

Carbon Pricing in High-Income OECD Countries

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Executive Summary

Most economists consider human-made greenhouse gas (GHG) emissions an unintended negative externality of production and consumption. A negative externality occurs when the effects of producing or consuming goods and services impose costs on a third party which are not reflected in the prices charged for said goods and services. In the context of GHG emissions, this negative externality is calculated using the “social cost of carbon,” which is the future damage to society (adjusted to present value) of one additional tonne of carbon emitted to the atmosphere today.

Governments have a wide variety of policy alternatives to address the negative externality of emissions depending on the degree and depth of the policy intervention. They can either mandate individuals and firms to change their behaviour through command-and-control regulations, grant subsidies and tax credits to foster cleaner energy sources, or use market-based mechanisms to correct the misalignment of incentives. It is widely acknowledged that carbon pricing, one of these market tools, is the most cost-effective policy to reduce emissions, as it relies on price signals and trade to provide flexibility to economic agents as to where and how emissions mitigation occurs.

Generally, there are two main types of carbon pricing mechanisms: carbon taxes and emissions trading systems (ETS). With a carbon tax, governments set the tax rate, generally according to the social cost of carbon, and allow the market to figure out the optimal amount of emissions. In an ETS, governments create a carbon-permits market by capping the aggregate amount of emissions and allowing trade between emitters to determine the price.

However, certain conditions must be met for carbon pricing to deliver cost-effective emissions reductions. Carbon pricing revenues should be recycled back into the economy in the form of tax reductions to mitigate the gross efficiency costs of introducing a carbon tax or an ETS into an already distorted taxation environment. Also, carbon pricing revenue should not be used to subsidize specific energy sources as it would defeat the purpose of providing flexibility to individuals and firms. Second, the introduction of carbon pricing tools must be accompanied by the repeal of non-pricing emission control regulations such as emissions caps, mandated fuel standards, technology-based standards, subsidies to electric vehicles, and renewable power mandates. Layering regulations on top of emission-related taxes will have distortionary effects causing disproportionate damage to the economy.

This report includes thirty-one high-income OECD countries, where each country has either implemented a carbon tax, an ETS, or a combination of both pricing mechanisms. Carbon taxes are being implemented in 14 of them whereas 25 of these countries have their emissions covered by an ETS. Our analysis finds that, on average, 74 percent of carbon tax revenues in high-income OECD countries go directly into their general budget with no earmarking for any specific expenditure, while 12 percent are ring-fenced

for environmental spending, and only 14 percent for revenue-recycling measures. This means that most governments are using carbon taxes as a revenue-raising tool rather than a mechanism to internalize the negative externalities of emissions in a cost-effective manner. Additionally, the vast majority of ETS revenues are being used to artificially accelerate the use of renewable energy sources, infrastructure, and technology.

The study also finds that no high-income OECD country has used carbon pricing to repeal emission-related regulations, but instead have introduced new ones following the adoption of the carbon tax or the ETS. Emissions caps, mandated fuel standards, technology-based standards, and renewable power mandates are just some examples of these regulations that undermine the cost-effectiveness of carbon pricing mechanisms. The majority of high-income OECD countries have a combination of support schemes for renewable energy sources, carbon pricing tools, and command-and-control regulations.

Overall, no high-income OECD country is following the textbook model of an optimal carbon pricing system, undermining their theoretical efficiency by design and implementation.

Introduction

Carbon pricing is one of the most widely debated policy topics in Canada and around the world, becoming one of the front-rank issues in energy and environmental policy. The objective of a carbon price is, not surprisingly, to set a price on carbon dioxide (CO₂) emissions, the single largest contributor to greenhouse gases (GHG). Setting a price on carbon dioxide emissions will create an incentive for individuals and firms to adjust their behaviour as to where and how GHG mitigation occurs. When designed properly, carbon pricing is widely acknowledged as the most cost-effective way to reduce GHG emissions as it relies on market instruments, such as price signals and trade, to align incentives.

However, certain conditions must be met in order for carbon pricing to deliver emissions reduction without significantly damaging the economy. For instance, setting a price on carbon dioxide should be accompanied by the repealing of all the corresponding emission regulations and the recycling of carbon pricing revenues back into the economy in the form of tax cuts or rebates to citizens (McKittrick, 2016). This means that layering carbon pricing mechanisms on top of regulations will not only distort the price signal but will also cause disproportionate damage to the economy. Similarly, not returning carbon pricing revenues in the form of household rebates or reductions in other distortionary taxes will amplify the gross efficiency costs of introducing a price on CO₂ emissions.

Nonetheless, the analysis of this study finds that, on average, 74 percent of carbon tax revenues in high-income OECD countries go directly into their general budget with no earmarking [1] for any specific expenditure, while 12 percent are ring-fenced for environmental spending, and only 14 percent for revenue-recycling measures. This shows that most governments are using carbon taxes as a revenue-raising tool rather than a mechanism to internalize the negative externalities of emissions in a cost-effective manner. Additionally, the vast majority of Emission Trading Systems' (ETS) revenues are being used to artificially accelerate the use of renewable energy sources, infrastructure, and technology.

This analysis finds that all high-income OECD countries are deviating from the textbook carbon pricing model, which illustrates that the efficiency of pricing systems are being undermined by design and implementation. The extent to which each country deviates from the model is examined throughout the study.

The study begins by outlining the conditions associated with the textbook design of a cost-effective carbon pricing system and describes the best ways to use revenues. The next section analyzes the 14 high-income OECD countries that implement a carbon tax and examines how countries allocate revenues. The following section analyzes

[1] Earmarking or hypothecation refers to a practice in which tax receipts, either from a single tax base or as part of a wider pool, are assigned to pay for a specific purpose (Wilkinson, 1994).

the emission trading systems from 25 high-income OECD countries and examines how systems are designed and how auction revenues are used. The final section discusses regulatory measures that are being implemented alongside carbon pricing in various high-income countries.

Carbon Pricing and the Textbook Model

Textbook economics considers human-made greenhouse gas (GHG) emissions an unintended negative externality of production and consumption. Broadly speaking, a negative externality arises when the effects of producing or consuming goods and services impose costs on others which are not reflected in the prices charged for the goods and services being provided (Boundreaux and Meiners, 2019). For example, driving a car generates emissions, which in turn generates costs to society that are unaccounted for in the price charged for gasoline. This hidden cost to society, called the “social cost of carbon”, is the future damage to society of one tonne of additional carbon emitted to the atmosphere today (Watkiss and Downing, 2008). Since people do not bear these costs personally there is no incentive to avoid them. Therefore, policies can be implemented to internalize the costs associated with the negative externalities of GHG emissions—in particular CO₂ emissions—until market prices reflect an alignment between private and social costs.

Governments have different policy choices to address the negative externalities of CO₂ emissions. They can mandate households and firms to change their behaviour through traditional command-and-control regulations, grant subsidies and tax credits to incentivize the use of cleaner energy sources, or use market-based mechanisms, such as carbon pricing policies, to correct the misalignment of incentives. Out of the three choices, mechanisms that use market instruments allow the most flexibility and cost-effectiveness in the pursuit of meeting environmental goals (Stavins, 2019b; Christiansen and Smith, 2012). In other words, carbon pricing is the cheapest and most effective policy choice to reduce emissions if done properly.

The key idea that lies behind the cost-efficiency of carbon pricing is called the *equimarginal* rule, which means equalizing the marginal cost of emission abatement. Every firm or consumer who emits greenhouse gases has various options for reducing their emissions, and some are much more expensive than others. Since what matters is the total quantity of emissions rather than the way they are distributed among firms, we want to avoid a situation where, for instance, one emitter is paying \$200 per tonne to cut emissions that another emitter could cut for \$15 per tonne. In general, we want a system in which those who have the cheapest options for emission reductions undertake the most reductions. Emission pricing accomplishes this by creating a common cost ceiling below which it is economically advantageous for an emitter to cut emissions. Once the cost of further reductions hits the ceiling the emitter no longer pursues emission reductions. If all emitters face a common price ceiling, it equalizes the marginal cost of action and ensures the overall emission reductions are done at the lowest possible cost to society.

