capable of responding to shifting circumstances. In response to new and significant competitiveness risks, for example, the Government of Canada has previously revised standards for the iron and steel and nitrogenous fertilizer sectors.

3. Cost to Households

Carbon pricing under LETS generates very few additional costs for households (Fellows & Tombe, 2023). Recent analyses suggest that the effects of carbon pricing on inflation are minimal overall (Standing Committee on Finance, 2023; Tombe & Winter, 2023). The effects of use standards and OBAs are similarly muted. Relative to full carbon pricing, OBAs further minimize these already small costs, with minimal direct costs for households.

4. Direct Fiscal Costs

The fiscal costs of LETS is a function of the overall number of OBAs in the system. As discussed above, OBAs are foregone revenue for governments, so overall fiscal costs should be evaluated relative to scenarios with more or fewer OBAs in a system where LETS offers a predictable headline carbon price over time. In general, using OBAs reduces the overall direct fiscal costs of LETS (Bastani, 2023). Governments that use more OBAs will generate less overall revenue, with overall fiscal costs dependent upon a government's approach to recycling the revenues back into their economies.

There are several other interactions between OBAs and other components of LETS that can also influence overall fiscal cost. If revenues are recycled in ways that are duplicative or overlap with OBAs, the system will carry greater fiscal costs. Stacking of additional incentives, including bespoke subsidies and broad-based tax credits, will also affect the overall fiscal cost of LETS.

5. Administrative Feasibility

The risk of leakage that can come from adjusting LETS typically leads to risk-averse decision making from policy-makers. Even low risk of leakage could deter policy-makers from continuing to tighten benchmarks stringency. This risk is arguably already evident today. Calibrating thresholds for sectors to balance competitiveness and system performance can be challenging for governments, given that industry has more information about their own activities and will likely continue to lobby for more generous output subsidies.

Each province has its own specific set of formulas for evaluating how benchmarks are set every year, but they are capable of amending these formulas with legislation. The federal equivalency test developed under the Greenhouse Gas Pollution Pricing Act provides the federal government with the ability to enforce stronger standards or new criteria. The forthcoming 2026 federal review is the next juncture at which the federal government could agree to change the rules under which their markets operate.

6. Diplomatic Considerations

The use of LETS has not given rise to tensions with Canada's trading partners. As previously discussed, similar mechanisms are in use in many countries that have implemented industrial carbon pricing. As long as performance standards are not set in ways that may run afoul of specific trade agreements, their diplomatic implications are few. It is worth noting that the United States has ruled, in the context of the EU Emissions Trading System, that extra allocations to firms that are at greater risk of leakage constitute a countervailable subsidy (United States Department of Commerce, 2020).

7. Policy Interactions

LETS have a number of important interactions with other climate policies. The way that performance standards are set ultimately defines the rules of supply and demand within any provincial market. The price of credits and the expectation around whether credit prices will rise or fall are crucial for the environmental effectiveness of LETS.

LETS must strike a balance. They require the marginal price of carbon to continue to rise over time to be environmentally effective, but performance standards that are overly loose would lead to oversupply of credits. This downward pressure on credit prices would cause the marginal price of carbon to collapse. On the other hand, overly tight performance standards can create leakage risk. Provided the marginal price of carbon is strong, and carbon credit markets are not oversupplied, well-calibrated use of performance standards and OBAs can help avoid the need for subsidies that are more vulnerable to the challenge of free ridership.

The extent to which performance standards and credit prices interact is a function of the overall health and maturity of the credit market. In provinces where a relatively large share of industrial emissions come from EITE facilities, like Ontario, credit markets are likelier to be shallow and less effective due to looser standards and relatively few compliance options for emitters. By contrast, Alberta's TIER market covers relatively few high-EITE facilities and has numerous options for compliance. This makes for a more liquid and robust trading market but also increases the risk of policy interactions due to the market involvement of entities that are not directly covered by the regulation.

Border Carbon Adjustments

1. Environmental Effectiveness

If a border carbon adjustment (BCA) worked as intended and allowed for a strengthening of the carbon price, it would be environmentally effective. In terms of emission reductions, a BCA's effectiveness is largely a function of what happens to the headline carbon price; the higher the price, the stronger the penalties for GHG-intensive facilities, which would have to purchase more costly credits to cover their emissions, and the greater the rewards for low-carbon facilities, which can sell excess credits at the higher carbon price.

