United Nations Handbook
on carbon taxation for developing countries

Chapter 3: Designing a Carbon Tax

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Chapter 3A: Basic elements in designing a carbon tax

1. Motives for introducing carbon dioxide taxation, commonly referred to as a carbon tax, have been discussed in chapter 2. Once a decision has been made to consider such a tax, the policymaker is faced with a number of choices. In this chapter we will primarily deal with issues regarding the taxing power and tax base, while tax rates and ways to address undesired distributional effects for households and firms will be addressed in chapter 3 B and 3 C. As the choice of taxpayer and time of tax payment also are aspects of importance when designing the tax, these aspects are given some attention in this chapter although administrative issues primarily are handled in chapter 4.
2. To sum up, key aspects for policymakers to consider for the basic design of a carbon tax are listed in a short check list in the following section. These aspects will all be further elaborated in the following.

1. Check list for basic design of a carbon tax

3. Important choices when designing a carbon tax, which will be highlighted in this chapter are summarized below.

- Consider **possible taxing power boundaries** – national or subnational tax? Cooperation essential among different national ministries and other relevant public bodies.
- **Scope of the tax** – the decision of whether to measure and tax direct emissions or use a method of taxing fuels using average carbon content of fuels for tax rate calculation.
- **When is the tax to be paid** – at which point in the distributional chain, or point of regulation, of fuels or occurrence of emissions are legal entities to be made responsible for paying the tax?
- **Taxpayer** – connected to the point of regulation is the matter of which legal entity who will be responsible for paying the tax to the authorities.
- **Sectors, activities and kind of fuels to be covered by the tax** – the discussion of different approaches and their consequences (see also chapter 3C on Addressing undesired effects for households and industry).

4. After deciding on the approach based on the issues singled out above, a potential tax base can be defined. It is strongly recommended to thoroughly analyse the size and characteristics of the tax base prior to the tax implementation, to ensure the achievement of the desired effects.

2. Indirect taxation vs direct taxation

Box 1: Special characteristics of an indirect tax compared to a direct tax

Direct taxes are normally paid directly by an individual or business relating to, for example ownership of real estate, or income gained by the individual or business. An indirect tax is levied on particular goods or services and is normally collected by a producer or retailer, not the final consumer. The cost of an indirect tax is in most cases passed on to the consumer as part of the purchase price of the goods or services.

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

Table 1: Direct vs Indirect taxes

5. Before discussing the actual design choices that faces the policymaker, it is necessary to identify some on the differences between indirect taxes and direct taxes, in order to set the scene for our continued discussions.

6. Taxes are generally divided into direct taxes and indirect taxes. Direct taxes are imposed on a person or property and are normally paid directly by that person or property owner to a local or national tax authority. Examples are 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). However, the basic concept of an indirect tax means that the producer or seller who pays the levy to the tax authority is passing the cost of the tax on to the consumer as part of the purchase price of the goods or services. This is normally the case in most situations when goods or services are provided for payment. There are basically two kinds of indirect taxes, sales taxes or value added taxes and excise taxes on specific goods or services which are typically imposed in addition to a sales tax or value added tax.

7. 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 in some jurisdictions labelled an excise duty). An excise tax is typically[1] a per unit tax, costing a specific amount for a volume or unit of the item, whereas a sales tax or value added tax is an ad valorem tax and proportional to the price of the goods. Another difference

[1] There are although 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.

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 applicable to all sales occurring in a jurisdiction.

8. Compared with a direct taxation system, there are some issues that warrant special consideration when assessing how a carbon tax system may be set up in a country with little or no experience in levying excise taxes. Aspects relating to when in the supply chain a carbon tax can be levied and who faces the cost of the tax are of special interest and will be further discussed below.

3. Who faces the cost of a carbon tax?

Box 2: Difference between who pays a carbon tax and who bears the cost of such a tax

In carbon tax legislation rules are laid down as to which legal entity will be responsible for paying the tax to the Government (taxpayer). A carbon tax is aimed at giving consumers an incentive to change their behaviour and consume less amounts of fossil fuels. Whether this effect is achieved depends on whether the taxpayer can pass the cost of the carbon tax on to the consumers or not.

9. There is a difference between who is targeted by the tax and legally responsible for paying it, and who in the end bears the burden of the tax. In economics, 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 for a product, which typically imposes an economic burden on both producers and consumers. Tax incidence is said to "fall" upon those who ultimately bear the burden of the tax. The key concept is that the tax incidence or tax burden does not depend on where the revenue is collected (so called statutory incidence), but on the relative own-price elasticities of demand and supply which, in turn, determines the extent to which the taxpayer can pass the cost of the tax on to the consumers

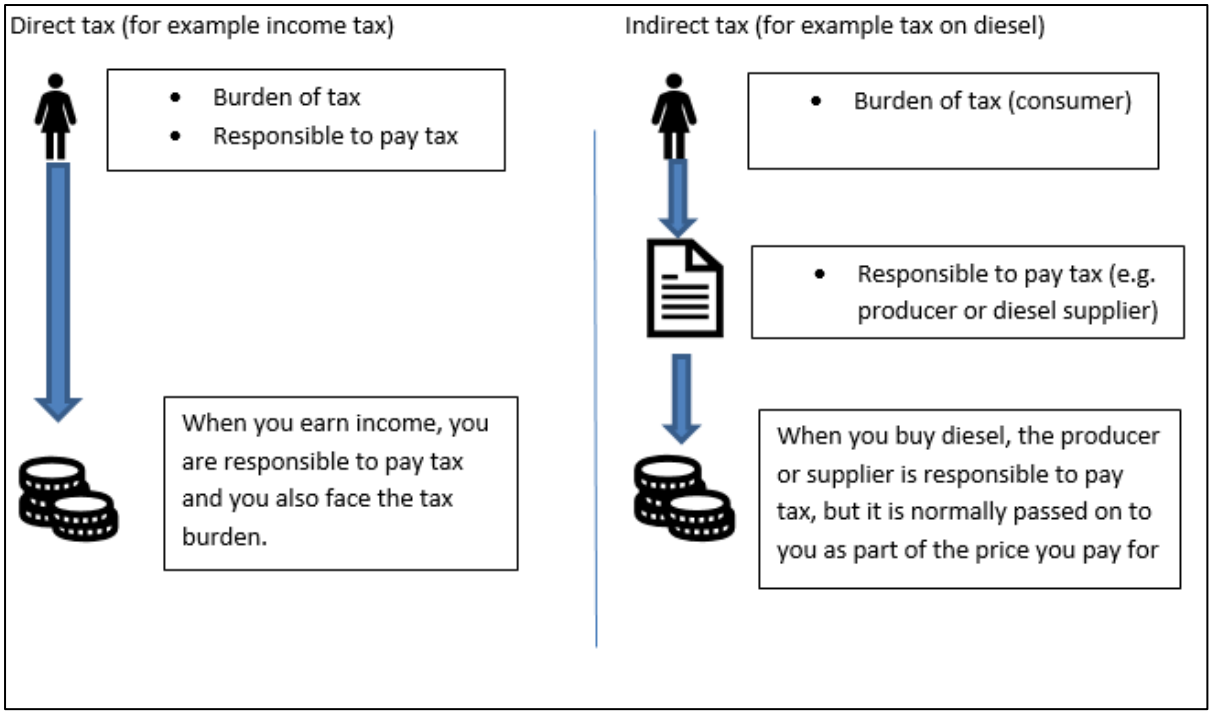

Figure 1: Direct vs indirect tax – who pays the tax and who faces the tax burden

10. In the case of a carbon tax, the tax incidence depends on whether the entities obliged to pay the carbon tax to the authorities (taxpayers) can pass it on to the consumers or not. If the entities can raise the product price to compensate for the full amount of the tax, the whole tax incidence falls on the fuel consumers. In this discussion, 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 product price is not raised, the producer will bear the full incidence of the tax. The consumption will remain unaffected and the emissions of carbon dioxide will not be reduced.

11. There are several important issues to consider in this discussion. For instance, if a governmental price regulation exists, it may not be possible to increase the price and pass on the burden of the tax. In this case the tax burden falls on the taxpayer entities, reducing their profits. A carbon tax under these circumstances will not reduce emissions in the short term, but solely work as a revenue raiser. However, most entities act in markets where they will have possibilities to pass on at least part of the increased cost of the tax to consumers. That means, in most scenarios the incidence of the carbon tax will be split 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 an international competition. In these cases, it might be plausible to discuss the need for 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 3C.

4. Taxing power

4.1. Consider taxing power boundaries early in policy design

12. The statutory power to levy taxes, or in other words the authority to levy taxes, varies between jurisdictions. The same goes for the definition of how this power is to be exercised. These rules can take the form of constitutional requirements, general public law requirements, supra-national principles or arrangements. When designing a carbon tax, it is important to understand the boundaries of these rules. These boundaries may influence certain design choices as well as identify potential gaps in regulation. Some countries, such as for example Indonesia, has adopted a fiscal decentralisation policy, giving provincial and local governments the authority to levy certain taxes and also decide on the use of the revenues from such taxes.

13. In addition, considering the taxing power early in the process of evaluating design choices will help provide a clearer view on who should be involved in the design and the implementation of a carbon tax and what resources the carbon tax policy makers can have at their disposal to effectively implement and apply a carbon tax.

14. Besides constitutional and regulatory requirements that may influence whether a carbon tax is introduced at municipal, state/province or federal level, the potential impact on cross jurisdictional value chains should also be considered. The lower the subnational level of introduction, the higher the complexity and the potential for double or multiple taxation for producers, retailers and customers. The level of introduction will also influence the need for adjustments to the system to deal with potential impacts on carbon leakage and competitiveness.

4.2. The institutional framework in general for setting and collecting taxes

15. The purpose of taxation has traditionally been to raise funds to meet the expenditure plans of the government. Thus, an institutional framework is in most countries already in place, determining the taxing power for taxes with that objective. Often, taxes are designed by national Ministries of Finance and the tax collection is carried out by Tax Agencies or Customs Authorities. A mandate and governance structure for setting and collecting regular taxes tends to be in place.