Generally, there are two main types of carbon pricing mechanisms: carbon taxes and emissions trading systems (ETS). With a carbon tax, governments set the tax rate, generally according to the social cost of carbon, and allow the market to figure out the optimal amount of emissions. In principle, such a system ensures emitters internalize the externality by paying the extra tax rate for each emitted tonne of CO₂. Additionally, it creates an incentive for firms to reduce emissions to the point where their marginal abatement costs [2] are equal to the emissions tax level. If all emitters face the same tax rate, they equalize the marginal cost of emission reductions, which is a key condition for minimizing the economy-wide costs of emission reductions

In an ETS, governments create a carbon-permits market by capping the aggregate amount of emissions and allowing trade between emitters to determine the price. Under this system, governments establish an allowable overall level of CO₂ emissions and allocate allowances to emitting firms, either freely or through auctions (or a combination of both), in the form of permits. Firms then trade these allowances according to market forces in the permits market. Under this approach, firms are incentivized to reduce emissions to the point where their marginal abatement costs are equal to the market-determined price of tradable allowances. Since all firms face the same price, again the marginal abatement costs are equalized across sources.

In this sense, both market instruments “allow any desired level of pollution cleanup to be realized at the lowest overall cost to society, by providing incentives for the greatest reductions in pollution by those firms that can achieve these reductions most cheaply” (Stavins, 2003: 359). Overall, there is a strong consensus among economists that the most efficient way to achieve emissions reductions, while at the same time continuing to foster economic growth, is by using these market mechanisms and letting individuals and businesses decide whether it is in their best interest to pay the price of emitting GHG or to find other ways of cutting their emissions that are less costly.

However, for these assumptions to hold the carbon pricing policy must meet certain conditions: revenue neutrality, and the absence of other non-pricing emission-related policies and regulations. Another crucial criterion to consider is the accurate calculation of the social cost of carbon but, due to data limitations, this paper will not address this issue. [3]

[2] Marginal abatement cost is the cost of reducing an additional tonne of CO₂ from the environment (Kesicki and Strachan, 2011).

[3] When calculating the social cost of carbon, it is crucial to consider the marginal cost of public funds (MCPF), which is the cost to the economy that arises as a result of the government raising an additional tax dollar. The gross efficiency costs of a carbon tax can be mitigated if the tax rate is deflated by the MCPF (McKenzie, 2016; McKittrick, 2016). (In other words, even if the social cost of carbon is, say, \$40 per tonne, if distortions caused by the pre-existing tax code make raising additional tax revenue cause economic damage, then the optimal carbon tax rate should be set at less than \$40 per tonne.) Additionally, the accurate calculation of the social cost of carbon relies on the discount rate used to compare social costs and benefits in the present versus social costs and benefits in the future.

Revenue neutrality

One of the benefits of choosing a market-based instrument, such as a carbon tax or ETS, over traditional command-and-control regulations is that the former can raise revenue that could be used to offset some of the costs of the policy while the latter imposes additional costs with no offsetting revenue potential. Indeed, the use of carbon pricing revenue is one of the key considerations policy makers have to bear in mind when designing these policies.

Implementing a carbon tax, for example, will exacerbate the efficiency costs associated with existing distortionary taxes, increase the overall burden of the tax system, and further distort decisions about working, saving, investing, consuming, and producing (Goulder, 2013). This inefficiency, called the tax interaction effect, is a result of introducing a new tax into a pre-existing distorted tax system. Although it is called a *tax*-interaction effect, the same problem arises when regulations are introduced. To mitigate the effect, revenue raised by carbon pricing policies can be recycled back into the economy through reductions in other taxes, thus creating offsetting reductions in distortions elsewhere in the system, such as by reducing labour taxes, sales taxes, and corporate or personal income taxes. Since regulatory measures do not yield public revenue, such cost-offsets are not possible, making the economic cost of the policy more expensive. Research generally shows that using carbon tax revenues to cut capital taxes—corporate taxes or personal income rates on interest, dividends, or capital gains—produces the largest economic efficiency benefits, roughly offsetting the economic cost of the carbon tax (Murphy, 2019).

In principle, an auction mechanism in an ETS can raise revenue and accomplish the same outcome (Stavins, 2019a). Parry and Williams (2010) have shown that auctioning and recycling revenue via income tax cuts would have the least social cost, while recycling revenue in lump-sum dividends or granting emissions allowances freely would be a costlier approach. Dinan and Rogers (2002) also found that, in the case of the US, the deadweight loss [4] of a carbon pricing policy with auctioned permits and recycled revenues through reductions in either business income tax rates or payroll taxes would be over six times less than a scenario in which said revenues are returned to individuals as lump-sum rebates.

Revenue neutrality requires carbon pricing revenue not to be used to subsidize specific energy sources. Subsidizing wind and solar generation with carbon pricing revenue, for instance, will inevitably defeat the purpose of these policies, which is to correct incentives and allow individuals and businesses to find the most affordable methods of emissions reduction. These subsidies will artificially increase the price of power generation for consumers, amplifying their costs to society (Moore and Vanderplas, 2018).

[4] Deadweight loss is the cost to society as a result of an inefficient allocation of resources within a market (Harberger, 1964).

Overall, revenue neutrality is one of the most crucial conditions carbon pricing systems have to meet in order to mitigate the gross efficiency costs to the economy as a result of implementing a carbon tax or an ETS. As the 2018 Nobel laureate in economics expressed it: “The importance of revenue recycling is surprising and substantial ... the tail of revenue recycling would seem to wag the dog of climate-change policy” (Nordhaus, 1993: 317).

No belts-and-suspenders

Belts-and-suspenders is a term used to describe the combination of a carbon pricing policy with non-pricing emission control regulations (Levinson, 2010). Examples of non-pricing policies are emissions caps, mandated fuel standards, technology-based standards, subsidies to electric vehicles, and renewable power mandates. One problem with policy layering in this form is that the regulatory measures may have marginal abatement costs very different from each other and usually higher than the emission charge. Consequently the equimarginal rule no longer holds and the overall economic cost of the abatement policy ends up being higher than it needs to be.

Another problem is that layering cost regulations over taxes “may hide or partially obscure the costs of carbon pricing” (Aldy, 2017: 12) as it sends conflicting price signals to consumers who will have to pay both the explicit carbon price and the higher goods prices as a result of regulations. These additional compliance costs will be passed through to consumers, but “unlike a tax, the government will not raise any revenue that it can use to reduce other taxes to compensate for these higher prices” (Mankiw, 2009: 35). [5]

This scenario, often called double regulation, amounts to “paying twice for the same target” (Oikonomou and Jepma, 2008: 147) and will, therefore, exacerbate the already amplified deadweight loss as a result of carbon pricing. In this case, two different climate policy instruments (carbon pricing and regulations) that pursue a similar environmental goal (emission reductions) will increase the costs of the policy without yielding any significant marginal benefit.

Additionally, the belts-and-suspenders approach often distorts incentives given their redundant nature. For instance, regulations that phase out coal, cap methane emissions, and mandate fuel standards are unnecessary if there is already a carbon price in place signaling the cost of emissions to individuals and firms. Market-based and revenue-raising policies already create incentives for adopting emission control technologies and may increase incentives for investment in pollution control (Benneer and Stavins, 2007). These incentives may be undermined or counteracted by command-and-control regulations that try to force specific outcomes.

[5] Overall, revenue-raising (RR) tools are preferred over non-revenue-raising (NRR) tools since they have the potential to offset the efficiency losses created by introducing a price on emissions in an already distorted taxation environment. Not only do NRR policies fail to exploit said revenue-recycling effects, but their gross efficiency costs are higher for any given target level of emissions reduction (Goulder, Parry, and Burtraw, 1996).

Furthermore, the coexistence of support schemes for renewable power generation and carbon pricing policies may increase marginal abatement costs, making it harder for companies to transition to cleaner sources and technologies (Fankhauser et al., 2010). Sorrel and Sijm (2003: 429) found that a combination of a support scheme for renewable electricity and carbon permits, for example, will increase “overall abatement costs while contributing nothing to the aggregate cap.” They can also discourage low-carbon investment in the private sector (Nordhaus, 2011; Blanco and Rodrigues, 2008) since marginal abatement costs can be exacerbated when certain energy sources are subsidized by taxpayers. Given that there is already a carbon price in place signaling the common cost ceiling for abatement, subsidizing wind or solar energy, for example, will artificially increase this ceiling, making it more difficult for private actors to invest in the most cost-effective emissions reduction technologies. Similarly, the existence of feed-in-tariff programs [6], another case of a belts-and-suspenders approach, may also negatively affect and undermine the effectiveness and performance of a carbon pricing mechanism (Tu and Mo, 2017). Specifically, in an ETS, an aggressive push for renewable energy might reduce the demand for carbon emission allowances in the permits market, weakening the trade-determined price signal.