Absent leakage protection, however, beyond some threshold, an increase in carbon price would simply reduce the viability of some trade-exposed firms, who could not pass through those costs to buyers and would, therefore, suffer either loss of profits or loss of market share.[7] BCA is aimed at addressing this problem by reducing that loss of market share; it forces importers of foreign goods to pay the same carbon costs paid by Canadian producers and potentially rebates the cost of carbon to exporters. As such, it allows policy-makers to strengthen the headline carbon price without the restrictive concern over competitiveness and leakage impacts.

In terms of global environmental impacts, a Canadian BCA that is credited for carbon prices paid abroad would create incentives for other countries to implement carbon pricing. While this shouldn't be the aim of a BCA, it would be a positive incidental effect.

The export coverage model sees some portion of production—that which is exported—not subject to a carbon price. If exports are a significant percentage of total production, this risks unbalancing the carbon credit markets; high-carbon producers will tend to export, removing a significant source of demand for credits. This is a particular concern for Canada, which exports atypically high percentages of domestic production in many of the covered sectors. This might be partly solved by design, for example, by tying rebates to a sectoral benchmark rather than actual carbon costs paid.

The cooperative model imposes charges based on national sectoral average GHG intensities rather than installation-level performance, which means that it will overcharge clean foreign producers and undercharge high-carbon foreign producers. This impairs its environmental effectiveness in terms of incentivizing those producers to decarbonize.

2. Competitiveness Impacts

As noted above, BCA is specifically designed to prevent leakage; in the Canadian case, it would aim to ensure that foreign-produced goods pay carbon costs equivalent to what they would pay were they produced in Canada under the federal output-based pricing system (OBPS) regime. Cosbey et al. (2019), in a meta-analysis of the literature, find that "detailed numerical analyses using multisector, multi-region models consistently find significant potential for BCA to reduce leakage rates." The EU's impact assessment of various Carbon Border Adjustment Measure (CBAM) options similarly found that the CBAM would be effective at preventing leakage (European Commission, 2021).

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[7] In our previous report, we found major differences between the EITE sectors in Canada as to where that threshold might lie.

There are significant caveats, however, to the general finding that BCA is effective at preventing leakage. The first is that it matters whether the BCA in question rebates the carbon price on exports. Canada's EITE sectors, as export-focused as they are and being price takers, would suffer a significant loss of market share under the CBAM-style BCA variety, where the carbon price was not somehow rebated on Canada's exports.

The second caveat is that a BCA needs to strike the right balance between comprehensive downstream coverage and feasibility/effectiveness. That is, if the coverage of a BCA were limited only to basic goods such as flat steel and aluminum ingots, foreign producers would slightly process their steel and aluminum before exporting to Canada to avoid BCA coverage, meaning leakage. If, on the other hand, coverage was extended far down the value chain to manufactured goods, it would be administratively challenging to assess the embodied carbon in covered goods, and the benefits in terms of leakage prevention would be minuscule; manufactured goods tend to have very low value of embodied carbon as a percentage of total price.

3. Costs to Households

BCAs enable producers to pass through the costs of carbon pricing to consumers without fear of being undercut by non-carbon-priced imports. This cost increase is the point of BCAs—it creates incentives throughout the entire value chain to encourage the consumption of low-carbon goods, along with investment in the production of those goods. In the mid-transition—that is, until low-carbon production has become cost competitive with traditional production—this means higher prices to households consuming the covered goods, with cost incidence shared between producers whose production will decline and consumers who will pay higher prices for products that contain steel, aluminum, and other covered goods.

For example, a more stringent carbon price on steel and a BCA to enforce a similar price at the border would, in the short run, simply increase the price of steel in Canada. But eventually, as GHG abatement technologies like DRI using green hydrogen become more cost-effective, they would be adopted, and those costs would come down. In the mid-transition, steel producers would pass along what costs they could to customers (carbon costs and costs of abatement), but full cost pass-through would be limited by the availability of substitutes. Thus, while downstream purchasers of steel, like manufacturers of pipes and tubes, would bear some of those costs (as would final consumers/households), steel producers would also have to bear some. How much those costs would be is an empirical question that we have not explored, but we note that the impacts of those costs will be diminished the further down the value chain we go; as with the example cited above, carbon costs in an automobile will amount to a very small percentage increase in final price.

