

Market-Based Clean Performance Standards as Building Blocks for Carbon Pricing

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Our strategy calls for combining public investment, a secure social safety net, and fiscal discipline. In that framework, the Project puts forward innovative proposals from leading economic thinkers — based on credible evidence and experience, not ideology or doctrine — to introduce new and effective policy options into the national debate.

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This policy proposal is a proposal from the author(s). As emphasized in The Hamilton Project's original strategy paper, the Project was designed in part to provide a forum for leading thinkers across the nation to put forward innovative and potentially important economic policy ideas that share the Project's broad goals of promoting economic growth, broad-based participation in growth, and economic security. The author(s) are invited to express their own ideas in policy papers, whether or not the Project's staff or advisory council agrees with the specific proposals. This policy paper is offered in that spirit.

BROOKINGS

Abstract

As emitters of nearly one quarter of all greenhouse gas emissions in the United States, industrial sectors are key players in the effort to mitigate damages from climate change. However, investing in the low-carbon technologies necessary to reduce industrial carbon emissions—particularly for industrial sectors with energy-intensive production processes—can place domestic firms at an economic disadvantage relative to their unregulated, international competitors. In this proposal, I discuss using tradable performance standards as a strategy to reduce industrial carbon emissions. Tradable performance standards would set carbon emission benchmarks tailored to energy-intensive industrial production processes against which a firm’s emissions would be evaluated. Firms with emissions in excess of their benchmark would be required to pay; firms that reduce emissions below their benchmark would receive tradable credits, which can be sold to other firms facing higher emissions abatement costs. The proposal additionally outlines several guidelines and policy choices that must be made during the implementation of tradable performance standards.

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Introduction

In signing the Paris Agreement, nearly 200 nations agreed to keep global temperature rise this century well below 2 degrees Celsius above preindustrial levels and pledged to pursue a target rise of 1.5 degrees Celsius. Although the framework provides for working to strengthen the global response over time, it relies on individual countries to determine their own decarbonization strategies, which to date fall significantly short of the effort needed to meet the stated goals (International Energy Agency 2018).

Economists generally agree that broad-based, global carbon pricing would be a strong and cost-effective policy solution (e.g., Stern and Stiglitz 2017). Although a growing number of countries and jurisdictions have responded to the call—25 emissions trading systems (ETSs), mostly located in subnational jurisdictions, and 26 carbon taxes, primarily undertaken on a national level, have been implemented or scheduled—these systems cover just 20 percent of global greenhouse gas (GHG) emissions (World Bank 2018).¹ Furthermore, average carbon prices remain well below the range needed in 2020 to stay consistent with achieving the temperature goal of the Paris Agreement.

Instead, what one observes among countries taking seriously their ambitions for a low-carbon transition is a mixture of policies targeting the most energy- and carbon-intensive sectors. For example, the European Union (EU), which has the largest functioning ETS, covers only large emitters with that program, and relies on renewable energy mandates, energy efficiency targets, vehicle standards, fuel taxes for end-users of energy, and a variety of policies implemented at the national levels. Perhaps surprisingly, the industrial emitters covered by the explicit carbon price in the ETS face significantly lower effective carbon prices than emitters in sectors covered by fuel taxes or regulations (Verdonk 2019). In several countries, now, there is a push to demand more ambitious decarbonization in the industrial sectors through additional performance standards or carbon floor prices (Böhringer and Fischer 2019).

In the United States concerns for industrial competitiveness and consumer price impacts have long dogged climate policy debates. In 2009 the myriad concessions required

for an economy-wide cap-and-trade program to pass the House (the American Clean Energy and Security Act of 2009, or Waxman-Markey) resulted in a 1,400-page bill that was never taken up in the Senate. The Regional Greenhouse Gas Initiative of the Northeastern states simply avoided covering industrial emissions by focusing only on electricity generation. Only California successfully established a cap-and-trade program covering all sources. Notably, the state had already made greater shifts toward less energy-intensive industries in prior decades, as compared to the nation as a whole (Levinson 2016).

The global experience suggests that successful climate policies are rarely built on textbook versions of cap-and-trade programs or carbon taxes alone. An important additional policy tool is the performance standard—which is the focus of this paper. Performance standards entail benchmarks—determined per unit of output—against which an emitter’s performance is evaluated. Essentially, a performance standard requires firms to pay a price for their emissions in excess of the benchmark and may also offer credits to firms reducing emissions below the benchmark. In contrast, under the simplest version of a carbon tax, firms pay in proportion to their total emissions.

Performance standards are familiar policies that have traditionally commanded popular support. They are appealing because the benchmarks set a tangible goal and identify known technologies that can be reasonably deployed by industries. Majorities of Americans—from both parties—consistently favor the idea of industrial performance standards, renewable energy standards (University of Michigan 2015), and fuel economy standards (Newport 2018). This popularity stands in stark contrast to support for direct carbon pricing; only among left-leaning Americans (and among economists) can consistent support for carbon taxes be found (Newport 2018). Opinion polls in Europe reach similar findings (Bedtsed, Mathieu, and Leyrit 2015). Carbon taxes rely on the invisible hand using a visible tax; performance standards make the regulatory hand more visible than the emissions price, although the latter can still play a strong role.

Moreover, as this proposal explains, performance standards can be made relatively efficient. In a number of circumstances,

they even have economic advantages relative to simple national carbon pricing. This proposal discusses many performance standard design questions, but two key features deserve special emphasis: First, performance standards must be tradable (or carbon levies must be refundable) to provide consistent incentives for emitters to reduce emissions even when they have already met the standard. Second, energy-

intensive, trade-exposed (EITE) sectors deserve to be treated differently from how other sectors are treated, with benchmarks that offer more protection from the cost effects of climate policy. Though comprehensive carbon pricing remains the ideal policy option in many circumstances, well-designed performance standards also have an important role to play.

The Challenge

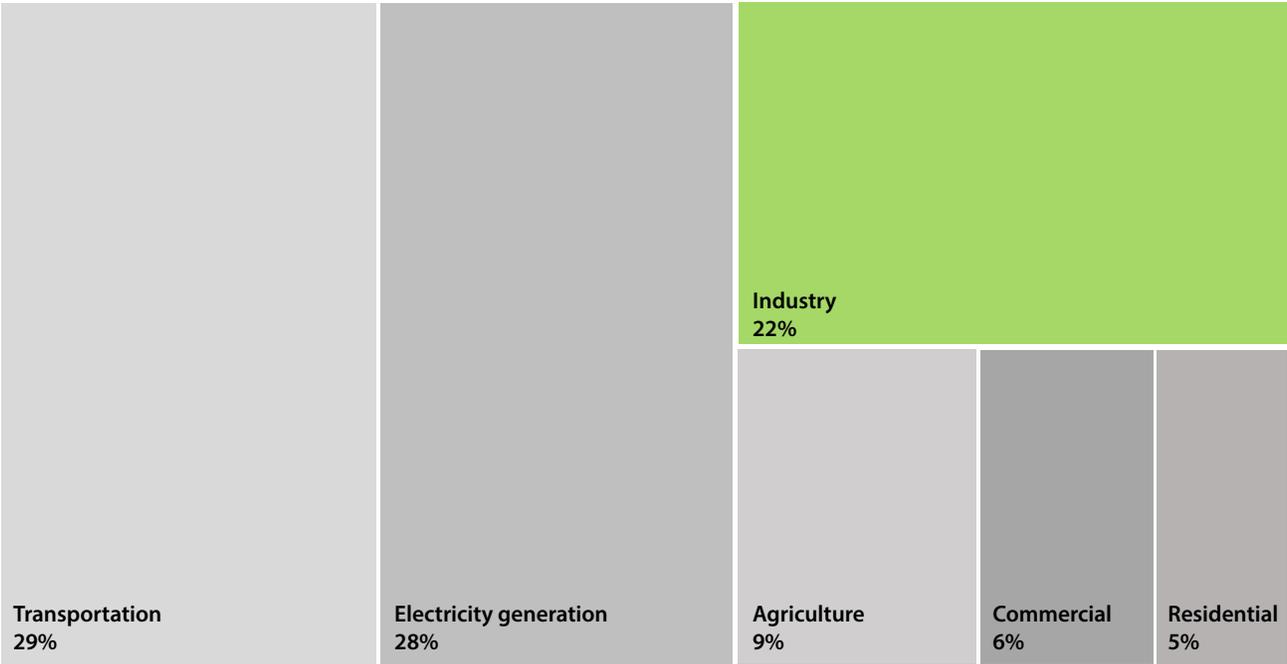
We cannot ignore industrial emissions if we want to take the climate challenge seriously; they account for 22 percent of U.S. carbon emissions (figure 1). At the same time, climate-conscious consumers, businesses, and governments are increasingly demanding goods, procurement, investments, and construction with low carbon footprints. Therefore, U.S. industries will need to decarbonize not only to address climate change, but also to be internationally competitive in the future. This decarbonization is possible only with significant investments (Bataille et al. 2018).