Another issue that arises when combining subsidies for renewable power generation and carbon pricing policies is that governments are effectively engaging in the flawed industrial policy of picking winners and losers. Mandating which type of energy we should use requires the government to choose a “winning” industry, running “the risk of backing technologies that are fundamentally flawed” (Christensen et al., 2011: 30). A price on emissions should be sufficient to signal investors to spend their resources in the technologies they see fit, regardless of fuel and generation price uncertainty. The effectiveness of a price on emissions can be undermined without a careful handling of policy interactions with subsidies and regulations as they can become redundant (OECD and WBG, 2015).

[6] A feed-in-tariff program (FIT) offers long-term contracts at fixed non-market prices paid to renewable energy producers to guarantee revenue that would cover upfront investment costs (Fellows, Moore, and Shaffer, 2016).

Carbon Pricing Systems by Country

31 high-income OECD countries are included in this analysis, where each country has either implemented a carbon tax, an emission trading system, or a combination of both. We start our analysis by examining high-income OECD countries that have implemented a national carbon tax. Next, we evaluate carbon policy in countries that have implemented or are a part of an emission trading system. Nine countries—Denmark, Finland, France, Ireland, Portugal, Slovenia, Sweden, Switzerland, and the United Kingdom—where a combination of both carbon pricing mechanisms have been implemented are included in both sub-sections.

It's important to note that this paper only examines high-income OECD countries with national carbon pricing systems; it therefore doesn't analyze regional models such as those implemented in California, Quebec, British Columbia, and the Regional Greenhouse Gas Initiative. [7]

Carbon taxes

Carbon taxes are being implemented in 14 out of the 31 high-income OECD countries: Canada, Chile, Denmark, Finland, France, Iceland, Ireland, Japan, Norway, Portugal, Slovenia, Sweden, Switzerland, and the United Kingdom. For the purposes of this analysis, having a carbon tax means having an explicit tax on CO₂ emissions. **Table 1** shows carbon tax rates and carbon tax revenue as a percentage of GDP and as a percentage of total government revenue for these countries.

Given the differences in sectors covered, tax rates, and taxed CO₂ emissions, these figures are not directly comparable between countries. However, it is important to analyze how much is being raised by high-income OECD countries in order to have a picture of the magnitude of carbon tax revenues in developed economies. Additionally, examining carbon tax receipts relative to government's revenue is useful as it tells us their relative importance in governments' budgets.

As shown in table 1, Finland and Sweden collect the largest amount of carbon tax revenues relative to their GDP with 0.70 percent and 0.48 percent, respectively. Canada's carbon tax, implemented in April 2019, will raise 0.12 percent of the country's GDP (Canada, 2019; IMF, 2019). On the other hand, the UK and Japan are the countries that collect the least carbon tax revenue relative to the size of their economies with 0.04 percent and 0.05 percent respectively. In terms of governments' total revenue, Finland and Sweden top the list with carbon tax receipts comprising 2.5 percent and 2.14 percent,

[7] The Regional Greenhouse Gas Initiative is a regional ETS among the states of Connecticut, Delaware, Maine, Maryland, Massachusetts, New Hampshire, New Jersey, New York, Rhode Island, and Vermont.

Table 1: Carbon tax rates and revenues as percentage of gross domestic product (GDP) and total government revenue (latest available data)

Country	Implementation year	Tax rate (US\$/tonne of CO ₂)	Carbon tax revenues as percentage of GDP (%)	Carbon tax revenues as percentage of total government revenue (%)
Canada	2019	15	0.13	0.83
Chile	2017	5	0.06	0.26
Denmark	1992	26	0.07	0.12
Finland	1990	70	0.7	2.5
France	2014	50	0.28	2.08
Iceland	2010	31	0.35	0.64
Ireland	2010	22	0.13	0.55
Japan	2012	3	0.05	0.27
Norway	1991	59	0.42	1.12
Portugal	2014	14	0.07	0.16
Slovenia	1996	19	0.33	1.38
Sweden	1991	127	0.48	2.14
Switzerland	2008	96	0.15	1.49
United Kingdom	2013	24	0.04	0.12

Sources: World Bank, 2019; Budgets for each country FY 2017/2018 except Canada (FY 2019/2020) and France (FY 2016/2017) (see References); IMF, 2019; author calculations.

respectively, of the governments' budgets. The UK and Denmark share the last spot with carbon tax revenues making 0.12 percent of their total revenue. Canada's carbon tax receipts will amount to roughly US\$2.1 billion for the fiscal year 2019/2020 (Canada, 2020) or 0.83 percent of the total budget. This means that for every CAD \$100 that will flow into the federal government's budget in 2019/2020, 83 cents will come from the carbon tax.

The average tax rate for these countries was US\$40.07 per tonne of CO₂-equivalent, with Sweden having the highest tax rate at US\$127 and Japan the lowest tax rate at US\$3 (World Bank, 2019). Although these prices are not comparable between countries due to differences in sectors covered, taxed CO₂ emissions, exemptions, and compensations, having an idea of the dollar amount countries are taxing CO₂ emissions is useful as we compare them to the cost of carbon today. The OECD conservatively estimates that the marginal damage of CO₂ emissions as of today is around €30 or roughly US\$33.7 per tonne of CO₂-equivalent (OECD, 2018), meaning that high-income OECD countries are, on average, taxing CO₂ emissions above the OECD's low-end estimation.

Use of revenue

On average, 74 percent of carbon tax revenues in high-income OECD countries go directly into their general budget with no earmarking for any specific expenditure, while 14 percent are ring-fenced for environmental spending, and only 12 percent for revenue-recycling measures (**figure 1**). This fact would suggest that most governments are using carbon taxes as a revenue-raising tool rather than a mechanism to internalize the externalities of emissions in an efficient manner. **Table 2** shows the use of carbon tax revenues by each of the 14 high-income OECD countries with a carbon tax. Sources for figure 1 and table 2 are given in the text of the remainder of this subsection.

Figure 1: Use of carbon tax revenues by high-income OECD countries

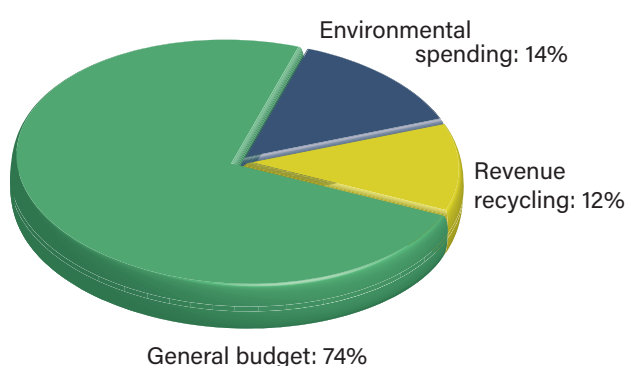


Table 2: Use of carbon tax revenues by high-income OECD countries (latest available data)

Country	Environmental spending (%)	Revenue recycling (%)	General budget (%)
Canada	10	90	0
Chile	0	0	100
Denmark	0	0	100
Finland	0	0	100
France	27	0	73
Iceland	0	0	100
Ireland	0	0	100
Japan	100	0	0
Norway	0	0	100
Portugal	36	0	64
Slovenia	0	0	100
Sweden	0	0	100
Switzerland	26	74	0
United Kingdom	0	0	100

General budget

The general budget trend refers to countries in which all their carbon tax revenues strictly flow into their general funds with no specific earmarking or hypothecation. For instance, due to legal restrictions in its tax system, Chile, which implemented a carbon tax in the context of a broader tax reform in 2017, cannot direct their carbon tax revenues to any specific expenditure (Schlegelmilch and Joas, 2015; Chile, 2014). Ireland, another example, implemented a carbon tax in 2010 after entering into a bailout program with the European Central Bank, the European Commission, and the International Monetary Fund in the aftermath of the global financial crisis. From 2010 to 2012, the carbon tax contributed between 21.5 and 24.6 percent of the required tax increases stipulated by the bailout program (Convery, Dunne, and Joyce, 2013). However, all revenue is directed towards the Central Fund of the Exchequer with no direct link from carbon tax receipts to any specific expenditure or recycling measure (Ireland, 2019).

