Chapter 4: General Issues in Designing a Carbon Tax

1. Introduction

139. In this chapter, we will explore some of the main issues raised in designing a carbon tax. We examine the basic elements in carbon tax design, such as tax incidence, taxing power, tax base and the point of regulation.

140. We refer to the two principal design approaches, the Fuel Approach - which uses fuels as the tax base and sets the tax rate based on carbon content- and the Direct Emissions Approach - which establishes the tax directly on emissions. However, these will be discussed in detail in Chapter 6: Carbon Tax Design Approaches in Practice.

141. Finally, design mechanisms to deal with the undesired distributional effects on households and firms will be addressed in Chapter 7. As the choice of taxpayer and time of tax payment are also relevant for design, they are given some attention in this chapter, but are primarily dealt with in Chapter 8 on tax administration.

2. A carbon tax in context with other forms of taxation

142. A carbon tax is a tax on carbon emissions. However, in practice, the tax base is a product, a process, or a service; thus, it is typically considered a type of indirect taxation, and more specifically an excise tax. Therefore, a jurisdiction's experience with indirect taxation should be the starting point for considering the implementation of a carbon tax. See Box 5 for a definition of the types of taxes.

143. With indirect taxation, the producer or seller who pays the tax usually passes the cost on to the consumer as part of the purchase price of the goods or services. This means that a carbon tax, levied on fuels by weight or volume or on actual emissions, would be referred to as an indirect tax and more precisely an excise tax (or excise duty).

144. There are some issues that warrant special consideration when assessing how a carbon tax system may be implemented in a country with little or no experience in levying excise taxes. These will be further discussed below.

Box 5. Indirect and direct taxation

Taxes are generally divided into direct taxes and indirect taxes. Direct taxes are imposed on a person or property and are normally paid directly. Examples include personal and corporate income taxes and property taxes. An indirect tax, on the other hand, is levied on specific goods or the provision of services and is collected and paid to the tax authority by an entity in the supply chain (usually a producer or an intermediary such as a retailer).

There are basically two kinds of indirect taxes: sales taxes or value added taxes (VAT), and excise taxes on specific goods or services. The former is typically imposed in addition to a sales tax or value added tax.

An excise tax is usually expressed as a per unit tax established on a specific volume or unit of an item, whereas a sales tax or value added tax is an ad valorem tax and proportional to the price of the goods.[50]

Another difference is that an excise tax typically applies to a narrow range of products (such as alcohol or tobacco products or petroleum products) while a sales tax or value added tax is more generally applied to all sales occurring in a jurisdiction.

Examples of taxes

Direct taxes	Indirect Taxes
Income Tax Corporate Tax Property Tax Inheritance Tax Wealth Tax	Excise Duties, e.g., alcohol, tobacco, fuels, emissions Sales Tax Value Added Tax

3. Who faces the cost of a carbon tax?

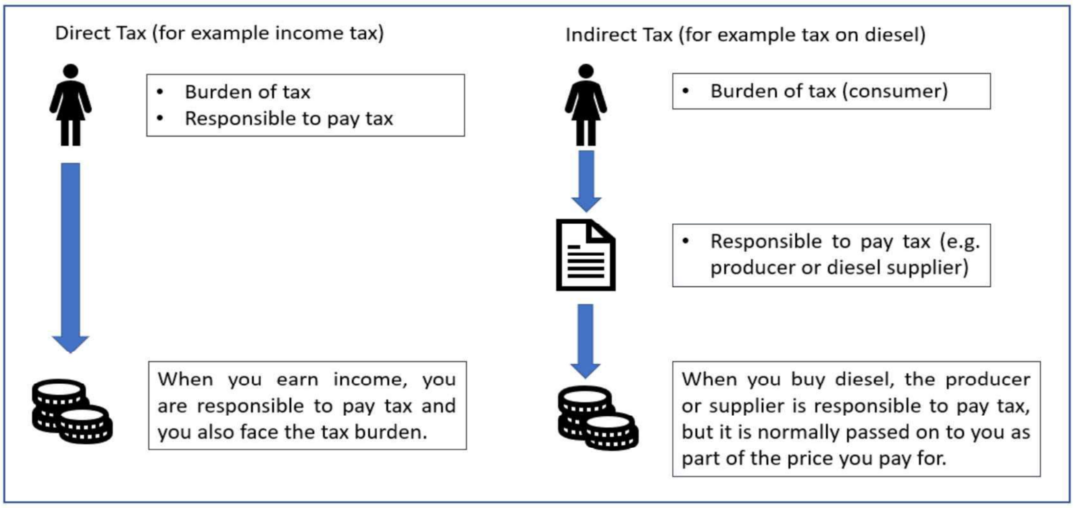
145. A carbon tax is aimed at giving consumers an incentive to change their behaviours and consume less carbon-intensive products. Carbon tax legislation determines which legal entity will be responsible for paying the tax, which is the taxpayer. The carbon tax incentive effect will depend on whether the taxpayer can pass the cost of the carbon tax on to the consumers, who are expected to change their behaviours. However, there may be a difference between who is targeted by the tax, who is legally responsible for payment, and who bears the tax burden.

146. The tax burden or tax incidence is the effect of a specific tax amount on the distribution of economic welfare in society. The introduction of a tax drives a wedge between the price consumers pay and the price producers receive, which typically imposes an economic burden on both producers and consumers. The tax incidence is said to “fall” upon those who ultimately bear the burden of the tax. The key issue is that the tax incidence or tax burden does not depend on where the revenue is collected (this is known as statutory incidence), but on the relative own-price elasticities of demand and supply which, in turn, determines the extent

50 There are also examples of ad valorem excise taxes, such as the carbon tax in Costa Rica which is calculated as a percentage of the price of certain fuels.

to which the taxpayer can pass the cost of the tax on to the consumers. Figure 3 presents this schematically.

Figure 3 Direct vs indirect tax – who pays the tax and who faces the tax burden



147. In the case of a carbon tax, the tax incidence depends on whether the entities obliged to pay the tax can pass it on to the consumers. If the entities can raise the product price to compensate for the full amount of the tax, the tax incidence falls completely on the consumers. It is important to emphasize that a change in consumer behaviour is needed for the tax to fulfil the purpose of reducing emissions. If the producer is neither able to abate emissions nor raise the product price, the producer will bear the full incidence of the tax, consumption will be unaffected, and carbon dioxide (CO_2) emissions will not be reduced.

148. There are several important issues to consider in this discussion. For instance, if a regulated price exists, it may not be possible to increase the price and pass the burden of the tax. In this case, the tax burden falls on the taxpaying entities, reducing their profits. Under these circumstances, a carbon tax will not reduce emissions and operate as a revenue raiser, at least in the short term.

149. However, most entities operate in markets where it is possible to pass on at least part of the increased cost to consumers. This means that, in most cases, the carbon tax incidence will be divided between the taxpayer entities and the consumers. There are, however, circumstances where the taxpayers are unable to transfer increasing costs to consumers, for instance when facing international competition. In these cases, it may be necessary to introduce exemptions and/or lower tax rates for certain sectors of the economy. Another option might be for jurisdictions to engage in regional cooperation on carbon taxation. These issues will be further discussed in Chapter 7.

4. Taxing power

4.1 Taxing power boundaries

150. The statutory power or authority to levy taxes varies across and within jurisdictions. It is established in rules that can take the form of constitutional arrangements, public law requirements, supra-national principles, or other legal obligations. These rules may influence specific design choices as well as identify potential gaps in regulation. Some countries, for example Indonesia, have adopted a fiscal decentralisation policy that gives provincial and local governments the authority to levy certain taxes and decide on the revenue use.

151. Considering taxing power arrangements early in the design process will help provide a clearer view on who should be involved in the design and implementation of the carbon tax and which resources policymakers have at their disposal to effectively implement the tax.

152. Cross jurisdictional value chains should also be considered. Implementing the tax at lower subnational level may involve more complexity due to the potential for double or multiple taxation of producers, retailers, and consumers. This may also require adjustments to deal with potential carbon leakage and competitiveness.

4.2 Existing institutional frameworks for setting and collecting taxes

153. In most countries, an institutional framework is already in place to implement taxes which involves a mandate and governance structure for setting and collecting taxes. Taxes are usually designed by Ministries of Finance and collected by Tax Agencies or Customs Authorities.

4.3 Distinct features of a carbon tax

154. Carbon taxes have some distinct features that make them different from other taxes. The primary purpose of a carbon tax is not to raise revenue but to change the behaviour of households and firms. An effective carbon tax should incentivise the reduction in carbon emissions.

155. Complementary or overlapping carbon emission reduction policies will affect the effectiveness of carbon pricing policy (see Chapter 10 for a discussion) and in some cases on how the tax is collected.[51] Given the policies and objectives of different government agencies, coordination across the government is important when considering the introduction of a carbon tax.

51 E.g., Singapore recently introduced a carbon tax that will not be collected through the Tax Authorities. The tax works through emission certificates. Although there is no carbon emission certificates market, the tax will be collected through the issuance of certificates, which will be done outside the Tax Authorities.

156. When designing a carbon tax, technical expertise on environmental and energy issues is crucial for setting the tax rate and the effective design and administration of the tax, particularly in the case of the Direct Emissions Approach (see Chapter 6). This expertise is usually found outside the Ministry of Finance and Tax Authorities. Therefore, cooperation between relevant government agencies is an essential part of the evaluation process leading up to the implementation of a carbon tax.

157. A carbon tax can also be designed using the existing excise tax administration system, particularly with the Fuel Approach (see Chapter 6). In this case, existing tax collection authorities can administer the tax effectively since implementation does not differ from other excise taxes and, therefore, cooperation between government agencies can be centred on broad carbon emissions' reduction policy strategies.

4.4 Constitutional rules regarding taxing power

158. National constitutions or similar documents often regulate taxing power. The constitutional requirements to introduce taxing powers or legislate tax rules may be more stringent than the constitutional requirements and checks to general legislation. This means that policymakers will need to consider constitutional requirements and the confines of the fiscal system in general, as they determine carbon tax design choices.

159. One example of a jurisdiction that has more stringent constitutional requirements for taxes is California (United States of America). Its constitution requires a two-thirds supermajority vote for tax measures, which heightens attention to what is a "tax". After the State of California created a cap-and-trade programme that auctioned emissions allowances, a court determined the system did not impose a "tax" and therefore did not require a supermajority for its approval.

160. Carbon tax design can be adjusted to accommodate such restrictions, but understanding constitutional requirements and boundaries upfront improves the effectiveness of implementation.

161. Some jurisdictions require that an independent legal body review the constitutionality of a tax bill before it is put in force. This is, for example, the case in France, where the original proposal of introducing a carbon tax in 2009 was blocked by the country's Constitutional Council. The Council expressed concerns that the tax included too many exemptions, among them certain industries, e.g. trucking, and agriculture, which would have made the tax unfair and inefficient. The carbon tax finally introduced in 2014 had addressed those concerns by broadening the scope of the tax and closing the loopholes in the prior proposal.

162. While many jurisdictions do not earmark tax revenues for specific purposes,

it is common for jurisdictions to specify in advance how environmental tax revenues will be used, particularly if they are assigned for additional environmental protection expenditures. Earmarking all or a portion of tax revenues can be a tool for a government to gain acceptability for the introduction of a carbon tax (see Chapter 9 on Revenue Use).

163. Some constitutional rules prohibit even this kind of informal earmarking by, for example, defining specific taxes that can be introduced in a limited way without mentioning a carbon tax. Exceptionally, this could mean that introducing a carbon tax could not be possible without constitutional changes. If this would apply, efforts can be made to change the Constitution, although that may be a long and difficult political process to undertake for the sake of a single tax.

164. However, even if policymakers need to address specific constitutional issues in their national jurisdictions, it is rare to find situations where constitutional requirements would significantly hinder the introduction of a carbon tax.[52]

4.5 *Special considerations for jurisdictions with subnational levels*

165. In case a jurisdiction has subnational levels, a country's constitution or public law arrangements will likely contain rules as to which levels of the state have taxing powers, e.g., municipal level, provincial level and/or federal level. These levels may vary depending on the types of taxes. Moreover, in the case of carbon taxes, both constitutional mandates that regulate environmental as well as taxes may be relevant.

166. In Canada, provinces and territories are required to have a carbon pricing instrument that meets a level of stringency determined by the federal government, otherwise a federal carbon pricing system applies; this is known as the federal backstop. The federal system is composed of a fee on fossil fuels, known as the fuel charge, and an output-based pricing system for large industrial facilities that applies either fully or partially depending on the circumstances in each province or territory.

167. Even if there is no conflict between subnational governments on mandates, it is helpful to stipulate which tax takes precedence. A subnational government may

52 When taxing power constitutional restrictions exist, they are often not applicable to other instruments. This means that alternative instruments could be considered, other than prices or regulations of carbon emissions. For example, the European Union (EU) initially explored the possibility of introducing a carbon tax framework for the Union. However, according to the EU Treaty rules, tax rules need to be approved by unanimity whereas an emission trading system could be introduced by qualified majority. The EU Emissions Trading Scheme (EU ETS) ended up being easier to introduce than an EU-wide carbon tax, mandatory in all the Member States, in large part for that reason. Discussions within the EU have continued to extend the current tax framework for energy products to also cover a mandatory carbon tax, as a complement to the EU ETS for sectors which are not covered by the EU ETS. It has, however, not proved possible to reach unanimous agreement on such a tax system so far. As the current EU legislation allows EU Member States to introduce a carbon tax unilaterally as part of their general excise duty regime, seven countries have chosen to do so up to date.

be inclined to introduce a carbon tax before action is agreed on at the national level. For example, in the USA, implementing a federal carbon tax is challenging, therefore many individual US states have implemented state or regional carbon pricing instruments.[53]

168. Clarity on the interaction of a carbon tax across levels of government could garner more support for introducing the tax at a subnational level, while calling for introduction of the same or a similar tax at a higher state level. The federal tax could become credible against the state tax once it is introduced. It could also be argued that the subnational tax should cease to apply once a federal tax has entered into force because of double taxation or compliance costs.[54]

169. Concerns over double taxation also occur at the supra-national level. For this reason, the European Union (EU) Commission proposed a carbon tax framework to be introduced for EU Member States. Such a wide mandatory framework has, however, not yet been decided within the EU. See Box 6 for discussion.

Box 6. Example of carbon taxes within the EU Energy Taxation Framework

In the EU. most fuels are subject to an excise duty. Eight Member States have also chosen to implement a carbon tax. These taxes are due at (i) production or extraction, or (ii) importation into the EU. However, a carbon tax in an EU country does not become chargeable until it is released for consumption to the Member State. This means that, in terms of administering and levying the carbon tax, the taxable event occurs as follows:

- The departure of taxable goods, including irregular departure, from a tax suspension arrangement.
- The holding of taxable goods outside a tax suspension arrangement where a carbon tax has not been levied pursuant to the applicable provisions of EU law and national legislation.
- The production of taxable goods, including irregular production, outside a tax suspension arrangement.
- The importation of taxable goods, including irregular importation, unless the goods are placed, immediately upon importation, under a tax suspension arrangement.

Each EU Member State has discretion as to where the tax is liable on the distribution chain, that is there is flexibility in determining the extent of the tax suspension regime.

Some EU countries are applying rules which result in a relatively few taxpayers. Such taxpayers are normally to be found early in the distributional chain, while operators further down the distributional chain will not be involved in the tax collection. Tax rebates are, in those cases, normally administered by the end users asking for a tax reimbursement. Another way could be to introduce approval procedures for businesses, which under tax control may receive the fuels tax exempted.

While some EU countries, for example of Sweden (see further in Chapter 6), allow large business consumers to be taxpayers, the EU legislation does not allow private individuals to register as taxpayers. This means, for example, that petrol stations selling motor fuels to households are not taxpayers but buy the fuels already taxed in a previous leg of the distributional chain.

53 California implemented the Western Climate Initiative, and the New England States in the northeast have implemented the Regional Greenhouse Gas Initiative (RGGI).

54 For example, in Spain, Autonomous Communities have the constitutional power to establish new taxes, subject to the condition that they do not overlap with taxes at the national level. Following the Constitution, several Autonomous Communities have created a wide array of regional environmental taxes (e.g., on CO2 emissions, thermonuclear electricity production, electricity, waste, etc.). The situation has given rise to compliance costs for firms operating with facilities subject to taxation in more than one Autonomous Community; in some instances, it has led to Constitutional Court cases as well.

Checklist 2. Taxing power

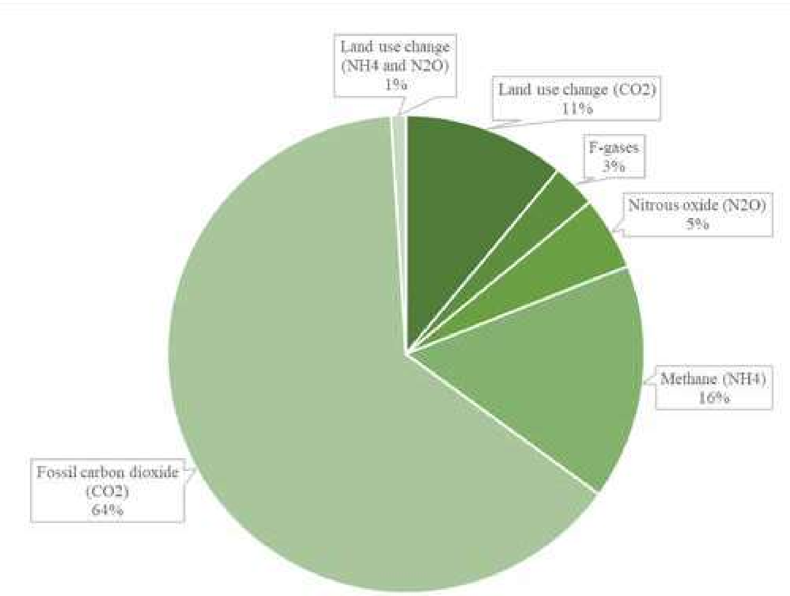
1. Consider taxing power arrangements
2. Assess issues of double or multiple taxation within and across jurisdictions
3. Consider the current institutional framework, particularly existing taxation system
4. Raise awareness of increased coordination efforts
5. Assess constitutional restrictions, for example, earmarking limitations

5. Scope of the carbon tax

5.1 *What to tax?*

170. The simple answer to the question of what we are going to tax is carbon emissions. Carbon is the primary element that may give rise to the release of CO_2, if submitted to a combustion or other processes (See Chapter 2). Emissions of CO_2 from fossil fuels and industrial processes amounts to roughly two thirds of the global greenhouse gas (GHG) emissions, as illustrated in Figure 4 below. Of these, the combustion of fossil fuels account for more than 80 percent.[55] In this Handbook, we will principally focus on CO_2 emissions from fuel combustion, although one of the approaches to carbon taxation discussed below can also accommodate taxation of other processes that generate carbon emissions as well.