The challenge is to decarbonize industry in a way that is both tractable and cost effective in the absence of broad-based national—and international—carbon pricing. Energy-intensive manufacturing is often considered to be the “hardest nut to crack” (Carbon Market Watch 2019). While the technologies to generate clean electricity are widely known and increasingly available at competitive costs to power users, it is more difficult to decarbonize industrial processes.

Substantial new innovation is necessary for industrial processes to become clean, and that innovation is unlikely to occur without financial reward to developing them. One way to provide such a reward is to price the carbon emitted by energy-intensive manufacturers. However, such direct pricing is almost never done because, unlike electricity generators, manufacturers of energy-intensive commodities are often highly exposed to international competition. Simply charging a high price for the emissions of these manufacturers is likely to drive some economic activity out of the country, shifting the location of production but not lowering global emissions.

In the United States many of the largest sources of industrial emissions come from energy-intensive, trade-exposed (EITE) sectors (figure 2), including the production of metals like steel and aluminum, minerals like glass and cement, chemicals, and pulp and paper. Tackling those emissions must be done in a way that encourages the industries to invest in low-carbon techniques at home, rather than seek low carbon costs abroad.

FIGURE 1.
Total U.S. Greenhouse Gas Emissions by Sector, 2017



Source: United States Environmental Protection Agency 2017a (Inventory of U.S. Greenhouse Gas Emissions and Sinks).
Note: Total may not sum to 100 percent due to rounding.

Given the infeasibility (at least in the short run) of establishing a global carbon price, the first steps toward encouraging cleaner industrial production will not—and arguably *should* not—involve the economist’s view of a pure carbon price. However, carbon pricing is a powerful instrument for environmental change that cannot be ignored; the path we go down should also be one that facilitates transitioning toward economy-wide carbon pricing in the future when that option becomes more feasible.

Part of the challenge of decarbonization—and the focus of this proposal—is to use sector-based clean performance standards in an efficient and effective way, providing heavy industry with incentives to begin making the necessary investments and innovation in low-carbon manufacturing techniques. Those standards would address carbon leakage concerns (i.e., the substitution of foreign for domestic activity), use market mechanisms to encourage cost-effective abatement decisions across firms and facilities, allow for periodic increases, and enable linkages across sectors and with other carbon-pricing mechanisms.

Before detailing the proposal, it is helpful to discuss the economic basis for performance standards. Variants of performance standards have been deployed around the world, with lessons for how policies might be designed at home, either at a federal- or a state-level jurisdiction.

THE ECONOMICS OF PERFORMANCE STANDARDS

There are legitimate economic rationales for considering market-based clean performance standards as part of a broader decarbonization policy program. First, we define

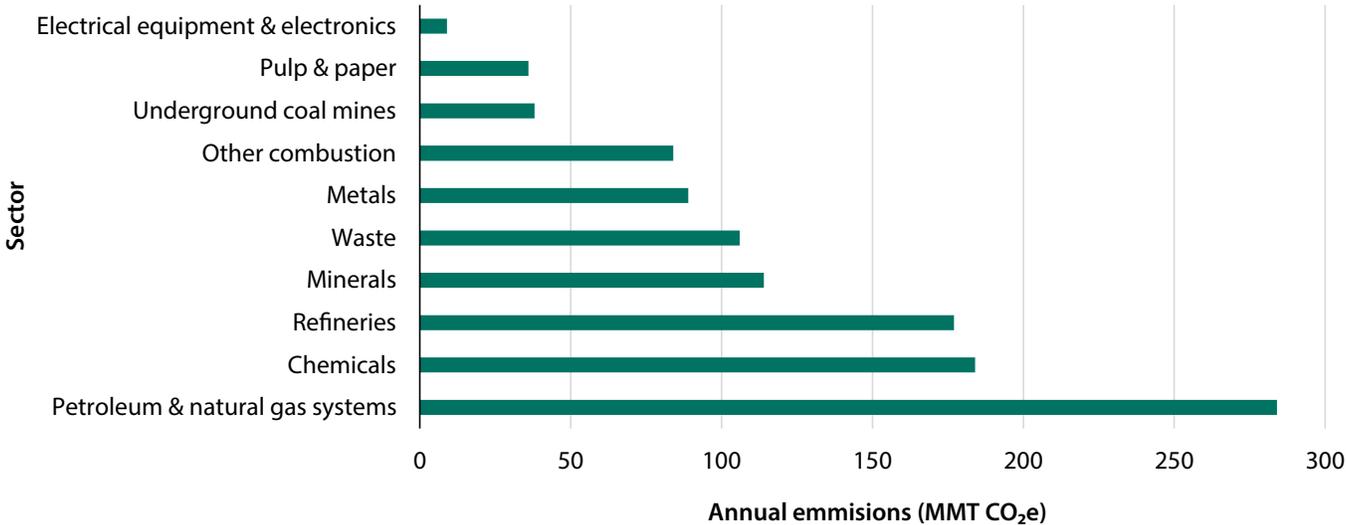
what we mean by these policies, and then consider some of the economic evidence.

Performance standards come in many forms. The essential component of a performance standard is the *benchmark* against with a firm’s performance is evaluated. Since firms come in all shapes and sizes, the benchmark is a sector-specific target of emissions per unit of output.

A classic regulation would stipulate that firms are expected to emit no more per unit of production than the benchmark. If they exceed that threshold they are subject to a penalty, and do not receive credit for reducing emissions below the benchmark. We will focus instead on performance standards that incorporate *flexibility mechanisms*, such as tradable credits or refundable taxes. That is, firms emitting in excess of the benchmark on a per unit of output basis must pay for those excess emissions, and firms emitting below the benchmark get credits for those reductions.

Tradable performance standards (TPSs) embody this logic. An average emissions rate target is determined for the covered sector (e.g., refineries), and firms that can lower their emissions intensity relatively cost-effectively will choose to reduce their emissions below the target, receiving credits in exchange. They then sell the credits to firms with relatively high costs of reaching the target. A TPS was used successfully in the United States to phase out lead in gasoline. Americans are also familiar with Corporate Average Fuel Economy (CAFE) standards, under which manufacturers must meet a maximum average fuel consumption intensity for their vehicles. CAFE allows tradable credits for compliance.²

FIGURE 2. U.S. Industrial Emissions by Sector, 2017



Source: United States Environmental Protection Agency 2017b (Greenhouse Gas Reporting Program).
 Note: CO₂e refers to emissions of carbon dioxide and carbon dioxide equivalents; MMT refers to millions of metric tons.

The benchmarks in the TPS can be considered a form of output-based free allocation: For each unit of production, the firm gets credits in the amount of the benchmark for free. These credits are valuable, since they can be sold if not used. For this reason, such benchmarking policies are also referred to as output-based rebating (OBR). With OBR, instead of collecting revenues from taxing emissions or auctioning allowances, the government returns the revenues to the firms in proportion to their output. Importantly, the government does not allocate allowances only to preexisting firms, nor do they distribute them on the basis of current emissions, but rather on the basis of current output.

OBR has also been used in conjunction with emissions taxes. Sweden uses a refundable emissions tax to control emissions of oxides of nitrogen. By returning the revenues to the affected power plants, regulators in Sweden were able to implement a higher emissions charge than otherwise, which has led to greater reductions (Sterner and Höglund-Isaksson 2006).

In a cap-and-trade system, OBR can be implemented with output-based allocation of emission allowances. Most ETSs that cover industrial emitters—including California, China (pilot systems), the EU, Korea, and New Zealand—use some form of production-based benchmarks (World Bank 2018).

Americans are already familiar with renewable portfolio standards (RPSs), which are perhaps the most widely used tradable credit programs in the United States. Most states use RPSs to meet renewable market-share targets in the power

sector. For example, utilities might be required to generate 30 percent of their electricity from renewable sources. Market-based, clean performance standards share some features with RPSs but also differ in several ways (box 1).

Although both use tradable mechanisms to achieve their objectives, they do not have the same targets. RPSs are designed to promote specific types of technologies; although they may reduce emissions by displacing fossil energy sources, they do not target (or create a price for) emissions directly. Market-based clean performance standards, by contrast, do put a price on emissions, and therefore offer a broader array of incentives to reduce them.

MARKET INCENTIVES WITH OUTPUT-BASED REBATING

Carbon pricing is typically considered an ideal solution because it can influence not only the choice between fossil fuel and renewable energy sources, but also a whole host of decisions made throughout the entire supply chain, exploiting opportunities for reducing emissions, improving resource conservation, finding cleaner substitutes, and avoiding carbon costs. By the same token, the typical concern about OBR is that, by exempting some emissions from being priced, the societal costs of those emissions will not be passed on to subsequent links in the chain, and many of those opportunities will not be taken. However, this logic excludes some important considerations that will be discussed below.

BOX 1.