Iceland, Slovenia, and the United Kingdom are also examples of high-income OECD countries that direct their entire carbon tax revenues to their general budget. The United Kingdom, for example, implemented their Carbon Price Floor (CPF) policy in 2013 after a decline in the European Union Emission Trading System allowance price. It is used as a price floor for the European Union Emission Trading System (EU ETS) allowances in the UK's electricity sector, therefore acting as a tax in practical terms. This means that the CPF tops up the EU ETS allowance price until it reaches roughly US\$24 per tonne of CO₂. Due to competitiveness concerns, the CPF rate was frozen at US\$24 per tonne from 2016 to 2020 (Hirst, 2018). All of the CPF revenue goes directly into Her Majesty's Treasury (Hirst, 2018).

However, some countries which currently direct their entire carbon tax revenues to their general budget have reduced other distortionary measures, such as income taxes and labour costs, at some point in time. This model has been widely used in Scandinavian countries in an effort to shift away from income and labour taxes to energy and environmental taxation. Tax reforms in these countries are often in the form of “packages” where increases/decreases in energy taxes, including carbon taxes, are bundled with reductions in income taxes/and or taxes related to industry (Carl and Fedor, 2016). For example, Sweden reduced and simplified income and labour taxes in 1991 following the implementation of a carbon tax in that same year. Further income tax reductions were made between 2001 and 2006 after increasing the carbon tax rate, and labour costs were reduced between 2007 and 2013 (Sweden, 2018). However, all carbon tax receipts currently flow into Swedish general budget (Sweden, Ministry of Finance, personal communication, June 2019).

Finland implemented a carbon tax in 1990 and reduced personal income tax and employer's social security contributions in the 1997 and 2011 energy tax reforms, shifting away from labour taxes to energy and carbon taxes (Sumner, Bird, and Smith, 2009). In the 2011 energy tax reform, income and labour tax reductions were five times greater than the revenue generated by the carbon tax (Sumner, Bird, and Smith, 2009). However, all Finnish energy tax revenues flow directly into the general state budget (Conway et al.,

2017). Norway, for instance, implemented a carbon tax in 1991 that covers 55 percent of the country's emissions and reduced the business income tax rate in 2015, partially funded by carbon tax revenues (Carl and Fedor, 2016). Currently, all carbon tax revenues are directed to the general budget with no link between these and any particular spending program or tax rate decrease (Norway, Royal Ministry of Finance, personal communication, June 2019). In Denmark, for example, the introduction of its carbon tax in 1992 was accompanied by a reduction in labour taxes, following further reductions in the Green Energy Tax Package reform in 1996 and 1998 (Speck, 2008). However, it is worth mentioning that Danish labour tax reductions have usually exceeded the revenues generated by the carbon tax (Speck, 2008). Currently, all carbon tax revenue flow directly into the general budget with no hypothecation (Denmark, Ministry of Taxation, personal communication, July, 2019).

Portugal, which introduced its carbon tax in 2014, had a one-time reduction of personal income tax in 2015 but no further revenue-recycling measure has been adopted since. The Portuguese carbon tax is one of three levies that make the Tax on Oil and Energy Products or, as it is called in Portugal, *Imposto sobre os Produtos Petrolíferos e Energéticos* (ISP). In 2018, over 30 percent of its carbon tax revenue went to the country's Permanent Forest Fund, the Environmental Fund, and to the Institute for Financing Agriculture and Fisheries (Portugal, 2019) with the remaining revenue flowing into the general budget.

France's *Contribution Climat Energie* (CCE) is a method of calculation of internal consumption taxes, proportional to the CO₂ content in energy products. Thus, the CCE calculates the CO₂ content of the consumption tax on energy products (TICPE), natural gas (TICGN), and coal (TICC). This is done because the French government wanted to introduce exemptions to certain sectors of the economy due to competitiveness concerns (Rogissart, Postic, and Grimault, 2018). In 2016, France recycled over 80 percent of its carbon tax revenues through the Tax Credit for Competitiveness and Employment (CICE) for companies paying social security contribution to their employees and through household rebates (Rocamora, 2017). However, in 2017, 73 percent of carbon tax revenues went directly to the country's general budget with the remaining money going to a special account which finances the development of renewable energy sources (France, 2017).

Revenue recycling

The second pattern refers to countries who earmark their carbon tax receipts for revenue-recycling and some other spending measures. Only two out of the 14 high-income OECD countries with carbon taxes recycle their revenues back to the economy as a rule every year, as rebates to households or reductions in other distortionary taxes or costs. Switzerland, for instance, recycles two-thirds of their carbon tax revenues through a reduction in individuals' mandatory health premiums and through a reduction of old age insurance payroll tax payments to companies (Federal Act on the Reduction of CO₂ Emissions, 2011). The remaining third of carbon tax revenues are used to fund the

Programme Bâtiments, a federal program intended to subsidize thermal insulation of buildings, replacing fossil-fuel powered heaters and electricity supply with renewable energy sources, and renovations with energy efficiency standards (Switzerland, Federal Office of Energy, 2019).

Furthermore, Canada recycles 90 percent of its carbon tax revenues through household rebates, called Climate Action Incentive payments, with the remaining 10 percent being used to support particularly affected sectors such as SMEs, municipalities, universities, schools, colleges, hospitals, NGOs, and indigenous communities (PBO, 2020).

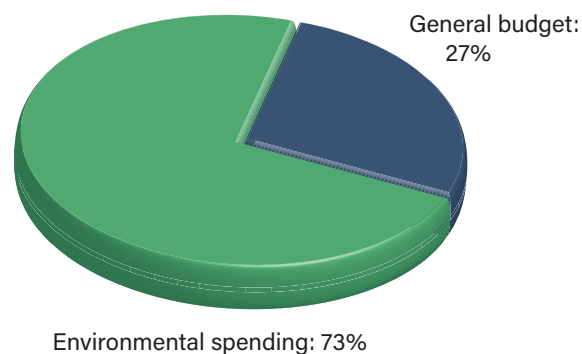
Environmental spending

Japan, which introduced a carbon tax as part of a broader tax reform in 2012, is the only high-income OECD country that earmarks all of their carbon tax revenues to green spending. Japan's carbon tax revenues are particularly earmarked for renewable energy infrastructure, energy conservation programs, and energy efficient equipment for small and medium-size companies (Japan, Ministry of the Environment, 2012).

Emission Trading Systems (ETS)

ETSs in high-income OECD countries are used more frequently than carbon taxes, particularly because of the broad coverage of the European Union ETS. 25 out of the 31 high-income OECD countries have their emissions covered by an ETS, 22 of them from the EU ETS. South Korea, New Zealand, and Switzerland have their own national ETS. ETSs' use of revenue is clearly different from how countries use their carbon tax revenues. On average, over 70 percent of ETS revenues for these countries are ring-fenced for green spending while almost 30 percent go directly into their general budget with no earmarking for any specific expenditure (**figure 2**). Not a single high-income OECD country recycles their ETS revenue back into the economy. The average allowance carbon price for these ETSs was US\$15.5 (ICAP, 2019), much lower than the OECD's low-end estimation of carbon costs today.

Figure 2: Use of ETS auction revenues by high-income OECD countries, 2018



Sources: See table 3.

Use of revenue

Raising revenue under an ETS is slightly different than under a carbon tax. In order to address competitiveness concerns and carbon leakage (where emitting companies might take their business to other more deregulated jurisdictions), permits or allowances are sometimes given freely by governments to emitting companies. This is the case with the EU ETS Phases I (2005–2007) and II (2008–2012) in which roughly 97 percent of the allowances were allocated for free using industry benchmarks (ICAP, 2019). During Phase III (2013–2020) 57 percent of the allowances were and are still auctioned while the remaining permits will be allocated for free. In 2018, the average allowance price for an EU ETS tonne of CO₂ was US\$18.76 (ICAP, 2019).