Ultimately, the costs a BCA imposes on households are the intended costs of a higher carbon price, and they would be felt even without a BCA in a hypothetical world with an industrial carbon price and no international trade.

4. Direct Fiscal Impact

The direct fiscal impacts of a BCA start with the revenues that a BCA would generate from charges imposed on imports. Much more significant, however, would be the revenues generated by any increase in average carbon prices that the BCA would allow. That is, if the BCA allowed Canada to strengthen its carbon price by lowering the performance standards it uses to determine at what point firms must start paying for GHG emissions or by increasing the marginal carbon price, that would be a potentially much larger source of revenue. The export coverage model of BCA, which would refund carbon prices at the point of export, would have much less potential to generate revenue from carbon pricing.

The final fiscal impact would depend on regime design, in particular on what was done with the collected funds. If a BCA were to return all the collected revenues to affected exporters, either to help defray the costs of compliance, or via a fund dedicated to helping developing country exporters decarbonize, then the impacts of the border charge itself would be fiscally neutral (aside from the costs of administering the regime). Similarly, if the increased revenues from a higher carbon price were all recycled back to Canadian producers to help them decarbonize, the final direct impact would be neutral.

5. Administrative Feasibility

If a BCA is implemented so that it aims to precisely replicate carbon prices paid domestically (as it would be under the CBAM-style and export coverage models), it is highly complex to administer. The first complexity would be in calculating the effective carbon price paid by Canadian producers since OBA means that none pay the headline carbon price as an average price. Presumably, the charge levied on importers and any rebates granted to exporters would have to be calculated equivalent to the average price paid by domestic producers, which would be different for each sector and difficult but not impossible to assess.

Another stress point is calculation of embodied GHG in imports. Demanding actual data from importers involves creating a standard to which they must report, and a standard for accreditation for verifiers to certify those data, as well as establishing a review mechanism to ensure compliance. It would also involve maintaining accurate default values for each good and each trading partner, to be used in the event that actual data are not available/not submitted (the CBAM does this).

One way to avoid complications would be to assign global default values to GHGs embodied in imports, based, for example, on some percentile of performance by Canadian producers. The cooperative BCA option described above uses national sectoral average values instead of demanding actual data from individual foreign producers. These sorts of simplifying assumptions, however, make BCA a blunt instrument that does not accurately reward low-carbon foreign firms or punish high-carbon ones, making it less of a strictly environmental instrument. In part for that reason, such assumptions might not pass the test of trade law (considered below).

The EU pioneering this policy pathway offers significant opportunities for lessening the administrative burden. Canada could, for example, adopt elements of the EU reporting standard and its accreditation standard for verifiers and could reference its default values. While helpful, the EU effort is not something that could be simply replicated by Canada. The EU reporting methodology, and so its accreditation standard, is determined by the realities of the EU ETS and would not translate directly to the Canadian OBPS. As well, the coverage of goods for a Canadian and EU BCA would not be identical.

6. Diplomatic Considerations

As Cosbey et al. (2021) note, one of the key challenges to Canada implementing a BCA is the fact that such high percentages of the covered goods are part of significant and established trade flows between Canada and the United States.

The United States has reacted strongly and negatively to the EU's CBAM and would likely be even more concerned about such a measure imposed by Canada. Canada is a much larger export market for the United States than is the EU; 2022 U.S. export values of iron and steel, fertilizers, and aluminum to Canada were more than 4.5 times the value of those exports to the EU. A Canadian BCA would undoubtedly create a high-level diplomatic row with a trading partner that does not hesitate to unilaterally impose retaliatory trade sanctions.

The cooperative BCA option attempts to address this problem by providing a form of BCA that both Canada and the United States could conceivably agree to implement in concert. "Cooperative" in this context doesn't necessarily mean the United States and Canada would have identical regimes. For one thing, the price might be different; Canada would probably charge its headline domestic carbon price, and the United States would have to decide what it would charge. For another thing, neither country would necessarily be exempt from the other's charges, and GHG emissions intensities in the covered goods, while similar between the two countries, are not identical. There are ways to address this last issue. For example, the two countries could agree that any country's goods would be exempt under two conditions: if they had concluded an agreement committing to jointly reaching some improved level of GHG intensity over time and if they were currently within a specified percentage of differential in emissions intensity.