4.3. Will the same institutional rules and framework apply for a carbon tax?

16. As has been discussed in the previous section, a carbon tax has some distinct features that makes it different from other kinds of taxes. This relates in particular to the fact that 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 will incentivise the reduction of carbon emissions.

17. Other parts of government may have an interest in setting carbon reduction policies, which will have an impact on the features and effects of the carbon pricing policy and

in certain cases in how the tax is collected[2] as well. Given the policies and potentially different objectives of various government Ministries, coordination among various parts of government is beneficial when considering and introducing a carbon tax. Understanding the goals and actions that other Ministries are setting to deal with reduction of carbon dioxide emissions, climate change and energy transition, will increase the pool of expertise on the subject as well as the opportunities for alignment and coordinated buy in.

18. When designing a carbon tax based on a Direct Emissions Approach (see further discussions later in this chapter) the technical expertise of environmental and energy related matters may be crucial for the effective design and administration of such a tax and this expertise is usually found outside the national Ministries of Finance and authorities normally already assigned to the collection of taxes in general. Cooperation between relevant government Ministries and bodies is thus an essential part of the evaluation process leading up to implementing a carbon tax.

19. On the other hand, as will also be highlighted in subsequent discussions in this chapter, a carbon tax may also be designed in a way that makes use of already existing excise tax administration systems (the Fuel Approach, see further below). The need for cooperation between different Governmental bodies could in this case relate more to the overall design of carbon reduction policy strategies, while the administration of the carbon tax will be handled by regular tax collection authorities in a way that do not differ much from that of other taxes.

4.4. Are there particular rules in the constitution regarding taxing power?

20. National constitutions or similar documents often allocate taxing power and how taxing power needs to be exercised. The constitutional requirements to introduce taxing powers or legislate tax rules may be more stringent than the constitutional requirements and checks to legislation in general. This means that policymakers may need to consider constitutional requirements and the confines of the fiscal system in general, as it may influence the choice to introduce a carbon tax as well as its design.

21. One example of a jurisdiction that has more stringent constitutional requirements for taxes is the US State of California. 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 auction system did not impose a “tax” that should have been approved by a supermajority requirement.

22. Carbon tax proposals can generally be adjusted in design to accommodate such restrictions but understanding constitutional requirements and boundaries upfront improves the effectiveness of introduction.

[2] 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.

23. Some jurisdictions ensure that the constitutionality of a tax law proposal is reviewed by an independent legal body before being put in force. This is for example the case in France, where an 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, trucking and agriculture, which would have made the tax unequal and inefficient. The carbon tax which was finally introduced in France in 2014 had addressed those concerns by broadening the scope of the tax and thus tightening certain loopholes in the prior proposal.

24. While many jurisdictions do not earmark tax revenues for specific purposes, it is common for jurisdictions to indicate in advance how revenues from environmental taxes, such as a carbon tax, will be used and to what extent these revenues will be spent to increase environmental protection. Earmarking of all or a portion of the tax revenues can be a tool for a Government to gain popular support for the introduction of a carbon tax, as it may ring-fence funds for specific environmental causes. This will be further discussed in chapter on *Revenue Use [yet to be written]*. Some constitutional rules even prohibit this kind of informal earmarking, e.g. by defining in a limited way the specific taxes that can be introduced 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.

25. However, even if policy makers need to address specific constitutional issues in their national jurisdictions, it is rare to find situations where constitutional requirements would significantly hinder the very introduction of a carbon tax[3].

4.5. Special considerations for jurisdictions with subnational levels

26. In case a state 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 types of taxes.

27. For a carbon tax, the constitutional mandate for regulating environmental issues should be considered as well as the mandate for taxation in general as these mandates may be

[3] In case exceptional constitutional limitations exist for taxing power, they are often not applicable to other instruments. This means that other instruments could be considered that price or regulate carbon dioxide emissions. E.g. the European Union initially explored the possibility to introduce 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 cover also a mandatory carbon tax, as a complement to the EU ETS for sectors which are not covered by the EU ETS. This far it has, however, not proved possible to reach unanimous agreement on such a tax system. 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.

differently allocated. Ensuring the support of the various levels of a state upfront may be an alternative to having to change the constitution to align.

28. In Canada, provinces and territories are required, by 2019, to have a carbon pricing instrument of some sort that meets a level of stringency determined by the federal government. In the case of provinces and territories that do not have a sufficiently stringent system, or at their request, a federal backstop applies. The federal system is composed of a regulatory charge on fossil fuels (called the fuel charge) and an output-based pricing system for large industrial facilities and applies either fully or partially depending on the circumstances in a given province or territory. Some provinces have instituted legal proceedings challenging the constitutionality of the federal backstop legislation on the ground that it exceeds federal jurisdiction.

29. Even if there is no conflict between various subnational entities on mandate, it is very helpful to stipulate which taxes take precedence. A subnational entity may be inclined to introduce a carbon tax before action is agreed at national level. For example, currently, in the USA, it is very challenging to introduce a federal carbon tax. However, individual US states may consider state carbon taxes and some proposals have been up for discussion over the past years.

30. Including clarity on the interaction between a tax at various 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 creditable 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.

31. In Spain, Autonomous Communities have the constitutional power to create 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 carbon dioxide emissions, thermonuclear electricity production, electricity, waste, etc.). The situation has given rise to compliance costs on firms operating or with facilities subject to taxation in more than one Autonomous Community, in some instances it has led to Constitutional Court cases as well.

32. Besides ensuring clarity on how the various taxes interact, e.g. whether they can be credited one against the other, concerns of double taxation could also be dealt with by considering taxation at a higher national or even supra national level. For example, the mandate for introducing a carbon tax could be exercised at national or even supra national level to outline the framework and main design features for a carbon tax rather than introducing different taxes at a lower level. As mentioned earlier, the EU Commission proposed a carbon tax framework to be introduced in EU Member States. Such a mandatory EU wide framework has, however, not yet been decided within the EU.

33. In general, it is important to consider at what level the taxing power would be most appropriate. As climate issues are global, introducing an explicit pricing mechanism on

carbon dioxide emissions, like a carbon tax, is economically most efficient and effective when introduced as broadly as possible. Certain aspects are easier to retrofit and adjust once the tax is in place whilst others are considerably more problematic to adjust once the tax is implemented. Canada, for example, has introduced a federal system for carbon taxation where a minimum price of carbon is set. However, it did not require other design features to be aligned, such as what exactly is the scope and how should the definition of carbon be determined. The latter aspects are as crucial for achieving good environmental results.

5. Scope of the carbon tax and defining the tax base[4]

5.1. What are we going to tax?

34. The simple answer, to the question of what we are going to tax, is carbon. Carbon is the primary element that may give rise to the release of carbon dioxide, if submitted to a combustion process. If kept in the nature, carbon will not on its own lead to emissions of greenhouse gases (GHG). Carbon dioxide amounts to roughly 80 percent of the total greenhouse gas emissions emitted globally and already this fact speaks highly in favour of starting out by focusing taxation on these greenhouse gas emissions. In this handbook, we will thus focus our discussion on the use of carbon within the context of its conversion into carbon dioxide when being combusted as a fuel.

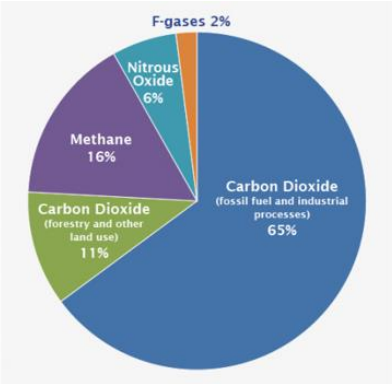

Figure 2: Global Greenhouse Gas Emissions by Gas

35. Carbon dioxide enters the atmosphere mainly through burning of fossil fuels (such as coal, natural gas, and oil), solid waste, trees and wood products. Carbon dioxide is removed from the atmosphere when it is absorbed by plants or in ocean waters as part of the biological carbon cycle or artificially in a framework of carbon capture and storage. Taking these facts into account, there are two basic approaches when considering what to tax. One is focusing on a tax by volume or weight units of the fuels

[4] Unless otherwise stated, the source for facts on the Chilean carbon tax is Rodrigo Pizzaro, 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).

giving rise to emissions when combusted ("the Fuel Approach"), where the tax rate is based on standardized amounts of carbon content in those fuels. The other includes measuring the emissions directly as they occur from the burning of such fuels ("the Direct Emissions Approach"). There are pros and cons with both approaches and the design choice depends on the national prerequisites in a specific jurisdiction and both can in principle result in well-designed carbon taxes. A discussion will follow below, where also examples will be given from tax systems currently in force in different jurisdictions[5].

36. Many jurisdictions across the globe – such as for example most countries in the European Union, 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 carbon dioxide from the propulsion of the vehicle. However, these kinds of taxes are not within the scope of this handbook.

37. While carbon dioxide by far accounts for the vast part of greenhouse gases emitted from combustion of fuels and thus merits the focus of this handbook, also smaller amounts of nitrous oxide and methane are emitted during the combustion, depending on the type of fuel and method of combustion[6]. Emissions of other greenhouse gases than carbon dioxide can be converted into carbon dioxide equivalents (CO_2e) to enable a comparison between the emissions and some jurisdictions using the Direct Emissions Approach in their carbon tax design are applying this method to also include other greenhouse gases in their tax scheme.

38. There are also examples of jurisdictions, which have introduced taxation of fluorinated greenhouse gases, so-called f-gases, the most common ones being hydrofluorocarbons (HFC) and perfluorocarbons (PFC)[7]. 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.