Under the EU ETS Directive 2009/29/EC (Directive 2009/29/EC of the European Parliament and of The Council, art. 10) at least 50 percent of auction revenues must be spent on climate and energy related purposes such as:

- Contributions to the Global Energy Efficiency and Renewable Energy Fund
- Contributions to the Adaption Fund
- Measures to avoid deforestation
- Spending on forestry and CO₂ sequestration
- Mitigation and adaption of climate change
- Investing in low-emitting public transportation
- Spending on research and development in renewable energy and technology
- Investing in energy efficiency programs

If half of the auction revenues are not reported as being spent in the above mentioned purposes, member countries have to demonstrate domestic fiscal or regulatory support to climate and green energy related programs. Furthermore, the directive also specifies that member countries can use their auction revenues to fund green initiatives in Third World countries. For example, Hungary used a portion of its auction revenues to invest in a sustainable water management project in Uganda (European Environment Agency, Reporting Obligations Database, 2019). Other countries contributed to the EU's Green Climate Fund, instituted in 2010 to support developing countries in their efforts to reduce greenhouse gas emissions and tackle climate change.

Table 3 shows the use of auction revenues by each of the 25 countries which participate in ETS. In 2018, Austria, the Czech Republic, Denmark, Finland, France, Germany, Greece, Ireland, and the Netherlands spent 100 percent of their auction revenues on climate and renewable-energy related purposes. Other big EU environmental spenders were the United Kingdom (82 percent), Portugal (76 percent), and Italy (70 percent). However, in absolute terms, Germany, the UK, and Spain were the countries that spent the most in climate change and energy related purposes with a combined 4.7 billion EUR (European Environment Agency, Reporting Obligations Database, 2019).

All of Germany's auction revenue, which amounted to roughly 2.5 billion EUR in 2018 (the largest in the EU ETS), is directed to the country's Energy and Climate

Table 3: Use of auction revenues by high-income OECD countries, 2017/2018 or year of latest available data

Country	Environmental spending (%)	Revenue recycling (%)	General budget (%)
Austria	100	0	0
Belgium	51	0	49
Czech Republic	63	0	37
Denmark	100	0	0
Estonia	38	0	62
Finland	100	0	0
France	100	0	0
Germany	100	0	0
Greece	100	0	0
Hungary	17	0	83
Ireland	100	0	0
Italy	70	0	30
Latvia	100	0	0
Luxembourg	51	0	49
Netherlands	100	0	0
New Zealand	----	---	----
Poland	51	0	49
Portugal	76	0	24
Slovak Republic	100	0	0
Slovenia	100	0	0
South Korea	100	0	0
Spain	64	0	40
Switzerland	0	0	100
Sweden	56	0	44
United Kingdom	82	0	18

Sources: European Environment Agency, Reporting Obligations Database, 2019; ICAP, 2019.

Fund (EKF). The EKF invests in promoting energy efficiency standards, CO₂ building renovations, research and development in renewable energy sources, grants to electricity-intensive companies to offset price increases, subsidies for the purchase of electric-powered vehicles, adaptation and safeguarding of forests to climate change, and to fund the National Climate Initiative (European Environment Agency, Reporting Obligations Database, 2019).

The UK, the second largest auction market in the EU ETS, spent roughly €1.3 billion in environmental related measures in 2018. For instance, money from the allowance auctions was used to fund a carbon capture and storage programme, an energy innovation programme, climate change research, and financial incentives to renewable-powered buildings and apartments (European Environment Agency, Reporting Obligations

Database, 2019). Spain, the third biggest environmental spender in the EU ETS, spent €830 million in biodiversity and adaptation measures in parks and bodies of water, subsidies for renewable-powered electricity, and a waste management program (European Environment Agency, Reporting Obligations Database, 2019).

Switzerland's ETS, introduced at the same time as its carbon tax in 2008, covers 11 percent of the countries' GHG emissions and is currently in its mandatory phase (2013–2020). Although most allowances are given for free through output-based allocation, auctioned permits are expected to increase to 70 percent of all allowances in 2020. All of the Swiss ETS revenues, US\$4.51 million in 2018, are fed directly into the general budget (ICAP, 2019). South Korea's ETS, introduced in 2015, is the second largest carbon market in the world covering roughly 70 percent of the country's GHG emissions and 591 of the country's large emitters (ICAP, 2019). Currently in its Phase Two (2018–2020), South Korea's ETS first allowance auction was held in January 2019 and brought in US\$12.74 million. All auctioning revenues are earmarked for environmental spending towards research, development, and procurement of emission-reduction technology (ICAP, 2019). New Zealand introduced its ETS in 2008 but no allowance auction has been held since all of the permits are given for free to tackle carbon leakage and competitiveness losses (ICAP, 2019). The first auctions are expected for 2020 and no rule for the use of auctioning revenue has been established.

Regulations and subsidies

Overall, carbon pricing systems will not be cost-effective “if pricing is layered on top of an emission-regulating regime already in place” (McKittrick, 2016). This is another measure to assess the effectiveness of a carbon tax or an ETS. These regulations will add more costs and create more deadweight loss to the economy. The Ecofiscal Commission (2017) notes that if a carbon tax or cap-and-trade scheme is poorly designed, it can undermine the effectiveness and cost-effectiveness of the policy. In particular, the report lists some additional, non-pricing climate policies that are being implemented or considered alongside carbon pricing. The report lists “regulating methane emissions in the oil and gas sector” as an example of an additional, non-pricing measure in Canada.

Although the focus of this paper is in the use of carbon pricing revenues, it is important to note that no country has used carbon pricing to replace climate regulations; instead many countries have done the opposite and have introduced new regulations following the implementation of a carbon pricing system. The following are a couple of examples.

Chile introduced its Energy Route 2018–2022 as a regulatory framework to transition to a decarbonized economy. This regulatory framework establishes a forced-growth approach to renewable energy through a mandatory increase of small-scale renewable generation capacity by four times and increasing the number of electric vehicles by ten times (Chile, 2018). Additionally, the framework introduces new regulations for solid biofuels and energy efficiency programs for industry, mining, transport, and building sectors. It also proposes a phase-out plan for coal-fired power plants (Chile, 2018).

Canada is planning to introduce a Clean Fuel Standard regulation in 2022 requiring annual carbon intensity reductions and minimum low-carbon-intensity content for liquid fuels (Canada, 2019). Denmark introduced its Energy Agreement 2012–2020 as a regulatory framework aimed at reducing GHG emissions by imposing energy efficiency standards for buildings and energy companies and an aggressive expansion of renewable power generation (International Energy Agency, 2017a).

Finland, which introduced its carbon tax in 1990 and participates in the EU ETS, implemented a Feed-In-Tariff program in 2010 for wind, biogas and wood chip electricity generation in an effort to increase the consumption of renewable energy to 38 percent by 2020 (Act No. 1396/2010). That same year, the government introduced an energy performance standards regulation for buildings undergoing renovation or alteration (Decree 4/13, 2013). In 2016, the executive released its National Energy and Climate Strategy for 2030 in which they adopted a 50 percent reduction target in oil energy demand, expanded investment subsidies for green technology, and introduced a phase-out plan for coal-fired power plants (Finland, Ministry of Economic Affairs and Employment, 2017).

France, arguably one of the European countries with the most stringent regulations, introduced the Energy Transition Law in 2015, one year after implementing its carbon tax. This law, which has over 200 articles, capped nuclear power output, adopted a 50% cut of national energy use by 2050, mandated a minimum 10% of low-carbon vehicles for taxis and rental companies, imposed a mandatory environmental impact assessment of investment portfolios, banned the production of disposable plastic bags, and introduced a Feed-In-Tariff program for electricity produced from renewable energy sources (Loi no 2015-992, 2015). Additionally, in 2017, France mandated an end to all exploration and production of hydrocarbon fossil fuels by 2040.