Differences between Market-Based Clean Performance Standards and Renewable Portfolio Standards

	Market-Based Clean Performance Standards	Renewable Portfolio Standards
Aim	Reduce the emissions intensity of output to or below a maximum standard	Increase the market share of a given clean production technology (e.g., renewable sources as a percent of generation) to or above a minimum standard
What is traded?	Emission allowance	Green certificate
What generates a credit? (What is implicitly subsidized?)	One unit of output by any entity in the sector receives a benchmark allocation	One unit of output by a qualifying technology (renewable electricity) receives a green certificate
What generates a liability? (What is implicitly taxed?)	One unit of emissions by any entity in the sector necessitates the surrender of an allowance	One unit of output by any entity in the sector (electricity) necessitates the surrender of a percent of a certificate

Figure 3 illustrates the different cost components of compliance with a carbon tax, expressed per unit of output. The firm will choose to abate its emissions as long as the incremental (marginal) cost of doing so is less than the carbon price; for the remaining (embodied) emissions, the firm prefers to pay the price rather than abate its emissions. The actual compliance costs—the costs that society pays to abate emissions—are represented in the dark green shaded area. The larger, light green rectangular area represents the costs of paying for the remaining emissions embodied in each unit of production. In most cases, unless the emissions reduction target is very large or the cost of extensive abatement is very low (a flatter marginal cost curve), the rectangle of emissions costs will be larger than the triangle of compliance costs.

Benchmarking or OBR (shown in figure 4) reduces the burden on firms by relieving them of some responsibility for paying for the embodied carbon costs. This can dramatically reduce the costs that firms need to pass on to purchasers of their products.

From the firm’s perspective, it still faces the socially efficient incentive to abate emissions—since it pays the full carbon price for any additional emissions—but it has less total pressure on its costs. That certainly makes performance standards more palatable to the firm than full carbon pricing. From society’s perspective, however, the question is less clear. How important is it from a decarbonization perspective that the firm’s consumers face the embodied carbon costs? In other words, will the price that consumers face be too low to encourage the full range of behavioral changes that a carbon price could achieve?

RATIONALES FOR OUTPUT-BASED REBATING

Not requiring firms to pay embodied carbon costs has a clear downside: the diminished incentives for consumers of

the carbon-intensive products to use less of them or to seek out alternative products. That means that cleaner substitutes are not on a level playing field with the traditional energy-intensive products. Firms will expend more effort improving the processes of the traditional products than developing alternative products.

However, there are a number of circumstances in which lessening the carbon cost pass-through can *enhance* the efficiency of the carbon price. Notably these are situations when other market or policy imperfections are in play, meaning that perfectly pricing the social cost of carbon emitted by an industry does not alone lead to an efficient allocation of resources.

Carbon Leakage

The first and most important advantage of OBR is that it can mitigate carbon leakage, which is a problem in the absence of a global price on carbon. Carbon leakage is defined as the increase in foreign emissions resulting from a policy to reduce domestic emissions. Due to intense international competition, firms may be limited in their ability to pass on costs to their consumers. EITE firms in particular, which produce highly traded and easily substituted commodities, face this challenge. If they attempt to recoup increased costs of emissions by charging higher prices for their products, they risk losing market share to foreign competitors that do not face a comparable burden. If they do not raise prices, their profitability falls and investments may be driven elsewhere. In both cases, the reduction in emissions at home from diminishing production are partly (or even more than) offset by increases abroad. Thus, for industries whose foreign competitors are not asked to pay for their embodied carbon, OBR keeps the playing field more level and thus helps mitigate carbon leakage (Fischer and Fox 2012a).

FIGURE 3.
Costs per Unit of Output of Complying with a Carbon Tax

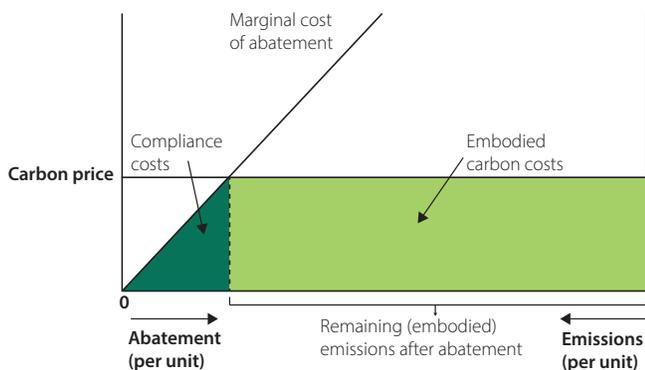
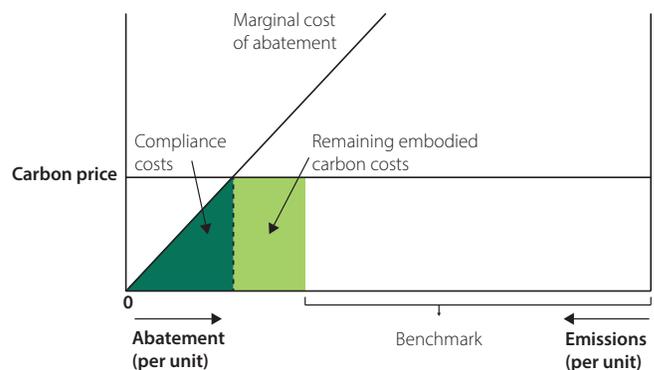


FIGURE 4.
Costs per Unit of Output of Complying with a Carbon Price and a Benchmark



OBR is not the most direct way of addressing carbon leakage—making sure that everyone pays the same carbon price would be. Absent global carbon pricing, policymakers could ensure that consumers pay for all embodied carbon by using border carbon adjustments (BCA). Although arguably more efficient than OBR in theory, BCA is technically challenging, diplomatically controversial, and possibly vulnerable to World Trade Organization (WTO) legal challenges (Cosbey et al. 2019). OBR is thus a next-best solution, and one must weigh the costs of poorer consumer signals against the benefits of avoided carbon leakage. For products that face strong competition from close substitutes—in the absence of global carbon pricing or BCA—those potential consumer signals are muted anyway, making OBR a strong second to the ideal policy (Bernard, Fischer, and Fox 2007).

Directing Innovation

For important carbon dioxide (CO₂)-intensive industries like the chemical, cement, and steel industries, reducing emissions requires much more than procuring power from renewable sources or tweaking production methods. Addressing these emissions will require significant innovation and investments in low-carbon industrial processes, which entail large, up-front capital costs. Although a strong future carbon price signal is necessary for such investments to have value, OBR can further support emissions pricing in three ways.

First, forgiving embodied carbon costs (i.e., implementing a policy like OBR that does not require firms to pay for embodied costs) leaves firms with more cash flow to finance investments. Similarly, improving profitability should also improve access to capital. Second, by keeping domestic firms competitive and helping them maintain a stronger market presence, OBR raises the value of making such investments, since a positive return is more likely. Third and finally, there is growing evidence of path-dependence in energy- and environment-related innovation, wherein traditional dirty technologies have an advantage (Aghion et al. 2016). The levels of carbon prices needed to break the cycle and shift research efforts toward clean technologies are higher (and possibly unacceptably high) when the policy must act alone (Acemoglu et al. 2012). Supporting clean innovation directly helps this transition, and a Hamilton Project proposal by David Popp aims to do precisely this (2019). But so does supporting the output of the industry adopting the clean technologies, which expands the market for the fruits of investments in clean innovation.

Inequality in Consumer Impacts

Less carbon cost pass-through can mean smaller impacts on consumers. In addition, it can have less divergent impacts on consumers. For example, in the power sector, studies have shown wide variation in expenditures not only across

the income distribution but also for consumers with similar incomes. The disparities imply that even a carbon tax that is redistributed in seemingly progressive ways (similar to citizen dividends) will hit some people on the lower end of the distribution hard.³ Furthermore, those in the middle class with similar income and family profiles may have wildly different cost impacts, depending on where they live or their particular circumstances, which may be out of their control. OBR in this case helps maintain horizontal equity by limiting the price increases that drive the unequal cost impacts (Fischer and Pizer 2019). Figure 5 shows this comparison of impacts across and within income groups; note that the range of potential impacts are much more narrow for the TPS (shown in green) than they are for the cap-and-trade approach (shown in purple). Of course, avoiding too much within-group (horizontal) inequality with OBR means there is very little remaining revenue to rebate to households to smooth the impact on low-income consumers. In figure 5 we see this effect: the *average* change in income is slightly negative for all groups under the TPS, while on average the poorest groups would see their net income rise with a cap-and-trade. Thus, there can be some tension between the two different types of social inequality that could be important to policymakers.