There is a rich body of literature that debates whether BCAs in general would be legal under World Trade Organization (WTO) rules, with many recently asking the same question about the EU's CBAM in particular (Espa et al., 2022; Leal-Arcas et al., 2022). It is impossible to say with certainty whether a specific measure violates WTO rules until the WTO's Dispute Settlement Body has delivered its judgment, and that can only happen if the measure is brought to the WTO by a complaining member. As yet, there is no case law specifically considering BCA, and there are no cases pending.

There are a few obvious ways that a Canadian BCA might risk breaching WTO obligations. GATT law imposes a basic obligation to treat imported goods no less favourably than domestically produced ones (national treatment principle), and this might be violated either by a BCA imposing carbon costs on upstream Scope 3 emissions (which are not directly covered under the OBPS) or by denying foreign producers the ability to earn tradeable credits by beating sectoral performance standards. It might also be argued that imposing the federal backstop price violates national treatment, even if the price is lowered to account for OBA since some Canadian producers face effective prices lower than that under provincial regimes. Moreover, a cooperative model BCA could be faulted for discriminating against producers that are less GHG intensive than the national default values they are assigned. Such breaches of GATT obligations might be saved by GATT's General Exceptions (Article XXb or XXg) under strict conditions designed to allow for legitimate environmental protection while screening out the protection of competitiveness. This is where most of the legal debate centres, and the answers would depend fundamentally on the design of the BCA in question. The cooperative model BCA would be hard-pressed to receive protection under Article XX; assigning a default GHG intensity essentially breaks the environmental protection rationale for the charges faced by clean foreign producers.

The export coverage model would face different legal challenges. The WTO law here is different for the refund of taxes and the refund of regulatory costs, so it matters which one Canada's carbon pricing regime is deemed to be. While under Canadian law the LETS is deemed a regulation, not a tax, if it were deemed a tax under WTO law, a BCA would have a chance of being found legal if it refunded that tax at the point of export. By contrast, a BCA that rebated *regulatory costs* of carbon for exported goods would likely be found to be a prohibited export subsidy under the WTO's Agreement on Subsidies and Countervailing Measures (SCM Agreement). The SCM Agreement does not have environmental exceptions like those found in the GATT. Moreover, if the subsidy were indeed found to be prohibited, under SCM law, it would have to be removed.

Ultimately, the reaction to an export coverage BCA might not be disputed under international trade law at all. WTO members have the right to investigate and countervail subsidies at the national level, and the United States is a heavy user of these sorts of trade remedies. As a rule, national trade remedies are faster and tend to be more favourable to the investigating country's interests. A countervailing duty by the United States against export rebates in Canada would eliminate the BCA's leakage protection in export markets.

7. Policy Interactions

As noted above, the main function of a BCA regime is to interact positively with carbon pricing, enabling higher ambition with less risk of competitiveness impacts. There are no significant concerns about policy interactions with BCA. One possible exception is with the export coverage model of BCA. If the rebates of carbon costs were delivered directly and in full back to the covered firms, this would risk unbalancing the carbon credit markets; high-carbon producers will tend to export, removing a significant source of demand for credits. Average carbon cost for those exporters will also be much lower, since those exporters will not need to purchase credits. This is a particular concern for Canada, which exports atypically high percentages of domestic production in many of the covered sectors. This might be partly solved by design, for example, by tying rebates to a sectoral benchmark rather than actual carbon costs paid.

Product Emissions-Intensity Standards

1. Environmental Effectiveness

As envisioned in this paper, product emissions-intensity standards would be set at levels that do not impose additional requirements on Canadian facilities. They would, in other words, be no stricter than the emissions-intensity performance benchmarks under the LETS.

The primary decarbonization incentive facing Canadian facilities would remain the industrial carbon pricing system. A product emissions-intensity regime complements the pricing system in a similar way to a BCA. By ensuring that domestic producers are not undercut by high-carbon foreign producers, emissions-intensity standards would provide policy room for higher average carbon prices in Canada. These higher carbon prices, in turn, would drive industrial emissions reductions. As such, the effectiveness of a product emissions-intensity standard at achieving domestic emission reduction is linked to its ability to enable high effective carbon prices.