39. Another aspect of carbon tax coverage is what sectors the tax will cover, or in other words what are the sectors, subsectors or certain economic activities to be targeted. This is a broader question than what types of fuel or emissions from what kind of

[5] 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 which prices 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 very complex to administer and will not be covered in this handbook. See for further reading: https://static1.squarespace.com/static/54ff9c5ce4b0a53decccfb4c/t/5ad8d232758d46c25386e589/1524159026153/27916-CPLC-ExecBrief-CarbonPricing-v7.pdf.

[6] There are seven greenhouse gases covered by the United Nation's Framework Convention on Climate Change (UNFCC), including apart from carbon dioxide six others, namely methane, nitrous oxide, hydrofluorocarbons, perfluorocarbons, sulphur hexafluoride and nitrogen trifluoride.

[7] 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 national level.

installations to be covered. In jurisdictions without any carbon pricing system in place, a broader carbon tax will typically provide more opportunities and thus more efficient emission reductions. Circumstances will differ between jurisdictions and the most suitable coverage of the carbon tax will depend on a range of factors, including, for example, the emissions profile of the jurisdiction; other relevant tax policies; the structure of key sectors; and government capacities for administering the tax. To attain emission reductions, it is important to analyse what reductions are possible to achieve in the targeted sectors, and to what costs. As a result, governments can also see a need to address potential adverse impacts (on e.g. firm competitiveness and distributional effects) from the tax. This is further discussed in chapter 3C.

5.2. The Fuel Approach

5.2.1. Basic concept

40. Currently the predominant method of carbon taxation in jurisdictions worldwide is to levy a carbon tax on specific fossil fuels, primarily oil, gas and coal, and their derivative products. The tax would, in principle, be levied at a point close to the extraction of the fuel (in a mine or crude oil extraction site) or at importation into the jurisdiction. However, most tax schemes to some extent allow the tax due upon extraction or importation to be suspended during part of the distributional chain, if the fuels are handled by approved bodies. This means that the tax in these cases is levied when the fuels are leaving such an established tax suspension arrangement. An example of a tax suspension arrangement is the one applicable for excise taxes (including carbon taxes) within the EU. Member States have a certain 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 below. The time when a tax will be due to be collected is briefly discussed later in this chapter, but administrative issues will be discussed in more detail in chapter 4.

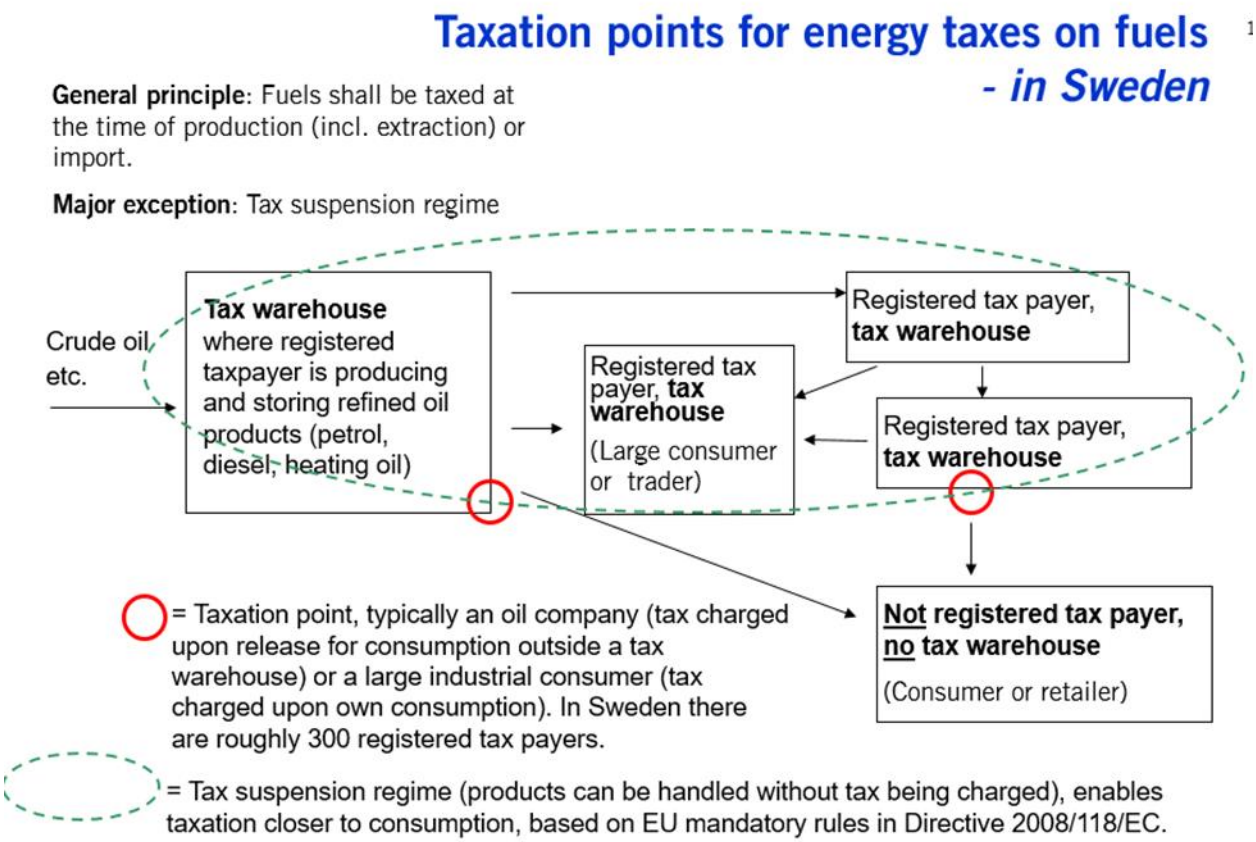

Figure 3: Example Taxation points for the carbon tax in Sweden

41. In the case of fuel combustion there is a close relation between carbon content and carbon dioxide emissions. Therefore, when drafting the law, pre-calculated general tax rates can be used. These tax rates are based on the average fossil carbon content of the fuels, not on the actual emissions occurring from the consumption nor considering any emissions occurring during the production of the fuel. Calculations made by Government officials, based on the average carbon content of the fuels, will determine the tax rates laid down in the tax legislation. No measurements of actual emissions are 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 coal) based on calculations of the average carbon content of the relevant fuel. Volume or weight units are standard trade units and such an approach makes it easier for tax administration, as such tax rates are easy to apply for operators as well as for the authorities. The calculation of the tax rates will be further outlined in more detail below. This is something that would be done by the responsible Ministry or other body drafting the relevant carbon tax legislation and is not something to be left to the bodies given the task to administer the tax and transfer the collected tax amounts to the relevant Government authority.

42. The table below shows examples of emission factors and heating values for a few common types of fuels from the IPCC Emission Factor Database and the IEA Energy Statistics Manual. The carbon content and the emission factor, as well as the heating values, vary for all fuels depending on the composition of the fuel. Hence, specific

values should be used where available to reflect national or facility-specific circumstances. Also see box 4 below.

Table 2: 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): https://www.iea.org/publications/freepublications/publication/statistics_manual.pdf
*** Emission factor multiplied by heating value

43. For any given specific fuel type, when completely combusted in dry air the relation between the carbon content and carbon dioxide emissions is exact. Most jurisdictions, for administrative reasons, have chosen to group similar fuels in fuel categories with the same tax rate per litre. This is for example normally the case with diesel fuels of different qualities, which the IPCC emission factor for that fuel in the table above indicates. While this means that a certain approximation is done, the relation to carbon content is still deemed sufficiently close for the carbon tax to be effective and provide an incentive to reduce carbon dioxide emissions.

44. It may be noted that fuel qualities may change over time due to technical developments, the Swedish example is a case in point. 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 major simplification that lowered administrative

costs for business and tax authorities[8]. However, recently Sweden updated the emission factor used for diesel to better reflect diesel qualities common on the Swedish market of today[9]. As coal is not a fuel commonly used for taxable purposes in Sweden, since 1991 an average emission factor for different coal types (such as hard coal, lignite and coke) has been used to lay down a single tax rates for all coal types. A country with a major coal consumption may very well chose to use specific emission factors for each coal fuel type to achieve a balanced tax rate based on the specific emission factor of a particular type of coal. The important thing to consider, however, is that the carbon content of each single consignment of a fuel is never measured for carbon content but rather relies on pre-calculations based on average emissions. And as discussed above, such a design will still create a sufficiently effective carbon tax.

45. In general, jurisdictions are taxing the fuels only when they are used as motor fuels or for heating purposes, 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 such does not prevent taxing the fuel products when used for such purposes.

[Possible to add a picture of fossil fuels, such as oil, natural gas and coal]

5.2.2. Coverage of fuels by the Fuel Approach

Box 3: Examples of fuels subject to a Fuel Approach carbon tax in different jurisdictions

Seven states in the European Union have introduced national carbon taxes covering all motor fuels, coal and the bulk of commercially available liquid and gaseous fuels used for heating purposes. In those jurisdictions, the carbon tax has been added to an already existing general excise duty scheme, either as part of the general excise duty or as a separate tax.

For various reasons, countries may choose to only tax certain fuels. Iceland only taxes petrol, diesel and heating gas oil. India and the Philippines only tax coal, while Mexico taxes coal and petroleum products (not natural gas) and Costa Rica levies tax on all fossil hydrocarbons. On the other hand, natural gas as motor fuel and coal are exempted from the carbon tax coverage in Colombia. The carbon tax in Argentina covers all major fossil fuels used in motor fuels or for heating purposes with the exemption of natural gas and liquified petroleum gas used for heating purposes.

[8] 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.

[9] 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.

46. Basing carbon taxation on fuels has the administrative advantage of allowing a policymaker to make use of a general system of fuel taxation. Such systems already exist in some form in many jurisdictions. The naming of this instrument may vary across jurisdictions – tax, excise duty, levy being the most common names.