Uncertainty about Consumer Demand

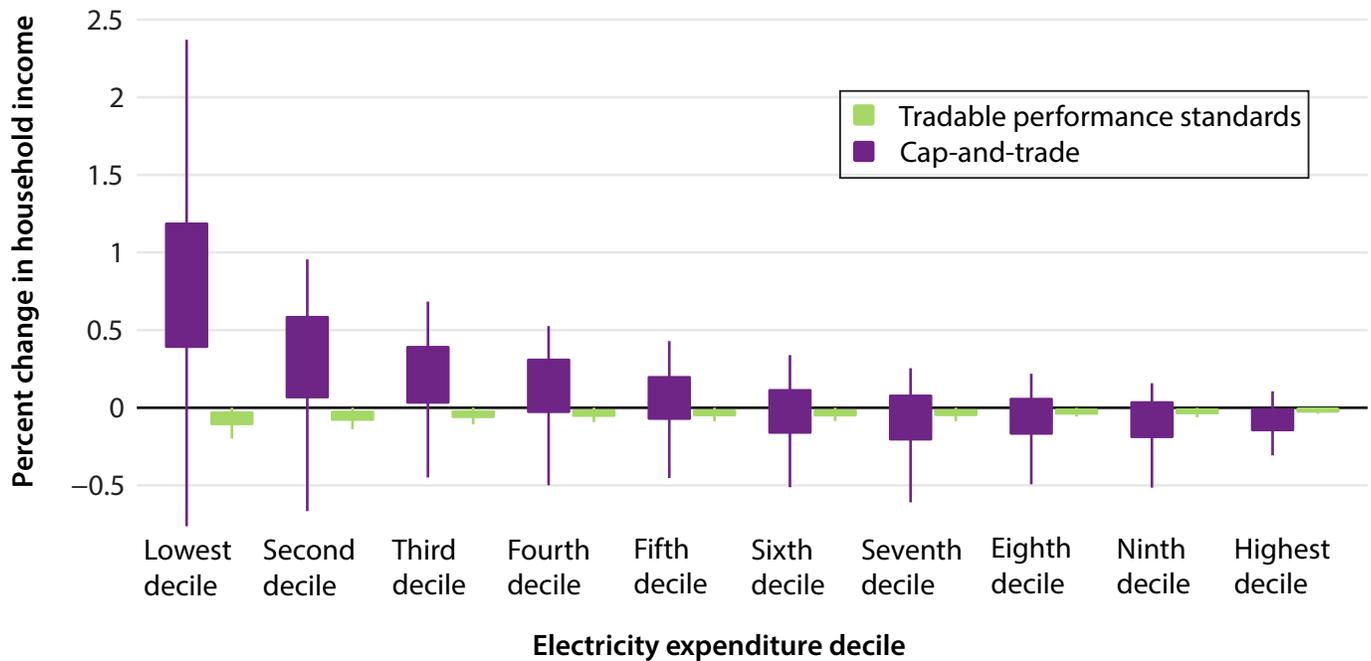
When future demand for output is highly uncertain, such as due to macroeconomic fluctuations or changing consumer tastes, the costs of capping emissions at a specific level are also uncertain, especially on a sectoral basis. For example, in the event of a recession, demand for emissions falls but a cap does not, resulting instead in a large drop in allowance prices; this drop was observed in the EU during the Great Recession. In this case, tradable performance standards can be preferable to a fixed cap on emissions in the sector, because they allow for some emissions adjustment as the economic situation evolves (Kellogg 2019).⁴ In the long run, because of the support to output, OBR maintains higher levels of economic activity (employment, capital, and output) for a given emissions target. Furthermore, accounting for business cycle fluctuations, OBR can meet emissions targets with lower expected costs than with a cap or tax, and less volatility than with a tax alone (Fischer and Springborn 2011).

Other Market Distortions

Climate policies are implemented in an economy with numerous other distortions. In some cases, these preexisting distortions in other markets can be exacerbated by a climate policy, particularly if that policy has large effects on product prices. Limiting those interactions can therefore help improve efficiency. For example, the taxation of labor income creates a disincentive to supply labor, and price increases arising from a carbon price tend to further erode the real wage and exacerbate that problem (Parry and Oates 2000). By

FIGURE 5.

Comparison of Tradable Performance Standards and Cap-and-Trade



Source: Bureau of Labor Statistics 2014 (Consumer Expenditure Survey); Fischer and Pizer 2019.

Note: The simulation assumes a total compliance cost of \$10 per household, while the value of total embodied carbon would cost an additional \$93 per household. The distribution of individual electricity expenditures is based on the 2014 Consumer Expenditure Survey. Boxes indicate interquartile range (25th to 75th percentile). Vertical lines, or whiskers, show the range of values outside the interquartile range, excluding extreme values. Analysis based on Fischer and Pizer (2019).



some estimates, the cost of these tax interactions can be on the same order of magnitude as the cost of carbon leakage (Fischer and Fox 2012b). These costs depend importantly on how revenues from climate policy are used: If they are used to improve the efficiency of the tax code—substituting for other types of tax—then costs from tax interactions would be reduced. If the revenues would not lead to reduced taxation elsewhere (or to efficient additional government spending), OBR can be an attractive complement to carbon pricing by limiting the price increases that drive tax interactions in the first place (Fischer and Fox 2011). Of course, as noted before, emissions revenue has many potential uses, of which OBR is one, and there are inherent trade-offs between addressing inequality and reducing the efficiency costs of taxation.

Markets may also be distorted by regulations or barriers to competition. For example, electric utilities are natural monopolies and must charge prices above their marginal costs to recover their average costs. As a result, residential electricity rates in much of the U.S. are often higher than the social marginal costs—inclusive of carbon emission costs as well as marginal production costs—even before carbon pricing (Borenstein and Bushnell 2019).

For all these reasons, performance standards can be an economically sensible approach to regulating emissions. For EITE sectors, the issues of carbon leakage and directing technical change, as well as uncertainty, are the strongest rationales. For those sectors, the ability of firms to pass increased costs is lower and the potential efficiency loss of OBR (relative to carbon pricing) is therefore smaller, as are the potential interactions with other market distortions. For energy-intensive sectors that are not trade-exposed—like electricity—the efficiency costs of subsidies are more pronounced, so the rationale for OBR depends more on the political-economy and macroeconomic interactions, as well as one’s particular concerns about social equity.

Climate policy should not wait for an economist’s ideal approach to be implemented. Market-based clean performance standards have a strong role to play not only in the low-carbon transition, but also in the transition to low-carbon policy. Because benchmarks are by definition product- and sector-based, performance standards offer an opportunity to begin decarbonization in key sectors without the need for a comprehensive, economy-wide carbon pricing policy. In fact, many jurisdictions have gone this route, as described below.

Experience with Intensity Standards

Some form of benchmarking (e.g., OBR) has been used in most of the jurisdictions that have chosen to regulate carbon emissions in a market-based manner. Variants of output-based allocation of emission allowances are used in cap-and-trade programs in California; New Zealand; Québec, Canada; the former system in Australia; some sectors in the Republic of Korea; and some sectors in most of the Chinese pilot programs (World Bank 2018). Output-based performance standards have been used in Alberta, Canada, and now form part of the Canadian Federal backstop climate policy. These different experiences shed some light on the benefits and pitfalls of different design choices.

OUTPUT-BASED ALLOCATION IN CAP-AND-TRADE SYSTEMS

U.S. Experience

Although its proposed economy-wide cap-and-trade system did not become law, the Waxman-Markey bill (American Clean Energy and Security Act) of 2009 actually pioneered the use of output-based allocation for EITE sectors to address competitiveness and leakage issues, under the section “Ensuring Real Reductions in Industrial Emissions” (Fischer and Fox 2011).

Waxman-Markey defined EITE sectors as manufacturing sectors (excluding refining) that are at least 5 percent energy (or CO₂) intensive and 15 percent trade intensive, or 20 percent energy intensive; other sectors may petition for inclusion. Applying these criteria, 44 of nearly 500 industries were presumed eligible (at the six-digit level of the North American Industry Classification System), with most of them concentrated in the manufacture of primary goods—chemicals, metals, nonmetallic minerals (e.g., cement and glass), and some minerals processing (EPA 2009).

Free allowance allocations were explicitly output-based. Firms in eligible sectors would get free allowances based on their production levels, multiplied by a sector-specific carbon benchmark, initially equal to 100 percent of sector average emissions; both direct and uncompensated indirect emissions costs are included. Allocations were to be updated annually, based on average production in the most recent two years. A provision was made to phase out these allocations over 10

years starting in 2026—unless the president deemed them to still be necessary.

The system currently implemented in California drew on lessons from Waxman-Markey, as well as the EU experience discussed below. To identify sectors prone to leakage, California uses similar metrics but assigns different levels of leakage risk. California identified 16 sectors as high risk (trade intensity > 19 percent), 13 as medium risk, and 3 as low risk (trade intensity < 10 percent).⁵ Free allocation is initially generous for all but will be phased out more quickly for lower levels of leakage risk.

European Union Emissions Trading System Treatment of Industry

The EU ETS is the world’s first and largest cap-and-trade system for CO₂ emissions, although it primarily covers just the power sector and major industrial emitters. It has evolved through several phases. In the first two phases (2005–7 and 2008–12), national allocation plans were used to distribute allowances; nearly all the emission allowances were allocated for free and the cap was overallocated. For the third and current phase (2013–20), the determination of the cap was centralized to the European Commission. The cap was tightened, and free allocations were rationalized with common rules; free allocations were also rationed, moving toward greater use of auctioning. The ETS no longer grants free allocation to the electricity sector. Instead, it switched to output-based benchmarks for the manufacturing sectors, and it is gradually ratcheting down those allocations with the intent to focus on the EITE sectors most exposed to carbon leakage (European Commission n.d.a).

The allocation system is a hybrid between grandfathering—a fixed, unconditional allocation based on some historic factor unrelated to current practices—and output-based allocation, which is conditional on production. A grandfathered allocation is essentially a windfall to current firms—a fixed amount of carbon cost compensation for lost profits that they can take to the bank whether or not they continue producing. In contrast, under OBR a firm gets free allowances based on how much it produces, which has the effect of subsidizing production and offsetting losses to competitiveness.