Figure 4. Global GHG Emissions per gas, 2019



CO2 equivalents calculated with Global Warming Potentials (GWP-100) of the Fourth IPCC Assessment report (2017) (AR4). Source: United Nations Environment Programme, 2020

55 Olivier and Peters, 2020.

171. There are two basic approaches when considering what to tax. One is a tax on the volume or weight units of the fuels giving rise to emissions when combusted; this will be referred to as the Fuel Approach, where the tax rate is based on standardized amounts of carbon content in fossil fuels. The other is a tax on emissions directly at source; this is known as the Direct Emissions Approach.

172. There are advantages and disadvantages with both approaches. The design choice will depend on the national conditions, since both can, in principle, result in well-designed carbon taxes.[56] A discussion will follow below using examples of tax systems currently in force in different jurisdictions.[57] The two different approaches will be discussed in more detail in Chapter 6.

173. The design must determine which are the sectors, subsectors, or economic activities to target. This is a broader question than the types of fuels, emissions, or facilities covered. Circumstances will differ across jurisdictions, and having tax coverage that is consistent with the policy objectives will depend on the emissions profile of the jurisdiction, relevant tax policies, the structure of key sectors, and government capacity to administer the tax. In general, for jurisdictions without any carbon pricing system in place, a broader carbon tax will usually be more efficient.

174. To achieve the expected emissions' reductions, it is important to assess what is technically and economically possible in the targeted sectors. As a result, governments must consider potential adverse impacts on firm competitiveness and distributional effects from the implementation of the tax. This is further discussed in Chapter 8.

Box 7. GHG emissions targeted

CO_2 is the principal GHG emitted from the combustion of fuels and thus merits the focus of this Handbook, however smaller amounts of other gases such as nitrous oxide and methane are also emitted during combustion, depending on the type of fuel and method of combustion[58]. Emissions of greenhouse gases other than carbon dioxide can be converted into carbon dioxide equivalents (CO_2e). Jurisdictions that use the Direct Emissions Approach can apply CO_2e to compare between different gases, and include other GHG in their tax scheme.

There are also examples of jurisdictions that have introduced taxation of fluorinated greenhouse gases, so-called f-gases, the most common ones being hydrofluorocarbons (HFC) and perfluorocarbons (PFC)[59]. However, f-gases are generally used for refrigeration systems.

This means that such taxation would not relate to the burning of fuels and the tax design would need to be found outside of a system of taxing fuel products or actual emissions from the combustion of the fuels and therefore merit different considerations that are beyond the scope of this document.

56 Many jurisdictions across the globe – such as most countries in the EU, Sri Lanka, South Africa, and Zimbabwe – have introduced an element into their taxation of the acquisition of ownership of passenger cars which accounts for emissions of CO_2 from the propulsion of the vehicle. However, these kinds of taxes are not within the scope of this Handbook.

57 Most carbon taxes currently in existence follow either the Fuel Approach or the Direct Emissions Approach. However, in literature, consumption-based carbon taxes are also discussed as an alternative approach to existing carbon taxes. Consumption-based carbon taxes price carbon further to the point of final consumption. In theory, pricing carbon consumption, rather than just production, can help to avoid the risk of carbon leakage. However, consumption-based carbon taxes only really exist in theory as they are complex to administer and will not be covered in this Handbook. See for further reading: CPLC, 2018.

58 There are seven GHG covered by the United Nation's Framework Convention on Climate Change (UNFCCC), including apart from CO_2, six others, namely methane, nitrous oxide, hydrofluorocarbons, perfluorocarbons, sulphur hexafluoride and nitrogen trifluoride.

59 Denmark and Norway, for instance, tax emissions of carbon dioxide as well as f-gases, while Spain is an example of a jurisdiction with a tax solely on f-gases at the national level.

5.2 Who will pay the tax?

175. Choosing the taxpayer and liable sectors will depend on the objective of the tax, the tax approach, and the administrative conditions in the implementing jurisdiction. In the case of the Fuel Approach, discussed in more detail in Chapter 6, the taxpayer will depend on the fuel distribution chain which typically involves a range of agents operating at different points.

176. The actual payment of the tax – when and by whom – should be regulated in the carbon tax legislation. These issues are of interest to authorities set to administer the carbon tax and, consequently, to legislators considering how to design their tax legislation. The legislator's choice depends on the possibilities for the taxpayer to transfer the cost of the tax down to the fuel supply chain or the consumer.

177. The jurisdiction's current administrative structure and its expected development will be important in identifying who pays the tax. It should also be highlighted that many developing countries are adopting digital tax declarations systems, which can significantly facilitate the tax administration while resources can concentrate on ex-post tax control in the form of tax audits and spot-checks (see also Chapter 8 on administration).

5.3 How to tax?

178. The point of regulation, or when to charge the tax, will depend on the tax approach taken. A distinction between upstream, midstream, and downstream points of regulation is sometimes used in economic literature to identify the point at which the tax is controlled or collected.

179. It is crucial to analyse which agents will bear the burden of the tax and if they are responsive to the price signal. To ensure efficiency and environmental integrity, households and firms should respond by changing their behaviour. Whether the price is passed on to the final consumer will depend on price elasticities, trade exposure and, in the case of regulated contracts, the nature of the trade agreements between sellers and buyers of the fuel. This should be considered in the design but cannot be regulated by the tax legislation.

180. Another important aspect is the challenge associated with administering the tax, including difficulties in monitoring, reporting and verification (MRV). Due to administrative complexities and the number of taxpayers, it would not make sense to let each individual consumer, for example, private persons using petrol-consuming cars, be responsible for paying the tax to the Government or some other public body.

Box 8. Summary of principal elements in carbon tax design

The **tax base** defines what is to be taxed and determines the different approaches to carbon taxation discussed in this Handbook. This is a design choice, but it also has relevance for the administrative burden and tax rate. In the case of the Direct Emission Approach, the tax base is emissions, usually CO_2, but it can be broadened to other GHG emissions. In the case of the Fuel Approach, the tax base is fuels that give rise to CO_2 emissions when combusted.

The **taxable event** refers to the occurrence of the event that makes the tax due. In the case of the Fuel Approach, the taxable event can be the importation, sale, or consumption of the fuel volume. In the case of the Direct Emission Approach, the taxable event is when emissions occur. In the first case, the point of regulation may vary, but in the second, the point of regulation must be now of the emissions. The **point of regulation** refers to the moment when the tax authorities regulate the taxable event.

The **tax rate** refers to the rate or price carbon emissions costs will be set at. This is usually determined in the legislation. In the case of the Direct Emissions Approach, the rate is fixed by the legislation; in the case of the Fuel Approach, the carbon emission rate is translated into the carbon content of fuels, so the tax rate will vary by fuel type and volume depending on the pre-established amount of CO_2 emissions released to the atmosphere when a specific fuel type is being combusted.

The **taxpayer** is the economic agent that pays for the tax. Note that this is not necessarily who bears the burden of the tax (see above, for a discussion). The taxpayer must be clearly identified and regulated. In the case of Direct Emissions Approach, the taxpayer is the facility that generates the emission. In the case of the Fuel Approach, there may be some flexibility as to whom the taxpayer can be. For example, as is further discussed in the next chapter, Sweden has limited the administrative burden of charging multiple taxpayers by registering tax warehouses who should pay the tax to the authorities.

The **tax administration authority** is the public body charged with administering the tax or overseeing its administration. Usually this is the tax authority, but in the case of the Direct Emissions Approach, the role of environmental agencies will be especially important in verifying and controlling the emissions data submitted by the tax liable facilities. Although the Fuel Approach does not require additional expertise, there may be exemptions or reimbursement schemes, e.g., for businesses performing a certain environmentally friendly activity, carbon capture and storage. The policymaker must acquire relevant data (such as average emission factors, type of fuels and, in some cases, production processes) to determine carbon content, set the formula for calculating the tax and transform it into the weight or volume units used to lay down the tax rates in the legal text. This is done through the tax declaration form. Once that is made, it is straightforward to apply the carbon tax and calculate future tax rates changes.

Checklist 3. Core elements of Carbon Tax Design

Consider taxing power arrangements

1. What to tax?
   - (i) Tax base – emissions or fuels?
     - (a) Which emissions? GHG or CO2
     - (b) Which fuels? All fuels, the most relevant in the jurisdiction
   - (ii) Tax base - which sectors?
   - (iii) Consider technical viability
   - (iv) Consider economic feasibility

2. Who to Tax?
   - (i) Who is the taxpayer?
   - (ii) Who is liable?

3. How to Tax?
   - (i) When is the tax payment – what is the taxable event and/or point of regulation?

6. Conclusion

181. In this chapter, we explored some of the general issues raised in designing a carbon tax. We examined basic elements such as tax incidence, taxing power and issues raised by taxations at sub and supra national levels. We also briefly discussed the tax base and referred broadly to two design approaches, the Fuel Approach -which uses fuels as the tax base and sets the tax rate based on carbon content - and the Direct Emissions Approach - which establishes the tax rate directly on emissions, as practical approaches for carbon tax design.

182. The final section explored the specific questions of carbon tax design, namely, what, who, and how to tax. In Chapter 6, we explore these questions in more detail, drawing specifically on two country cases that have adopted the Fuel and Direct Emissions Approach respectively, and discuss design elements associated with these different approaches. Further, in Chapter 8, the different elements of the tax design are dealt with from an administrative perspective, considering the actual procedures needed development to make the tax scheme operational for the body or bodies in charge of those tasks.

183. Before going into detail, we examine, in the next chapter, different criteria or considerations to set the tax rate, a key design issue.

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Chapter 5: Setting the Tax Rate

1. Introduction

184. Setting the tax rate is an essential element in the policy design of a carbon tax since it has direct consequences in achieving the environmental objective and impacting the economy. There are various economic theories and approaches that could be used to help policymakers determine the tax rate.[60]

185. In this chapter, we examine practical approaches to determining the tax rate, complemented by country examples.[61] These are the Standards and Price Approach, the Revenue Target Approach, and the Benchmarking Approach. These methodologies should not be considered independently since they support an integrated decision-making process. This is because each one provides insights that can help find a tax rate in line with a desired climate policy objective.

2. Basic considerations for setting the tax rate

186. Since the impacts of the tax can be difficult to predict in advance, implementing a carbon tax should be viewed as a learning-by-doing process. To meet the objectives of the Paris Agreement, jurisdictions should strive to implement a carbon tax as soon as possible. If the desired policy goal is not reached after a certain period (to be analysed according to the jurisdiction's specific economic and social circumstances), a tax adjustment should follow. A dynamic tax rate trajectory could help to increase the effectiveness of the tax. Hence, it is advisable for jurisdictions to start applying a carbon tax, irrespective of the starting rate.[62]

187. The range of carbon tax rates currently implemented across the world varies from less than US$ 1 per tonne of carbon dioxide equivalent (tCO_2e) to over US$ 100.[63] It is worth noting that the jurisdictions that have the highest rates in place did not start their carbon tax programmes at a high level. Most jurisdictions (for example, Sweden) initiated their carbon tax programmes with relatively low tax rates, increasing them over an extended period.[64] Nevertheless, most initiatives currently implement relatively low carbon tax rates, generally below US$ 30 / tCO_2e.[65]

188. To achieve the 1.5 degrees Celsius temperature increase limit target agreed upon by the Paris Agreement, the High-Level Commission on Carbon Prices

60 Kettner-Marx and Kletzan-Slamanig, 2018.
61 PMR, 2017. (p. 89).
62 PMR, 2017. (p. 95).
63 For an overview, see World Bank Group, 2021.
64 Hammar & Åkerfeldt, 2011.
65 OECD, 2021.

proposed a carbon price ranging from US$ 50 – 100 / tCO_2e by 2030.[66] These rates are high compared to the current state of the art of carbon taxation. However, even low initial tax rates can serve as price signals since the tax rate can later be adjusted to a level consistent with environmental targets.

189. Ideally, the introduction of a carbon tax should include a political commitment to increase rates over time to reach a specific emission reduction target. The implementation of hard commitments to raise carbon prices is difficult, but some design features may help. Examples include politically committing to higher rates when carbon prices rise in neighbouring countries or with trading partners, ensuring that changes to the tax rate do not require changing primary legislation, and ensuring that the revenue generation and use is integrated in the fiscal policy.[67]

190. Applying a uniform carbon tax rate to all emission sources is considered more efficient.[68] However, in practice, some jurisdictions apply different effective carbon tax rates[69] according to fuel use (e.g., heating, transport) or sectors (e.g., households, industries). Different tax rates within an economy may be necessary to achieve policy acceptance. See Chapters 3 and 7 for a discussion.

3. The theoretical framework

3.1 Theory of externalities

191. The theoretical framework that supports carbon taxation is based on the theory of externalities developed by Pigou.[70] The idea is that carbon emitters generate an externality by imposing costs and disservices on others, without paying the full cost of the resulting damage that occurs. Therefore, since private and social costs do not coincide, there is a market failure and the market solution is not efficient, generating environmental damage.

192. However, it is possible to internalize external costs and achieve a socially efficient outcome, through a tax on the externality, in this case carbon emissions, at a rate consistent with the marginal external costs. The tax should equalize the private costs of an economic agent (marginal private costs) to the costs to society (marginal social costs). As a result, polluters bear the costs of their economic actions[71] and produce or consume at the socially optimal level.

66 CPLC, 2017; IPCC, 2018.
67 PMR, 2017. (p. 95).
68 Kettner-Marx and Kletzan-Slamanig, 2018.
69 See for an overview Carbon Pricing Dashboard, The World Bank available at https://carbonpricingdashboard.worldbank.org/map_data
70 Pigou, 1920.
71 Pearce, 2003. Pigou, 1920.

Box 9. Carbon taxes and the Nobel Prize

William D. Nordhaus was one of the first economists who combined economic and climate-related models. He created an Integrated Assessment Model, which describes the interplay between the economy and climate. Nordhaus supports the idea of implementing carbon taxes. His research showed that carbon pricing through emission trading schemes or carbon taxes is an efficient way of lowering carbon emissions.

In 2018, Nordhaus received the Nobel Prize in Economics. The Nobel committee recognized with the award the economics of climate change, which underlines the relevance of a carbon tax.[72]

Nordhaus' model is often used to simulate how the economy responds to climate change. Moreover, his Integrated Assessment Model can also be used to calculate the cost of climate change. This data can help to define the tax rate of a carbon tax.

In addition, the model provides a methodological framework to examine the consequences of various climate change policies, like carbon taxes. The practical relevance of the model was demonstrated through the application by the Intergovernmental Panel on Climate Change (IPCC), who referred to the work of Nordhaus when calculating the costs of climate change.[73]

3.2 Pigouvian taxation – internalising external costs

193. According to economic theory, the tax rate of a Pigouvian tax should be set equal to the marginal social cost of the pollution, thus increasing the price for the activity causing the pollution and reducing its demand. See Box 10 for an analytical presentation.[74]

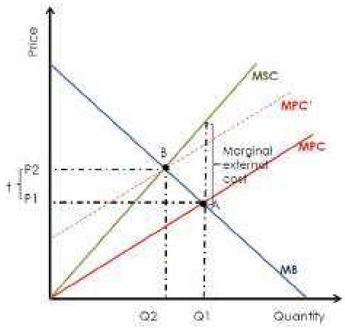
194. Determining the optimum Pigouvian tax is difficult since it requires considerable information, including an assessment of environmental damage, as well as, in the case of climate change, intergenerational assumptions on preferences.[75] Furthermore, assumptions on adaptation and technological change and the choice of the discount rate[76] are also necessary. Thus, even the most complex model is subject to a degree of uncertainty.

195. Therefore, although the theory of externalities and Pigouvian taxation are the conceptual frameworks behind determining effective carbon tax rate, in practice, there are several approaches to set the rate.

72 For further reading on the contribution of William Nordhaus, see http://www.nobelprize.org/uploads/2018/10/advanced-economicsciencesprize2018.pdf.
73 IPCC, 2018.
74 See Chapter 2.
75 Hope, 2006; Nordhaus, et al., 2000; Nordhaus and Yang, 1996; Isaacs, et al., 2016.
76 The discount rate refers to the rate that future costs and benefits are discounted relative to current costs.

Box 10. Technical Note: Pigouvian Taxation

Figure 5. Pigouvian Taxation



The graph illustrates how a Pigouvian tax works. The horizontal axis represents the amount of output produced by the good/product that generates pollution. The vertical axis represents the market price. The marginal benefit (MB) curve measures the MB (benefit from the production of each additional unit of the good) which arises for society at different levels of production. The marginal private cost (MPC) represents the marginal costs (costs of each additional unit of the good) which can be attributed to the producer. Finally, the marginal social cost (MSC) measures the marginal costs (costs of each additional unit of the good) to the society. The MSC is composed of the MPC and the costs of the externality. Point A represents the market equilibrium with the quantity Q1 and the price P1 which arises without any intervention. However, point A is not optimal for society as its costs are not covered completely at the level of the producer. As a result, the costs exceed the social benefit. To correct the market failure, a tax (t) at the level of the marginal external cost could be introduced. Thereby, the MPC will be shifted to the MSC at point B, which represents the social optimum. At this level, production is reduced to Q2 at the new price P2. At point B, the MSC equals the value of the MB.[77]

Source: Kettner-Marx and Kletzan-Slamanig, 2018

4. Practical approaches to set the carbon tax rate

4.1 Standards and Price Approach – to reach a specific carbon reduction target

196. In practice, several approaches can be used to set a carbon tax rate. One approach is to set the tax rate corresponding to a specific carbon reduction target; this is known as the Standards and Price Approach (also known in literature as *Baumol-Oates* approach).[78] The focus of the Standards and Price Approach is not the determination of the correct social cost of carbon, but the tax rate required to achieve a specific emission reduction target.

197. The approach involves initially setting an emission reduction target (standard), for example, the commitments under the Nationally Determined Contributions (NDC), then estimating the tax rate (price) consistent with this goal. Given the high level of uncertainty, the initial tax rate can be adjusted by “trial and error” to reach the set standard. Following the iterative approach suggested by the Standards and Price Approach helps to reach the specific emission reduction targets by adjusting the price

77 Kettner-Marx and Kletzan-Slamanig, 2018.
78 Baumol and Oates, 1971; Walker and Storey, 1977.

signal so it becomes more accurate.

198. The main advantage of this method is that it is not necessary to find the economic optimal tax rate since the emission reduction goal will be reached following a dynamic tax rate trajectory. However, the disadvantage of the Standards and Price Approach is that there needs to be strong political commitment to follow this strategy over several years, because regular tax rate adjustments are crucial. Those adjustments must be solely based on environmental objectives, rather than on political considerations.

199. This approach is feasible if the primary purpose of the carbon tax is to meet a specific emission reduction target. Emission targets could be set in a national law or as a political commitment. Moreover, an emission reduction target can be based on the NDC under the Paris Agreement and the United Nations Framework Convention on Climate Change (UNFCCC).

Box 11. Standards and Price Approach in practice

A Standards and Price Approach was used to determine the tax on waste in Denmark and helped to achieve a solid waste reduction of 26 percent between 1987 and 1998. The tax was levied per ton of solid waste, which was produced by industry and construction activities.