47. For the Member States of the European Union, there is a harmonized tax framework for taxation of fuels[10],which the EU Member States need to follow in their national tax implementation. This framework does not oblige the Member States to levy a carbon tax, but if a Member State decides to introduce such as tax it is considered a duty covered by the harmonized EU tax framework[11]. This means that the seven EU Member States which have chosen to introduce a specific carbon tax are 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.

48. 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 [12]). In some cases, the introduction of a carbon tax was combined with a reduction in the pre-existing excise tax covering the same fuels. 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 steers towards a low-carbon energy mix. This means that a carbon tax in this respect tends to outperform an excise tax where the tax rates are laid down without no specific logic and rather based solely on political deliberations.

49. The same way of introducing a carbon tax can be used in non-EU jurisdictions, as taxing energy has become a common source of revenue raising across the world. There are different approaches of how to treat the interaction between these two different taxes. Sweden, for instance, has over the years chosen to significantly increase its carbon tax share of the total tax on energy products. Most other EU countries have, however, added a smaller – but in most cases increasing – carbon tax on top of their already existing taxation of energy products. The same goes for Lichtenstein, Norway and Switzerland, which are European countries outside the EU. The carbon taxes in Lichtenstein and Switzerland are, however, not levied on road fuels, which are only subject to an excise duty not specifically based on the carbon content of fuels.

[10] Council Directive 2003/96/EC of 27 October 2003 restructuring the Community framework for the taxation of energy products and electricity, see https://eur-lex.europa.eu/LexUriServ/LexUriServ.do?uri=OJ:L:2003:283:0051:0070:EN:PDF. The products to be taxed are listed in Article 2 of the directive. For more info on carbon tax rates in the EU Member States, see the European Commission's on-line information tool Taxes in Europe Database (TEDB) at https://ec.europa.eu/taxation_customs/economic-analysis-taxation/taxes-europe-database-tedb_en.

[11] See Article 4.2 of Directive 2003/96/EC.

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

50. The carbon tax base in Iceland consists of petrol, diesel and heating gas oil, as these are the only fossil fuels available on the market in that country. Outside Europe, some countries, for instance India, Mexico, the Philippines and Zimbabwe, have chosen to tax only a few fuels. In the case of India and the Philippines only coal is being taxed, while Mexico taxes coal and petroleum products. The Colombian carbon tax base consists of natural gas and other petroleum products. Although not specifically designed as a carbon tax, an example of a country having introduced a tax only on certain fuels is Zimbabwe, where only petrol and diesel are taxed. 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 liquified petroleum gas used for heating purposes.

51. Costa Rica is the Latin American pioneer in carbon taxation, as the country has had such a tax 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.

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

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

54. Competitive concerns for certain business sectors, 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 further chapter 3C).

5.2.3. Methodology to calculate a carbon tax by the Fuel Approach

55. If policymakers use the Fuel Approach to design a carbon tax, the essential element in the design phase is to pre-calculate tax rates to be proposed in the tax legislation based on average fossil carbon content for specific fuel types. The basic thinking behind such a design has been outlined above and there are significant administrative advantages with this approach, such as low administrative costs since it is possible, in most cases, to build on existing tax administration structures. To facilitate the understanding of this approach, an example from Sweden is given in the box below of how to calculate a carbon tax rate per litre of petrol.

Box 4: 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 CO_2-emissions from combustion can be calculated from specific emission factors and heating values for different fuels (see examples in Table 2 above) and the tax rate is then obtained by simply multiplying the emissions with the general carbon tax level.

Emission of CO_2 [kg CO_2/unit] * General carbon tax level [currency/kg CO_2] = Carbon tax rate [currency/unit]

Example, calculation of carbon tax rate on petrol in Sweden 2018.

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

Emission factor: 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

The general carbon tax rate: 1.15 SEK/kg fossil CO_2

2.323 kg/litre * 1.15 SEK kg/fossil CO_2 = 2.67 SEK/litre

5.2.4. The tax rates are presented in the tax law in weight or volume units

56. There is no need to express the method of calculation in the legal carbon tax provisions. However, to increase transparency the amount of tax per kg of fossil carbon, which is the basis of the tax calculation, can be mentioned in the tax law or in other official regulations. For example, the Swedish legislative tradition is to keep statutes as short and simple as possible and provide additional explanations in the preparatory works (Government Bills). When the carbon tax was first introduced in Sweden in 1991, the relevant Government Bill, containing the proposal presented to Parliament for decision on the carbon tax law, 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. 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 liquefied petroleum gas (LPG), 1 000 m^3 for natural gas and 1 000 kg for coal and coke.

5.2.5. It is possible to differentiate based on fuel quality

57. Different coal qualities have, as was mentioned above, significant differences in carbon content. If such fuels are major energy sources in a country, it could make sense to set different tax rates based on the carbon content for the various coal qualities. The same design approach as have been laid down above can be used.

58. Further, the increased use in some jurisdictions of motor fuels consisting of mixtures of fossil and biomass components can be a further challenge to an administratively simple and easily controllable system, if the fossil carbon content of the fuel is the base of the tax. Whether the components made up from biomass sources add complexity to a tax system depends 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.

5.2.6. Some aspects relating to carbon content in fuels of biomass origin

Box 5: Fuels of biomass origin

The focus in most jurisdictions that have introduced carbon taxation based on the Fuel Approach has been on fossil fuels. Fuels of biomass origin have not been covered by the tax. However, low blends of ethanol and biodiesel into petrol and diesel are often subject to the same carbon tax rate as their fossil equivalents, due to administrative reasons and, in some cases, legal constraints when combining a tax exemption with another policy measure. Some jurisdictions, however, take account of the biomass part when calculating the tax rate for the petrol and diesel mixture.

[Maybe include illustration of liquid biofuels]

59. Another decision facing a policymaker is whether the tax base should relate to the fossil carbon content of fuels, or to carbon content in general, which also would include biomass-based fuels, as for instance ethanol and biodiesel. 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 of the changes in atmospheric temperature[13]. However, the global debate is increasingly focusing on indirect emissions in land use changes which may be triggered by biomass for fuel production.

60. Some jurisdictions consider a switch to biomass-based fuels fulfilling laid down sustainability criteria as part of the solution towards a low-carbon economy, while other jurisdictions are more inclined to be alarmed by problems with the increased use of such fuels and would rather focus solely on a transition to other renewable energy sources such as wind and solar. Motives for the latter approach can, for instance, be found in OECD reports concluding that policy support for biofuels contributes little to reduced greenhouse-gas emissions and other policy objectives, while it can be one of several factors contributing to raise international food prices. However, an in-depth discussion about this issue is outside the scope of this handbook.

61. 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

[13] 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 (add source). The remaining 25 percent is due to changes in land use, primarily deforestation.

general principle of not subjecting fuels of biomass origin to a carbon tax 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.

5.2.7. Low blends of ethanol and biodiesel into petrol and diesel

62. Even if the prevailing principle in jurisdictions that have introduced a carbon tax is to tax only fossil fuels, some simplifications have often been made for administrative reasons. This relates, for example, to taxation of petrol and diesel. When using the Fuel Approach method, many countries tax low blends of ethanol into petrol and Fame (biodiesel) into fossil diesel by the same rate per litre fuel, as if the fuel mixture would have been of 100 percent fossil origin. This is particularly true if countries have introduced another economic instrument, such as a quota obligation scheme, to ensure certain amounts of biofuels on the market. Almost all EU countries have now introduced national quota systems for biofuel blending into petrol and diesel and this has normally meant that the tax rates for petrol and diesel are 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.

63. Depending on where in the distribution chain a carbon tax is to be levied, jurisdictions may also encounter administrative problems if aiming to enable a tax exemption for low blended ethanol. However, this is a tax design problem and there are solutions to be found, such as extensive bookkeeping and verifications or legal definitions of the level of a low blend to be eligible for a tax refund.

5.2.8. Take account of the biomass part of petrol and diesel when calculating the carbon tax rate

64. In some countries using the Fuel Approach design, such in Sweden and France, the carbon tax per litre of petrol and diesel have been calculated to take account of the blend of biomass fuels following a quota obligation.[14] However, the use of pure or high blended liquid fuels of biomass origin, which yet amounts to low volumes in most

[14] 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 4 above, 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 % 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 * (1-0.077) = 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.

countries, are often exempted from applicable carbon taxes. Another example is British Columbia, Canada where the carbon tax applies to ethanol at the same rate as petrol and to biodiesel and renewable diesel at the same rate as diesel or light fuel oil.

65. When British Columbia introduced its renewable fuel standard in 2010, which requires an average annual blend of five and four percent renewable content for petrol and light fuel, respectively, carbon tax rates on these fuels were reduced by five per sent to reflect the resulting emission reductions.

5.2.9. Finland – an example of a jurisdiction with an innovative view of future carbon taxation

66. Finland was the first country in the world to introduce a carbon tax in the early 1990's and like the other Nordic countries, the carbon tax in Finland is a key component in the country's pathway to a low-carbon and eventually carbon neutral society. The Fuel Approach method is used. Since 2011 the energy taxation of motor fuels and heating fuels has been based on energy content, carbon dioxide emission component and local emissions of fuels.

67. The carbon component is based on the carbon dioxide emissions of each fuel in a life cycle perspective. Biofuels are subject to a carbon tax rate that is reduced from 50 to 100 percent according to the performance, giving a full carbon tax exemption for the environmentally best biofuels – 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[15].

68. The key parameter in the Finnish system is still taxing fossil carbon. However, when classifying biofuels in three levels of the carbon tax, the legislator has based these levels on life cycle values[16] providing how much life cycle carbon dioxide emissions reduction is achieved relative to equivalent fossil fuels. Biofuels that fail to meet set sustainability criteria are subject to the same carbon tax per energy content as the equivalent fossil fuel, as there is deemed to be no savings in fossil carbon dioxide emissions. 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, no carbon tax is levied in Finland on second generation biofuels made of waste, residues, lignocellulose, etc., as these fuels in average are calculated to have carbon dioxide emissions savings of over 80 percent. Comparing the current Finnish carbon tax design with, for example the Swedish carbon tax, the emission factors used are different as Finland looks at life cycle emissions and not at

[15] Directive 2009/28/EC of the European Parliament and of the Council of 23 April 2009 on the promotion of the use of energy from renewable sources and amending and subsequently repealing Directives 2001/77/EC and 2003/30/EC, https://eur-lex.europa.eu/legal-content/EN/ALL/?uri=CELEX:32009L0028.