In the EU, each installation's free allocation is calculated using product-specific benchmarks, as one would expect with OBR. The allocations are fixed for the entire trading period, as is normal with grandfathering, but they can be adjusted in response to changes in a firm's production or capacity levels beyond given thresholds. Furthermore, firms can expect benchmark-based readjustments with each new phase. As a result, the longer-run incentives generated by the system are more similar to those of OBR than those of pure grandfathering.

For the most part, the product benchmarks were arrived at by calculating the average GHG emissions (per ton of product) of the best-performing 10 percent of the installations producing each designated product in the EU. At the beginning of the current trading period in 2013, manufacturing industry received 80 percent of its benchmarked allowances for free, and that will fall to 30 percent in 2020. Delineating the products was a task in itself: After a great deal of technical work and consultations, the Europeans arrived at 54 benchmarks. At that point, an official list of sectors and subsectors deemed to be exposed to a risk of carbon leakage was compiled (totaling 175 products); these sectors get 100 percent of their benchmark allocation.⁶

Thus, we see that the EU has phased in greater carbon pricing and phased out free allocation. By the end of Phase 4, only sectors at highest leakage risk will receive free allocation. Furthermore, those criteria will become more stringent, requiring a higher combined score of emissions intensity and trade exposure.

TRADABLE PERFORMANCE STANDARDS

Canada

The Canadian Federal backstop policy applies to provinces not otherwise meeting carbon pricing and reduction objectives. The policy, designed by the federal department Environment and Climate Change Canada, imposes a carbon tax (initially \$20/tCO₂) on fuels; large polluters, however, are exempt from this tax, and instead face a separate Output-Based Pricing System (OBPS). Facilities covered by the OBPS get an industry-specific emissions intensity benchmark (in tons of CO₂ equivalents per physical unit of output, i.e., tCO₂e/MWh, or tCO₂e/ton of steel). Their compliance obligation equals this benchmark times their annual production. If the facility's emissions fall below this obligation, the facility is granted tradable compliance credits for the difference. If a facility's annual emissions exceed its benchmark allocation, it must meet the compliance obligation by surrendering saved or purchased credits for the difference or pay the going carbon fee to the government. The benchmarks are set at 80 percent of average industry emission intensities, with 90 percent of the average being granted for certain sectors deemed highly exposed to carbon leakage, including the cement, fertilizer,

and iron and steel sectors. The fact that benchmarks are set below 100 percent of the average emission intensity is intended to result in positive credit prices. However, these prices are bounded above by the compliance alternative of paying the carbon fee, which constitutes a ceiling price for credits. (Credits cannot be used for compliance by non-OBPS entities.)

After deliberations and industry consultations, Environment and Climate Change Canada decided to establish separate benchmarks for many production processes, such as processes used in the manufacture of steel products. Notably, separate benchmarks are being given to electricity sector emitters, differentiated by fuel source, and renewable energy sources receive no credits (Environment and Climate Change Canada 2019). This decision was taken to limit economic displacement in the short term, but is likely to greatly reduce the effectiveness of the market mechanism. Since with OBR the production subsidy is in proportion to the benchmark, sources with bigger benchmarks (larger emitters) get bigger subsidies. This kind of benchmark differentiation thus diminishes incentives to switch fuels as a way of reducing emissions. For this reason, the differentiation will be phased out over time as the benchmark for coal declines toward the emissions intensity of natural gas by 2030; coal-fired generation would require carbon capture and sequestration to meet that target. Most provinces have separate targets for renewable energy, which may offset the exclusion of renewable sources from the benchmarks.

Alberta, Canada

The province of Alberta pioneered a form of carbon pricing with benchmarking. The Specified Gas Emitters Regulation (SGER) took effect in 2007, requiring facilities emitting more than 100,000 tons of CO₂ annually to reduce their carbon emissions intensity by 12 percent within a decade. Regulated entities—many of which involved oil sands producers or heat and power generators—could reduce their emissions directly through operational improvements, or comply by buying locally sanctioned offsets or by paying \$15 per ton to a technology fund; the latter solution has occurred in many cases.⁷ Although important symbolically, by some estimates the SGER reduced emissions in Alberta by only 3 percent relative to what they would have been without the SGER (Dobson and Winters 2015). SGER baselines (benchmarks) were facility specific; this design discouraged the efficient use of cogeneration (i.e., the simultaneous generation of electricity and useful heat), since facilities already using efficient technologies were not credited for doing so. In 2017 an economy-wide price on carbon was introduced, and in 2018 SGER was replaced with the Carbon Competitiveness Incentive Regulation. Under the new regime, benchmarks became product specific rather than facility specific, thus essentially implementing output-based allocation of emissions credits.

The Proposal: Building the Blocks

Market-based performance standards can be a part of building or extending a climate policy, sector by sector. They are especially useful when comprehensive carbon pricing faces technical or political difficulties or when carbon leakage risks are significant. Market-based performance standards encourage cost-effective improvements in emissions intensity without imposing on firms the larger costs of paying for embodied carbon, which puts domestic firms at a disadvantage vis-à-vis unregulated competitors. This makes performance standards well suited for unilateral implementation, such as by a state, a group of states, or a national government. In this section, we discuss the main design choices.

THE BASICS

Choose the Policy Target

As noted above, there are three main types of market-based performance standards. Each of these options combines an emissions price with an OBR. The choice of which to use depends on which element of climate policy one would like to set—and ultimately to which kind of policy one would like to build up in the long run.

The first option is to set the carbon price and refund some or all of the revenues via an OBR. Many economists advocate fixing prices rather than quantities for carbon emissions, largely because this policy performs better when there is uncertainty about how costly it is to reduce emissions (Cramton et al. 2017; Metcalf 2019). In addition, establishing certainty about the carbon price is useful to investors seeking assurance of a return to clean investments. Incorporating new sectors into the policy immediately implies price harmonization (an important metric of efficiency) without setting up a complex trading system. A carbon tax also sets a strong focal point for coordination across jurisdictions, and an obvious basis of comparison of ambition.⁸

However, in most jurisdictions a tax requires a legislative process and different technical expertise and agency authorities than an environmental regulation, which can make building coverage across jurisdictions more difficult. Thus, an output-refunded emissions tax can be more appropriate for a large system of emissions pricing, either at

the federal level or for dealing with EITE sectors in a state that is implementing an economy-wide carbon price.⁹

The second option is to set total emissions in the sector with a cap, and then allocate allowances based on output. This choice creates certainty about meeting quantitative emissions goals, but emissions prices will be uncertain. Of course, it can be difficult to justify a specific emissions target for an individual industrial sector for a global pollutant with so many diverse sources and abatement opportunities. Multiple narrow caps will lead to very different prices and marginal abatement costs—unless trading is allowed across them. Furthermore, policymakers tend to worry much more about unexpectedly high prices than they do about low ones, and therefore tend to overallocate emissions caps. EU ETS prices have been much lower than the implicit marginal abatement costs in non-ETS sectors, and California and Regional Greenhouse Gas Initiative prices have been supported by the floor price as much as by the stringency of the cap (Burtraw, Palmer, and Kahn 2010). Thus, this option is best if one plans to build quickly to a multi-sector, multi-jurisdictional cap-and-trade system, in which the various caps components system-wide can be set with sufficient stringency.

The third option is to set emissions intensity with a tradable performance standard. In this case, average emissions per unit are fixed, while total emissions and their prices are uncertain. This choice is appropriate for sector-specific policies where the goal is implementing an intensity reduction through changing technologies and processes. For example, a broadly acceptable carbon price may not be sufficient to bring forth novel technologies. A TPS can allow for a more ambitious goal by appealing to the public's preferences for technological solutions. An emissions price will still emerge from the market mechanism but may be less publicly prominent.¹⁰

Of course, separate standards lead to different prices and marginal abatement costs across sectors, as much as separate caps would. In the preceding example, the TPS was intended to supplement a carbon price and realize sector-specific technological ambitions. However, TPS can also be used as a stepping-stone toward broad-based carbon pricing by broadening and linking the TPS to other systems. Like a cap-and-trade regime with OBR, TPS can be developed as

a regulation, and proper coordination can allow for linking through credit trading, as discussed below, which serves to harmonize carbon prices across the linked sectors.

Ultimately, these policy options can all deliver cost-effective reductions in emissions, assuming that problems of market power can be avoided in both emissions trading and rebating. Of course, the options differ, such as in their response to uncertainty, but they can each also be modified to adopt some of the characteristics of the other mechanisms, such as with floor prices or safety valves (also discussed below). The preferred choice may simply be whatever version is the most politically and administratively feasible for the jurisdiction undertaking it (and for likely linking partners) and allows the greatest ambition in reducing emissions.

Choose the Sectors

Typically, the power sector is the first to be covered by a carbon pricing plan, either through carbon-inclusive fuel taxes or cap-and-trade. Often, it is the most important to address, since it is responsible for a large share of GHG emissions, as shown in figure 1. Next come the large industrial emitters, followed by other fossil fuel users more broadly. (The transportation sector is equally important, but as a collection of non-point-source emitters, it is often treated separately.) We will focus on the thornier problem of the industrial sectors, but first discuss the power sector, since its inclusion will affect the treatment of downstream sectors.