The purpose of the tax was to affect behaviour and support a national plan to increase the recycling rate to 54 percent in 1996. The Danish authorities did not attempt to evaluate the externalities associated with waste treatment. This means that no economic model served as a basis for the tax rate. Tax rate adjustments helped to reach the targeted standard. The tax rate gradually increased from DKr (Danish Krone) 40 / ton to DKr 375 / ton in 2000. Therefore, the tax can be seen as following the principles of the Standards and Price Approach.[79]

Source: Andersen and Dengsøe , 2002

4.2 Revenue Target Approach

200. Different policy objectives may encourage jurisdictions to implement carbon taxes. Aside from environmental considerations, one of the main reasons for implementing carbon taxes is raising revenue.[80] Although carbon taxes are primarily intended for climate mitigation policy, they can generate a considerable amount of tax revenue. In 2020, the total value of all carbon taxes and emission trading systems in force was US$ 53 billion.[81] Therefore, carbon taxes can contribute to the general budget or to reduce unwanted distributional effects of the carbon tax itself (see Chapter 9 on Revenue Use).

201. Jurisdictions may set the tax rate in a way that maximises tax revenue or that generates a specific level of revenue. To determine the expected tax revenue, the approach needs data on price-elasticities to determine the specific revenue target

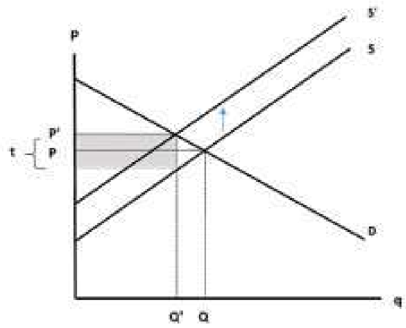
79 Andersen and Dengsøe, 2002.
80 PMR, 2017. (p.93).
81 World Bank, 2021.

(see Box 12, Price Elasticities).[82] This is because the tax revenue generated from a specific tax rate depends on the markets and price-elasticities of carbon-intensive products.

Box 12. Revenue Target Approach – economic theory

The Revenue Target Approach is based on microeconomic theory. The graph below illustrates the supply (S) and demand (D) curves. In the initial scenario, market equilibrium emerges at the intersection of both curves. At this point, the market produces the quantity Q at a price of P. However, the market equilibrium changes after the implementation of a tax (t). The S curve is shifting because of the increasing cost of production. As a result, a new equilibrium will be reached at the intersection of S' and Q'. The tax revenue is calculated by multiplying the new quantity Q' by the tax rate t. In practice, setting the carbon tax rate through the revenue target approach is a tricky task, as the tax revenue depends on many factors which need to be considered. Examples are price elasticity, market power and economic situation.

Figure 6. Graphical representation of the Revenue Target Approach



Source: PMR, 2017

202. For example, one of the motivations behind Chile's carbon tax was raising revenues for the increased spending expected for a significant education reform. The fiscal reform implemented in 2014 modified the tax system considerably, including the implementation of a carbon tax. The fiscal reform was estimated to collect US$ 8.3 billion in total and the carbon tax around US$ 168 million. However, the government did not define in advance a specific revenue target, which had to be met with the carbon tax.[83]

203. Carbon taxation can be a stable source of revenue over short-term fiscal planning horizon.[84] However, as carbon emissions decrease over time, the tax base will erode, reducing expected revenues.

The Revenue Target Approach has generated criticism from an environmental point of view. It is argued that the primary aim of carbon taxes is to internalise

82 Abenezer Zeleke, 2016.
83 Pizarro, Pinto, Ainzúa, 2017).
84 PMR, 2017. (p. 120).

external costs and not to raise the tax revenue for the government. Hence, there is concern that revenue targets as an objective may affect long-term environmental integrity objectives.

Box 13. Price elasticities

To follow the Revenue Target Approach, it is crucial for policymakers to know the price elasticity for products that are subject to the carbon tax. In economics, the own-price elasticity measures the responsiveness of the demand for a good or service after a change in its price.

Studies have shown that the price elasticity of fuels is relatively inelastic in the short-term. This means that the demand response is disproportionately low compared to changes in the price. This is partly because emitters cannot change their habits in the short term. However, in the long term, studies have shown that the fuel price elasticity is higher, which means that the demand responds to price changes.[85]

4.3 Benchmarking Approach

204. Another approach to determining tax rates is known as the Benchmarking Approach. Two methodologies have been proposed for benchmarking existing carbon tax rates or other market instruments. These are explored in turn.

Benchmarking comparison with carbon tax rates

205. As of 2021, more than 30 jurisdictions had adopted a carbon tax. The Organisation for Economic Co-operation and Development (OECD) and the World Bank publish updates on new and existing carbon tax rates and carbon pricing instruments on a regular basis.[86] Jurisdictions can use the tax rate implemented in other countries as a 'benchmark' for setting their own.

206. Table 2 presents a selection of current carbon tax rates, ranging from US$ 2.61/ tCO_2e (Japan) to around US$ 137.24 / tCO_2e (Sweden). The wide spectrum of tax rates is an indicator that carbon taxes follow different policy strategies.[87]

Table 2. Carbon tax rate around the world in April 2021

Jurisdiction Covered	Nominal tax rate in April 2021 (US$ / tCO_2)
Argentina	5.54 (most liquid fuels)
British Columbia	35.81
Chile	5
Colombia	5
Denmark	28.14 (fossil fuel)

85 Abenezer Zeleke, 2016; World Bank, 2021.
86 World Bank, 2021; OECD, 2021.
87 See Chapter 2.

Finland	72.83 (transport fuel)
France	52.39
Japan	2.61
Mexico	3.18 (upper limit of the tax)
Norway	69.33 (upper limit of the tax)
Singapore	3.71
South Africa	9.15
Sweden	137.24
Switzerland	101.47

Source: Data based on Carbon Pricing Dashboard; The World Bank.

207. The Benchmarking Approach relies on an analysis of the tax rates as well as the tax design of other jurisdictions. It is important to underscore that headline tax rates may differ from effective rates due to different design options. For example, they may be levied on different levels of the production chain, include exemptions for certain industries, have different coverage, or include revenue-recycling, among other design options.

208. As jurisdictions have different framework conditions, policymakers should consider which is comparable to their own when choosing their tax rates. Regarding the selection of comparable jurisdictions, factors to consider include:[88] (i) policy objective; (ii) similar economies/politics; (iii) demographic factors; (iv) energy production; (v) geographic distribution; (vi) potential for coordination, and (vii) tax system.

209. The list only presents the most relevant factors. It is also important to consider current trends and the international development of carbon taxes in a benchmarking analysis. This could help policymakers to approach the discussion at the national level.

210. An especially relevant factor to consider is the carbon tax level of key trading partners and competing jurisdictions. Policymakers may be concerned with introducing high carbon taxes compared to taxes applied by key trading partners. The Benchmark Approach also considers the tax rate level of competing jurisdictions to reduce the risk of carbon leakage. Political concerns regarding carbon leakage and competitiveness are, in practice, key factors for setting the tax rate (see Chapter 7).

211. While it can be useful for policymakers to be informed about existing carbon tax rates in other jurisdictions, it should be noted that, in most cases, carbon tax rates are significantly lower than the tax rates necessary to achieve the Paris Agreement emission reduction targets. For instance, the High-Level-Commission on

88 PMR, 2017. (p. 95).

Carbon Prices proposed a carbon price of US$ 50–100 / tCO_2 by 2030.[89] Currently, only seven countries (Finland, France, Liechtenstein, Luxembourg, Norway, Sweden, and Switzerland) have tax rates higher than US$ 40 / tCO_2.[90] Therefore, given current tax rates, it is questionable from an environmental perspective whether a benchmarking analysis rate is appropriate to set carbon tax rates.

212. At the same time, studies from the OECD have shown that taxes on fossil fuel products have been rising steadily in many jurisdictions. For example, Alberta (Canada), British Columbia (Canada), Finland, France, Latvia and South Africa have increased – some of them significantly – their carbon tax rates since 2018. This recent development could encourage the implementation of a more ambitious carbon tax rate.

Box 14. Examples of carbon tax rate changes made between 2019 and 2021

- Iceland's carbon tax rate increased from ISK 3850 / tCO_2e (US$ 27 / tCO_2e) to ISK 4235 / tCO_2e (US$ 30 / tCO_2e) on January 1, 2020
- South Africa's carbon tax increased from R 120 / tCO_2e (US$ 7 / tCO_2e) to R 127 / tCO_2e (US$ 7 / tCO_2e) on January 1, 2020.
- Ireland's carbon tax increased by EUR 6 / tCO_2e (US$7 / tCO_2e) to EUR 26 / tCO_2e (US$ 28 / tCO_2e) for liquid transport fuels on October 9, 2019, and other fuels from May 1, 2020.
- Latvia's carbon tax increased from EUR 4.50 / tCO_2e (US$ 5 / tCO_2e) in 2019 to EUR 12 / tCO_2e (US$ 14 / tCO_2e) in 2021.

Source: The World Bank, State and Trends of Carbon Pricing 2019 - 2021

Benchmarking comparison with other market-based instruments

213. The benchmarking analysis does not have to be exclusively limited to the comparison of carbon tax rates. Considering other market instruments in the analysis can contribute to the aggregated price signal on carbon emissions in each jurisdiction and therefore provide a broader context. In this respect, specific taxes on fuel (excise taxes) can also be relevant to consider in a benchmarking analysis, as well as prices observed in emissions trading systems.[91]

214. Although they do not explicitly price carbon, excise taxes on fuels mirror carbon taxes and can support the benchmark analysis. However, since taxes may differ across fuel types, it is not always clear which specific tax rate should be used for benchmarking, for example, the tax rate for diesel, petrol, or coal. Another issue to consider is carbon prices observed in emission trading schemes. For example, Portugal and Iceland use the allowance prices within the EU Emission Trading Scheme to set their carbon tax rate.[92]

89 CPLC, 2017.
90 See for an overview: Carbon Pricing Dashboard; The World Bank.
91 OECD, 2018.
92 PMR, 2017. (p. 95).

215. It is also possible to use a measure of the aggregate effective carbon price signal in the benchmark analysis. So called *effective carbon rates* – consisting of carbon taxes, excise taxes on fuels and prices of tradable emission permits – these are calculated by the OECD for many countries.[93] See Box 15.

Box 15. OECD effective carbon rate

The OECD publishes the effective carbon rates for 44 OECD and Group of Twenty (G20) countries, on a regular basis.[94] In its report, the OECD measures the carbon pricing gap, which represents the difference between actual effective carbon rates and a benchmark rate.

The first benchmark, EUR 30 / tCO_2, is an historic low-end price benchmark of carbon costs and a minimum price level to start triggering meaningful abatement efforts. The second benchmark, EUR 60 / tCO_2, is a forward looking 2030 low-end and mid-range 2020 benchmark. The third benchmark, EUR 120 / tCO_2, is a central estimate of the carbon costs in 2030.

The 44 OECD and G20 countries together have not even reached a fifth of the goal to price all emissions at least at EUR 60 / tCO_2 in 2018. Therefore, most jurisdictions do not reach even the lowest estimated costs of society. However, the top ten performing countries in 2018 progressed by around 6 percent points towards the EUR 60 benchmark. But 60 percent of the emissions from energy use are still not taxed at all. The OECD concluded that more needs to be done to steer economies along a decarbonized growth path. It is important to notice that in the OECD report, emissions from biomass are also included when effective carbon rates are calculated. For countries with large shares of energy from biomass, the effective carbon rates for fossil energy may be higher than what the OECD estimates indicate.

Source: OECD, 2021

Checklist 4. Approaches for setting the tax rate

1. Standards and Price Approach: Set the tax rate to achieve a specific carbon reduction target
2. Revenue Target Approach: Set the tax rate to achieve a specific carbon revenue target or goal
3. Benchmarking Approach: Set the tax rate compared to other comparable jurisdictions (neighbours, trading partners, jurisdictions with similar levels of development)
   (i) Comparing Tax Rates: Carbon Tax Rates
   (ii) Comparing other market-based instruments: Carbon prices

5. Dynamic Tax Rates

5.1 The role of politics

216. In this chapter, various approaches for setting a carbon tax rate were discussed. They can help jurisdictions to create a policy strategy; however, to prevent the tax rate level from becoming subject to short-term political considerations, achieving the broadest political consensus is also important.

93 OECD, 2018.
94 OECD, 2021.

5.2 Tax rate trajectory

217. Policymakers should consider different strategies for imposing the optimum tax rate, which may also involve considering the tax rate trajectory. One strategy is to introduce an initial tax rate that remains at the same level for the initial period ("static carbon tax rate"). Another strategy is to adjust the tax rate over time to soften the impacts of the tax. In practice, dynamic tax rate strategies have been used by several jurisdictions.[95]

218. To ensure compliance and limit opposition, policymakers can implement a low tax rate in its initial year and then increase the rate later ("ramp-up introduction").[96] If a jurisdiction has decided to apply a slow ramp-up strategy, the tax rate would be increased gradually until the tax rate reaches the desired level. Under the ramp-up strategy, it is easier to adjust and anticipate carbon taxes. The economy would have more time to invest in alternative environmentally friendly technologies and would not face major economic shocks.

219. For example, the Canadian State of British Columbia and Federal Canadian Government implemented a ramp-up strategy. British Columbia introduced a carbon tax at a rate of Can$ 10 / tCO_2 in July 2008. The province then gradually increased the tax rate in the next four years by Can$ 5 each year, reaching its target level at Can$ 30 in 2012. Meanwhile, the carbon tax rate increased to Can$ 45 on April 1, 2021, and a further increase is planned for April 1, 2022.[97]

220. A similar approach was taken by France, which introduced a carbon tax in 2015. Legislation set a rising tax rate for each year up to 2021 when it is planned to reach EUR 56 / tCO_2. The French legislators also laid down the goal for the tax rate to reach EUR 100 in 2030 without defining the actual tax rates between 2021 and 2029 from the outset. However, following nation-wide protests, the tax rate was frozen at EUR 44.6 / tCO_2 for 2019 and remains at this level.

221. Singapore has also implemented a carbon tax with an initial tax rate of S$ 5 / tCO_2 in 2019. The intention of Singapore is to increase the tax rate gradually to S$ 10 to 15 / tCO_2 in 2030.[98]

222. It is not necessary to define the exact trajectory for a specific tax level. However, to achieve the environmental objective, it is important to define the future targeted tax level when introducing a carbon tax. This provides a clear price signal, and emitters will respond to the expected carbon price from the beginning of the implementation of the tax.

95 PMR, 2017. (p. 95).
96 IEEP, 2013 (p. 58)
97 World Bank Group, 2019.
98 World Bank Group, 2019. (p. 41).

223. A gradual increase of the carbon tax rate seems politically desirable, as it is easier to gain political support for gradual implementation. Moreover, it also gives investors and businesses time to phase-out carbon-intensive facilities. Nevertheless, the ramp-up strategy also has risks. First, the environmental effect is limited in its initial phase, due to relatively low tax rates. Second, low initial tax rates may remain because of political considerations.[99]

224. An alternative strategy is to implement a static carbon tax rate, which means that the carbon tax rate stays the same after its introduction. Such an approach has the advantages of giving the market a stable and predictable price signal. However, to be effective from an environmental point of view, the tax rate will need to be set at a sufficiently high level that achieves the environmental objective and moves towards a greener growth path.[100] Also, a static carbon tax rate at a high level is likely to face more political opposition than a ramp-up strategy by those who are affected by the tax. If a static approach with a high tax rate is chosen upon implementation, it would need be to be part of a comprehensive reform package including certain compensatory measures for vulnerable groups of society.[101]

5.3 *Regular adjustments of the tax rate*

225. Setting the carbon tax rate is not a one-time task. It is an ongoing process requiring constant adjustments. This is because the optimum tax rate is always subject to uncertainties since the exact impact of the tax is not predictable in advance. Therefore, it is important to evaluate and adjust carbon tax rates over time.

226. Moreover, as economic circumstances change, or as new information is available and economic models perfected, the assessment of the optimum tax-rate could be revaluated (see Box 16). Furthermore, changes in a jurisdiction's climate mitigation target or a change in public support may occur.[102]

Box 16. Tax rate and inflation

Even if the tax rates remain constant, jurisdictions may decide to index the carbon tax rate to inflation to ensure a stable environmental effect. This is because, with inflation, a constant tax rate dampens the incentive effect. Therefore, Colombia, Denmark, the Netherlands and Sweden, have indexed their carbon and energy taxes to inflation to maintain the price signal of their tax rates.

The effect of not indexing the tax rate is illustrated by Argentina. Argentina currently applies a carbon tax that is valued at US$ 65.54 t/CO_2e in 2021. Worthy to note is the fact that the Argentinian carbon tax was originally priced at US$ 10 t/CO_2e in 2018. However, due to a massive currency devaluation of the Argentinian peso against the American dollar through the fiscal year of 2018, the effective carbon price was reduced to US$ 6.25 t/ CO_2e in 2018. It is still the highest price for the region, but it has the potential to be devalued even further considering the law does not foresee annual carbon price adjustments according to inflation.[103]

99 World Bank Group, 2019. (p. 97).
100 OECD, 2021.
101 PMR, 2017. (p. 95).
102 See Chapter 2.
103 World Bank Group, 2019. (p. 29).

227. To deal with economic change, policymakers may decide to implement predetermined adjustment formulas in the legislation.[104] The law can include specific criteria or scenarios that trigger changes in the tax rate. One example could be that the tax rate automatically increases if specific reduction targets are not met.

228. Moreover, economic factors like Gross Domestic Product (GDP) growth or changes in exchange rates could be used as triggering factors. Switzerland has implemented reduction target in its national carbon tax. The tax rate is raised by a predetermined formula in advance,[105] thus avoiding a new legislative process in Parliament. In the case of Portugal, the national carbon tax has incorporated an annual adjustment, which is dependent on economic criteria. However, predetermined adjustment formulas may raise constitutional and political concerns in some jurisdictions.

229. Another approach is to periodically review the carbon tax rate, for example, via a special committee. Experts can assess the impacts of the carbon tax. Past experiences and available information about future developments allow those expert committees to draft concrete proposals for tax rate changes. The composition of the panels may differ in each jurisdiction. To avoid political interests, these committees can be composed of experts or stakeholders.

230. Reviewing the carbon tax rate can also be part of the general political considerations. For example, Norway reviews its carbon tax rate on a yearly basis, as the Norwegian tax law requires it to be presented as part of the annual national budget. During this process, the Norwegian carbon tax rate have increased.[106] Also, Ireland reviews the status of their national carbon tax rate on a yearly basis considering international trends of carbon pricing.[107] One advantage of the reviewing processes is that it provides more flexibility compared to a strict adjustment formula. However, any review of tax rates involves a political decision-making process and the amount of input from external experts and stakeholders in that process will undoubtedly vary across jurisdictions.