[16] 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.

emissions at the combustion. This affects the value of the emission factors used, but not the general method for calculating the tax rate and the how the carbon tax is still expressed in volume or weight units in the tax law.

69. In conclusion, even in this form of a Fuel Approach the need for environmental knowledge for the tax authority is small, or even non-existent. What the tax administration basically needs is how to calculate and audit the number of litres fuel sold by the taxpayer. This is a task which tax authorities normally are well familiar with.

5.3. The Direct Emissions Approach

5.3.1. Basic concept

[Maybe an illustration showing emissions from a stationary installation, such as large industrial plant?]

70. An alternative to a tax based on the carbon content of the fuel is to measure the actual emissions. With this approach, which we call the Direct Emissions Approach, the carbon tax targets carbon dioxide emissions regardless of the type of fuel being used in the group of stationary installations chosen.

71. This approach has attracted increased attention in recent years, it relies on direct reporting of emissions from certain types of 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. Those facilities may often already be subject to requirements to measure emissions by IPCC regulations or even more stringent national environmental codes. This might seem to be a more accurate approach, but the number of emission sources is often large and measurement systems are not precise, which implies high administration costs. Moreover, in the case of taxes based on actual emissions rather than on the carbon content of fuels, jurisdictions may need to establish new systems for monitoring, reporting and verification. While such requirements already exist regarding large industrial and power installations in the UNFCCC national reporting guidelines, this is not the case for emissions from either smaller plants or vehicles.

72. A variation is to focus on certain processes and types of emissions. This approach allows for coverage of activities beyond fossil fuel combustion and, therefore, also of GHGs other than carbon dioxide as well as of other sources of pollution from certain installations. In this way, jurisdictions may be able to ensure broader coverage, especially where a large part of their emissions are not fuel-based. This kind of an approach would work best in a context where a jurisdiction’s policy approach is primarily addressing emissions from certain types of stationary installations. It is thus not a system well suited to cater for incentives to reduce emissions from small plants, 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.

73. A policymaker considering the Direct Emissions Approach is likely to need more assistance of technical expertise on environmental and energy related matters in the tax design than the Fuel Approach. As will be further outlined in chapter 4, a carbon tax based on a Direct Emissions Approach will also be administered in a way which differs from the tasks authorities normally assigned to the collection of taxes are familiar with. On the other hand, a Direct Emissions Approach of a carbon tax design can strengthen already existing environmental schemes on reporting emissions and co-benefits can thus be found in this respect.

5.3.2. Coverage of emissions by the Direct Emissions Approach

Box 6: Examples of fuels subject to a Direct Emissions Approach carbon tax in different jurisdictions

Chile introduced a green tax reform in 2017, which included a carbon tax, targeting emissions from facilities with stationary sources comprised of boilers or turbines with a combined thermal power of 50 MW. It covers around 40 percent of Chile's emissions affecting 94 facilities in different parts of the country from a range of sectors. The Chilean carbon tax can be viewed as a Direct Emissions Approach carbon tax.

In the San Francisco Bay Area, USA and Singapore, the carbon tax is calculated from measured emissions from certain large stationary installations. Several different greenhouse gases are measured and converted into carbon dioxide equivalents. A similar approach is chosen in South Africa.

74. Although not as common as taxation of fuels, there are jurisdictions that have chosen to tax direct emissions of carbon dioxide. A clear example of such a carbon tax approach is Chile, which introduced a green tax reform in 2017. The reform included the introduction of two new green taxes, namely a carbon tax and a local pollution tax. Both taxes target emissions from facilities with stationary sources comprised of boilers or turbines, which individually or together have a thermal power of at least 50 MW. Even with this fairly high threshold, over 40 percent of the national carbon dioxide emissions is covered by the carbon tax. While the carbon tax covers emissions of carbon dioxide, the local pollution tax covers other local pollutants, namely PM (particulate matters, such as e.g. dust or smoke), NO_X (oxides of nitrogen) and SO_2 (sulphur dioxide).

75. The Chilean carbon tax exempts stationary sources which use renewable, non-conventional means in which the primary energy source is biomass. In other words, also by using a Direct Emissions Approach, it is possible to let it cover only fossil carbon emissions.

76. Other examples include the San Francisco Bay Area, USA which is the first local urban carbon tax in the USA (in force since 2008) and the recently (1 January 2019) introduced carbon tax in Singapore. Both these jurisdictions calculate the tax on measured emissions arising from combustion of fuels in certain large stationary installations. By converting emissions from other greenhouse into carbon dioxide

equivalents (CO_2e) such other greenhouse gases are included in the taxation scheme as well.

77. The San Francisco Bay Area Tax is charged on emissions from installations which are subject to local environmental regulations (permits), while the Singapore carbon tax requires any industrial facility that emits direct emissions equal to or above 25,000 tCO_2e annually to register as a taxable facility and pay the carbon tax.

78. A similar approach is to focus on emissions from certain processes is done in South Africa, where a carbon tax came into force on June 1, 2019. The South African carbon tax[17] targets CO_2e emissions above a certain level from fuel combustion, electricity generation and industrial processes as well as estimated fugitive emissions[18]. While in principle using a Direct Emissions Approach, the emissions taxed are calculated based on emissions factors pre-determined according to a methodology approved by the relevant authority. The tax law also lays downs standard values in case such a methodology does not exist for a specific activity.

79. The installations targeted by a Direct Emissions Approach carbon tax are, in many cases, already obliged to measure their emissions and report them according to the IPCC framework. There may also be national requirements in place, following environmental regulation schemes. To implement the Direct Emissions Approach a measurement, reporting and verification system is necessary (so-called MRV). This requires cooperation between the national tax administration and agencies with environmental and technical knowledge to be able to control and monitor the measurement of the emissions to ensure tax control. All parties to the Paris Agreement will be required from 2024 to report their emissions using the guidelines of the Paris Rulebook. Although developing countries with limited capacity may initially report with flexibilities, parties will, over time, increase the accuracy of the inventory of national emissions, thereby also increasing the possibility to implement a well-designed carbon tax. One of the principal advantages of the Direct Emissions Approach would therefore be, while more difficult to implement, that it will strengthen the countries' MRV capabilities which is required for a range of international commitments and local policies.

80. 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. In effect, the only requirement to monitor emissions is to ensure reporting at the facility level. It is this feature of the approach which is relevant to develop more

[17] For further information about the South-African carbon tax, see Republic of South Africa Carbon Tax Bill B-46-2018, http://www.treasury.gov.za/comm_media/press/2018/2018112101%20Carbon%20Tax%20Bill%202018-B46-2018.pdf.

[18] 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.

sophisticated policy instruments or introduce other complementary environmental policies such as local pollution controls.

5.3.3. Methodology to calculate a carbon tax by the Direct Emissions Approach

81. There are examples when a jurisdiction has chosen to let its carbon tax only cover emissions from certain kinds of stationary facilities, where the consumption of fuels take place. This could be the case of large power plants. Here a tax on actual emissions could serve as a feasible option. Chile and Singapore are jurisdictions which have opted for this approach. In many cases such installations would, due to regulations following the UNFCCC national reporting guidelines or additional national environmental requirements, be obliged to measure their emissions. Thus, determining the tax on these values would be appropriate. Adding the use of such measured emissions also in a carbon tax could give more incentives to strengthen the reporting system. This could be true in a jurisdiction, which has no prior taxation of fossil fuels and thus has no tax administration system already in place. However, when such a jurisdiction decides to broaden the scope of the tax say to propellants, the measurement of actual emissions arising from the combustion at the point of consumption would no longer be feasible.

82. The Direct Emissions Approach raises different issues and problems to the Fuel Approach. In the following we will discuss some of the more complex issues, primarily related to the definition of a facility and the tax liability. Depending on how the tax is designed, the definition of a facility, or what are the boundaries of the tax liability, is an issue to consider in the design. This, in turn, is associated with the established criteria of who pays the tax.

83. Jurisdictions may identify the affected facility depending on an emission threshold, say 10,000 or 25,000 tons of carbon dioxide emissions emitted during a calendar year. This has two problems, first, how to define the specific boundaries that define a facility. Is it a spatially contained area, or broader processes that span a larger area? Is it one chimney stack or many? A second issue is that the threshold approach requires the development or existence of an MRV system before 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 this tax approach.

84. Another approach is the one taken by Chile, where the liable facility was determined by a technological condition, namely the existence of boilers and turbines with 50 MW potential capacity, and the tax was based on the annual emissions, regardless of a specific emissions threshold. The advantage of this approach is that it facilitates the identification of the liable facility by the regulator, without recourse to an MRV system, and places the burden on the facility to develop its MRV system in order to report its emissions, thus determining the tax liability.

85. However, this approach requires a strict definition of the liable facility. As a facility may have more than one structure or chimney, the law or regulatory statute requires a precise definition of facility.

In the case of Chile, it was defined as "*the set of structures and installation 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*." Consequently, the definition of a liable facility depends on the specific technology available, basically boilers and turbines, and only if they have a thermal capacity of 50 MW or more. For this reason, the tax is directed to facilities in different economic sectors, such as food processing, refining and electricity generation.