As evidence of the paramount importance of the power sector, no jurisdiction that has put in place a carbon price has excluded the power sector (World Bank 2018). Whether the power sector is a good candidate for performance standards depends on answers to two questions. First, could a significant amount of fossil-based electricity be imported from outside the regulating jurisdiction? Second, would pricing the carbon embodied in electricity cause sufficiently large and heterogeneous impacts as to render an ambitious carbon price infeasible?

Most jurisdictions do not use performance benchmarks in conjunction with carbon pricing for the electricity sector, with the exception of the Canadian Federal backstop OBPS.¹¹ The EU quickly phased out free allocation to power producers in its ETS, recognizing their ability to pass carbon costs on to consumers. With little extraterritorial electricity trade, carbon leakage from that sector is not a concern for the EU. States in the Regional Greenhouse Gas Initiative, which covers only the power sector, avoided output-based allocations; instead, some states invested in demand-side reductions that relieved pressure on retail electricity prices. California, being exposed to electricity trade with other states, requires imported electricity to pay for a measure of embodied carbon, rendering OBR unnecessary for that sector. In other words,

they use border adjustments rather than OBR. Alberta, facing pressure to limit consumer impacts, instituted a cap on electricity prices that, once reached, would be maintained using carbon levy revenues. Alberta thus achieved the aim of OBR—to allocate the emission revenues in a way that keeps product prices from rising—but with direct price controls rather than a market-based way.

In contrast, OBR is common for industrial sectors covered by carbon pricing regimes. Benchmarks for free allocation are used in the EU's ETS, New Zealand's ETS, Alberta's carbon levy, Canada's OBPS, and California's cap-and-trade system. When implementing OBR in these cases, the important question is how to identify which sectors should have their products eligible for benchmarking allocations. Since the consumer impacts of pricing the carbon content in industrial commodities (which are ultimately embodied in final goods) are relatively small, distributional effects are less of a concern than they are in the power sector. However, for sectors that are both energy-intensive and trade-exposed (EITE), carbon leakage is a legitimate concern. These are the sectors that are limited in their ability to pass on embodied carbon costs and thus are the sectors for which substantial carbon costs may put them at a significant competitive disadvantage on international markets. These sectors are thus good candidates for using a form of tradable performance standards to encourage emissions reductions.

Most jurisdictions use two criteria for determining eligibility: (1) carbon cost exposure and (2) trade exposure. For the former, CO₂ intensity (e.g., tons of direct and indirect GHG emitted by the sector per value added) multiplied by the projected emissions tax or allowance price is a preferred measure (Cosbey et al. 2019). It is important that the first criterion be an appropriate *cost exposure* threshold, rather than simply carbon or energy intensity. The cost burden is determined by the combination of carbon intensity and carbon price, so little leakage is expected with low carbon prices. For the second criterion, trade intensity—measured as the value of imports and exports in the sector relative to total production plus imports—is commonly used. Although it is not a perfect measure of the extent to which trade competition would impede the ability to pass on carbon costs and cause leakage, it is transparent, readily available, and a reasonable approximation of trade exposure.¹² Because firms in sectors that may be asked to pay a carbon price will lobby for preferential treatment, the criteria and thresholds for selecting eligible products must be fixed and transparent.

Although several jurisdictions have made eligibility for OBR conditional on meeting one of the criteria, most experts emphasize the importance of requiring sectors to meet criteria for *both* trade and carbon exposure (Cosbey et al. 2019). Failure to do so can make for a poorly targeted policy that

unnecessarily protects some industries and fails to sufficiently protect others. In the current phase of the EU ETS (2013–20, Phase 3), the designers allowed coverage of firms that were trade-exposed without also being GHG-intensive, with a resulting 175 products designated vulnerable to leakage.¹³ For the next phase (2021–30, Phase 4) the carbon leakage list has been reduced to about 50 sectors (European Commission n.d.b), but excess eligibility combined with a declining amount for free allocation may leave some sectors that are truly vulnerable to leakage with insufficient compensation. California assigns different levels of leakage risk, phasing out allocation more quickly for lower levels (California Code of Regulation 2011). New Zealand, as an island economy, declared all of its industrial sectors EITE.

In most cases, however, focusing on EITE sectors means narrowing the field to a few common industrial commodities. Typical sectors that are given this benchmarking treatment include the manufacture of iron and steel, aluminum, cement, ceramics, glass, chemicals, fertilizers, and pulp and paper. These products also have the advantage of being relatively uniform, which is necessary for developing rational benchmarks (discussed next). As one ascends the value chain, products become more differentiated, making the defining of the relevant comparison increasingly difficult. At the same time, for more complex goods like automobiles or electronics, energy and carbon costs represent a smaller share of value added, and product differentiation limits the intensity of trade competition. For this reason, these manufactured goods would not usually be eligible for OBR and would be better served by standard carbon pricing.

Set a Benchmark

Setting the benchmark involves answering three main questions: (1) What emissions in the product's life cycle are included in the calculation? (2) How many benchmarks should be used for similar products? and (3) How stringent should the benchmark be relative to current practice?

The first is a question of scope. It asks which embodied GHG emissions face carbon pricing, to what extent they impose a cost burden on firms in the sector, and whether data to account for them can be feasibly collected. To use the language of Cosbey et al. (2019), Scope 1 emissions are direct emissions from a given product's production process; Scope 2 emissions are indirect emissions associated with purchased energy use (electricity, steam or heat generated off-site and purchased); and Scope 3 emissions are indirect production-related emissions related to other inputs (like metal in machines) or possibly downstream activities like transportation or waste disposal. Scope 1 emissions should certainly be included, because they are what will be priced directly with the tradable credit or carbon tax system. Scope 3 emissions are generally excluded, since calculating them is complex; the

embodied carbon costs are typically a relatively small share of production costs, and, unless the carbon pricing system is very comprehensive, they may not even be priced.

Whether to include Scope 2 emissions is the most important question. They can represent the majority of embodied emissions in certain sectors, such as aluminum, steel, and cement. Whether they *should* be included in the benchmark depends on whether those upstream emissions (e.g., from the electricity sector) are priced in such a way that the costs are passed through to the industrial sector. If the electricity sector does not face a carbon price, or itself receives OBR, then the emissions embodied in the purchased electricity are not priced, and thus the indirect emissions should not be included for the sector's benchmark. Whether they *can* be included also depends on the policy approach, as a benchmark for indirect emissions can only function in a multi-sector carbon pricing or trading system, since the benchmark for rebates exceeds the direct emissions under control of the sector.

The second question is whether to differentiate any products according to their production processes. For example, steel can be made from iron ore using a blast furnace or from scrap steel using an electric arc furnace, with vastly different emissions intensities. Separate benchmarks can be considered if the resulting products are themselves perceived differently in the market, for example if virgin steel has different applications than steel from scrap metal. By contrast, electricity is the same whether generated with natural gas, coal, or renewable sources. The problem with differentiating fuel- or process-specific benchmarks for similar products is that they tend to subsidize carbon-intensive sources more, making clean sources less competitive.¹⁴ Process-specific benchmarks for similar products should thus be avoided, or at most only used transitionally. For example, Canada has adopted fuel-specific benchmarks for electricity, but phases out differentiation over a few years.

The third and final question of how to set the benchmark level is the important one for determining how stringent the policy will be. A common starting point is to identify best practices in the industry at hand; this exercise proves what is both technically and economically feasible. Identifying average practices discerns what standard would be nonbinding. The benchmark standard must be lower than the average to achieve substantial emissions reductions. For example, Canada used 80–90 percent of average to begin with, and the EU used the average of the top 10 percent of performers, then offered 80 percent of that benchmark as the free allocation. Importantly, these benchmark credits should be tradable (or an associated carbon levy should be refundable) to give consistent incentives to reduce emissions, whether emitters are above or below the benchmark. Otherwise, if the performance standard is set above some firms' current

practice, those firms will not benefit from reducing further. With a tradable performance standard, the price of carbon that emerges will depend on the overall stringency of the standard. If one adopts other features that determine or limit the carbon price, then the benchmark becomes primarily a refunding mechanism.

FURTHER IMPROVEMENTS

Combine with a Price Ceiling and Use Revenues to Fund Reductions

Setting a price ceiling for carbon credits can reduce cost uncertainty for firms and allow for a more ambitious performance standard target. Firms are given the safety valve option of making carbon contributions at this price ceiling in lieu of finding credits to cover all their excess emissions.

These contributions can help fund low-carbon capital investments, enabling the sector to reduce its emissions and raise its ambitions. Recycling carbon contributions this way can lead to more abatement at lower carbon prices (Hagem et al. forthcoming). Although economists generally argue that the optimal carbon price and investment subsidies should ideally be determined separately, earmarking has been shown to boost public confidence in tax policies, including carbon taxes (Baranzini and Carattini 2017; Bristow et al. 2010; Kallbekken, Kroll, and Cherry 2011).