6. Setting tax rates under challenging circumstances

231. Special consideration may be necessary for a country in an extraordinary condition, as compared to other countries. For example, countries may face an external unexpected event affecting economic performance that may require adjustments - the COVID-19 crisis is a case in point. Choosing a tax design which is

104 See Chapter 2.
105 See Article 10 *Verordnung über die Reduktion der CO_2-Emissionen (CO_2-Verordnung)* vom 30.12.2012 (Stand 19.02.2019), AS 2012 7005.
106 PMR, 2017. (p. 97).
107 Report of the Joint Committee on Climate Action, 2019.

easy to administer is a key issue for countries under such circumstances. Economic growth and development are essential in fighting widespread poverty. Therefore, concerns might exist that high carbon taxes could slow down future economic development that may hamper access to basic services and infrastructure.

232. However, it can also be argued that tax revenues help countries to mobilize resources to strengthen their social and educational systems, that could help to reach a higher growth path. Additionally, resource-rich countries may feel dependent on carbon-intensive industries such as coal, oil, cement, steel, and aluminium. Therefore, they may be concerned that climate protection counters their economic growth and development. Nevertheless, in practice, all countries have special economic and demographic characteristics that need to be considered when setting a tax carbon tax rate.

233. Colombia provides an example of connecting carbon taxes with broader development objectives and predefining tax rate trajectories. In 2017, Colombia implemented a tax to support a lower-carbon development path. Colombia also used the tax revenue of the carbon tax to finance investments in low carbon projects, adaptation, and technological innovation. The initial tax rate was set at US$ 5 but included annual increases of 1 point plus inflation until the tax rate reaches US$ 10. In its initial year, the Colombian carbon tax generated tax revenue of nearly US$ 250 million, which was more than initially expected. The Colombian Government assessments have shown that the carbon tax was not regressive, which means that households with higher income are more affected by the tax.

234. Trade-offs between economic development and emission reduction may exist in some countries. Examples are countries that are strongly dependent on carbon-based energy resources and on energy imports.[108] In these cases, the imperative of development and poverty reduction may justify lower carbon tax rates in the short term.

235. Lower tax rates could help to support a smooth transition from a carbon-based economy to a low-carbon economy. Moreover, lower carbon tax rates may also be justified in countries with lower purchasing power. A lower purchasing power can lead to the situation that a given tax rate, which is derived from the tax rate of a rich country, would be more burdensome for least developed countries. Therefore, carbon tax rates, which are applied in countries with strong economic performance, may not be suitable or overshooting for countries with challenging economic performance. In developing countries, lower carbon tax rates may be justified due to specific economic situations where the impact of a price change in fuel prices is higher.

108 CPLC, 2017. (p. 19).

236. Although there may be justifications to have lower carbon tax rates in some countries due to specific and extraordinary circumstances, this does not mean that these countries should not implement carbon taxes. Well-designed carbon taxes can play a major role in a sustainable development in all countries. Carbon taxes are promising tools in achieving the UN Sustainable Developments Goals (SDGs) by 2030.

Checklist 5. Strategies to determine the tax rate trajectories

1. Fixed Tax rate
2. Dynamic Tax Rate
    - (i) Predetermined Adjustment
        - (a) Ramp-up strategy
        - (b) Based on national conditions e.g. Inflation indexed
        - (c) Based on external conditions e.g., trading partners
    - (ii) Flexible
        - (a) Based on revaluation and assessment of policy objectives, such as emission targets
        - (b) Based on technical committed evaluation
3. Tax Rate considering economic conditions
    - (i) Adjustments based on economic strategy e.g. green growth strategy
    - (ii) Adjustment considering economic crisis e.g. COVID-19 emergency

7. Conclusion

237. The tax rate is a key element in the policy design of a carbon tax. It has direct consequences in achieving the environmental objective and may have considerable impacts in the economy. In theory, the tax rate should be set at the marginal social costs of the environmental damage generated by the emission of an additional unit of carbon. However, in practice, setting the tax rates follows an integrated decision-making process.

238. This chapter has discussed various practical approaches to determine the tax rate and drawn from several country examples. Nevertheless, regardless of these approaches and the final tax rate chosen, implementing a carbon tax, even at low rates, will be important. In the next chapter, we discuss the practical design of a carbon tax considering the two principal approaches.

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Chapter 6: Carbon Tax Design Approaches in Practice[109]

1. Introduction

239. This chapter examines the two principal carbon tax design approaches, the Fuel Approach (which uses fuels as the tax base and sets the tax rate based on the carbon content of the fuels) and the Emissions Approach (which establishes the tax directly on emissions).

240. To illustrate, we draw on two specific examples. The first is the Swedish carbon tax, based on the Fuel Approach, which has had over thirty years' experience and could be considered a benchmark of carbon tax design and implementation. The second is the relatively recent experience in Chile with a tax on carbon emissions, one of the few examples of a middle-income country implementing this approach. The examples serve to address some of the specific questions raised by carbon tax design considering the two different approaches.

2. The Fuel Approach

2.1 *Basic concept*

241. The Fuel Approach is the predominant method of carbon taxation around the world. It involves taxing fossil fuels, primarily oil, gas, coal, and their derivative products, and setting the tax rate based on the carbon content of the fuel. The key to this approach is that carbon emissions are closely related to the carbon content of a specific fuel; therefore, emissions from fuel combustion can be determined accurately by standardized carbon emission factors.

242. Therefore, once the carbon tax rate has been determined, carbon content is used to establish the specific tax rates on fuels based on average emission factors. The advantage of this approach is that measurement of actual emissions is not necessary. A jurisdiction introducing a carbon tax could thus choose to express their carbon tax rates by volume or weight units (such as litre of petrol or tonne of

109 Unless otherwise stated, the source for facts on the Chilean carbon tax is Rodrigo Pizarro, Universidad de Santiago de Chile (expert in the Subcommittee) and for facts on the Swedish carbon tax Karl-Anders Stigzelius and Susanne Åkerfeldt, both Swedish Ministry of Finance (experts in the Subcommittee).

coal) based on the average carbon content of each fuel type.

2.2 Carbon tax rates applied to different fuels in practice

243. When completely combusted in dry air, any given fuel type will provide an exact relation between the carbon content and emitted carbon dioxide (CO_2). The relationship between the energy content or physical units of fuel (mass or volume) on the one hand, and the resulting emissions from combustion on the other, can be expressed in so called emission factors. In real world situations, other aspects of fuel quality and, to a lesser extent, combustion technology, will also affect total emissions. For CO_2, however, emission factors mainly depend on the carbon content, and emissions can thus be estimated accurately based on the amount of fuel combusted and the average carbon content of the fuel.[110]

244. Therefore, in the case of the Fuel Approach, carbon tax rates on fuels, based on carbon content, can be applied by operators and authorities using volume or weight units; these are standard trade units facilitating tax administration enormously. The advantage is that the calculation of the tax revenue can be carried out by the Ministry drafting the carbon tax legislation and not left to the agencies responsible for administering and collecting the tax.

245. For administrative reasons, most jurisdictions have chosen to group similar fuels in categories with the same tax rate per litre. This is normally the case with diesel fuels of different qualities, which may have marginally different carbon content. However, the emission factor is still deemed sufficiently close for the tax to be set on the fuels, and the carbon tax would still be effective and provide an incentive to reduce CO_2 emissions.

246. The table below presents examples of emission factors and heating values for common fuel types from the Intergovernmental Panel on Climate Change (IPCC) Emission Factor Database and the International Energy Agency (IEA) Energy Statistics Manual. The carbon content here expressed in terms of emission factors (kilogram (kg) CO_2 per Gigajoule (GJ)), as well as the heating values (GJ per m^3 or tonne), varies for fuels depending on their composition. Hence, specific values should be used where available to reflect national or facility-specific circumstances. See Table 3 below.

110 IPCC, 2006.

Table 3. Examples of emission factors and heating values for common fossil fuels

	Emission factor* (kg CO_2 per GJ)	Heating value**	Emissions from combustion***
Petrol	73	33 GJ per m^3	2409 kg per m^3
Diesel oil	74	37 GJ per m^3	2738 kg per m^3
Liquified petroleum gas (LPG)	63	24 GJ per m^3	1512 kg per m^3
Fuel oil	77	40 GJ per m^3	3080 kg per m^3
Coal (anthracite)	98	30 GJ per tonne	2940 kg per tonne
Natural gas	56	38 MJ per m^3	2128 kg per 1000 m^3

** IPCC default values: https://www.ipcc-nggip.iges.or.jp/EFDB*
*** Estimates based on typical net calorific values and densities (for liquid fuels): EIA, 2017.*
**** Emission factor multiplied by heating value.*

247. Fuel quality may change over time due to new technologies or practices. For example, when the Swedish carbon tax was introduced in 1991, an average emission factor for diesel, as well as light and heavy fuel oils for heating purposes, was used to calculate a single tax rate per litre for all these fuels. At the time, the quality of these liquid fuels was reasonably close, and applying the same carbon tax rate for all these fuels was a simplification that lowered administrative costs for business and tax authorities considerably.[111] However, Sweden recently updated the emission factor used for diesel to better reflect diesel qualities available today.[112]

248. The need for precise emission factors will also depend on fuel use. For example, since coal is not a fuel commonly used in Sweden, an average emission factor for different coal types (such as hard coal, lignite, and coke) is sufficient with a single tax rate for all coal types. However, a country with large coal consumption may need more precise emission factors for different coal fuel types to strengthen the emission reduction incentive. The important thing to consider is that the carbon content of each single consignment of a fuel is not measured, but rather authorities rely on calculations based on average emissions. Establishing tax rates in this manner will still create an effective carbon tax.

249. In general, jurisdictions mostly tax fuels when they are used as motor fuels or for heating purposes, and not when the fuel product is used for non-combustion purposes – such as coal or natural gas used as a component in certain industrial reduction processes or in purification filters. However, the calculation method as

111 Emission factor for light heating fuel and diesel was 2.74 kg CO_2/litre, for heavy fuel oil 2.97 kg CO_2/litre, which gave an average emission factor used of 2.86 kg CO_2/litre.
112 This meant that from 1 July 2018, the carbon tax rate for the fossil part of diesel is calculated on the emission factor of 2.54 CO_2/litre.

such does not prevent taxing fuel products when used for such purposes.

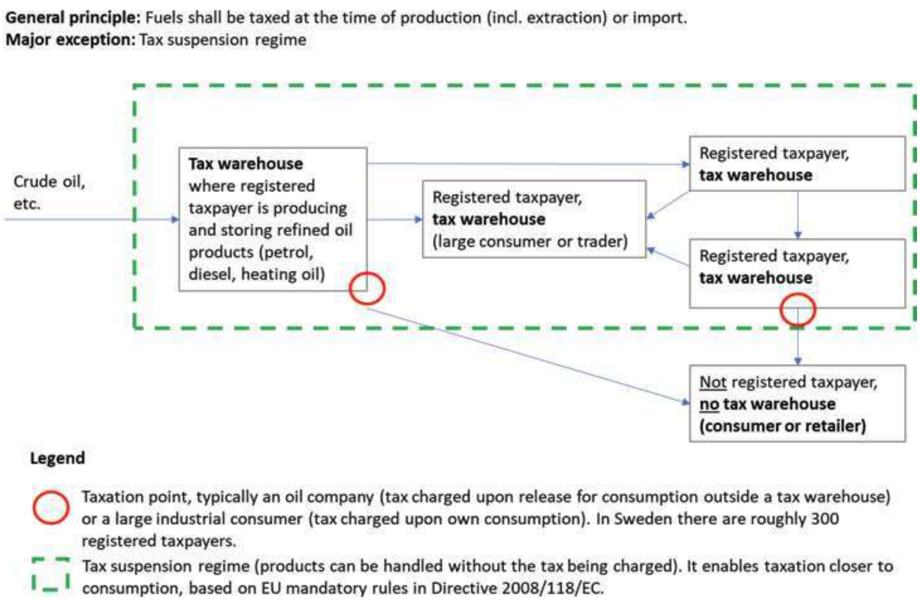
2.3 Point of regulation and tax payment

250. The point of regulation refers to when the tax is charged in the value chain. In the case of the Fuel Approach, the tax can be levied at any point in the value chain from the extraction (in a mine or crude oil extraction site) or importation into the jurisdiction, down the value chain until consumption, depending on the institutional framework.

251. In many cases, the tax is paid further down the value chain since most tax schemes allow the tax payment to be deferred during part of the distributional chain. Thus, the tax is paid after some form of the suspension arrangement. An example is the one applied to excise taxes (including carbon taxes) within the European Union (EU). EU Member States have a choice of who to register as taxpayers within the regime, but the basic principle is the same for all countries (see the illustration of the Swedish scheme in Figure 7). Administrative issues will be discussed in more detail in Chapter 8.

252. Jurisdictions choosing to design a carbon tax levied on fuels are likely to explore existing excise duties on the relevant fuels and who is responsible for the collection of such taxes. Choosing the same taxpayer for the new carbon tax will mean low additional administrative costs for both the taxpayers and the tax authorities.

Figure 7. Example taxation points for the carbon tax in Sweden



2.3.1 Carbon tax due early in the distributional chain

253. Administrative simplicity and effective tax control are key issues to consider. Keeping the number of taxpayers to a minimum is another way to keep costs low. One option would be to establish a tax collection point early in the fuel distribution chain, that is the point of extraction (such as coal mine, oil drill, natural gas pipeline) or importation. See illustration in Figure 7.

254. Coordinating tax collection with other taxes or duties can facilitate tax administration. For a country choosing to collect a carbon tax upon importation, tax collection can be coordinated with import duties on the taxable fuels. Zimbabwe is an example of this. Although the country does not have an explicit carbon tax, it collects a Petroleum Importers Levy on petrol and diesel (a tax on energy products) and combines it with other import duties. Firms or individuals holding a procurement license to import petroleum products in bulk into Zimbabwe are liable to pay this levy, which amounts to US$ 0.03 per litre.

255. However, while choosing a tax point early in the distributional chain (as illustrated in Figure 8) could offer administrative advantages in terms of relatively few taxpayers and better opportunities to conduct an effective tax control, there are other issues to consider. Crude oil and natural gas largely dominate the imports of fuels in most countries, and choosing a taxation point at importation can make it difficult to differentiate the carbon tax between different qualities of refined petroleum products (such as petrol, diesel, heavy fuel oil etc.). Colombia offers an interesting example.

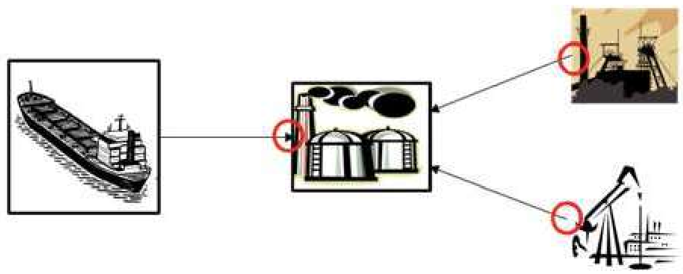
256. Colombia introduced a carbon tax in 2017.[113] The tax base consists of different refined petroleum products, namely natural gas (for certain industrial processes), LPG, petrol, kerosene, diesel and fuel oil. The importer or producer of such products is the body responsible for paying the carbon tax to the Government. In certain cases, the tax law gives the final consumer the right to ask for a tax reimbursement.

257. Choosing the same taxpayer for the carbon tax as the taxpayer of an existing excise duty on fuels, will mean low additional administrative costs. The carbon tax can be implemented as a new, separate tax or be incorporated as part of an already existing excise duty levied on fuels. A separate tax can be administrated in the same way as the existing excise duty and would not give rise to much additional administration. Since a carbon tax designed using the Fuel Approach is levied on weight or volume units, which is the same approach normally used for other excise taxes, this makes administration simpler. Introducing a separate carbon tax will also allow the government to more clearly advocate to the public that the tax has climate policy objectives.

113 For more information on Colombia's carbon tax please refer to the carbon tax legislation (Law 1819 of 2016 and the Decree 926 of 2017 (Congreso de la República, 2016; Ministerio de Hacienda y Crédito Público, 2017, and Gutierrez, 2017.

Figure 8. Example of a fuel tax design – tax payment early in the distributional chain

General principle: Fuels shall be taxed at the time of production (incl. extraction) or import.



Legend

Taxation point. Tax payer would typically be a mine owner, and oil driller or importer of oil or other fuels

Pros and cons:
+ Could facilitate tax control
+ Less number of taxpayers, easier tax administration
- Negative liquidity effects on business, as the tax is to be paid before fuels are sold to final consumer
- Difficult to differentiate tax between refined oil products
- Difficult to differentiate tax between areas of use

Note. Not applicable within the EU, as a major part of taxable events occur within a tax suspension regime system with authorized traders under Directive 2008/118/EC.

2.3.2 Carbon tax due later in the distributional chain

258. Many jurisdictions have taken the approach to levy taxes further down the value chain. One reason is the desire to be able to differentiate the tax depending on final fuel use or sectors.[114] Another is to avoid cash-flow problems by allowing trading of fuels between operators before reaching the final consumer, and therefore deferring tax payment.

259. In Norway, the carbon tax is due when the goods are imported or produced. However, in practice, this is not always the case. First, the production or import of taxable products must carried out by an entity which has been approved by the tax authorities, known as an approved tax warehouse. Tax liability occurs when the goods leave the tax warehouse. An importer can register as a tax warehouse and store the fuels without paying tax until the product leaves. The Norwegian tax system includes exemptions and reduced rates. These are either implemented as direct exemptions, which means that the registered importer or producer sells the product without paying tax or at a lower tax rate. In other cases, a situation like the

114 For example, for several years (1991-2017), Sweden applied different carbon tax rates for heating fuels used by industry compared to households and service sector firms; see Chapter 7 for further information.

Colombian case, it is accounted for as an end-user can ask for reimbursement of the tax.

260. Another example is the tax in British Columbia (Canada). In this case, the tax becomes liable for payment down in the distributional chain by enlisting the fuel distributors as tax collectors. First-time manufacturers or importers of a fuel must be appointed as a “refiner collector” for each fuel type they sell. They generally remit a security to the provincial government and are reimbursed as fuel is sold through the supply chain, until the tax is borne by end purchasers. The British Columbia scheme allows for exemptions from security requirements in some cases, for example, for direct fuel sales between refiner collectors, and for reporting exemptions in the case of natural gas sales.[115]

2.4 Using an existing fuel taxation administrative system

261. Basing carbon taxation on fuels has the administrative advantage of allowing a policymaker to make use of an existing fuel taxation administrative system. Since most jurisdictions already collect some form of fuel tax, excise duty or levy, they likely already have the necessary administrative infrastructure in place. For example, the EU Member States that have introduced a carbon tax have generally added it to an already existing general excise tax, either as part of the general excise duty (e.g., in France) or as a separate tax (e.g., in Denmark, Finland, Norway and Sweden[116]).[117] In some cases, the introduction of a carbon tax was combined with a reduction in the pre-existing excise tax covering the same fuels.