5.3.4. Measuring, Reporting and Verification Systems (MRV)

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

87. The general structure of the MRV system is composed of, at least, four components, namely

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

We will now look at these components in turn.

a) Registry

88. A key component of the MRV system is the system for registering emitting facilities. In general, the whole population of potential facilities liable to the tax should be registered to determine who complies with a predetermined threshold to be subject to the tax and is therefore liable. Most countries will already have some form of registrar of polluting firms who 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.

b) Measurement of Emissions

89. In the case of the Direct Emissions Approach, it may seem like the focus should be on the emissions measurement issue. But this not the main problem. In fact, it is not necessary for facilities to actually measure emissions. It is sufficient for them to control the use of fuels and estimate emissions based on the 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 systems for monitoring, reporting and verification

(MRV) at the facility level. More accurate reporting systems will be essential for international reporting and expanding carbon pricing policies across jurisdictions and sectors.

90. 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. In short, there are four possible measurement approaches.

i. 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.

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

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

iv. 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, fuel consumption, among others). For local pollutants, the emission factors provided by the United States Environmental Protection Agency (EPA) can be used, while for carbon the factors proposed by the Intergovernmental Panel on Climate Change (IPCC, 2006) can be considered.

c) Reporting

91. After the measurement, the facility must report its emissions to the Environmental Authority. 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 establishes 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 4.

d) Verification

92. 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.

93. The figure below presents the different issues raised by the MRV system.

Figure 4: Different issues raised by an MRV system

5.3.5 Point of regulation

94. As was discussed above, one of the issues of tax implementation is the point of regulation. A carbon tax based on the Fuel Approach can, depending on the tax design, use either an upstream or a more downstream point of regulation. A carbon tax on emissions must, however, be regulated downstream, as that is the moment when the emissions occur. While this is technically more difficult and requires the construction of an MRV system, it can be consistent with the development of other more sophisticated policy instruments, such as offsets, compensations schemes or transnational emissions trading.

95. A carbon tax based on the Direct Emissions Approach is a downstream tax calculated based on actual emissions released by facilities subject to taxation. As have been 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.

Box 7: Chile's carbon tax and measurement, reporting and verification systems (MRV)

Chile decided to use a downstream taxation mechanism so as to enhance the coherence between its mitigation policies for both global and local pollution. The national distribution of emissions was also considered, as most are released by a small number of facilities –

mainly power plants – that feature more advanced direct emissions measurement systems, thus facilitating management and adaptation to the new tax.

Furthermore, it was observed that an emissions standard already existed for thermoelectric power plants (for units rated for over 50 MW), serving as a forerunner for the new MRV system. Implementation of downstream environmental taxes has required the consolidation of institutional infrastructure that hinges on coordinated efforts by a number of ministries and public agencies, both to build develop methodologies and to implement the MRV system, besides drawing on a range of information provided by different state bodies agencies.

5.3.6. Institutions involved

96. The Fuel Approach basically requires technical or institutional support from the environmental agencies when defining the methodology for calculating the carbon tax rate. In the case of a carbon tax on emissions the role of technical and environmental agencies is permanently essential and are the key institutions that determine both the tax base and consolidate the emissions for the final tax. Thus, one of the problems or advantages of the Direct Emissions Approach is that it strengthens the coordination between environmental line ministries and the Ministry of Finances and the Tax Authority.

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

98. In general terms, the Ministry of Environment or an equivalent Agency would be responsible for coordinating the process through the regulation of emission measurement, reporting and verification systems, which constitutes the information base for the calculation of the tax.

99. After each facility declares its final emissions the Environmental Agency should verify and consolidate the emissions, then the Tax Authority will calculate the tax burden of the specific facility.

5.4. Summing up of pros and cons of different carbon tax approaches

100. In the table below, a summing up is made of the major pros and cons of the two tax design approaches previously discussed, which are the Fuel Approach and the Direct Emissions Approach.

Table 3: 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 CO_2 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 Other types of CO_2e emissions are outside scope Does not develop measurement, reporting and verification systems (MRV)
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 scheme Possible to include non-fuel combustion emission in scopes	Costly to measure Cannot be applied to small facilities Cannot be applied to transport fuels Administratively complex

101. However, while the table above compares and contrasts the different approaches, this is probably not the best way of assessing these approaches. 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.

5.5. Some aspects relating to the taxation of fuels in air transport and maritime

102. When developing and determining the appropriate scope of a carbon tax, geography is an important consideration for policy makers. In this respect, extending the scope of a carbon tax beyond the borders of a particular jurisdiction has the potential to lead to, amongst other aspects, double/multiple taxation depending on how the tax is structured. In this context, the existing international treaties and agreements that a country has enacted/ratified must also be considered, where it is important to note that 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).

103. This handbook aims to give an overview of how a general carbon tax, levied on fuels consumed within the borders of a certain jurisdiction, can be implemented. Taxing fuels used in commercial air transport and maritime (including fishing) present certain challenges, which will not be specifically dealt with in this handbook but may offer interesting approaches worth further, future considerations. Below are thus included some brief texts about the impact of international agreements and regulations as well as discussions that presently are starting in different fora on economic instruments to be used to curb fossil carbon dioxide emissions from commercial air transport and maritime.

5.5.1. Commercial air transport

104. There has been a widespread perception that it is not possible to tax fuel used in international aviation. This perception is based on the view that the Chicago Convention prohibits such taxation.

a) The Chicago Convention

105. The Chicago Convention from 1944 forms the basis for the International Civil Aviation Organization, ICAO, a specialized agency of the UN, and the rules regarding international civil aviation. The contracting states have, through the convention, agreed to not 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. Furthermore, the provisions of the Chicago Convention only apply to international flights. Therefore, the Convention imposes no limitation on a state's right to tax fuel taken on board and consumed during a domestic flight.

106. ICAOs Policies in the Field of International Air Transport only have standing as non-binding soft law. They contain ICAO Council Resolutions, in which the Council resolves that when an aircraft registered in one State departs from an international airport of another State either for another customs territory of that latter State or for the territory of any other State, the fuel taken on board for consumption during the flight shall be furnished exempt from all customs and other duties. Several States have, in an appendix to the policies, stated that they don't agree with the resolutions. Further specific agreements, known as Air Services Agreements (ASAs), permit contracting States to designate their national airline(s) the right to operate flights between the counterparty State(s), as well as specify requirements around for example safety, security, capacity, and ground handling services. ASAs, which are 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.

107. 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.

b) Carbon Offsetting and Reduction Scheme (CORSIA)

108. It can further be noted that in 2016, ICAO adopted the Carbon Offsetting and Reduction Scheme for International Aviation (CORSIA). Political agreement for CORSIA at ICAO was achieved on the condition that CORSIA would be the market-based measure applied to carbon dioxide emissions from international flights and on the basis, that emissions should not be accounted for more than once. The resolution means that carbon dioxide emissions from international aviation should be stabilized on year 2020 levels. Any carbon dioxide emissions above this needs to be compensated for. The new system will start by a voluntary phase and will be compulsory from 2027.

c) Ongoing discussions on Carbon Pricing and Aviation Taxes

109. In early 2019, several EU Member States argued in different fora that Member States, without effective global instruments being in place, should consider carbon pricing at the EU level. This could include the EU Emissions Trading Scheme, a tax on kerosene, an air passenger tax or a tax per flight. Following these discussions, the Netherlands held in June 2019 a conference on the topic, gathering politicians, civil servants and scientists from EU countries as well as other countries. *[This section may be updated pending further discussions prior to the publication of this handbook.]*

110. During the conference, it was a common understanding that taxing fuel for international aviation is legally possible. For example, countries may agree, on a bilateral basis, to tax fuel on flights between themselves and such taxation would be in compliance with international law[19]. There may be issues to consider, for example if there is an ASA prohibiting tax on fuel or how to handle flights from third countries.

111. At the time of the publication of this handbook, discussions are still ongoing on this topic.

5.5.2. International Maritime Transport

112. Unlike the case of commercial air transport, there are no restrictions in international or tax law prohibiting or limiting a State's right to tax fuels used on cross-border maritime transport of goods and in high-sea fishing exploration.

[19] https://ministeriefinancienconference-cms.lwprod.nl/uploads/1560873188_PacheTaxationHagueTextI.pdf

113. There is, as of yet, no international agreement establishing a country's entitlement to tax carbon emissions (or fuel consumption) deriving from international maritime transport. Absent such international agreement, two different sets of international regulations may come into play: (i) the regulations issued by the International Maritime Organization ("IMO"); and (ii) the UN Convention on the Law of the Seas ("UNCLOS"), which establishes a State's competence to regulate activities occurring in the high seas. None of them specifically deal with economic instruments relating to carbon emissions, but there is nothing that prevents them from implementing economic policies such as carbon taxes to reduce carbon emissions.

a) The Role of the IMO Convention

114. The IMO was created in 1948[20] as a specialized UN agency, with the purpose of developing, administrating, and legally implementing international regulations and practices to be followed with the cooperation of Governments, in order 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.

115. Given that the Kyoto Protocol specifically called on Annex I Parties to address emissions from shipping as part of their emissions reduction targets and following the admission of a more ample international framework for environmental protection through the Paris Agreement, in April 2018, the IMO decided to issue certain regulations with the aim to reduce the GHG emissions from international shipping transport to half the 2008 levels by 2050 which corresponds to a 50 % reduction. The IMO is continuously promoting technological innovation using the Energy Efficiency Design Index (EEDI) for new ships, which was made legitimate in 2011[21]). Since 1 January 2013, a new ship design needs to meet the EEDI for their ship type. This level is to be tightened incrementally 10 % every five years[22].

116. The short- and medium-term measures to achieve IMO's CO_2 emission targets, however, need to be further developed and specified. 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). Besides, the EEDI only applies to new ships, and since 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

[20] Initially named Inter-Governmental Maritime Consultative Organization (IMCO), in 1982 it changed its name to IMO.

[21] This is also known as the "Initial IMO Strategy on Reduction of GHG Emissions from Ships".