However, when incorporating a ceiling price, it is important that price not be too low. If the ceiling price is hit, the performance standard will not be hit. Alberta's SGER used a form of ceiling price, but it was low enough that little direct abatement occurred. Meanwhile, it is not clear how successfully the technology fund was administered.

Ideally, the price ceiling would be set to align with carbon prices in other sectors and with the social costs. The performance benchmark should be set to address carbon leakage potential and require, on average, net payments to generate some revenues to support necessary investments in technologies for the low-carbon transition. Some capital investments needed to switch to low-carbon production processes would not be financially viable without high and certain carbon prices and protection from competition, a combination that is likely not feasible in a unilateral policy context without TPS. In this case a combination of refunding based on output and refunding based on investment in abatement technologies can be effective.

Combine with a Price Floor

More often, however, tradable credit systems benefit from having a *price floor*. Quantity or intensity targets are invariably set without knowing what credit price will ultimately prevail, and the tendency is to overestimate costs and thus over-

allocate emissions (Burtraw, Palmer, and Kahn 2010). A price floor can then send a clear signal to investors that regulators are committed to decarbonization (Burtraw, Palmer, and Kahn 2010; Wood and Jotzo 2009). Price floors also reduce uncertainty and raise expected prices by eliminating price outcomes at the lower end of the distribution (Flachsland et al. forthcoming).

Defending a price floor, however, typically requires having unallocated credits, or government funding for purchasing credits at the floor price. OBR systems, in contrast, usually allocate nearly all the credits to the eligible sectors. For a cap-and-trade system, a few options are possible. One is if the OBR-regulated sector is in a larger cap-and-trade system with other (e.g., non-EITE) sectors, where a significant share of allowances is auctioned. In this case, an auction reserve price can ensure that additional allowances are not injected into the system if a minimum price is not met. The second option is to use consignment auctions in which firms must put up some of their allowances for auction.¹⁵ The firm's output-based benchmarks would be used to determine their share of the revenues from the allowances that are sold.

With a TPS, one cannot defend a price floor by withholding allowances, other than by making the benchmarks more stringent. However, one can easily add a performance standard on top of (as opposed to in exchange with) a carbon tax.¹⁶ In this case, the carbon tax acts as a floor price, while the performance standard is an additional compliance requirement. If the tax is sufficient to drive the industry to meet the intensity target, the value of credits in the TPS system is zero. If not, the intensity target is what determines the costs of compliance, and credit values will be equal to the additional price needed above the carbon tax to achieve compliance. In other words, in combining these policies the credit prices will adjust to eliminate, in a sense, any double taxation. By eroding credit values, however, the carbon tax also erodes the output subsidy implicit in the TPS (unless the tax is also refunded based on output).

A TPS that overlaps with a carbon price can thus be a way to raise ambition in the industry when the prevailing carbon price is viewed as too low to induce the necessary industrial transformation. A TPS can also be added on top of an ETS, much like the EU has separate renewable energy targets for the power sector on top of their ETS. The Dutch government is currently debating a performance standard system as a means of introducing a kind of domestic carbon floor price. The idea is that firms emitting above the benchmarks would have to pay the additional carbon price. Firms in sectors that have benchmarks for OBR under the ETS would then, in effect, receive combined output subsidies and would also pay combined prices for emissions.

Connect with Other Market Mechanisms

Systems with tradable credits can be easily linked by allowing joint compliance. Then firms in sectors or jurisdictions where abatement is relatively cheap can further reduce their emissions and sell credits that firms facing higher abatement costs can use for compliance in their system. Trading credits across sectors will harmonize carbon price signals, making decisions across sectors more cost-effective. Trading in this way avoids a situation in which one sector is taking relatively costly steps to achieve a marginal unit of emissions reduction, while others are doing less. Society would be better served if all of the less-costly steps were taken first; allowing for credit trading facilitates this. Over time, more sectors can be covered and brought into the carbon pricing system, building up to a more broad-based carbon pricing mechanism.

In all cases of linking, it would be important to harmonize benchmarks as well, lest some firms producing the same products get higher subsidies than others. Linking divergent TPSs has the tendency to raise emissions since production can shift to firms with the larger benchmarks, thus adding more emissions credits into the system. Similarly, cross-sector trading of TPS systems, or trading between a TPS and a separate ETS, has the potential to raise emissions: The cost savings from mutually beneficial trades will tend to lower output prices and thus expand production and emissions (Fischer 2003; Fischer, Mao, and Shawhan 2018). Such linkages still have benefits from harmonizing emissions prices, and the emissions consequences can be overcome by viewing linkage as a means to facilitate greater ambition.

Alternatively, to avoid expanding the total allocation of emission allowances, a TPS can easily convert to output-based allocation of allowances under a cap-and-trade system. For example, in the EU ETS the benchmarks are used for free allocation and the cap determines the allowances remaining for auction.

A simple way to link and harmonize TPS systems with a common ceiling price is to use a carbon tax. In this case, the performance benchmarks are the output-based refunding of the carbon tax. Canada's OBPS is intended to function in this manner, although in the early stages the benchmarks are sufficiently generous that credits will likely trade well below the federal carbon tax. For this reason, Canada does not allow OBPS credits to be traded to entities subject only to the carbon tax, for fear of weakening that price signal.

More generally, integration into a broader, more-efficient system can allow for benchmarks to be tightened more over time, and for phasing out the generosity of the free allocation as it is less needed.

Price Carbon Consumption

As previously noted, a downside of OBR is that downstream consumers do not receive full price signals about the carbon costs of the products they consume. This downside is an efficiency cost of not being able to use BCAs to address carbon leakage (for political, legal, or jurisdictional reasons). One way of addressing this downside is to add a carbon consumption tax. This tax would be levied on the product, regardless of where it was produced. The benchmark for the sector's allocation would be the benchmark for taxing the embodied carbon in the product. Because it is levied on consumption, imported goods would face the tax as well as domestic goods. Taxing carbon consumption would improve incentives for consumers and level the playing field for cleaner substitute products. Meanwhile, the upstream product-based benchmark keeps the playing field level between the domestic industry and its foreign competitors. In this way, combining OBR and a consumption tax achieves a "behind-the-border adjustment" for carbon that offers the same incentives as overt BCA, without resorting to trade measures (Neuhoff et al. 2016).

Phase Out Free Allocation

In some instances, free allocations have been useful for galvanizing the necessary political will to get emissions pricing going, even when those allocations are not necessary to avoid carbon leakage. However, those allocations do have opportunity costs, since revenues rebated to firms are not available for funding investments in technology, infrastructure, or otherwise lowering taxes. OBR also entails some costs in terms of efficiency, as discussed above: consumers do not always face the socially appropriate price signals. Therefore, it is a good idea to plan to phase out the free allocation, especially when it is not necessary to avoid carbon leakage.

Free allocation needed for transitional compensation can be phased out directly. The EU and California scheduled a phaseout for manufacturing sectors not deemed at high leakage risk. The Canadian system also made temporary its differentiated standards for emissions-intensive generation sources.

OBR used to address carbon leakage requires situation-dependent triggers for phasing out. As more jurisdictions join an emissions pricing system, more competitors face comparable prices and carbon leakage is less of a concern. Periodic reevaluation of the need for anti-leakage measures should be considered. Phasing out free allocation in these sectors, however, may require a multilateral approach. To the extent that other jurisdictions are pricing carbon but using OBR, competitors are still not being asked to pay for their embodied carbon emissions.

Questions and Concerns

1. Does your proposal envision a gradual phaseout of clean performance standards in favor of a standalone carbon price?

To be sure, an economy-wide carbon price with provisions for foreign competition—that is, with border carbon adjustments—is generally the most efficient policy response to carbon externalities. But when properly designed and used in the appropriate circumstances, clean performance standards offer an efficient second-best alternative. The question of whether performance standards should eventually be removed in favor of a carbon price without OBR depends on whether the carbon price would be implemented effectively, and in particular whether it would contain the necessary border carbon adjustments.

Particularly for subnational jurisdictions, implementing effective border adjustments may be practically and legally impossible due to interstate commerce rules and the federal government’s authority over trade policy. As such, by addressing competitiveness concerns, market-based performance standards can allow relatively ambitious regions to address industrial emissions without waiting for broad-based carbon pricing to emerge. Similarly, at the sectoral level, regulators could tackle standards for the highest-emitting sectors first.

The idea of thinking of market-based performance standards as building blocks is to recognize that they are a way to start pricing carbon. As those building blocks are linked—through trading or through common carbon floor or ceiling prices—and as more sectors or jurisdictions are added on, a broad-based carbon price will emerge naturally. This integration improves the efficiency of the carbon-pricing component of the collection of performance standards. Then policymakers can design rules for phasing out the OBR component of performance standards as more competitors are covered by the system, further enhancing effectiveness.

For example, as discussed above, free allocations can be phased out when not necessary to avoid carbon leakage. In addition, the number of distinct standards for similar products (i.e., for different technologies) can be reduced over time, thereby encouraging lower-carbon technologies.