262. Excise taxes reduce energy use and hence carbon emissions. However, they do not usually do so in a cost-effective way, because they are not aligned with the carbon content or the broader pollution profile of the taxed fuels. If an excise tax, on the other hand, is designed in proportion to carbon content, it generates an incentive for a low-carbon energy mix.

263. Since energy taxes are a common source of revenue, non-EU jurisdictions can draw from the EU experience to treat the interaction between energy and carbon taxes. Sweden, for instance, has chosen to increase its carbon tax significantly, as a share of the total tax on energy products. Other EU countries have, however,

115 For more information about the carbon tax in British Columbia, please refer to http://www.bclaws.ca/civix/document/id/lc/statreg/08040_01 and https://www2.gov.bc.ca/gov/content/environment/climate-change/clean-economy/carbon-tax

116 The legal provisions for the separate taxes are laid down in the same legal act in some Nordic countries and in separate legal acts in others.

117 EU Member States must follow the EU harmonized framework for taxation of fuels. This framework does not require Member States to levy a carbon tax, but it is covered under the harmonized EU tax framework. Seven EU Member States have chosen to introduce specific carbon tax by using the fuel tax base of this EU directive. It consists of all motor fuels, coal and the bulk part of all commercially available liquid and gaseous fuels used for heating purposes (See Article 4.2 of Directive 2003/96/EC).

added a smaller – but in most cases increasing – carbon taxes on top of the existing taxation of energy products. Liechtenstein, Norway, and Switzerland, which are European countries outside the EU membership, provide similar examples. Carbon taxes in Liechtenstein and Switzerland are not levied on road fuels; however, they are subject to an excise duty not based on the carbon content of fuels.

2.5 Coverage of fuels by the Fuel Approach

264. Different jurisdictions have chosen to tax different fuel sources depending on their specific conditions. For example, in Iceland, the carbon tax base is petrol, diesel, and heating gas oil, as these are the only fossil fuels available in that country. Outside Europe, some countries (for instance India, Mexico, the Philippines, and Zimbabwe) have chosen to tax a limited number of fuels. In the case of India and the Philippines, only coal is taxed, while Mexico taxes coal and petroleum products.

265. The Colombian carbon tax base consists of natural gas and other petroleum products. Although not specifically designed as a carbon tax, Zimbabwe only taxes petrol and diesel. The carbon tax in Argentina covers all major fossil fuels used as motor fuels or for heating purposes with the exemption of natural gas and LPG used for heating purposes.

266. Costa Rica is the Latin American pioneer, with a carbon tax in place since 1997. The Costa Rican tax base is fossil hydrocarbons, which means an application of the Fuel Approach. However, the carbon tax rate is not related to the fossil carbon content of the hydrocarbons nor based on the measurement of emissions, but rather by a percentage (currently 3.5) of the market price of the hydrocarbons.

267. The reasons behind these different approaches are often due to national contexts, such as existing administration systems, targeting fuels that represent the bulk of carbon emissions, or due to other public policy concerns. In Latin America, many of the countries currently applying a carbon tax exempt natural gas from the carbon tax base.

268. In Mexico and Argentina, natural gas is considered as a transitional fossil fuel. The policies in those countries aim to substitute carbon intensive fossil fuels such as coal, diesel, and petrol, for natural gas, which is less carbon intensive.

269. Competitive concerns for certain business sectors and social concerns for households or for specific geographical areas can also play a role, as measures to meet such concerns could ease the introduction of a carbon tax. Such measures can later be phased out during continued policy design (see Chapter 7).

2.6 Methodology to calculate a carbon tax by the Fuel Approach

270. If policymakers use the Fuel Approach to design a carbon tax, the essential element in the design phase is to calculate tax rates to be proposed in the tax legislation based on average carbon content for specific fuel types. To understand how tax rates are determined, consider the case of Sweden in Box 17 to calculate a carbon tax rate per litre of petrol.

Box 17. How to calculate the actual carbon tax rate for a fuel with the Fuel Approach

With the Fuel Approach, the rationale is that the carbon tax is applied to fuels, and the tax rate presented in the tax legislation is calculated based on the amount of CO_2 emitted when the fuel is combusted, expressed in volume or weight units of the fuel in question. The amount of carbon emissions from combustion can be calculated from specific emission factors and heating values for different fuels (see examples in Table 3 above). The tax rate is then obtained by simply multiplying the emissions with the general carbon tax level.

Emission of fossil CO_2 for specific fuel [kg CO_2/unit] * General carbon tax rate [currency/kg CO_2] = Carbon tax rate on specific fuel [currency/unit]

Example: calculation of carbon tax rate on petrol in Sweden 2018 (in Swedish Krona (SEK)/litre).

Heating value of fossil petrol: 31.39 GJ/m^3

Emission factor of fossil petrol: 74 kg CO_2/GJ

Emissions of fossil CO_2: 31.39 GJ/m^3 * 74 kg CO_2/GJ = 2323 kg CO_2/m^3

Volumetric conversion factor (standard): 1 m^3 = 1000 litre, therefore 2323 kg CO_2/m^3 = 2.323 kg CO_2/litre

General carbon tax rate: 1.15 SEK/kg fossil CO_2

Carbon tax rate on fossil petrol: 2.323 kg CO_2/litre * 1.15 SEK kg/fossil CO_2 = 2.67 SEK/litre

Source: Swedish Ministry of Finance

2.7 Tax rates are presented in the tax law in weight or volume units

271. Legislation on carbon tax provisions need not present the method of calculation of tax rates. However, to increase transparency, the tax rate per kg of fossil carbon, which is the basis of the tax calculation (referred to as "general carbon tax rate" in Box 17), can be established in the tax law or in other official regulations. Decisions on this matter will also depend on legislative tradition in specific jurisdictions. For example, Sweden keeps statutes as short and simple as possible and provides additional explanations in the preparatory documentation (Government Bills).

272. When the carbon tax was first introduced in Sweden in 1991, the Government Bill presented to Parliament contained a detailed description of the method and emission values used by the Government when calculating the actual tax rates. The description included a list of emission values used for the different fossil fuels. However, the actual legal text proposed to Parliament only consisted of the carbon tax rates expressed in weight or volume units, which has since been the transparent

and established method in Sweden.[118]

2.8 Differentiation based on fuel quality

273. Different fuel qualities may have significant differences in carbon content. If such fuels are major energy sources in a country, different tax rates based on the carbon content should be set for the various qualities. The same design approach laid down above can be used.

274. The use of fossil and biomass fuel mixtures can be a challenge when determining the carbon content of the fuel and therefore the tax rate. The administrative complexity will depend on the choice of the taxable event. If a finished product is not established until it leaves a fuel depot and is due to be taxed, regular bookkeeping will enable the taxpayer to pay the correct tax. Such a system has been applied in Sweden for many years.

2.9 Some aspects relating to carbon content in fuels of biomass origin

275. Another decision facing a policymaker is whether the tax base should relate to the fossil carbon content of fuels, or to carbon emissions generated in general, which may include biomass-based fuels, for instance ethanol and biodiesel (commonly referred to as biofuels). Most jurisdictions that have introduced carbon taxation have primarily sought to deal with emissions from fossil fuels, since these fuels are predominant on the global fuel market and contribute by far to most greenhouse gas (GHG) emissions.[119] However, the global debate is increasingly focussing on indirect emissions in land use changes which may be triggered by biomass for fuel production.

276. Some jurisdictions consider biomass-based fuels (also referred to as “bioenergy”) to be carbon neutral and therefore part of the solution towards a low-carbon economy, while other jurisdictions focus solely on a transition to other renewable energy sources such as wind and solar. Motives for the latter approach may include, for instance, that bioenergy can place pressure on land use, and canaffect biodiversity.[120] An in-depth discussion on this issue is outside the scope of this Handbook.

277. Sweden is an example of a country rich in forest resources, where sustainable forestry management is a key component of the country’s agricultural and forestry policy. The general principle of not subjecting fuels of biomass origin to a carbon tax

118 The units used for the Swedish carbon tax are litre for petrol, m^3 (1 000 litres) for gas oil, kerosene and heavy fuel oil, 1,000 kg for LPG, 1,000 m^3 for natural gas and 1,000 kg for coal and coke.

119 The IPCC has stated that 75 percent of the changes in the temperature in the atmosphere during the past 25 years relates to the combustion of fossil fuels. The remaining 25 percent is due to changes in land use, primarily deforestation. (IPCC, 2014).

120 See for example OECD, 2020.

has prevailed since the introduction of such a tax in 1991. A restriction to applying this principle only to biofuels fulfilling certain established sustainability criteria has since been introduced, following mandatory EU legislation. An increased use of non-fossil fuels has played a key role for Sweden's road towards a low-carbon economy. The reasoning behind the Swedish approach is that combustion of sustainable biofuels would not result in a net increase of carbon in the atmosphere and therefore those fuels should not be subject to carbon taxation.

2.10 Low blends of ethanol and biodiesel into petrol and diesel

278. When there are fuel blends, carbon taxation may require simplification for administrative efficiency. When using the Fuel Approach method, many countries tax fossil fuels mixed with biomass components, such as ethanol or biodiesel, at per litre tax as if the fuel were 100 percent of fossil origin. Although most EU countries have introduced biofuel quotas for fuel blending in petrol and diesel, carbon tax rates have remained the same, regardless of the content of biomass fuels in those motor fuels. EU state aid provisions put legal constraints on EU Member States' possibilities to combine a quota obligation scheme with tax exemptions.

279. Depending on where the carbon tax is levied on the distribution chain, jurisdictions may encounter administrative problems in implementing tax exemptions, for example, adding ethanol in petrol fuel blends. However, this can be resolved with extensive bookkeeping and verifications for the different components or legal definitions of the level of a low blend to be eligible for a tax refund.

2.11 Taking account of the biomass part of petrol and diesel when calculating the carbon tax rate

280. Some countries, such as Sweden and France, consider the biomass component of fuel blends to determine the per litre of petrol and diesel carbon tax rate121. The use of pure or high blended liquid fuels of biomass origin, which amounts to low volumes in most countries, is often exempted from applied carbon taxes. Another example is British Columbia. In the Canadian province, the carbon tax is applied to ethanol at the same rate as petrol and biodiesel, and to renewable diesel at the same rate as diesel or light fuel oil.

281. British Columbia approached the issue more broadly when the renewable fuel

121 Prior to the introduction of the quota obligation in Sweden, the carbon tax rate for petrol and diesel only applied to fossil fuels, whereas now the tax rate is calculated for the fuel blend. Compared to the example in Box 18 above, when calculating the Swedish carbon tax rate for petrol for 2020, the heating value of fossil petrol was 32.76 GJ/m^3 and the emission factor 72 kg CO_2/GJ (both values revised to better reflect current quality of fossil petrol in Sweden). Furthermore, assuming zero fossil emissions from sustainable biofuels and with a quota resulting in a 7.7 percent share of biofuels in petrol, the emissions of fossil CO_2 from blended petrol amounted to 32.76 GJ/m^3 * 72 kg CO_2/GJ * (10.077) = 2177 kg CO_2/m^3, or 2.177 kg CO_2/litre. Multiplying this with the 2020 general carbon tax level of 1.19 SEK/kg fossil CO_2, the carbon tax rate for petrol is obtained at 2.57 SEK/litre.

standard was introduced in 2010, requiring an average annual blend of respectively five and four percent renewable content for petrol and light fuel. Carbon tax rates on these fuels were reduced by five percent to reflect the expected emission's reductions.

Box 18. Finland – An example of a jurisdiction with an innovative view of future carbon taxation

Finland was the first country in the world to introduce a carbon tax in the early 1990s. It is a key component in the country's pathway to a low-carbon and eventually carbon-neutral society. Since 2011, taxation of motor and heating fuels has been based on energy content, a CO_2 emission component and local emissions of fuels.

The CO_2 emissions of each fuel source are based on the carbon content using a life-cycle perspective. Biofuels are subject to a carbon tax rate that is reduced from 50 to 100 percent according to performance, giving a carbon tax exemption for the biofuels that are considered best from an environmental point of view (sometimes referred to as second generation or advanced biofuels), and applying different levels of carbon taxation for other biofuels based on parameters laid down in EU legislation[122].

The Finnish system taxes fuels based on carbon content; however, biofuels are classified in three levels based on the emissions reduction achieved, relative to equivalent fossil fuels considering the life-cycle carbon emissions[123]. Biofuels that fail to meet sustainability criteria are subject to the same carbon tax (per energy content) as the equivalent fossil fuel, as they are not considered to be emissions-reducing. Biofuels that meet the sustainability criteria (e.g., agriculture origin/first generation biofuels) and where emission savings exceed 50 percent, are subject to a carbon tax rate corresponding to 50 percent of the carbon tax applicable to the equivalent fossil fuel.

Finally, carbon taxes are not levied on second generation biofuels made of waste, residues, lignocellulose, etc., as these fuels are considered to, on average, have CO_2 emissions savings of over 80 percent. Since the Finnish carbon tax design is based on life-cycle emissions, emission factors will differ from other jurisdictions. For example, the value of the emission factors used will be different with respect to Sweden (and other countries that base their tax on the actual carbon content of fuels). However, the carbon tax is still expressed in volume or weight units in the tax law, and the general method for calculating the tax rate is the same.

In sum, with the Fuel Approach, even the more complex system implemented by Finland does not require environmental knowledge from the tax authority. What the tax administration basically needs is to determine how to calculate and audit the number of litres fuel sold by the taxpayer. This is a task which tax authorities are normally familiar with.

Source: Authors and Finland's Fifth Progress Report, 24 January 2020

2.12 *Summing up*

282. The Fuel Approach is a way of implementing carbon taxation by recognizing that over 75 percent of global CO_2 emissions come from the combustion of fossil fuels. Since the carbon content of fuels is relatively stable and consistent, setting the tax rate of fuels based on the carbon content, in effect, performs as a tax on carbon emissions. There are many advantages with this approach: it is administratively simple, it does not require a sophisticated system to monitor emissions, and, above

122 Directive of the European Parliament, 2009.

123 A life-cycle analysis (LCA) of the production of fuels is a technique to assess environmental impacts associated with all the stages of a product's life from raw material extraction through materials processing, manufacture, distribution, use, repair and maintenance, and disposal or recycling. There have been studies made in recent years comparing energy and carbon balances for production and use of different fuels.

all, it can be developed using the current excise tax institutional framework.

Checklist 6 Fuel Approach

1.	Tax Base	→	Fuels
2.	Tax Rate	→	Applied to different fuels
3.	Taxable event/point of regulation	→	Anywhere in the value chain
4.	Administration	→	Typically, existing excise tax administration
5.	Coverage	→	Usually, main fuel sources
6.	How to calculate tax rate		Depends on carbon content, some jurisdictions use carbon content and others the value chain
7.	How tax rates are presented	→	By volume or weight units
8.	Calculating total tax liability	→	Based on total fuel use/combusted
9.	Special considerations	→	Different fuel qualities and biofuel mixtures

3. The Direct Emissions Approach

3.1 *Basic concept*

283. An alternative to the Fuel Approach is a carbon tax on measured emissions. With this approach, known as the 'Direct Emissions Approach', the carbon tax targets CO_2 emissions at source regardless of fuel or processes. Although the tax is usually focussed on fuel combustion, it can be applied to emissions from any source. This is an obvious advantage since the tax can extend to non-fuel emission sources and other GHG and pollution emissions. The disadvantage is that it requires a more sophisticated administrative structure to measure emissions at source and, therefore, it can only generally be applied to large facilities.

284. This approach relies on direct reporting of emissions from stationary installations/facilities, such as large factories, power plants, and oil refineries. This is the case in Chile and, most recently, in Singapore and South Africa. These facilities are often already subject to legal requirements to measure emissions. Therefore, jurisdictions that have applied this approach have usually used existing reporting structures or legal mandates, such as in the United Nations Framework Convention on Climate Change (UNFCCC) national reporting guidelines.

285. However, although measurement at source may seem to be a more accurate approach to assess carbon emissions, measurement systems are often not precise; therefore, the Direct Emissions Approach is not necessarily more accurate than the Fuel Approach. Furthermore, it may involve uncertainty and higher administrative costs. Regardless of existing reporting structures, jurisdictions will most certainly

need to establish new administrative and regulatory systems for monitoring, reporting, and verification (MRV), particularly for smaller facilities.

286. With this approach, jurisdictions may be able to ensure broader coverage of emissions, especially where a large part of their emissions is not fuel-based. However due to the requirements for measurement at source, the approach would work best focussing primarily on emissions from large stationary installations. It is thus not a system well suited to cater for incentives to reduce emissions from small facilities, due to the major administrative costs likely to occur. For the same reason, it is not a foreseeable alternative for emissions from the propulsion of vehicles. Therefore, a variation of this approach is to focus only on certain processes and types of emissions.

287. A policymaker considering the Direct Emissions Approach is likely to need more assistance with technical expertise on environmental and energy related matters in the tax design than the Fuel Approach. As will be further outlined in Chapter 8, a carbon tax based on a Direct Emissions Approach will also be administered in a way that differs from the tasks normally assigned to tax authorities. On the other hand, a Direct Emissions Approach can strengthen already existing environmental reporting systems – and this has many additional advantages and benefits.

3.2 Coverage of emissions by the Direct Emissions Approach

288. Although not as common as taxation of fuels, there are jurisdictions that have chosen to tax direct emissions. For example, in a 2017 tax reform, Chile introduced two new green taxes, a carbon tax and a local pollution tax targeting emissions from large facilities comprised of boilers or turbines.[124] The tax targets emissions of CO_2 - covering over 40 percent national emissions - and the local pollution tax covers PM (particulate matters from dust or smoke), NO_X (oxides of nitrogen) and SO_2 (sulphur dioxide).[125]

289. Other examples include the San Francisco Bay Area carbon tax in the USA (in force since 2008) and Singapore that introduced its first carbon tax in 2019. Both these jurisdictions calculate the tax on measured emissions arising from combustion of fuels in large stationary facilities. By converting emissions from other greenhouse into CO_2 equivalents (CO_2e), other GHGs are also included.

290. The San Francisco Bay Area's tax is levied on emissions from facilities that are subject to local environmental regulations (permits), while Singapore's carbon tax requires any industrial facility that emits 25,000 tCO_2e or above a year, to register as a taxable facility and pay the tax.

124 The tax exempts biomass.
125 Pizarro and Pinto, 2019.

291. A similar approach is taken by South Africa where a carbon tax came into force in 2019. The South African carbon tax[126] targets CO_2e emissions above a certain threshold from fuel combustion, electricity generation and industrial processes, as well as estimated fugitive emissions.[127] While South Africa is, in principle, using a Direct Emissions Approach, the emissions taxed are calculated based on pre-determined emission factors, according to a methodology approved by the relevant authority. The tax law also lays down standard values, in case such a methodology does not exist for a specific activity.

292. The facilities targeted by a tax based on the emissions are, in many cases, already required to measure and report their emissions due to national or international regulations. However, a MRV system will still be necessary. This requires cooperation between the national tax administration and agencies with environmental and technical capacities, to be able to control and monitor emissions and ensure tax control.