In addition to enabling higher prices under the LETS, a system of emissions-intensity standards would incentivize emissions reductions in third countries. While not the main objective of the measure, this would be an important spillover effect. The effectiveness of a product emissions-intensity standard at achieving this objective would depend on the economic importance of the markets that had adopted it. This is because producers might choose to redirect their product sales to other markets rather than comply with the standards. Emissions-intensity standards applied to all products sold in Canada or the United States, for example, would be more difficult for producers to avoid than would a purely Canadian standard because of the size of the combined market.

2. Competitiveness Impacts

Product emissions-intensity standards would provide complete protection of the domestic market from high-carbon imports and encourage decarbonization of foreign producers who export to Canada or to other markets that have also adopted the standards. They would reserve these markets for exclusively lower-carbon industrial goods. Certainty as to the prohibition of high-carbon imports is one of the main advantages of this policy.

As with a BCA, there is a risk that importers would try to circumvent the requirements by importing downstream products not subject to them, such as vehicles. In this case, both the production of component materials and the assembly of final products might move to jurisdictions with laxer climate policies, and total global emissions might rise. Again, as with BCA, the challenge is to find the balance point where downstream coverage no longer makes sense. At some point, the standard stops making much difference, as in the case of an automobile, for which the final value of the good is high enough relative to the value of embedded carbon that a low carbon price in foreign countries is not a source of competitive advantage.

Emissions-intensity standards would not, however, be expected to completely level the playing field between producers in participating jurisdictions, nor would it completely eliminate the risk that production might move to a lower-carbon-cost jurisdiction. The carbon costs faced in each participating country will still differ, and these differences may be significant enough to cause producers to lose market share to other producers who also meet emissions-intensity standards. In other words, leakage might still occur even though competition from high-emitting producers is eliminated.

3. Costs to Canadian Households

The costs of the emission-intensity standards policy are initially directly borne by producers of emissions-intensive goods who must invest in emissions-reducing technologies and processes to continue to sell their products in markets that have adopted the standards. However, many of these producers will be able to pass a significant share of these costs on to their buyers. Because buyers will not have the option to purchase cheaper, high-carbon goods, they will effectively be a captive market for lower-carbon producers and could, therefore, be expected to absorb at least some of the costs of this policy.

In choosing the initial emissions-intensity levels under the standards, regulators would need to consider the impact on supply. Standards that are so strict as to preclude imports from key producing countries may result in supply shortages and high consumer prices on the domestic market. Industries such as construction that purchase large quantities of covered goods would face rising costs, and these, in turn, could result in higher consumer prices for essentials, such as housing. One way to address this is a timetable of standards that starts easy, ramps up, and is predictable, allowing for informed investment decisions in decarbonizing technology.

That said, the actual extent of cost pass-through from producers to consumers will depend in part on the supply and demand conditions in low-carbon markets. Where competition from other low-carbon producers is stiff, or where there are viable substitutes for the products, producers will pass on fewer costs to buyers.

4. Net Fiscal Cost

Unlike a BCA, there are no government revenues from a standards regime. There are also no government expenditures associated with this policy, except for the operational costs of establishing and enforcing a standards regime.

5. Administrative Feasibility

As is the case for a BCA, significant technical efforts on emissions standards, reporting, and verification methods would be necessary for the effective implementation of product emissions-intensity standards. Agreed methods for measuring and reporting on embodied carbon in most industrial sectors are only in the early stages of development. The implementing countries might be able to build on existing efforts, such as the EU implementing regulation for CBAM or U.S. standards for green government procurement under the Buy American Act.

However, it would be technically challenging to set standards in such a way as to achieve the right balance between environmental effectiveness and cost through time and to ensure that the standards do not impose new requirements on domestic producers (i.e., they remain less stringent than the performance benchmarks under LETS). Canada's LETS generally imposes limits at the sector level;[8] all firms in that sector must reduce their facility-level emissions to below their benchmark emissions intensity or purchase a credit/emissions allowance. In contrast, the product standard operates at the level of specific products and can be complied with only by reducing emissions. These differences would complicate the task of ensuring that the LETS consistently remains more stringent than a product standards regime. Each of the sectors included in our paper produces a range of products, and specific thresholds would likely need to be defined for each covered product. For example, the iron and steel sector produces intermediate products such as slabs, blooms, hot- and cold-roll strip, plate, and rod. Some of these will be associated with higher carbon intensity than others due to, for example, additional manufacturing steps. Thresholds would need to be set for basic and intermediate goods, but the regime's coverage would not extend to high-value-added finished products.