Japan, another high-income OECD country with stringent regulations, introduced its feed-in-tariff program in 2012 alongside with its carbon tax. The feed-in-tariff program offered above-market rates for renewable generation from bioenergy, geothermal, biomass, solar, and wind (Tanaka, Chapman, Sakurai, and Tezuka, 2017). In 2015, Japan implemented mandatory energy efficiency standards for large-scale non-residential buildings (Institute for Building Environment and Energy Conservation, 2016).

Germany, a participant in the EU ETS, enacted the Renewable Energy Sources Act in 2000 introducing a feed-in-tariff program for renewable energy generation. According to Dohmen, Jung, Schultz, and Trauffeter (2019) subsidies to wind, solar, and biomass facilities amount to €25 billion a year. Furthermore, in 2016 Germany's Grand Coalition announced its Climate Action Plan 2050, in which the government committed to introduce more robust energy regulation standards in the construction of new buildings and implement provisions regulating fertilizer use (Germany, Federal Ministry for the Environment, Nature Conservation, and Nuclear Safety, 2016). In the same year, Germany banned hydraulic fracking for the production of shale oil and gas and introduced additional subsidies for renewable power generation.

The United Kingdom has participated in the EU ETS since 2005 and has had a carbon price floor for the electricity sector since 2013. However, it has two emission

regulations in the electricity sector which are still in force. The first, introduced in 2010, is a feed-in-tariff program for households, businesses, and communities which promote small-scale electricity generation from renewable resources. The second, introduced in 2002, is a Renewables Obligation (RO) to support deployment of large-scale renewable projects. In 2016, the RO was replaced by the Contract for Difference program with the same objective behind it. Between 2002, when RO was first introduced, and 2016 RO and FIT subsidies amounted to £23 billion (Renewable Energy Foundation, 2017). Alongside the beginning of Phase I of the EU ETS in 2005, the UK introduced a Renewable Transport Fuel Obligation that mandated minimum requirements of renewable energy in transport fuel. Furthermore, the UK introduced minimum energy efficiency standards for private rented properties in 2016, adding to its already long list of energy regulations.

Since 2018, Switzerland has implemented its own feed-in-tariff program for hydropower, photovoltaic, biomass, and wind energy (International Energy Agency, 2018). New Zealand, which introduced its ETS in 2008, had already imposed an Energy Efficiency Regulations (SR 2002/9, 2002) in 2002 which outlined minimum energy performance standards for twenty different product classes. This regulation has been updated over the course of several years and is still in force. Additionally, in 2011, the government introduced the Engine Fuel Specific Regulations (2017/259, 2017) imposing minimum standards for fuel performance of petrol, ethanol, diesel, biodiesel, and their respective blends.

South Korea has had a Home Subsidy Program since 2004 that subsidizes installation costs of green equipment in private residential properties (International Energy Agency, 2017b). Additionally, the country's Renewable Portfolio Standard (RPS) was introduced in 2012, replacing its previous Feed-In-Tariff program for electricity generation. The new RPS regulation mandates that power companies with over 500MW of installed capacity must increase their share of renewable energy in total power generation until 2024 (Son, Kim, and Jeong, 2019). Companies that do not comply with specific targets will have to pay a financial penalty.

The EU ETS is the largest and oldest carbon market in the world, covering 28 EU Member States and 3 non-EU countries. Additional to its carbon pricing system, the EU has implemented a number of command-and-control regulations pushing for a reduction of greenhouse gas emissions. The most important emission regulations for the EU are Directives 2009/28/EC, 2009/30/EC, and 2012/27/EU. Directive 2009/28/EC, the renewable energy regulation, sets mandatory national targets in gross final consumption of energy from renewable sources by recommending the implementation of support schemes and other spending measures. It also stipulates that all EU Member States must have a National Renewable Energy Action Plan. Directive 2009/30/EC, the fuel standard regulation, sets technical standardized specifications for petrol, diesel, and gas-oil. The directive also requires a monitoring and reporting mechanism for life cycle greenhouse gas emissions per unit of energy from fuel and energy supplied. Directive 2012/27/EC, the energy efficiency regulation, mandates national energy efficiency targets that consider

the EU's cap of 1078 Mtoe of final energy consumption. The directive also introduces energy efficiency obligation schemes for distributors and retail energy companies in order to achieve their end-use energy savings targets.

Conclusion

Overall, carbon pricing systems must follow certain rules to have their intended effect of achieving the optimal balance between emission reductions and economic growth. However, we find that carbon pricing systems are being implemented globally without diligently abiding by the principles that make these systems work in an efficient manner. Based on an analysis of 31 high-income OECD countries, we find that, on average, 74 percent of carbon tax revenues in high-income OECD countries go directly into their general budget with no earmarking for any specific expenditure, while 12 percent are allocated for environmental spending, and only 14 percent for revenue-recycling measures. The results show that most governments are using carbon taxes as a revenue-raising tool rather than a mechanism to internalize the negative externalities of emissions in a cost-effective manner.

Carbon taxes are meant to replace all other climate-related regulations – however, the results show that no high-income OECD country has used carbon pricing to repeal emission-related regulations but instead have introduced new regulations alongside carbon pricing systems. In addition, most countries have a combination of support schemes for renewable energy sources and command-and-control regulations layered on top of carbon pricing systems. The results show that no high-income OECD country is following the textbook model of an optimal carbon pricing system, which undermines the theoretical efficiency by design and implementation.

The reality is that governments have a wide variety of policy alternatives to address the negative externality of emissions depending on the degree and depth of the policy intervention. Policymakers need to re-examine the design of carbon pricing systems and repeal command-and-control regulations that undermine the potential gains associated with setting a price on carbon.

References

- Aldy, J. E. (2017). *The Political Economy of Carbon Pricing Policy Design*. Harvard Project on Climate Agreements.
- Baldwin, R. E., and Robert-Nicoud, F. (2007). *Entry and Asymmetric Lobbying: Why Governments Pick Losers*. PSPE working papers. <http://eprints.lse.ac.uk/25171/1/PSPE_WP3_07_%28LSERO%29.pdf>
- Bennear, L. S., and Stavins, R. N. (2007). Second-Best Theory and the Use of Multiple Policy Instruments. *Environmental Resource Economics* 37: 111–29.
- Blanco, M. I., and Rodrigues, G. (n.d.). Can the Future EU ETS Support Wind Energy Investments? *Energy Policy* 34, 4: 1509–20.
- Boundreaux, D. J., and Meiners, R. (2019). Externality: Origins and Classifications. *Natural Resources Journal* 59, 1: 1–33.
- Canada, Environment and Climate Change Canada (2019). *Clean Fuel Standard: Proposed Regulatory Approach*. Government of Canada.
- Canada, Parliamentary Budget Office [PBO] (2019, April 25). *Fiscal and Distributional Analysis of the Federal Carbon Pricing System*. Government of Canada. <https://www.pbo-dpb.gc.ca/web/default/files/Documents/Reports/2019/Federal%20Carbon/Federal_carbon_pricing_EN.pdf>
- Canada, Parliamentary Budget Office [PBO] (2020, February 4). *Reviewing the Fiscal and Distributional Analysis of the Federal Carbon Pricing System*. Government of Canada. <https://www.pbo-dpb.gc.ca/web/default/files/Documents/Reports/RP-1920-024-S/RP-1920-024-S_en.pdf>
- Carl, J., and Fedor, D. (2016). Tracking Global Carbon Revenues: A Survey of Carbon Taxes Versus Cap-and-Trade in the Real World. *Energy Policy* 96: 50–77.
- Carvalho, P. (2017). *Portugal: State Budget 2018 – Brief notes*.
- Chile, Congreso Nacional de Chile (2014). *Ley 20780: Reforma tributaria que modifica el sistema de tributacion de la renta e introduce diversos ajustes en el sistema tributario*. Government of Chile.

Chile, Ministerio de Energia (2018). *Ruta Energética 2018–2022: Liderando la modernización con sello ciudadano*. Santiago de Chile.

Chile, Ministerio del Medio Ambiente (2018). *Tercer Informe Bienal de Actualización de Chile sobre Cambio Climático*. Government of Chile.

Christensen, C. M., Talukdar, S., Alton, R., and Horn, M. B. (2011). Picking Green Tech's Winners and Losers. *Stanford Social Innovation Review*. <https://ssir.org/articles/entry/picking_green_techs_winners_and_losers#>

Congressional Budget Office [CBO] (2009). *How Regulatory Standards Can Affect a Cap-and-Trade Program for Greenhouse Gases*. Government of the United States.