293. Starting in 2024, all parties to the Paris Agreement will be required to report their emissions using the guidelines of the Paris Rulebook. Although developing countries with limited capacity may initially report with some flexibility, parties will, over time, need to increase the accuracy of their national emissions inventory, increasing the capacity to implement a carbon tax based on emissions. Therefore, one of the principal advantages of the Direct Emissions Approach is that, although more difficult to implement initially, it forces countries to develop their MRV capabilities that will support a range of international commitments and local policies.

294. Further, while the Direct Emissions Approach places the tax on actual emissions, it is not necessary to have direct measurement of emissions at all sources. In effect, countries use a range of mechanisms to measure emissions that include continuous emissions measurement systems (CEMS), direct measurement, or estimations based on fuel use. The only effective requirement to monitor emissions is to ensure reporting at the facility level. This feature of the approach is relevant for developing more sophisticated policy instruments, or introducing other complementary environmental policies such as local pollution controls.

3.3 *Taxpayer*

295. If a Direct Emissions Approach is chosen for the design of a new carbon tax, it would be natural to choose the taxpayer as the entity that physically generates the emissions. Administrative advantages can be expected by coordinating the tax collection and payment with already existing obligations to report emissions based

126 For further information about the South African carbon tax, see Republic of South Africa Carbon Tax Bill B-46-2018.
127 Fugitive emissions are emissions of gases or vapours from pressurized equipment due to leaks and other unintended or irregular releases of gases, mostly from industrial activities.

on environmental regulations. Still, such a tax system would most likely require new administrative practices for the tax authorities, including necessary cooperation with – and the technical expertise of – environmental authorities to be able to carry out tax control.

3.4 Methodology to calculate the tax payment by the Direct Emissions Approach

296. For the Direct Emissions Approach, jurisdictions need to determine where the emissions are coming from. Therefore, defining the facility affected by the tax, or what the boundaries of the tax liability are, is crucial: Is it a spatially contained area, or does it involve broader processes that span a larger area? Is it one chimney stack or many? This not only limits coverage but also establishes the criteria of who pays the tax.

297. Determining the boundaries of a facility is not obvious in all cases. For example, in the case of Chile, a facility was defined as "*the set of structures and installations where one or more boilers or turbines are located, which are close to each other and that for technical reasons are under a single or coordinated operational control, that together have a thermal power capacity of* 50MW." Although the definition does not limit coverage to a sector, it does establish a boundary based on technological criteria of heat production. In effect, in the case of Chile, the tax affects sectors such as food processing, refining and electricity generation.

298. Moreover, jurisdictions often limit tax liability to an emission threshold for regulatory efficiency. In the case of Singapore, stationary facilities are liable if they surpass the emission threshold of 25,000 tons of CO_2e a year. While this limits coverage to those facilities that generate the most emissions, it may be problematic since applying the threshold requires the development or existence of an MRV system prior to identifying who is liable to pay the tax. Therefore, countries who do not have a sophisticated emissions reporting system will need to develop one before implementing these thresholds to identify potential taxpayers.

299. Through a strict definition of liable facility-based or an observable technology, namely the existence of boilers and turbines with 50 megawatt (MW) potential capacity (regardless of a specific emissions threshold), Chile avoided the above problem. Therefore, the regulator could, without recourse to an MRV system, identify liable facilities, and, therefore, place the burden on the facility to develop its own MRV system and report its own emissions.

3.5 Measuring, Reporting and Verification Systems (MRV)

300. Both the Fuel Approach and the Direct Emissions Approach will requireMRV. However, in the case of the Fuel Approach, the MRV system is, in effect, the current excise tax institutional system. The Direct Emissions Approach, on the other hand, will require a new MRV system.

301. The general structure of the MRV system is composed of, at least, four components:

- the registry of the facility and sources subject to the tax
- the measurement, monitoring (M) or quantification of emissions
- the reporting (R) mechanisms of emissions at the facility level, and
- the verification (V) of those emissions.

These are examined in turn.

Registry

302. A key component of the MRV is the system for registering facilities that are potentially liable for the tax. In general, all facilities should be registered to determine who meets a predetermined threshold and is therefore liable to pay the tax. Most countries will have some form of registry of polluting firms, which are already reporting emissions or are subject to some form of control. In the case of Chile, for example, the Pollution Release Transfer Registry (PRTR) was used. However, if no such registry exists, one must be developed.

Measurement of emissions

303. As mentioned above, despite the name of the Approach, it is not necessary for facilities to measure their own emissions. It is sufficient for them to keep track of the use of fuels, and estimate emissions based on their carbon content. What is required, however, is to report emissions at the facility level. This is the main advantage of using emissions as the tax base, since it forces facilities to make explicit, transparent, and certifiable declarations of emissions. It is the basis of the development of an institutional infrastructure to support MRV systems at the facility level. More accurate reporting systems will be essential for international reporting, as well as for expanding carbon pricing policies across jurisdictions and sectors. See Box 19 for the types of measurement available to facilities.

Reporting

304. After measurement, the facility must report its emissions to the relevant government agency. These must be verified (see below) and consolidated to report

to the authority in charge of the tax administration (Tax Authority). The emission reporting process should be based on specific guidelines that establish the conditions and standards that must be met, both to register the affected facilities and to report the taxable emissions. This will be further outlined in Chapter 8.

Verification

305. Verification systems refer to the institutional structures to validate, confirm or verify the emissions reported. Since this is a tax, the amount to be paid will be based on the reported emissions which need to be verified by the environmental authorities. However, if the objective is for the tax to evolve to other, more sophisticated systems (such as offsets or compensation schemes), some form of independent verification system could be conceptualized from the beginning and then later developed. Figure 9 summarizes the issues raised by the MRV system associated with the Direct Emissions Approach.

Box 19. Emission measurement alternatives

Facilities subject to the tax apply different methodologies or techniques for quantifying emissions for the purposes of paying the tax. These will vary across sectors and institutional capacities. There are four possible measurement approaches.

Direct measurement: It consists of the direct quantification of the output concentrations emitted, through a measuring device installed on site. Quantification can be carried out by continuous sampling or measurement systems.

Point or sampling: Collection of a sample with specialized equipment, for subsequent laboratory analysis or on-site measurement. The analysis delivers the output concentration and the representative flow at the moment of measurement.

Continuous: Real-time collection and analysis of emissions, through a CEMS. It can determine average emission schedules, generally during an annual period.

Estimate: This method consists of the indirect quantification of emissions, through emission factors (associated with the specific production process), and the annual activity level (hours of operation and fuel consumption, among others). For local pollutants, the emission factors provided by the United States Environmental Protection Agency (EPA) can be used,128 while for carbon emissions, the factors proposed by the Intergovernmental Panel on Climate Change (IPCC, 2006) can be considered.

128 These factors are regularly updated and can be found on the EPA website, at https://www.epa.gov/climateleadership/ghg-emission-factors-hub.

Figure 9. Different issues raised by an MRV system

Registry	Measurement	Report	Verification	Trade/offset
• Registry of potentially affected facilities • Establish reporting requirements • Determine necessary information • Responsibilities • Penalties • Technological platform • Training users • Regulatory agency	• Measurement methodologies protocols (e.g., CEMS, emission factors) • Base lines (in the case of reductions) • • Quality control • Responsibilities • • Penalties • • Enforcement agency	• Structure of report (e.g., required information, dates) • Responsibilities • Penalties • Quality control • Technological platform • Training users • Enforcement agency	• Verification system • Standards required for verifiers • Standards and criteria for verification • Responsibilities • Penalties • Quality control • • Training users • • Enforcement agency	• System of trades • Emissions registry • Allowance registry • Reduction registry • Establish reporting requirements • Determine necessary information • Responsibilities • Penalties • • Technological platform • Training users • Regulatory agency

3.6 *Point of regulation*

306. A carbon tax based on the Direct Emissions Approach is a downstream tax based on actual emissions released by facilities subject to taxation. Therefore, while the Fuel Approach can, depending on the tax design, use either an upstream or a downstream point of regulation, a carbon tax on emissions must be regulated downstream.

307. As outlined earlier in this Handbook, many jurisdictions around the world have introduced carbon taxation with somewhat different designs. However, Chile is the only Latin American country to have opted for a downstream tax, while Colombia and Mexico have chosen to institute upstream taxation based on carbon content of fuels.

308. A carbon tax based on a Direct Emissions Approach requires the measurement or estimation of actual emissions at the source. Therefore, the taxpayers are likely to be those who control the production process that generates the emission. These can either be the owner/renter of the installation where the emissions occur, or the business carrying out its activity in the facility and requiring the process which generates the emissions.

3.7 Institutions involved

309. The Fuel Approach requires technical or institutional support from environmental agencies when defining the methodology for calculating the carbon tax rate for specific fuels. In the case of a carbon tax on emissions, the role of technical and environmental agencies is permanent, as these are the key institutions that determine the tax base and consolidate the calculations of emissions for the final tax to be paid.

310. A central aspect in the implementation of the carbon tax is the coordination among various ministries and government departments for the construction of reliable methodologies and information systems on emissions, issuers, technologies, tax payments and fines.

311. Generally, the Ministry of Environment or an equivalent Environmental Agency would be responsible for coordinating the process through the regulation of emission MRV systems that constitute the information base for the calculation of the tax. After each facility declares its final emissions, the Environmental Agency should verify and consolidate them, while the Tax Authority will calculate the tax burden of the specific facility.

312. Thus, one of the problems (or advantages) of the Direct Emissions Approach is that it requires (or strengthens) the coordination between the Environmental Authorities, the Ministry of Finance and the Tax Authority.

3.8 Summing up the Emissions Approach

313. Conceptually, the Direct Emissions Approach targets emissions directly. However, there are both advantages and disadvantages to this approach. The most obvious advantage is that the tax on emissions is explicit, which can facilitate the introduction of a carbon tax in a country where new taxes are not easy to implement.

314. On the other hand, it can lead to increased institutional complexity and conflict in the shared responsibility for tax administration and tax control between Tax and Environmental Authorities. Another problem (which can also be an advantage) is that it will require the development of an MRV system. This is more expensive and may generate conflict, but will eventually be useful for additional purposes, such as developing inventories, enhancing domestic and international comparability, facilitating management within companies, and even generating conditions to move towards other policy instruments such as compensation mechanisms, offsets, and/or an emissions trading system.

Checklist 7. Direct Emissions Approach

1.	Tax Base	→	Emissions
2.	Tax Rate	→	Applied to emissions
3.	Taxable event/point of regulation	→	At the emission source, definition of facility required
4.	Administration	→	Require new MRV administration
5.	Coverage	→	Usually, large facilities
6.	How to calculate tax rate	→	No correction is required
7.	Calculating total tax liability	→	Based on total emissions
8.	Special considerations	→	MRV system required

4. Considering the different carbon tax approaches

315. The choice between the different tax approaches will depend on various factors: institutional capacity and legal restrictions. The general political economy of carbon tax implementation may also be relevant. Ultimately, the choice is not only technical but also political, and should be defined in terms of broader objectives.

316. Table 4 summarises the advantages and disadvantages of the different tax design approaches. Although the table compares the different approaches as alternatives, a better way of evaluating them is to consider them as complementary, since they have different advantages and disadvantages and achieve different goals in different sectors. In effect, jurisdictions may decide to implement a combination of both approaches.

5. Conclusion

317. This chapter has examined the issues raised by carbon tax design based on two alternative approaches, the Fuel Approach - which uses fuels as the tax base and sets the tax rate based on carbon content of the fuels - and the Direct Emissions Approach -which establishes the tax directly on emissions.

318. To illustrate, we drew on the examples of the taxes implemented in Sweden and Chile. Both approaches have different advantages and disadvantages, and potential challenges. However, the principal challenge, which affects them equally, is the potential conflict associated with implementing the tax, or the political economy of carbon tax design. In the next chapter, we explore the sectors affected and the available mechanisms to compensate or ameliorate impacts on households and firms. Although these issues go beyond the design of the tax, they should also be considered in the design phase.

Table 4. Some pros and cons of different carbon tax approaches

	Pros	Cons
Fuel Approach	• Incentive is clear – Polluter Pays (as tax is normally included in fuel price). • Administratively simple, can be added to an existing excise tax system. • Scope can include large part of CO2 emissions in small as well as big stationary facilities, as well as transport.	• If incentive to choose higher quality fuels within the same tax group is desirable, system may be more complicated as more tax rates are needed. • GHG emissions other than CO2 are out of scope. • Does not develop MRV systems.
Direct Emissions Approach	• Incentive is clear – Polluter Pays. • Making use of existing MRV and incentive to further develop MRV. • Possibility of developing other more complex instruments and of eventually converting to an emissions trading system. • Possible to include non-fuel combustion emission in scopes	• Costly to measure. • Difficult to apply to small facilities. • Cannot be applied to transport fuels. • Administratively complex.

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Appendix 2: Taxation of air and maritime transport

A1. *Introduction*

319. Extending the scope of carbon taxation to activities or processes that go beyond the borders of a jurisdiction can be problematic because it may to lead to double or multiple taxation, depending on how the tax is structured. Furthermore, international treaties and agreements enacted/ratified by a country may apply, and, under customary international law, a State may not use the provisions in its domestic law as a rationale for failing to adhere to the provisions of a treaty (Article 27 of the Vienna Convention).

320. This Handbook aims to give an overview of how a general carbon tax can be implemented within the borders of a jurisdiction. However, taxing fuels used in commercial air transport and maritime transport (including fishing) present specific challenges. Although this will not be dealt with in detail, this Appendix considers the principal issues with the purpose of offering interesting approaches worth exploring further, future considerations, and an overview of discussions ongoing in different international fora.

A2. *Commercial air transport*

321. There is widespread perception that fuels used in international aviation are exempt from taxation; this perception is based on the view that the Chicago Convention prohibits the taxation of these fuels.

322. The 1944 Chicago Convention establishes the rules regarding international civil aviation. The Treaty forms the basis for the International Civil Aviation Organization (ICAO), a specialized agency of the UN. The contracting States agreed not to tax fuel on board an aircraft of a contracting State, on arrival in the territory of another contracting State and retained on board on leaving the territory of that State. This only applies to fuel on board an aircraft when arriving in another State and for international flights. Therefore, since the Convention imposes no limitation on a State's right to tax fuel taken on board and consumed during a domestic flight, jurisdictions can impose carbon taxes on national commercial flights.

323. ICAO Policies in the Field of International Air Transport (and ICAO Council Resolutions) state that fuel taken on board an international flight should be exempt from all customs and other duties; however, these policies only have standing as non-binding soft law, and several States stated (in an appendix to the policies) that they don't agree with the resolutions. Further specific agreements, known as Air Services Agreements (ASAs), akin to an international treaty, can provide for

the exemption from customs duties, excise taxes and other duties and charges on aircraft, fuel, lubricating oils, technical supplies and spare parts used by an airline of the counterparty State in the provision of international air transport services.

324. Consequently, it is advisable that the scope of any local, regional, or national carbon tax regime examine and consider any existing international agreements prior to implementation.

325. Nevertheless, EU Member States have argued that without global instruments in place, a tax on kerosene, an air passenger tax, or a tax per flight is necessary. Furthermore, this position is sustained by the understanding that taxing fuel for international aviation is legally possible. For example, countries could, on a bilateral basis, tax fuel on flights between themselves while still following international law. At the time of the publication of this handbook, discussions are still ongoing on this topic.

326. To deal with international emissions, in 2016, ICAO adopted the Carbon Offsetting and Reduction Scheme for International Aviation (CORSIA). This is a market-based measure applied to CO_2 emissions from international flights, stating that CO_2 emissions from international aviation should be stabilized to 2020 levels. The proposal is that CO_2 emissions above this level should be compensated through an offsetting scheme. The new system will start by a voluntary phase and will be compulsory from 2027.

A3. *International maritime transport*

327. Currently, there are no international agreements establishing a country's right to tax carbon emissions (or fuel consumption) deriving from international maritime transport, nor restrictions prohibiting or limiting a State's right to tax fuels used on cross-border maritime transport of goods and in high-sea fishing exploration.

328. There are, however, two relevant international regulations: (i) the regulations issued by the International Maritime Organization (IMO), and (ii) the UN Convention on the Law of the Seas (UNCLOS). Neither specifically deals with economic instruments relating to carbon emissions, but nothing prevents countries from implementing policies such as carbon taxes to reduce carbon emissions.

329. The IMO was created in 1948 as a specialized UN agency, [129] with the purpose of developing, administrating, and legally implementing international

129 The IMO, initially named Inter-Governmental Maritime Consultative Organization (IMCO), has issued mandatory energy efficiency standards for new ships (the Energy Efficiency Design Index (EEDI)) and mandatory operational measures to reduce emissions from all ships which have entered into force in 2013, as amendments to MARPOL Annex VI. By 2025, based on the EEDI phased approach, all new ships are expected, based on that legislation, to be 30 percent more energy efficient than those built before 2014.

regulations and practices to be followed with the cooperation of Governments, to achieve the highest standards in matters concerning maritime safety, efficiency of navigation, and prevention and control of marine pollution from ships. The Marine Environmental Protection Committee was created to address environmental issues under IMO's remit.

330. UNCLOS, which was ratified by 166 parties (including the EU, but not the USA),[130] is a general convention and, as such, is compatible and may be subject to the provisions of other more specific conventions, provided that these do not contravene the basic principles embodied in the Convention. Therefore, UNCLOS may interact with the Paris Agreement and the Kyoto Protocol, for example, when it comes to setting specific and higher standards for environmental protection for shipping operations.

331. In 2018, the IMO adopted the Initial IMO Strategy on Reduction of GHG Emissions from Ships (Resolution MEPC.304(72)), aimed at reducing total GHG emissions from international shipping at least by 50 percent by 2050. To that purpose, the Strategy lists several candidate measures to reduce GHG emissions from international shipping. They do not, however, include carbon taxation.

332. IMO's policies so far have only addressed mitigation techniques and efficiency improvements, rather than carbon taxation or market-based initiatives (such as emissions trading). Since the EEDI only applies to new ships, and a ship's operational life ranges between twenty and twenty-five years on average, it is unlikely that energy efficiency standards would be sufficient to reduce CO_2 in the short- and medium-run. Even in the long-run, Smith et al. (2016) indicate that with the current designed EEDI, shipping's cumulative CO_2 emissions will be reduced by only 3 percent between 2010 and 2050. Smith et al. (2015, 2016), in a study commissioned by IMO, predict that the EEDI regulation alone will not change the increasing trends of CO_2 and GHG emissions.

333. The international maritime transport sector is not currently subject to the payment of any carbon tax (or environmental charge or other implicit price through market-based instruments). This has at least three adverse consequences. The *first* is a higher than optimal activity in international shipping (types of vessels, the routes they take, and the types of goods they transport), as this sector does not face the true global costs of international trade. The *second* is high fuel consumption

130 Established in 1982, UNCLOS is responsible for codifying the rules applicable to activities on the high seas, by: 1) establishing an international legal order for the economic and scientific exploration of seas and oceans; (2) facilitating international communication; and (3) promoting the peaceful uses of the seas and oceans, equitable and efficient utilization of their resources, the conservation of their living resources, and the study, protection, and preservation of the marine environment.