[22] An important measure to prevent pollution from oil tanker accidents, cleaning of oil tankers and disposal of engine room wastes is the 1973 International Convention for the Prevention of Pollution from ships, modified in 1978 (MARPOL 73/78). Annex VI of the MARPOL Convention, adopted in 1997 via an amending Protocol, regulates air pollution from ships.

emissions will be reduced by only 3% between 2010 and 2050. EIA (2017); and Smith et al. (2015, 2016) predict that the EEDI regulation alone will not change the increasing trends of CO_2 and GHG emissions.

b) The role of the UNCLOS

117. The 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. Furthermore, the UNCLOS regulates every state's rights and obligations when lending a vessel, the national flag to navigate through the high seas or to promote an economic activity in international waters.

118. UNCLOS, which was ratified by 166 parties (including the European Union, but not the United States), is a general convention and, as such, is compatible and may be subject to the provisions of other more specific conventions regulating, for example, environmental obligations , and defining international taxing rights, provided that the *lex specialis* in question does not contravene the basic principles embodied in the Convention. The UNCLOS may thus 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.

c) Conclusion

119. The international maritime transport sector is not currently subject to the payment of any carbon tax or environmental charge. 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 it does not face the true global costs of international trade. The *second* is too high fuel consumption (and too polluting fuels) and consequently too high carbon emissions[23]. The *third* is the lost opportunity of raising fiscal revenues raised from international shipping transport for countries participating in international trade, which are so critical for many low-income countries with low tax revenues.

120. 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.

121. 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 tax is a

[23] Bunker fuel consists primarily of residual and distillate fuel oil (see EIA (2015)). Starting January 1, 2020, the International Maritime Organization (IMO) will require that all fuels used in ships contain no more than 0.5 percent sulphur. The cap is a significant reduction from the existing sulphur limit of 3.5 percent.

specialized topic within the general field of environmental law, lex specialis derogat generali, and therefore it would be up to policy makers to define how taxing rights derived from global emissions could be allocated between states.

122. 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 the 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 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 (LICs) and small island developing states could be affected. To address any possible negative effects of implementing a carbon tax in the maritime sector may for example require to design a compensation scheme to the countries that are most affected.

6. When the tax is to be paid and by whom

(Some illustration/graph including money/revenues might be included)

Box 8: Key factors to consider when determining who will pay the tax and when

The carbon tax legislation needs to lay down provisions about who will be held liable to pay the tax to the authorities (taxpayer). The choice of taxpayer will depend on national conditions, such as already existing taxation of fuel, available tax control capacity, the organization of fuel distribution or the types of fuels targeted by the tax. Degrees of complexity of tax administration vs the need to be able to carry out tax controls are key issues to consider.

For a Fuel Approach design, there are examples globally of countries having chosen taxpayers in different stages of the distributional chain.

For countries choosing a Direct Emissions Approach a close link to existing environmental performance legislation has often been desirable.

6.1. Basics to consider when deciding on the taxpayer

123. The choice of what entity to give the legal responsibility for paying the tax to the authorities may seem like a purely administrative issue. However, emissions typically involve a range of actors operating at different points in the fuel distribution chain. In addition to determining which sectors or activities will be subject to the tax, jurisdictions also need to carefully consider the choice of taxpayer. Some more technical aspects involving the taxpayer and actual payment of the tax will be handled in chapter 4. The basics for jurisdictions to bear in mind are, however, highlighted in below as they are important features to ensure that the tax functions well to achieve the policy goals set out for it.

124. The actual payment of the tax – when and by whom – is a matter to be regulated in the carbon tax legislation. These issues are of interest to authorities set to administer the

carbon tax and in consequence also to legislators considering how to design their tax legislation. This is essential and not much attention has been given to these issues in the vast literature already dealing with carbon taxation. The key focus of literature seems to have been the issue of economic incentives for people and businesses to promote ecologically sustainable activities. The latter discussion depends e.g. on the possibilities for the taxpayer to transfer the cost of the tax down the fuel supply chain. This issue has been touched upon earlier in this chapter (see section 3).

125. There is no simple answer to which entity is best suited to be held responsible to pay a carbon tax to the authorities and when that event is to occur. It obviously primarily depends on the tax design approach chosen, but also to a large extent on already existing administrative structures in the jurisdiction and to what extent the jurisdiction would like to build on such existing administration. The environmental objective laid down for the tax is also a feature to be considered as well as the entity in the fuel distribution chain that is most likely to respond to the price signal of 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 labour resources can be concentrated on ex-post tax control in the forms of tax audits and spot-checks (see also chapter 4 on administration).

126. Jurisdictions choosing to design a carbon tax levied on fuels (the Fuel Approach) 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.

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

128. In determining the point of regulation, it is crucial to analyse which actors will bear the burden of the tax and if they are responsive to the price signal. To ensure efficiency and environmental effectiveness households and firms should respond by changing their behaviour. Whether the price signal will be passed on to the final consumer, by being part of the retail price of the fuel, is, however, a consequence of trade agreements between sellers and buyers of the fuel. It is nothing to be regulated in a tax act.

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

6.2. When will the tax be due – point of regulation

130. A distinction between upstream, midstream or downstream points of regulation is sometimes used in economic literature to identify the point at which the tax is controlled or collected. However, we are refraining from using this terminology as it risks adding to confusion, especially as these terms may have different meanings when used in different contexts.

6.2.1. The Fuel Approach

a) General principles

131. A general principle in a carbon tax based on a Fuel Approach, that is a tax system levying a certain tax amount on fuels by weight or volume unit, is that the fuels shall be taxed at the time the fuels enters the economy. This normally coincides with extraction or importation. A strict application of such a system is illustrated in figure 6 below and it may be a good starting point for a country which already administers some other kind of excise duty on the taxable fuels or has no prior experience of administering excise duties.

132. Administrative simplicity along with good possibilities for tax control are key issues to consider. Keeping the number of taxpayers to a minimum is another aspect to keep administrative costs low, which often is desirable to the authorities as well as to the taxpayers. One option would be to establish a tax collection point very early in the fuel distribution chain, that is the point of extraction (such as coal mine, oil drill, natural gas pipeline) or importation. Choosing a taxation point at importation would also have administrative advantages, as the tax collection can be combined with the collection of applicable customs duties to be paid upon importation. Further, a resource-rich country can choose to let the tax, at least from the start, be levied at the point of extraction, while a resource-poor country may feel it appropriate to start with only taxing fuels at the point of importation.

133. However, while choosing a tax point as illustrated in figure xx below could offer administrative advantages in terms of relatively few taxpayers and better opportunities to conduct an effective tax control, there are also some other aspects to consider. Crude oil and natural gas largely dominate the imports of fuels to 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.). However, in this regard Colombia offers an interesting example.

134. Colombia introduced a carbon tax in 2017[24]. The tax base consists of different refined petroleum products, namely natural gas (for certain industrial processes), liquified petroleum gas, petrol, kerosene, diesel and fuel oil and 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.

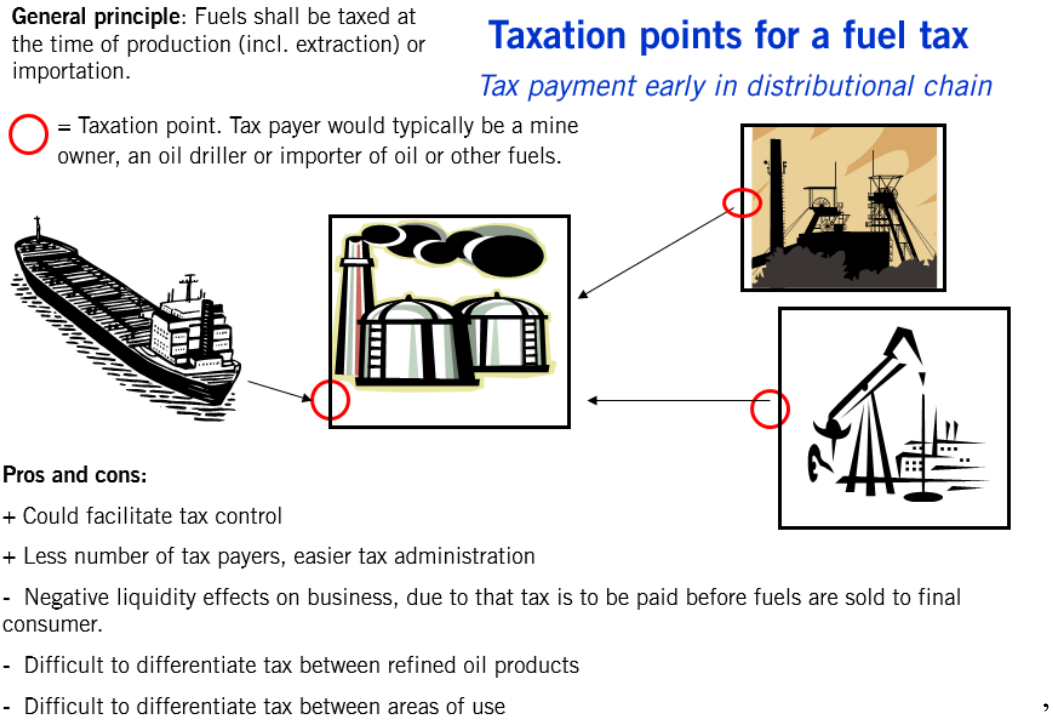

Figure 5: Example of a fuel tax design – tax payment early in the distributional chain

Note. Not applicable within the EU, as the major part of taxable events occur within a tax suspension regime system with authorized traders under Directive 2008/118/EC, see further figure 2.

[The figure above may be replaced by a new graph incorporating the possible taxation points in both major systems, the Fuel Approach and the Direct Emissions Approach]

b) Possible to coordinate tax collection with import duties

135. Coordinating tax collection with other taxes or duties could facilitate tax administration. For a country choosing to collect a carbon tax upon importation, it could be an alternative to coordinate the carbon tax collection with the collection of import duties due on the taxable fuels. Although not being an explicit carbon tax, Zimbabwe can be mentioned as a country which coordinates its collection of a tax on certain energy products, a Petroleum Importers Levy on petrol and diesel, with import duties[25]. Firms

[24] 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) http://es.presidencia.gov.co/normativa/normativa/DECRETO%20926%20DEL%2001%20DE%20JUNIO%20DE%202017.pdf and Gutierrez Torres, Daniela (2017): Interaction between the carbon tax and renewable energy support schemes in Colombia- Complementary or overlapping?, The International Institute for Industrial Environmental Economics, http://lup.lub.lu.se/student-papers/record/8927410.