Convery, F. J., Dunne, L., and Joyce, D. (2013, October). *Ireland's Carbon Tax and the Fiscal Crisis: Issues in Fiscal Adjustment, Environmental Effectiveness, Competitiveness, Leakage and Equity Implications*. OECD Environment Working Papers. <[doi:https://dx.doi.org/10.1787/5k3z11j3w0bw-en](https://dx.doi.org/10.1787/5k3z11j3w0bw-en)>

Conway, D., Richards, K., Keenlyside, P., Mikolajczyk, S., Streck, C., Ross, J., ... Tran, A. (2017). *Carbon Tax Guide : A Handbook for Policy Makers (Vol. 2) : Appendix : Carbon Tax Case Studies (English)*. World Bank Group.

Denmark, Statistics Denmark (2019). *Expenses and Revenues of General Government*. Government of Denmark.

Dinan, T., and Rogers, D. L. (2002). Distributional Effects of Carbon Allowance Trading: How Government Decisions Determine Winners and Losers. *National Tax Journal* 55, 2: 199–222.

Dohmen, F., Jung, A., Schultz, S., and Traufetter, G. (2019, May 13). German Failure on the Road to a Renewable Future. *Der Spiegel*. <<https://www.spiegel.de/international/germany/german-failure-on-the-road-to-a-renewable-future-a-1266586.html>>

European Environment Agency (2019). *Reporting Obligations Database*. <<https://rod.eionet.europa.eu/obligations/698/deliveries?d-4014547-s=3&id=698&id=698&id=698&id=698&tab=deliveries&tab=deliveries&tab=deliveries&tab=deliveries&d-4014547-o=2&d-4014547-p=1>>

European Parliament and European Council (2009). Directive 2009/28/EC of the European Parliament and of the Council: On the promotion of the use of energy from renewable sources and amending and subsequently. *Official Journal of the European Union*. <<https://eur-lex.europa.eu/LexUriServ/LexUriServ.do?uri=OJ:L:2009:140:0016:0062:EN:PDF>>

European Parliament and European Council (2009). Directive 2009/30/EC of the European Parliament and of the Council: Amending Directive 98/70/EC as regards the specification of petrol, diesel and gas-oil and introducing a mechanism to monitor and reduce greenhouse gas emissions and amending Council Dire. *Official Journal of the European Union*. <<https://eur-lex.europa.eu/LexUriServ/LexUriServ.do?uri=OJ:L:2009:140:0088:0113:EN:PDF>>

European Parliament and European Council. (n.d.). Directive 2012/27/EC of the European Parliament and of the Council: On energy efficiency, amending Directives 2009/125/EC and 2010/30/EU and repealing Directives 2004/8/EC and 2006/32/EC. <<https://eur-lex.europa.eu/LexUriServ/LexUriServ.do?uri=OJ:L:2012:315:0001:0056:en:PDF>>

Fankhauser, S., Hepburn, C., and Park, J. (2010). *Combining Multiple Climate Policy Instruments: How Not To Do It*. Centre for Climate Change Economics and Policy Working Paper; Grantham Research Institute on Climate Change and the Environment Working Paper.

Fellows, G. K., Moore, M. C., and Schaffer, B. (2016). *The Challenge of Integrating Renewable Generation in the Alberta Electricity Market*. SPP Summary Paper 9, 25.

Finland (2010). *Act No. 1396/2010 on the Production Subsidy for Electricity Produced from Renewable Energy Sources*. Government of Finland. <<http://www.finlex.fi/fi/laki/ajantasa/2010/20101396>>

Finland, Ministry of the Environment (2013). *Ministry of the Environment degree 4/13: on improving the energy performance of buildings undergoing renovation or alteration*. Government of Finland. <https://www.edilex.fi/data/rakentamismaaraykset/decreree_4_13_2013.pdf>

Finland, Ministry of Economic Affairs and Employment (2017). *Government report on the National Energy and Climate Strategy for 2030*. Government of Finland.

France, L'Assemblée nationale (2015). *LOI n° 2015-992 du 17 août 2015 relative à la transition énergétique pour la croissance verte*. Government of France. <<https://www.legifrance.gouv.fr/affichTexte.do?cidTexte=JORFTEXT000031044385>>

France, Ministère de la Transition écologique (2017, September 21). *Fiscalité carbone*. Government of France. <<https://www.ecologique-solidaire.gouv.fr/fiscalite-carbone>>

France, Ministère de l'économie (2018). *Les chiffres clés du PLF 2018*. Government of France.

Germany, Federal Ministry for the Environment, Nature Conservation, Building and Nuclear Safety (2016). *Climate Action Plan 2050: Principles and Goals of the German Government's Climate Policy*. <https://www.bmu.de/fileadmin/Daten_BMU/Pool/Broschueren/klimaschutzplan_2050_en_bf.pdf>

Goulder, L. H. (2013). Climate Change Policy's Interaction with the Tax System. *Energy Economics* 40, 1: S3–S11. <doi:<https://doi.org/10.1016/j.eneco.2013.09.017>>

Goulder, L. H., Parry, I. W., and Burtraw, D. (1996). *Revenue Raising Vs. Other Approaches to Environmental Protection: The Critical Significance of Pre-Existing Tax Distortions*. National Bureau of Economic Research.

Hahn, Robert W., and Stavins, Robert N. (2011). The Effect of Allowance Allocations on Cap-and-Trade System Performance. *Journal of Law and Economics* 54, 4: S267–S294.

Harberger, A. C. (1964). The Measurement of Waste. *The American Economic Review* 54, 3.

Hirst, D. (2018). *Carbon Price Floor (CPF) and the Price Support Mechanism*. House of Commons Library.

Iceland, Ministry of Finance and Economic Affairs (2018). *RÍKISREIKNINGUR 2018*.

Institute for Building Environment and Energy Conservation (2016). *Overview of the Act on the Improvement of Energy Consumption Performance of Buildings*.

International Carbon Action Partnership [ICAP] (2019). *Emissions Trading Worldwide: Status Report 2019*.

International Energy Agency (2017a). *Danish Energy Agreement for 2012–2020*. <<https://www.iea.org/policies/606-danish-energy-agreement-for-2012-2020?q=denmark>>

International Energy Agency (2017b). *Home Subsidy Program*. <<https://www.iea.org/policies/5096-home-subsidy-program?country=Korea&page=2&q=korea>>

International Energy Agency (2018). *Feed-in Tariffs for RES and Investment Grants for Small and Large (>100kW) PV, Hydropower, and Biomass*. <<https://www.iea.org/policies/4663-feed-in-tariffs-for-res-and-investment-grants-for-small-and-large-100kw-pv-hydropower-and-biomass?country=Switzerland>>

International Monetary Fund [IMF] (2019). *World Economic Outlook Database*. IMF. <https://www.imf.org/external/pubs/ft/weo/2019/02/weodata/weorept.aspx?pr.x=51&pr.y=16&sy=2018&ey=2024&scsm=1&ssd=1&sort=country&ds=.&br=1&c=156%2C128%2C142%2C182%2C172%2C132%2C961%2C176%2C178%2C144%2C146%2C158%2C112&s=NGDP_R&grp=0&a=>>

Ireland, Department of Finance (2018). *Economic and Fiscal Outlook: Budget 2018*. Government of Ireland.

Ireland, Department of Finance (2019). *Consultation on the Options for the Use of Revenues Raised from Increases in Carbon Tax*. Government of Ireland.

Japan, Ministry of the Environment (2012, October 1). Details on the Carbon Tax (Tax for Climate Change Mitigation). Government of Japan. <https://www.env.go.jp/en/policy/tax/env-tax/20121001a_dct.pdf>

Japan, Ministry of Finance (2017). *Highlights of the Draft FY 2018 Budget*. Government of Japan.

Kesicki, F., and Strachan, N. (2011). Marginal Abatement Cost (MAC) Curves: Confronting Theory and Practice. *Environmental Science & Policy* 14, 8: 1195–1204.

Levinson, A. (2010). *Belts and Suspenders: Interactions among Climate Policy Regulations*. National Bureau of Economic Research Working Papers.