(and too much use of polluting fuels) and consequently high carbon emissions[131] (see Smith et al. (2015)). The *third* is the lost opportunity of raising fiscal revenues raised from international shipping transport for countries participating in international trade. This issue is especially critical for many low-income countries with low tax revenues.

334. Absent an international environmental agreement to source and tax carbon emissions from international shipping, taxation of those emissions becomes a topic of exclusive competence of national States.

335. The attribution of indirect taxing rights over activities occurring on the high seas is not a topic covered under international tax treaties or the UNCLOS. Regulatory environmental standards are within the competence of the flag State, but as carbon taxation is a specialized topic within the general field of environmental law, it would be up to policymakers to define how taxing rights derived from global emissions could be allocated between States.

336. Taxing carbon emissions would be consistent with the principle, consolidated in the UNCLOS, that the responsibility for the emissions released on the high seas should be shared by the larger international community, and with IMO's guiding principle of non-discriminatory treatment of all ships regardless of the flag State. Extensive cooperation between all countries on this matter would represent a recognition of such responsibility and would be the first step in allowing countries to reach an agreement on a global carbon tax scheme for the international shipping sector. The international community (including IMO) acknowledges that low-income countries and small island developing States could be affected. Addressing potential negative effects of implementing a carbon tax in the maritime sector may, for example, require designing a scheme to compensate the countries that are most affected.

131 Bunker fuel consists primarily of residual and distillate fuel oil (see EIA (2015)). Starting January 1, 2020, IMO requires that all fuels used in ships contain no more than 0.5 percent sulfur. The cap is a significant reduction from the existing sulfur limit of 3.5 percent.

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Chapter 7: Addressing Undesired Effects on Households and Firms

1. Introduction

337. A carbon tax provides a price signal that generates an incentive to reduce emissions. However, concerns over the undesired effects on firm competitiveness and carbon leakage, together with fear of unwanted distributional impacts, can constitute political obstacles for its implementation. The concerns can be addressed both in the design of the tax and the introduction of additional mitigating measures.

338. This chapter discusses the possible negative side-effects of carbon taxes and explores measures to address undesired impacts. It also provides examples of how jurisdictions have introduced a carbon tax using two-level tax system and liability thresholds or exemptions.

2. Possible adverse effects from carbon taxation

339. Like any policy intervention, carbon taxation may have undesired effects or impacts. Carbon taxes may lead to price increases in goods and services, which can have negative impacts on households' disposable income and firms' competitiveness. Policymakers may want to avoid or mitigate these impacts. Addressing concerns over distributional effects, social equity, fairness, employment, and firm competitiveness, among others, is also important for achieving public acceptance. In addition, paying attention to possible adverse side effects can help safeguard the environmental integrity of the carbon tax as some of the measures available for policymakers to protect domestic firm competitiveness may help to avoid carbon leakage.

2.1 Negative impacts on households

340. The impact of a carbon tax on households is often at the centre of the public debate; this can provide valuable input to the design of the tax, or give insights to the need for policies complementing the tax and the possible design of such measures.

341. Concerns over distributional impacts, social justice, and equity implications are not only legitimate, but require the attention of policymakers to ensure the success of the tax. The wider policy context of those affected is also relevant; therefore, it is advisable to consider the implementation of the tax in the context of other economic policies. For example, the French nation-wide demonstrations organized by the "*Gilets Jaunes*" movement was sparked in late 2018 by, among other things, concerns over the effect of increasing carbon taxation on fuel prices and

how this would affect households.

342. The most common way to measure distributional effects is to study the impact on different income groups. While the empirical literature has predominately researched distributional effects from general excise duties on energy sources, these studies can nevertheless provide insights into the potential impacts of carbon taxation.[132]

343. Conventional wisdom regarding the distributional effects of taxation of energy sources has been that it is regressive, i.e., that these taxes increase the burden on low-income groups relatively more than those with higher income. However, more recent research suggests that taxes on energy can no longer be viewed as universally regressive; instead, the tax incidence (or the final distribution of the burden of taxation), depends on a variety of factors. These include, among others, the type of energy commodity being taxed, the social, physical, and climate characteristics of the jurisdiction, and how household income is measured.[133]

344. For instance, due to the profile of vehicle ownership in middle- and lower-income countries, taxation of motor vehicle fuels has been found to be neutral or even progressive.[134] However, households may be affected by a carbon tax not only from direct consumption (e.g., from the burning of fuels for transport or heating), but also from the increased price of carbon-intensive goods and services or inflationary impacts. These indirect costs to households are sometimes less tangible and hence more difficult to measure. Nevertheless, when examining the social effects of a carbon tax, it is important to consider both the direct and indirect effects.

345. In addition to the distributional effects of carbon taxation, other dimensions of the social impacts of the tax include the perception of fairness, equity, and social justice in the design and implementation of the tax.

2.2 Negative effects on firms

346. For firms, a carbon tax will increase the cost of carbon-intensive inputs. If the additional cost cannot be passed on to the consumers, the tax may affect competitiveness. Apart from the increased direct cost of emissions, or carbon-intensive inputs, the firm may also face increased costs from its own abatement measures. In the short run, measures to decrease emissions can entail fuel switching or other energy-efficiency improvements. There is also the possibility that some firms may choose to avoid the tax by reducing production, since, in the short run, it is likely that mitigation options are limited by capital constraints, current

132 Flues and Thomas, 2015; Pizer and Sexton, 2019.
133 Ibid.
134 Sterner, 2012. see e.g., Flues and Thomas, 2015.

technologies, and production processes.

347. In the long run, other types of mitigation efforts will be available, as firms have more time to raise capital, invest in Research and Development (R&D), and adopt new technologies. Firms' long-term investments can focus on reducing emissions within the existing production technologies and processes, or be aimed at changing entire production processes. Either way, the more significant mitigation measures a firm undertakes, the more resources are likely to have been invested, and hence the larger the direct cost is for the firm.

348. In addition to the direct cost of mitigation measures, firms may also face an indirect cost, measured as the loss in profits that follows from the fact that investment in abatement crowds out productive investments in capital and innovation that the firm would otherwise have undertaken. While the opportunity cost of capital does not increase expenditure for firms like the direct costs discussed above, it can have a long-term negative effect on, for example, competitiveness.[135]

349. Firms that produce a homogeneous product for an international market are normally price-takers, and they will not be able to pass the additional costs from taxation on to customers. Under these circumstances, an increase in production costs risks reducing domestic firms' market share. The competitiveness of such firms is likely to be more affected by a carbon tax than firms with a lower energy intensity and trade exposure. In jurisdictions where exporting firms constitute an important part of the economy, there may also be concerns over impacts on aggregated economic indicators such as total factor productivity, investments, employment, and output.[136]

350. Firms that can transfer a significant portion of their costs through prices without losing market shares (price-setters) are, in general, more likely to be less exposed to competitive effects. Knowing ex-ante which firms and sectors are more vulnerable requires a careful assessment, since it depends on the circumstances in each specific jurisdiction. There is no straightforward way to determine the vulnerability of a given firm or sector, but various measures of trade exposure and emission intensity are often used to identify which are likely to be negatively affected.[137]

351. It could be noted here that having to invest in less polluting technologies sometimes is considered to have a positive effect on, for example, firm productivity, profits, and competitiveness, as these investments will lead to enhanced resource

135 Ibid..
136 Ibid
137 As an example of how sectors at risk of carbon leakage can be identified, see the impact assessment supporting the preparation of the so-called carbon leakage list under the EU Emissions Trading System for the period 2021-2030, SWD(2019) 22 final.

efficiency, spur innovation and open new markets. Although there is considerable research on the empirical evidence to support the existence of the so-called Porter hypothesis (which stipulates that environmental regulations can enhance innovation and competitiveness), it is not conclusive. While regulation indeed seems to spur innovation, it is less clear to what extent stricter regulation also enhances business performance.[138]

352. There is considerable research on the possible interaction between environmental taxes (such as carbon taxes), energy prices and trade, and their impact on competitiveness.[139] These studies suggest that the effects of carbon taxes can be large, depending on which sectors are being investigated and what method is used for the analysis.[140] However, in ex-post evaluations, there is less evidence to support significant adverse effects from environmental taxes on firm competitiveness in general. As expected, studies confirm that negative impacts are more likely to occur in energy-intensive, trade-exposed sectors, but observed impacts have been found to be relatively small and short-term.

353. This is not to say that carbon taxes cannot have negative impacts on firm competitiveness, nor that concerns over such impacts do not need to be considered when designing and implementing the tax. But, to date, the evidence suggests that impacts are limited. There are several possible explanations for this, including that carbon taxation is only one of many factors that affect firms' choices.[141] Careful policy design may also have prevented or mitigated possible negative impacts.

2.3 Concerns over carbon leakage

354. The notion of carbon leakage is closely related to the question of adverse competitive impacts. Carbon leakage occurs when the carbon pricing in one jurisdiction results in increased emissions in another. If this happens, in practice, the carbon pricing policy would just displace carbon emissions from one area to another. While the effects of carbon taxes discussed above are manifested as increased costs for economic agents, carbon leakage reflects the effectiveness of the tax as an instrument to reduce global carbon emissions. There are several channels through which such leakage can arise; however, the discussion below will focus mainly on competitiveness-driven carbon leakage.

355. As a carbon tax increases the cost of domestic production, foreign goods gain a competitive advantage, and, as a result, consumption may switch towards

138 Se e.g., Ambec et al., 2011.
139 See e.g., discussion in Coste et al, in Pigato, 2019. Again, the literature referred to here is on environmental taxation in general rather than on carbon taxes, but, as noted earlier, the conclusions are in essence valid for carbon taxes as well.
140 Coste et al, in Pigato, 2019.
141 Ibid.

imported goods. As production and emissions decrease domestically, carbon leakage suggests that production of carbon-intensive goods will increase abroad. Since the effect on climate change from carbon dioxide (CO_2) emitted into the atmosphere is the same regardless of where the emissions occur, the overall effect of climate change mitigation cannot solely be measured by the domestic emission reductions.

356. If domestic production is less polluting than foreign production, the reduction in domestic emissions will be more than counterweighted by increased emissions abroad, and the total emissions at global level will be higher. The opposite can, of course, also be true, that is, when foreign production is cleaner, total emissions at the global level would be lower than if production had remained domestic. However, this latter scenario is less likely to happen, as it is reasonable to assume that production will move to jurisdictions with less stringent climate policy.

357. Carbon leakage can also occur as domestic firms choose to reduce production volumes in existing factories as a result of the tax, and that market share is taken over by foreign companies with higher carbon emissions. In the longer run, the situation can become permanent as investments, in anticipation of reduced profits or lower rates of return, shift away from the domestic industry, affecting future production capacity. In both cases, there is a risk that overall emissions will increase. Hence, addressing concerns over potential adverse effects of a carbon tax on competitiveness may also strengthen the environmental integrity of the carbon tax.

358. Besides the competitiveness channel, carbon leakage may also arise through energy markets, as reduced demand for fossil energy in countries with more stringent climate policies may cause a decline in global energy prices, which in turn can trigger higher energy demand and carbon emissions elsewhere.[142]

359. The empirical literature on carbon leakage – and especially through the competitiveness channel – coincides with the literature on trade, competitive effects, and environmental taxation. The evidence for carbon leakage to date is weak. While ex-ante studies (impact assessments conducted prior the policy change) show leakage rates varying from negligible to close to 100 percent, there is less support to be found for significant carbon leakage in ex-post evaluations (studies relying on actual data after the policy has been implemented).[143]

360. One explanation is that general excise duty taxation on energy or carbon taxation is just one of many factors that influence the decisions of firms and investors. Design features that aim at protecting firm competitiveness and carbon leakage, in existing carbon taxes and other pricing mechanisms, may have contributed as well.

142 For an overview of the forms and channels of carbon leakage, see Görlach and Zelljadt, 2018.
143 Coste et al. in Pigato, 2019.

Furthermore, carbon leakage has likely also been limited by the fact that carbon taxes to date have been set at rather modest rates.

Checklist 8. Possible adverse effects from carbon taxation

1. Impacts on households' disposable income

   Measure distributional effects by studying the impact of the tax on different income groups

   (i) The energy price channel
      - (a) Consider general electricity costs
      - (b) Consider heating costs

   (ii) The transport price channel
      - (a) Consider car ownership
      - (b) Public transport use

   (iii) The general price channel.

2. Impacts on firms

3. Consider direct and indirect costs borne by different types of firms:

   (i) Price-takers
      - (a) Consider direct cost of the tax (tax burden)
      - (b) Consider competitive issues
      - (c) Consider carbon leakage

   (ii) Price-setters
      - (a) Consider tax burden

4. Environmental integrity

   (i) Carbon leakage

3. Assessing the risk of negative effects

361. Understanding the unique challenges and specific context where the carbon tax is introduced will enable policymakers to design appropriate measures to avoid or counter unwanted negative effects such as carbon leakage, competitive effects, and distributional risks. It will also help to ensure that economic agents are not given unnecessary compensations. Accurately assessing and communicating how the proposed carbon tax will affect stakeholders are also helpful in gaining public acceptance (see Chapter 3).

362. There are many ways to analyse the impacts of a carbon tax. Assessments by experts and broad public consultations can be valuable sources of information for effective tax design and help policymakers identify the need for complementary

measures (see Chapter 10 for a discussion). However, economic and/or energy system modelling are often crucial in exploring the effects of alternative tax designs and complementary measures in more detail.[144]

363. There are a wide range of modelling approaches. Economic partial equilibrium models, for example, can help explain how a carbon tax affects a specific industry or sector, while a computable general equilibrium model can be particularly useful for estimating economy-wide effects such as the level and distribution of costs. On the other hand, the overall techno-economic potential, and possible paths to reach emission targets, can be explored using energy systems modelling.[145]

364. As different analytical tools provide insights from different perspectives, adopting a set of multiple approaches can be valuable. At the same time, modelling is costly and the lack of funding, availability of data and limited capacity may limit the number of alternatives. Regardless of the means available for the assessment, careful planning will provide policymakers with useful information for the design of complementary measures. International organizations may also aid in the analysis of domestic mitigation policies.[146]

4. Policy options to address concerns over unwanted adverse effects

365. Economic theory suggests that a uniform carbon tax with wide coverage will be the most cost-efficient design.[147] At the same time, stakeholders commonly raise concerns that the additional tax burden can lead to adverse effects on the competitiveness of domestic firms – especially in energy-intensive and trade-exposed sectors – causing carbon taxes to deviate from a theoretically ideal carbon tax. Many jurisdictions have strived for a balance between environmental objectives, risks of carbon leakage, and competitiveness of sectors subject to international competition.

366. The risk of undesired effects from a carbon tax can constitute significant political obstacles for its implementation and therefore needs to be considered in the process of designing the tax. The impact of a carbon tax in different income groups and geographical regions, and how such impacts are alleviated, are other factors determining the acceptability of the tax. Consequently, each carbon tax system needs to have a unique design to address such concerns. Box 20 presents examples of how different jurisdictions have designed their carbon taxes to minimize adverse impacts.

144 For a general overview of different modelling approaches, their strengths and weaknesses, see e.g., Pigato, 2019. and PMR, 2017.
145 Ibid.
146 E.g., the IMF has developed a spreadsheet tool to help countries evaluate progress towards their Paris Agreement mitigation pledges. See IMF, 2019.
147 Baumol and Oates, 1988.

Box 20. Country examples of carbon tax designs with various degrees of exemptions[148]

- The carbon tax in Argentina was adopted in 2017 as part of a comprehensive tax reform and entered into force in 2019. The tax partially replaced an already existing fuel tax. The carbon tax applies to CO_2 emissions from all sectors and covers almost all liquid fuels and coal, in total, 20 percent of all the Argentinian greenhouse gas (GHG) emissions. The use of fossil fuels in certain sectors and/or for certain purposes is partially exempt from the carbon tax, including international aviation and international shipping, export of the fuels covered, the share of biofuels in mineral oils and raw materials in petro-chemical processes. To offset the fuel price increase by the carbon tax, the existing tax on liquid fossil fuels was adjusted. For mineral coal, petroleum, and fuel oil, the tax rate started in 2019 at 10 percent of the full tax rate, increasing annually by 10 percent to reach 100 percent in 2028.
- The Colombian carbon tax was adopted as part of a structural tax reform and was launched in 2017. The tax applies to GHG emissions from all sectors with some minor exemptions. It covers all liquid and gaseous fossil fuels used for combustion, accounting for 24 percent of all GHG emissions in Colombia. Tax exemptions apply to natural gas consumers that are not in the petrochemical and refinery sectors, and fossil fuel consumers that are certified to be carbon neutral.
- In Mexico, the carbon tax is an excise tax under the special tax on production and services. It is not a tax on the full carbon content of fuels, but on the additional CO_2 emission content compared to natural gas. 46 percent of all GHG emissions in Mexico are covered. The tax is capped at 3 percent of the fuel sales price. Since 2017, companies liable for paying the carbon tax may choose to pay with credits from Clean Development Mechanism (CDM) projects developed in Mexico, equivalent to the market value of the credits at the time of paying the tax.
- The South African carbon tax came into force in 2019 and applies to GHG emissions from the industry, power, buildings, and transport sectors irrespective of the fossil fuel used. 80 percent of the South African GHG emissions are covered. For many sectors, tax exemptions starting from 60 percent up to 95 percent will apply. The level of tax exemption depends on the presence of fugitive emissions, level of trade exposure, emission performance, offset use, and participation in the carbon budget program. Also, residential transport is exempt from the carbon tax. Companies may be eligible for either a 5 or 10 percent offset allowance to reduce their carbon tax liability.

Source: World Bank, 2021

367. The most popular measures to deal with adverse effects are tax-reducing measures, lowering the effective carbon tax via exemptions, thresholds, or reduced rates. Another set of policies include support measures to affected households, firms, or sectors: output-based rebates or targeted support for resource efficiency and cleaner consumption and production. Also, reductions of taxes other than carbon tax (such as labour or income taxes) can be included in this group of measures. A third category of policies consists of trade-related measures, such as border carbon adjustments, consumption-based taxation, and international cooperation.149

368. These measures can contribute to the implementation of a carbon tax by increasing its public acceptance. The political economy aspects of carbon taxation must be acknowledged and the question of how to gain public acceptance for a carbon tax is examined in Chapter 3. A carbon tax will undoubtedly raise tax revenues, but, at the same time, measures to counter or mitigate unwanted effects from the tax often require public funding. Considerations regarding how and to what extent carbon tax revenues can be used to finance various other policy measures is further discussed in Chapter 9.

148 More information about these, and other carbon tax schemes around the world can be found in World Bank, 2021.
149 Pigato, 2019; PMR, 2017.