2. Would linking tradable performance standards across sectors and technologies lead to increased carbon emissions?

All else equal, linking two tradable performance standards will lead to higher emissions. Firms with larger benchmarks will tend to produce more after the integration, essentially adding more emissions credits to the overall system. This is by contrast to conventional permit trading systems, the integration of which does not affect the aggregate number of permits available.

Policymakers should be aware of this tendency when implementing TPS. As different standards are linked, benchmarks should be reduced or other parameters of the system tightened to achieve further emissions reductions.

3. Your proposal seems to focus on industrial sectors; what about other trade-exposed sectors like light manufacturing or agriculture?

Market-based performance standards work best when applied to a sector where (1) emissions can be readily measured and (2) products are relatively homogeneous. The first ensures the effectiveness of the carbon-pricing component, while the second safeguards the efficiency of the benchmarks.

For many non-EITE sectors, like vehicles or electronics, products are highly differentiated, making appropriate benchmarks difficult to determine. In these cases, carbon pricing with targeted incentives for low-carbon investments may be more straightforward than performance standards.

For agriculture, emissions from the sector are substantial but difficult to monitor, many arising from soil, manure, and fertilizer management practices. Thus, although agricultural commodities can be relatively easily defined, their emissions cannot. For this reason, the sector is challenging to bring into a market-based mechanism in a way that maintains the integrity of carbon credit trading. Carbon offsets from the agricultural sector are therefore generated through alternative practices that potentially reduce emissions, such as planting perennial crops or reducing tillage (González-Ramírez, Kling, and Valcu 2012). However, if agriculture’s energy-related emissions are brought into a larger carbon pricing scheme, benchmarks for commodity-specific rebates could be conceived.¹⁷ As for indirect emissions, note that

using performance standards in upstream sectors like steel or chemicals (which produce fertilizers) also insulates these downstream sectors from carbon costs.

This example illustrates the multi-level challenge of pricing carbon while avoiding leakage both upstream and downstream in the value chain, in which additional policy measures are required to encourage practices by trade-exposed sectors (like agriculture) that use less of carbon-intensive goods that are highly traded (like fertilizer).

4. How easily can a firm “reclassify” itself as belonging to a different industry in order to avoid performance standards?

Facing any regulation—not just performance standards—firms may seek to define themselves in a way that avoids mandatory participation. They may avoid hiring too many employees or emitting beyond a threshold. With OBR, since the cost consequences of participating in the regulation are smaller than with full carbon pricing, this kind of activity to avoid participation should be less pronounced. However, with OBR, firms do have an incentive to define themselves in a way that allows for the most advantageous benchmark. Therefore, extra care must be taken that the benchmarks and the products to which they apply are clearly defined and difficult to manipulate. Any differentiations must be based on immutable characteristics and not aspects under a firm’s control, like size or malleable product features.

Conclusion

Market-based performance standards provide a credible opportunity for policymakers to unilaterally address GHG emissions in key sectors. In the absence of a comprehensive, economy-wide carbon price, performance standards form useful building blocks toward better policy and can address important challenges like carbon leakage, distributional issues, and political acceptability. Designed well, they can allow for a transition

from sector-oriented policies toward more broad-based carbon pricing through the linking of credit trade across sectors or through the incorporation of a common carbon price ceiling. In the meantime, concentrating on specific sectors can focus attention on the technological opportunities and challenges, galvanize support, and provide incentives to start down the path of a low-carbon transition.

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Glossary of Terms

- **Border Carbon Adjustments (BCA):** Fees on imported goods produced in jurisdictions without carbon pricing mechanisms
- **Carbon Cost Exposure:** Emissions intensity multiplied by the projected carbon price
- **Carbon Leakage:** The increase in foreign emissions resulting from a policy to reduce domestic emissions
- **Emissions Intensity:** Carbon emission rate relative to the intensity of a given production activity
- **Emissions Trading System (ETS):** Enables firms to buy or sell emissions allowances
- **Energy-Intensive, Trade-Exposed (EITE) sectors:** Sectors with substantial carbon emissions; concerned with carbon leakage and limited ability to pass on embodied carbon costs
- **Output-Based Rebating (OBR):** Refunding of emissions revenues (or allocation of emission allowances) back to the regulated firms in proportion to their production.
- **Performance Standards:** Carbon emission benchmarks against which a firm's emissions are evaluated and sanctioned
- **Renewable Portfolio Standard (RPS):** A regulation requiring emissions/energy production from particular renewable energy sources
- **Tradable Performance Standard (TPS):** Firms within a given sector that reduce their emissions below an average benchmark set for that sector receive tradable credits that can be sold to other firms that face higher compliance costs

Endnotes

1. See the glossary for definitions of technical terms used in this paper.
2. CAFE standards are a particular—and arguably imperfect—example, but they do represent the evolution of standards toward incorporating more flexibility mechanisms (Greenstone, Sunstein, and Ori 2017).
3. For manufactured goods this issue may be less of a problem, as carbon-intensive intermediate goods form smaller shares of final goods, so the household impacts become relatively small.
4. An emissions intensity standard effectively indexes an emissions cap to the quantity of output, albeit in a way that incentivizes more output (Newell and Pizer 2008). See also Borenstein et al. (forthcoming) on price volatility in California.
5. The Table 8-1 of Cap-and-Trade Regulation 95870(a) (California Code of Regulations 2011).
6. In the current phase, a significant risk of carbon leakage is deemed if the sector meets a combined criteria of a 10 percent trade intensity with non-EU countries and a 5 percent cost increase due to the cap, or if the sector is either highly emissions intensive (30 percent cost increase) or highly trade-exposed (e.g., the non-EU trade intensity is above 30 percent).
7. This provincial fund is managed by the Climate Change and Emissions Management Corporation, with a mission “to accelerate the achievement of actual and sustainable reductions in greenhouse gas emissions and support climate change adaptation through partnerships and collaboration in the discovery, development and deployment of technology for application in Alberta.”
8. For example, the Pan-Canadian Framework on Clean Growth and Climate Change sets a minimum carbon price for provinces to meet or exceed.
9. An output-refunded tax may be preferred where emissions markets might not be so liquid, such as in states with few firms in a given sector. However, in that case one must be careful to make sure that the benchmarks for refunding are fixed, and not dependent on total revenues. Efficiency of a revenue-neutral output-refunded tax requires that no single firm has a significant share of total production. Otherwise, large firms know that the more they pay in emissions taxes, the more they get back in rebates, which diminishes their effective emissions price (Fischer 2010). Also, before it accepts an output-refunded carbon tax, the public must be convinced of the efficacy of emissions pricing, and that the policy is not merely a redistribution scheme, since some carbon pricing opponents have charged.
10. Indeed, in the CAFE credit trading program, whereas transactions are logged by EPA prices are not (Leard and McConnell 2016).
11. Some U.S. states have performance mandates for new sources, but these mandates differ from sector-wide tradable performance standards (Center for Climate and Energy Solutions 2019).
12. Recent studies offer some support for using the simple trade intensity proxy rather than, say, empirical estimates of trade sensitivity, which are difficult to standardize (Fowlie, Reguant, and Stephen 2016; Fischer and Fox 2018).
13. 2014/746/EU: Commission Decision of 27 October 2014 determining, pursuant to Directive 2003/87/EC of the European Parliament and of the Council, a list of sectors and subsectors that are deemed to be exposed to a significant risk of carbon leakage, for the period 2015 to 2019.
14. For another example, by setting source-specific emissions intensity standards the new Affordable Clean Energy rule could actually increase rather than reduce these emissions (Keyes et al. 2019).
15. The U.S. sulfur dioxide trading program had provisions for consignment auctions to ensure market liquidity.
16. A TPS could also overlap an ETS, for that matter.
17. According to the USDA Economic Research Service, fuel and electricity constituted 12-16 percent of total cash expenses for rice, cotton, peanut, and poultry producers compared with 7-10 percent for other crop and livestock producers (Hitaj and Suttles 2016). Thus, a 10 percent increase in energy prices would increase costs by about 1 percent for these subsectors.

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Highlights

Because industrial sectors contribute a large fraction of total greenhouse gas emissions in the United States, addressing their emissions is an essential element of combating climate change. In this paper, Carolyn Fischer of Resources for the Future proposes using tradable performance standards to reduce industrial carbon emissions. While sector-based performance standards do not establish an economy-wide carbon price, they can lay the groundwork for more comprehensive climate policies in the future.

The Proposals

Implement tradable performance standards with emissions benchmarks in industrial sectors that are carbon cost-exposed and trade-exposed. Firms with emissions in excess of their benchmark would be required to pay; firms that reduce emissions below their benchmark would receive tradable credits, which can be sold to other firms facing higher abatement costs.

Policymakers would follow guidelines provided by the author when making the following choices: designing the performance standard, selecting industrial sectors to target, and setting emissions benchmarks for various production processes.

Benefits

Tradable performance standards offer many advantageous features. The tradability of performance standards provides an incentive for firms to continue cutting emissions beyond their benchmark. Performance standards also encourage investment in low-carbon technologies without diverting economic activity to unregulated international competitors. As part of an overall emissions reduction strategy, tradable performance standards can help achieve important climate goals in an effective and efficient manner.



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