Mankiw, N. G. (2009). Smart Taxes: An Open Invitation to Join the Pigou Club. *Eastern Economic Journal* 35: 14–23.

McKenzie, K. J. (2016). *Make the Alberta Carbon Levy Revenue Neutral*. SPP Briefing Paper 9, 15.

McKittrick, R. (2016). *A Practical Guide to the Economics of Carbon Pricing*. SPP Research Papers 9, 28.

Metcalf, G. E. (2007). *A Proposal for a U.S. Carbon Tax Swap An Equitable Tax Reform to Address Global Climate Change*. The Brookings Institution.

Moore, S., and Vanderplas, A. (2018). *State Renewable Energy Mandates: A Regressive Green Tax on America's Poor*. Special Report 206.

Murphy, Robert P. (2019). *Carbon Pricing in Alberta*. Fraser Institute. <<https://www.fraserinstitute.org/sites/default/files/carbon-pricing-in-alberta.pdf>>

New Zealand (2002). *Energy Efficiency (Energy Using Products) Regulations 2002 (SR 2002/9)*. <<http://www.legislation.govt.nz/regulation/public/2002/0009/latest/DLM108730.html>>

New Zealand (2011). *Engine Fuel Specifications Regulations 2011 (SR 2011/352)*. <<http://www.legislation.govt.nz/regulation/public/2011/0352/latest/whole.html>>

Nordhaus, W. D. (1993). Optimal Greenhouse-Gas Reductions and Tax Policy in the ‘DICE’ Model. *The American Economic Review* 83, 2: 313–17.

Nordhaus, W. D. (2007). To Tax or Not to Tax: Alternative Approaches to Slowing Global Warming. *Review of Environmental Economics and Policy* 1, 1: 26–44.

Nordhaus, W. D. (2011). Designing a Friendly Space for Technological Change to Slow Global Warming. *Energy Economics* 33.

Norway, Ministry of Finance (2018). *Budget 2018*. Government of Norway.

Norway, Statistics Norway (2019). *Taxes on Greenhouse Gases Including Emissions Permits, Detailed Numbers*. Government of Norway.

Organisation for Economic Co-operation and Development [OECD] and the World Bank Group [WBG] (2015). *The FASTER Principles for Successful Carbon Pricing: An approach based on initial experience*. <<https://www.oecd.org/environment/tools-evaluation/FASTER-carbon-pricing.pdf>>

Organisation for Economic Cooperation and Development [OECD] (2018). *Effective Carbon Rates 2018: Pricing Carbon Emissions Through Taxes and Emissions Trading*. OECD Publishing.

Oikonomou, V., and Jepma, C. (2008). A Framework on Interaction of Climate and Energy Policy Instruments. *Mitigation and Adaption Strategies for Global Change* 13, 2: 131–56.

Parry, I. W., and Williams, R. C. (2010). What Are the Costs of Meeting Distributional Objectives for Climate Policy? *The B.E. Journal of Economic Analysis and Policy* 10, 2.

Portugal, Unidade Técnica de Apoio Orçamental (2019). *Tributação de combustíveis: estudo aprofundado e atualizado até final de 2018*. Government of Portugal.

Renewable Energy Foundation (2017, March 1). *The Total Cost of Subsidies to Renewable Electricity in the United Kingdom: 2002–2016*. <<https://www.ref.org.uk/ref-blog/340-the-total-cost-of-subsidies-to-renewable-electricity-in-the-united-kingdom-20022016>>

Rocamora, A. R. (2017). *The Rise of Carbon Taxation in France: From Environmental Protection to Low-Carbon Transition*. Institute for Global Environmental Strategies.

Rogissart, L., Postic, S., and Grimault, J. (2018, October). La Contribution Climat Energie en France: fonctionnement, revenus et exonérations. Point Climat 56.

Schlegelmilch, K., and Joas, A. (2015). *Fiscal Considerations in the Design of Green. Green Growth Knowledge Platform Research Committee on Fiscal Instruments*. <https://www.greengrowthknowledge.org/sites/default/files/downloads/resource/Fiscal_Considerations_in_the_Design_of_Green_Tax_Reforms_GGKP.pdf>

Sijm, J. (2005). The Interaction Between the EU Emissions Trading Scheme and National Energy Policies. *Climate Policy* 5, 1: 79–96.

Slovenia, Ministry of Finance (2019). *Republic of Slovenia State Budget 1992–2019*.

Son, D., Kim, J., and Jeong, B. (2019). Optimal Operational Strategy for Power Producers in Korea Considering Renewable Portfolio Standards and Emissions Trading Schemes. *Energies* 12 (Sustainable Energy Systems: Efficiency and Optimization). <doi:<https://doi.org/10.3390/en12091667>>

Sorrell, S., and Sijm, J. (2003). Carbon Trading in the Policy Mix. *Oxford Review of Economic Policy* 9, 3.

Speck, S. (2008). The Design of Carbon and Broad-Based Energy Taxes in European Countries. *Vermont Journal of Environmental Law* 10, 1: 31–59.

Stavins, R. N. (2003). Experience with Market-Based Environmental Policy Instruments. *Handbook of Environmental Economics* 1: 355–435. <doi:[https://doi.org/10.1016/S1574-0099\(03\)01014-3](https://doi.org/10.1016/S1574-0099(03)01014-3)>

Stavins, R. N. (2019a). *Carbon Taxes vs. Cap and Trade: Theory and Practice*. Harvard Project on Climate Agreements. <https://seors.unfccc.int/applications/seors/attachments/get_attachment?code=TJQGYTI096K3J33ANM1HWDWYEU51VRXNC>

Stavins, R. N. (2019b). *The Future of U.S. Carbon-Pricing Policy*. National Bureau of Economic Research. <https://www.hks.harvard.edu/sites/default/files/centers/mrcbg/working_papers/FWP_2019-02rev.0529.pdf>

Sumner, J., Bird, L., and Smith, H. (2009). *Carbon Taxes: A Review of Experience and Policy Design Considerations*. National Renewable Energy Laboratory.

Sweden, Ministry of Finance (2018). *Lessons Learned from 25 Years of Carbon Taxation in Sweden*. Government of Sweden. <https://www.government.se/48e9fb/contentassets/18ed243e60ca4b7fa05b36804ec64beb/lessons-learned-from-25-years-of-carbon-taxation-in-sweden.pdf#mce_temp_url#>

Sweden, Swedish Tax Agency (2018). *Energiskatter 1994–2018*. Government of Sweden.

Switzerland, Federal Department of Finance (2018). *Compte d’État 2018*.

Switzerland, Federal Office of Energy (2019). *Le Programme Bâtiments: Grandes orientations de la politique énergétique et climatique suisse*. <<https://www.leprogrammebatiments.ch/fr/le-programme-batiments/objectifs/>>

Tanaka, Y., Chapman, A., Sakurai, S., and Tezuka, T. (2017). Feed-in Tariff Pricing and Social Burden in Japan: Evaluating International Learning through a Policy Transfer Approach. *Social Sciences* 6, 127. <[doi:https://doi.org/10.3390/socsci6040127](https://doi.org/10.3390/socsci6040127)>

Tu, Q., and Mo, J.-L. (2017). Coordinating Carbon Pricing Policy and Renewable Energy Policy with a Case Study in China. *Computers and Industrial Engineering* 113, 294–304.

United Kingdom, HM Treasury (2018). *Budget 2018*. Government of the United Kingdom.

Watkiss, P., and Downing, T. E. (2008). The Social Cost of Carbon: Valuation Estimates and their Use in UK Policy. *The Integrated Assessment Journal: Bridging Sciences & Policy* 8, 1: 85–105.

Wilkinson, M. (1994). Paying for Public Spending: Is There a Role for Earmarked Taxes? *Fiscal Studies* 15, 4: 119–34.

World Bank. (2019). *State and Trends of Carbon Pricing 2019*. World Bank Group.

Zhang, B. (2013). Market-Based Solutions: An Appropriate Approach to Resolve Environmental Problems. *Chinese Journal of Population Resources and Environment* 11, 1: 87–91. <[doi:https://doi.org/10.1080/10042857.2013.777526](https://doi.org/10.1080/10042857.2013.777526)>

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