4.1 Tax-reducing measures

369. Most jurisdictions that have implemented a carbon tax have chosen to lower the carbon tax rate for some fuels and/or sectors or exempt them altogether. Measures such as exemptions, thresholds, reduced rates, or tax payment refunds, can be implemented temporarily, phased out stepwise, or be part of a long-term policy design. These kinds of measures are straightforward to implement and can target specific sectors or groups. In addition, they are easy to communicate and popular with groups benefitting from the measure. See Box 21, for examples.

370. An immediate result of reduced carbon tax rates and exemptions is the loss of revenues, which can be rather substantial. Another disadvantage is the dampening of the price signal, and therefore the weakened incentive for decarbonisation. As the price signal differs across sectors, the adoption of abatement measures will be more costly in those sectors not benefitting from the reduced rates, and thereby the overall economic cost of reaching the jurisdiction's abatement targets is likely to increase. If sustained, such measures may also prove counterproductive, as sectors benefitting in the short-term face the risk of being less adapted to compete in a low-carbon economy in the long-term.

371. As it may be difficult for policymakers to determine the appropriate scope, level, and duration of the reduced rates, careful ex-ante analysis can provide valuable input to the decision process. Measures to reduce the carbon tax payment nevertheless risk being questioned by those excluded from the tax reductions which may, in turn, contribute to negative perceptions on the fairness of the tax. Excessive tax exemptions can also lead to domestic legal challenges. For instance, the first attempt of a carbon tax in France was rejected by the National Constitutional Council in 2009, since the body deemed that multiple tax exemptions and thus differences in treatment were not consistent with the legislator's intentions.

372. It is crucial for policymakers to consider alternatives to exemptions and to balance the negative effects with the need to protect certain sectors of special importance to the economy. If exemptions are part of the tax design, policymakers may want to attempt to minimize their environmental and economic costs. This can be achieved by making exemptions targeted and, if possible, timebound with regular reviews.

373. In some carbon taxing schemes, offset allowances enable liable entities to reduce their tax payments by investing in carbon mitigating activities outside the scope of the tax. This can also be viewed as broadening of the tax base. An example of this can be found in Colombia, and Chile has recently approved a law in this direction.

Box 21. What sectors to exempt – some examples

To address adverse effects of a carbon tax, it is important to analyse how and to what extent such effects are likely to occur. Each jurisdiction faces different circumstances that need to be considered.

A common distinction is to exempt installations in sectors included in an emission trading system (ETS), as consumption of fuels in such installations is already covered by another economic instrument aimed to incentivize less emissions of CO_2. This line of action has been chosen by, for example, Denmark, France, Ireland, and Portugal, regarding emissions covered by the European Union Emissions Trading System (EU ETS).

In other jurisdictions, fuels or sectors considered important to the economy have been exempted from the carbon tax. One example is Switzerland, where only fuels used for heating purposes (not propellants) are taxed. The UK Climate Change Levy (CCL), which can be considered as a climate tax although it is calculated on the energy content of fuels rather than the content of carbon, has chosen a somewhat different approach by only levying the CCL on business consumption, thus exempting households from the levy altogether.

4.2 *Support measures*

374. In addition to tax exemptions and rebates, various types of support measures can be used to reduce the financial burden of entities or households affected by the tax. Such measures can be targeted to specific sectors or have even broader coverage. For example, it might be possible to reduce other taxes, lower employer contributions to labour costs, or implement government grants or programmes to maintain the competitiveness of especially vulnerable sectors, such as public support for clean technology investments. Reallocating carbon tax revenues collected from a sector to the firms within the same sector based on their share of domestic production – so-called output-based rebates – is another way to protect firms while still providing incentives for emission reductions.[150]

375. The durability of measures may differ depending on their objective. There may be, for instance, a need to combine short-term relief and long-term incentives for firms to adapt by adopting cleaner and more efficient technologies. As support schemes are often easier to implement than to withdraw, policymakers may want to announce upfront for how long, or under what circumstances, a particular measure will be in force.[151]

376. Support measures can also target households with tax reductions or flat payments. In certain jurisdictions (for instance in Canada), revenues from the Federal Carbon Pollution Pricing System are redistributed to households and individuals through an income tax and benefit return.[152] The British Columbian Climate Action Tax Credit is another example of a support measure that seeks to offset the impact of the carbon taxes paid by low-income individuals and families. The amounts received depend on family size and adjusted family net income. Yet

150 Pigato, 2019.
151 Ibid.
152 Government of British Columbia, 2021.

another scheme for allocating carbon tax revenues to households can be found in Switzerland, where part of the revenue from the Swiss carbon tax is redistributed uniformly to all residents, through an annual discount in the compulsory health insurance premium.[153]

377. Other support schemes for households can involve direct or indirect subsidies to reduce emissions through, for example, support for improved energy efficiency in housing or subsidies for public transport.[154] These measures will contribute to incentivising households to shift towards less polluting consumption patterns and help them lower their carbon tax expenditures. At the same time, care should be taken to ensure that support is given where it is needed most. For example, subsidising high-end electric vehicles will likely benefit households in higher income groups, and may prove to be both cost-ineffective and counter-productive from a public acceptance perspective.

378. Support measures imply a cost. Yet, cost for targeted support to a certain group (e.g., low-income households or disproportionately affected workers, or communities such as coal-mining areas) may not necessarily be high in relation to the overall carbon tax revenue.[155] It is important that these measures are designed with care, preferably supported by ex-ante analysis of the need for, and effects of, possible support policies.

379. Jurisdictions may choose to implement a carbon tax as part of a wider tax reform. This may provide the opportunity to support affected households and firms through adjustments of existing taxes. For instance, the Swedish carbon tax was introduced in the early 1990s in a major reform including reductions of already existing taxes on energy, as well as taxes on labour, capital, and income. Subsequent changes (increases) to the Swedish carbon tax rate have also often taken place in the context of broader tax reforms, which have helped package the implementation of the new rates.[156] More recently, Chile, Argentina and Colombia have introduced carbon taxes in the context of broader tax reforms.

380. Introducing or increasing a carbon tax as a part of a general tax reform not only gives policymakers the chance to present the carbon tax in a wider context, but it also provides an opportunity to implement complementary measures to address distributional (income and/or geographical) concerns related to the impact of the carbon tax. Similarly, reductions in broad-based, non-carbon taxes can also be designed to benefit firms or specific sectors. Revenues from the carbon tax can of course also be used to address distributional concerns or reduce inefficiencies in

153 Swiss Federal Office for the Environment, 2021.
154 PMR, 2017.
155 Pigato, 2019.
156 Hammar et al, 2013.

other parts of the tax system, the latter possibly resulting in the so-called double dividend (society gaining from the carbon tax through both its impact on the climate as well as from the improved functioning of the tax system and the economy).

4.3 Trade-related measures

381. Trade-related measures that address carbon leakage and competitiveness concerns arising from carbon taxation are rare in practice. In the EU ETS, the risk of carbon leakage has been addressed by allocating free emission permits to installations in the most exposed sectors.[157] A measure that has been discussed as a tool specifically for addressing the risks of carbon leakage is a Carbon Border Adjustment Mechanisms (CBAM). A CBAM aims to put domestic firms facing a carbon price on an even footing with importers that operate under a lower or no carbon price, and can serve as an alternative to other measures in force to prevent the risk of carbon leakage, such as the allocation of allowances free of charge under an ETS. Charging a levy on imports corresponding to the difference in carbon price between the jurisdictions would be an example of such measure.

382. If and how a CBAM can be used in practice as a tool against carbon leakage is still an open question. At present, no country has implemented this measure; administrative burden, technical feasibility, the availability of data, the risk of retaliation from other countries, and perhaps most importantly, the compatibility with the World Trade Organization (WTO) rules, are a few of the challenges often mentioned in relation to CBAM.[158] Nevertheless, in 2019, the instrument has gained renewed attention as the European Commission announced that it would draft a proposal for a CBAM covering the import of certain products to the EU to reduce the risk of carbon leakage.[159] The proposal was presented and adopted in July 2021.[160]

383. The EU CBAM will apply from 2023, starting with a transitional phase until 2026, which will only include reporting of embedded emissions in imported goods (without paying a financial adjustment). From 2026, financial obligations, consisting of surrendering CBAM certificates covering the embedded emissions, will come into force.

384. Another possible mechanism is consumption-based taxation (CBT). This means that a carbon tax is levied on domestic consumers, and products are taxed on their carbon-intensity regardless of where they are produced. While common in tobacco and alcohol taxation, CBT applied to climate concerns has yet to be

157 C (2019) 930 final.
158 For an overview of the economic and legal challenges see e.g., Cosbey et al., 2019.
159 Communication of the European Green Deal, EU Commission Document presented on 11 December 2019, see https://ec.europa.eu/info/publications/communication-european-green-deal_en.
160 For more information, please visit https://ec.europa.eu/taxation_customs/green-taxation-0/carbon-border-adjustment-mechanism_en.

introduced. As with CBAM, there are many uncertainties surrounding the practical feasibility of consumption-based carbon taxation.

385. Climate change is a global challenge that requires international cooperation. A global price on carbon is the most cost-effective policy instrument to reduce carbon emissions in line with the Paris Agreement.[161] Although there is no experience with global carbon prices, there is experience with coordination across international ETS programmes such as the Western Climate Initiative, and the EU ETS. However, as there is no experience in the case of carbon taxes, bilateral or multilateral agreements would be necessary to move forward. These could take the form of common minimum carbon tax levels agreed upon between jurisdictions, such as the Federal Carbon Pollution Pricing System in Canada, or within a larger group of trade partners.

386. A summary of the three main categories of policy instruments that can be used to address unwanted adverse effects of carbon taxes can be found in Table 5 below.

161 World Bank, 2017.

Table 5. Overview of measures to address unwanted adverse effects of carbon taxes

Tax-reducing measures

Measure	Advantages	Drawbacks
Exemptions	• Target and effectively protect vulnerable industries (at least in the short term). • Relatively simple to implement (but only for downstream tax). • Popular with industry groups; easy to communicate.	• Undermine tax price signals and environmental effectiveness. • Difficult to determine appropriate level and extent ex-ante. • Risk of rent-seeking and challenge from/ extension to nonexempted industries. • Increase abatement costs for other sectors. • Costly option in terms of tax revenue. • Risk of long-term competitiveness loss.
Reduced rates		
Tax payment refund		
Offsets	• Incentive for emission reductions in uncovered sectors. • Incentive for private investment in emission reductions.	• Undermine price signals for the taxed industry. • Administratively complex to ensure environmental effectiveness. • Reduced tax revenues. • Effectiveness at improving competitiveness depends on offset prices.

Support measures

Measure	Advantages	Drawbacks
Support for resource efficiency and cleaner production	• Retain price signal and additional abatement incentives. • Promote green innovation. • Popular with industry groups. • Possibility to leverage commercial finance. • Flexible in design.	• Scope for gains varies depending on country, sector, firm type, etc. • May not provide immediate or full relief to industries. • Depending on scheme, widely varying cost and can be difficult to scale up at industry level.
Output-based rebates	• Retain tax price signals and abatement incentives for producers. • Strong leakage protection. • Divides industry opposition: Up to half of industry enjoys net gain (if sufficient revenue is used to finance rebates).	• High cost to public budget (although less than exemptions). • Reduce incentives for producers to adopt cleaner inputs and for consumers to shift to cleaner products relative to CBAM and CBT (but better than exemp tions).
Flat payments	• Retain price signal. • Simple for citizens to claim. • Popular with the public. • Potential for net positive social and economic benefits.	• Cost to public budget.
Reducing broad-based (non-carbon) taxes	• Reduce distortions from the tax system, for example, by reducing corporate income taxes or electricity taxes • Potential "double dividend" (creating net gains to output/welfare/ employment)	• Tax revenue reduced by using environmental tax to finance reductions in other taxes • Benefitting the economy rather than individual sectors with industry-specific competitiveness problems

Trade-related measures		
Measure	**Advantages**	**Drawbacks**
Carbon border adjustment mechanisms (CBAM)	• Effectively prevent competitiveness losses and leakage, while maintaining tax price signal. • Prevent free riding by non-taxing jurisdictions. • Do not put pressure on public budgets.	• Administratively challenging. • Uncertainty regarding WTO compatibility (though well-designed measures could likely be defended) • Risk retaliations by partners and damaging trade/climate negotiations. • Limited experience to date.
Consumption-based taxation (CBT)	• Effectively address competitiveness and leakage risks. • Extend pricing to non-domestic emissions. • Lower legal/political risks than CBAM.	• Limited experience to date with application to climate (although standard for taxation of other “bads” like tobacco and alcohol). • Administratively complex for design options with best environmental effectiveness.
International cooperation	• Retain price signal and protect against leakage. • Leverage domestic tax to encourage equivalent effort in partner jurisdictions. • No administrative cost or legal risk.	• Not controlled by domestic policymakers only. • Difficult to negotiate across many countries and in sectors with many competitors. • Only regional examples to date, no global ones.

Source: Adapted from Pigato, 2019. and PMR, 2017.

Checklist 9. Compensatory measures

1. Tax exemptions
   (i) Consider thresholds
   (ii) Reduced rates for sectors or groups

2. Support Measures
   (i) Lower other taxes
   (ii) Support for technology investments for firms
   (iii) Tax rebate or income support for households
   (iv) Support for energy efficiency investments

3. Trade-related Measures
   (i) Carbon border adjustment mechanisms
   (ii) Consumption-based taxation

5. Administrative simplicity, environmental integrity, and fairness

387. Fear of adverse impacts from a carbon tax may justify measures that seek to avoid or alleviate these negative effects. At the same time, these measures often come with unwanted side effects of their own.

388. Although concerns over firm competitiveness and distributional effects must be addressed when they arise, the indiscriminate exemptions and tax reductions can lead to increased complexity and inefficiency in the administration and collection of the tax. Countries without experience in excise duties on energy may, therefore, want to strive to grant the least exemptions/price differentiations possible to avoid complexity and thereby reduce implementation costs. A key to a simple administrative system is to consult widely with the different actors within society, and get their input prior to introducing the tax, to avoid a web of exemptions.

389. Carbon taxes aim to equalize private costs and social costs. Exemptions undermine this aim, thereby limiting the efficiency and effectiveness of the tax. If emissions are taxed at different rates or exempt, policymakers should be aware of unintended, environmentally harmful responses which could in some cases defeat the initial purpose of the tax and increase the country's carbon footprint.

390. Nevertheless, governments may need to resort to tax exemptions and rebates to gain public acceptance, particularly while discussing the introduction and implementation of the tax. As carbon taxes become more popular and widely

used, calls for tax fairness and equity also gain traction.[162] In fact, the notion of fairness is strongly associated with use of revenues (see Chapter 9).

391. Stakeholders tend to support carbon taxation when revenues are used in projects that are high in the public agenda, are returned to the public according to the ability to pay through targeted exemptions, rebates, or corresponding reduction of other taxes, or are employed towards projects that will derive a positive environmental result and are consistent with the sustainable development goals.[163] What is considered high on the agenda depends on the jurisdictions' level of understanding of climate change, civic engagement, level of inequality, and economic development (See Chapter 3). Therefore, these issues are tailored depending on the country context. The question of how to gain public acceptance for a carbon tax was discussed in detail in Chapter 3.

6. Examples of carbon tax introduction: Two-level tax systems and thresholds

392. To date, over 30 national or subnational jurisdictions have implemented a carbon tax, all with different measures to protect competitiveness and address distributional risks. A two-level tax system and/or the adoption of thresholds are examples of exemptions that can be found in some of these jurisdictions.

393. In a *two-level carbon tax system*, different carbon tax rates apply to different parts of the economy; this system is easier to administer than lowering the tax rates for individual sectors and companies. A two-level tax system may be a feasible design, possibly leading to better environmental results overall, as the politically acceptable alternative could be a general carbon tax for all operators, set at a much lower level to protect the domestic industry subject to international competition.

394. A *threshold* is a minimum level of activity (or emissions, or technologies) that will trigger tax liability or responsibility for paying the tax. The purpose of a threshold is often to reduce the costs of reporting and administration.

395. To examine the need of a threshold, several characteristics can be analysed. One is the proportion of emissions derived from small emitters. If there are many small sources of emissions in sectors covered by the carbon tax, a relatively low threshold may be needed to ensure that a significant proportion of emissions is covered by the tax. The cost of reporting in relation to the tax amount, the capabilities among firms to administer a carbon tax, and the risk for intersectoral leakage are other important aspects to consider. A threshold could also result in

162 Falcão and Cottrell, 2018.
163 Baranzini, Caliskan and Carattini, 2014.

small firms deciding not to grow, to avoid the tax and counteract the establishment of large-scale operators.

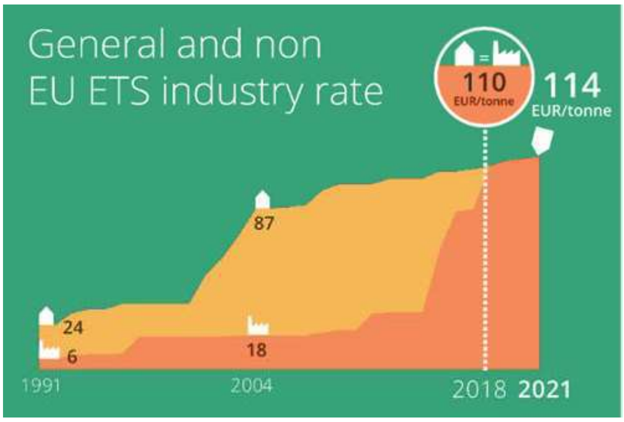
396. In the case of carbon taxes, thresholds applied directly to emissions are common.[164] By contrast, jurisdictions that apply their carbon tax to fuels at the level of distribution, typically do not apply thresholds. Applying a tax to fuels normally does not require direct measurement of emissions, and is often built upon existing excise taxes, thereby making thresholds unnecessary. Applying thresholds in these cases could also create market distortions by encouraging consumers to purchase from smaller wholesalers.

397. An example of thresholds is the later abolished Australian Carbon Pricing Scheme, where emissions were taxed when they were released into the atmosphere. The threshold was set to 25,000 tCO_2e in order to not burden smaller facilities with reporting obligations. Another example is Chile, where the carbon tax was initially only applied to emissions from boilers and turbines in facilities of a certain capacity (above 50 MW). Such a technical condition is easily observable, whereas an emissions threshold requires that reporting be already in place.

Box 22. Country example of a two-level carbon tax

When designing the Swedish carbon taxation system, to avoid negative effects on domestic industry and carbon leakage, two carbon tax levels were introduced. The lower carbon tax level was applied to fuels used for heating purposes by the industry. The lower tax level has, since the introduction of the tax in 1991, been phased out in Sweden and was fully abolished in 2018. Such a lower tax level has been the prerequisite for a high tax level for other sectors, and one important cause of the emission reductions achieved in the high taxed sectors.[165]

Figure 10. Development of the Swedish Carbon Tax.



Note: General level and industry level. Industry level outside the EU ETS since 2008.

Source: Government Offices of Sweden

164 Most jurisdiction establish a 25,000 tonne CO_2 annual emission threshold for tax liability.
165 Hammar and Åkerfeldt, 2011.