Canada's Clean Fuel Regulations provide an important domestic precedent for regulations of this type, as these establish mandatory emissions-intensity thresholds for many fuels sold on the Canadian market, including imported fuels (Government of Canada, n.d.). The Clean Fuel Regulations may point to the way to resolving a series of implementation-related questions, including legal authorities, standard-setting, and enforcement methodologies.

For some heavy industrial materials, such as low-carbon steel and cement, there may also be a need for complementary regulatory changes, for example, to adapt building codes so that low-carbon materials are expressly permitted in construction and infrastructure projects.

[8] Some systems, like Alberta's Technology Innovation and Emissions Reduction regulation, set firm-specific standards rather than sector-wide ones.

6. Diplomatic Considerations

Product emissions-intensity standards, like BCA, would be contentious among Canada's trading partners, though they would likely not be as negatively seen as BCA; producers are used to complying with standards, and, unlike a BCA, this regime does not impose border charges. Nonetheless, foreign producers who do not meet the standards would lose all access to the Canadian market, and they could be expected to view the measure as heavy-handed and to encourage their governments to challenge it using provisions in international trade agreements. Whether or not governments ultimately decide to challenge the measures using trade law, the imposition of standards could become a source of diplomatic friction between Canada and certain exporting countries if the volume of trade impacted was high enough.

On the other hand, if these standards were adopted jointly by Canada and its major trading partners, their international acceptability would be enhanced. As discussed earlier, the lack of a carbon price in the United States is not a barrier to the adoption of emissions-intensity standards. Joint adoption of these standards by the United States, Canada, and potentially other countries as part of an international initiative would significantly reduce, though not eliminate, the risk of disputes.

China and India, as major exporters of heavy industrial goods that could be prohibited under an emissions-intensity standards regime, would likely be among those most strongly opposed. Developing countries might also object on the grounds that they should not bear the costs of mitigating climate change caused by developed countries.

Effective international cooperation on mandatory emissions-intensity standards would likely have to start between a small number of countries whose heavy industries are at roughly similar emissions intensities. It may be possible to make use of existing forums, such as the Climate Club or the EU–US Global Agreement on Sustainable Steel and Aluminum, if membership in the latter were to expand beyond the two jurisdictions. Eventually, an emissions-intensity standards regime would ideally be set at an international level and adopted by many countries.

The prospects for Canada-U.S. cooperation on an emissions-intensity standards regime in the near term are uncertain. As discussed earlier, the absence of a national system of carbon prices in the United States is not a barrier to cooperation on emissions-intensity standards. Some Canadian and U.S. heavy industrial sectors also have similar current emissions intensities (Climate Leadership Council, 2020; Vidovic et al., 2023), which would make it technically feasible to set a single standard applicable in both markets. That said, successful bilateral cooperation on mandatory standards would require strong political will in addition to technical feasibility. In March 2023, Prime Minister Trudeau and President Biden committed to work together to promote North American trade in green steel and aluminum, as well as other low-emissions goods, and to better understand and promote common approaches that reduce carbon leakage (Prime Minister of Canada, 2023). Joint work on emissions-intensity standards would advance these goals. Moreover, the Biden Administration has recently announced the formation of a new Climate and Trade Task Force with a mandate to address carbon leakage. However, international cooperation of this type takes time, which is a concern for sectors facing immediate competitiveness and leakage challenges.

While some U.S. experts report growing bipartisan interest in trade and climate policies, given shared concern for economic competitiveness and support for domestic manufacturing among Republicans and Democrats (Ye, 2024), the upcoming election in the United States is currently generating a lot of uncertainty with respect to the approach that a future U.S. government will take to climate policy. That same uncertainty extends to the likelihood of cooperation on instruments such as product emissions-intensity standards.

7. Policy Interactions

No significant policy interactions are expected.

As considered in this paper, a set of mandatory emissions-intensity standards for heavy industrial goods would co-exist alongside Canada's industrial carbon pricing system. As discussed under effectiveness, product emissions-intensity standards would complement the industrial pricing system by prohibiting imports of competing high-carbon goods. They would be less stringent than performance standards under the LETS, but unlike LETS standards, the only way to comply with them would be to reduce emissions intensity. If these standards were only slightly less stringent than the performance standards under LETS, they would depress demand for credits in covered sectors.

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