[25] https://www.zimra.co.zw/index.php?option=com_content&view=article&id=1201&Itemid=139.

or individuals holding a procurement license to import petroleum products in bulk into Zimbabwe are liable to pay this levy, which amounts to USD 0.03 per litre.

c) Carbon tax due later in the distributional chain

136. Choosing the same taxpayer for the carbon tax as an already 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, e.g. in the form of human resources employed. As we have seen from the previous sections, a carbon tax designed by the Fuel Approach means that the tax is levied by weight or volume units, that is the same as other excise duties are normally levied. Introducing a separate carbon tax will also make it possible for a Government to more clearly advocate to the public that the tax is a climate tax.

137. Even if the general principle still is to levy a tax close to production or importation, many jurisdictions have deviated from this principle. There may be several reasons for this. One is the desire to be able to differentiate the tax rates depending on final use of a fuel, such as between different sectors of the economy[26]. Another, which may be especially interesting in a country with high tax rates, may be to facilitate trading of the fuels between approved operators before reaching the final consumer. Negative liquidity effects on business may be avoided by such a construction, as the tax will not need to be paid before the fuel has been sold to the final consumer.

138. The discussion of when in the distributional chain to let the tax be due, is a matter primarily occurring then assessing the Fuel Approach. If choosing the Direct Emissions Approach, the issue does not really occur, as the tax administratively normally will coincide with the measurement of the emissions.

Example Norway's Carbon Tax [May be put in a box]

139. Norway is an example, where the liability to pay the carbon tax normally arises when the goods are imported or produced. However, this is not always the case in practice. First, production of taxable products in Norway must take place in and by an entity which has been approved by the tax authorities, known as an approved tax warehouse. Liability to pay tax does not occur until the goods leave the tax warehouse. An importer may choose to register in the same way. This means that the registered taxpayers can store the fuels without having to pay the tax. The Norwegian tax system includes certain cases of 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 abovementioned Colombian case, it is accounted for as an end-user can ask for reimbursement of the tax.

[26] For example, Sweden applied for several years (1991-2017) different carbon tax rates for heating fuels used by industry compared to households and service sector firms, see further chapter 3C.

Example Carbon Taxes within the EU Energy Taxation Framework

140. The bulk part of all commercially available fuels is subject to excise duty in the EU Member States. Following the choice of the Member State, the excise duty may include a specific carbon tax, currently seven Member States have chosen this approach. Such carbon taxes are in principle chargeable at the time of:

- Production, including, where applicable, their extraction, of taxable goods within the territory of the EU
- Importation of taxable goods into the territory of the EU.

141. However, a carbon tax in an EU country does not become chargeable until it is released for consumption the Member State. This means:

- The departure of taxable goods, including irregular departure, from a tax suspension arrangement.
- The holding of taxable goods outside a tax suspension arrangement where 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.

142. This model is very similar to the one used in Norway. However, within the EU each Member State has discretion as to where in the distribution chain the tax is liable, that is there is flexibility in determining the extent of the tax suspension regime.

143. 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 and 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.

144. While some EU countries, for example of Sweden (see further in chapter 4), 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.

Example – British Columbia's Carbon Tax

145. British Columbia, Canada[27] is an example of a jurisdiction that has moved the event when the tax becomes liable for payment and consequently also the taxpayer 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 collector for each fuel type they sell. They generally remit 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 fuel sales between refiner collectors and natural gas sales to be exempt from security.

6.2.2. The Direct Emissions Approach

146. 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, this can either the owner/renter of the installation where the emissions occur or the business carrying out the activity requiring the process from the installation giving rise to the emissions.

147. Measuring emissions at source does not necessarily involve actual measurement – although it is better to do so – emissions can still be estimated, based on fuel inputs and carbon content emission factors, but it does require the development of a measurement, reporting, and verification (MRV) systems for emissions at source. This will inevitably require close cooperation between Tax and Environmental Authorities, which may many times be difficult. There are pros and cons of such an approach. The most obvious 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. 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. Other advantages include that the MRV system developed will be useful for purposes over and above those necessary for green taxes, such as developing inventories, enhancing domestic and international comparability, facilitating management within companies, and even generating conditions to move towards more sophisticated policy instruments such as compensation mechanisms, offsets, and/or an emissions trading system.

[27] For more information about the carbon tax in British Columbia, please refer to https://www2.gov.bc.ca/gov/content/environment/climate-change/planning-and-action/carbon-tax.

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Table of Contents

Chapter 3B: How to set the carbon tax rate

1. Check list for setting the carbon tax rate

- At an initial stage, the most important thing is to **introduce a system for carbon taxation**.
- Implementing a carbon tax rate is a learning by doing task, as new information becomes available, carbon tax rates should be subject to an **ongoing evaluation process.**
- Carbon tax rates should, ideally, be consistent with the targets of the Paris Agreement. Policymakers may rely on economic data to set the rate. However, in practice, **a dynamic tax rate trajectory** may be feasible as there is a lack of clarity about the exact social costs of carbon. Thereby, the tax rate could be adjusted if specific policy emission reduction targets are not met.
- However, in the end, **setting the tax rate is a political decision**. From an environmental point of view, instead of waiting to find the most appropriate tax rate, which is enormously challenging in practice, a rate should be agreed upon. In practice, this rate should subsequently be evaluated and adjusted accordingly, if necessary.

2. Basic considerations for setting the tax rate

1. Setting the rate of a carbon tax is an essential element in the policy design of a carbon tax. The level of the tax rate has direct consequences on the effectiveness of the environmental objective envisaged via the tax and on the economy as a whole, since it is influencing fossil fuel market prices. Therefore, setting the tax rate merits careful consideration. This chapter will point out key aspects for policymakers to consider when making this decision.

2. Implementing a carbon tax is a learning by doing process because the impacts of the tax can be difficult to predict in advance. Hence, it is advisable for jurisdictions to start applying a carbon tax, irrespective of the starting rate[1]. From a policy perspective, and in meeting the objectives of the Paris Agreement, jurisdictions should strive to enter the carbon taxation ladder as soon as possible and gradually increase the rate over time and hence achieve a more significant carbon tax rate as soon as possible. To the extent 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 accuracy of the tax. There are also economic theories and approaches that could be used in setting the tax rate[2].

[1] Partnership for Market Readiness. 2017. *Carbon Tax Guide: A Handbook for Policy Makers*, World Bank, p. 95.
[2] Kettner-Marx, C., Kletzan-Slamanig, D., 2018, *Carbon Taxes from an Economic Perspective*, WIFO Working Paper 554/2018.

3. The range of carbon tax rates currently in force in jurisdictions across the globe varies from less than one US $ / tCO2e to over one hundred dollars[3]. It is worth noting that the highest taxing jurisdictions did not start their carbon tax programs by immediately applying a very high tax rate. Most jurisdictions (such as for example Sweden) initiated their carbon tax program with relatively low tax rates, increasing them over extended periods of time[4]. Despite that, most initiatives levy relatively low carbon tax rates below US $ 30 / tCO2e [5].

4. However, to reach the 1.5℃ temperature target agreed upon by the Paris Agreement, the High-Level Commission on Carbon Prices proposed a carbon price ranging from US$ 40 to US$ 80 / tCO2 by 2020 and US $ 50 – 100 / tCO2 by 2030[6]. A brief comparison with the current state of the art of carbon taxation will show that these are quite high prices to achieve in a relative short time period, which is an argument to start as early as possible. However, even low initial tax rates can serve as a starting signal, since the tax rate can be adjusted to a level, which is in line with environmental targets after its implementation. Therefore, even getting the system started with a low initial carbon tax rate could create the basis for a – from an environmental perspective – successful carbon tax. Ideally, the introduction of a certain tax rate should include a political commitment that the rate will increase over time to reach a specific emission reduction target. The implementation of hard commitments to raise carbon price trajectories is difficult, even impossible, however, certain design features may help. Examples include political commitments 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, ensuring that its revenue generation and use is integrated within the fiscal policy[7].

[3] For an overview, see World Bank Group. 2019. *State and Trends of Carbon Pricing 2019*. Washington, DC: World Bank. © World Bank. https://openknowledge.worldbank.org/handle/10986/31755 License: CC BY 3.0 IGO.
[4] Hammar & Åkerfeldt, *CO_2 Taxation in Sweden – 20 Years of Experience and Looking Ahead*, 2011, https://www.globalutmaning.se/wp-content/uploads/sites/8/2011/10/Swedish_Carbon_Tax_Akerfedlt-Hammar.pdf.
[5] OECD, 2018. *Effective Carbon Rates 2018: Pricing Carbon Emissions Through Taxes and Emissions Trading*, p. 8.
[6] *IPCC, Mitigation Pathways Compatible with 1.5°C in the Context of Sustainable Development in Special Report: Global Warming of 1.5 ºC above pre-industrial levels and related global greenhouse gas emission pathways, in the context of strengthening the global response to the threat of climate change, sustainable development, and efforts to eradicate poverty* IPCC (2018), p. 153.
[7] Partnership for Market Readiness. 2017. *Carbon Tax Guide: A Handbook for Policy Makers*, World Bank, p. 95.

5. If jurisdictions apply one uniform carbon tax rate, which applies to all emission sources, such a price signal can help to reach carbon reduction goals in an economical efficient way[8]. The goal of this chapter is to provide suggestions of policy instruments, which may help to set a proper carbon tax rate. Some jurisdictions have chosen in practice to apply different carbon tax rates[9]. Following this idea, carbon tax rates can be distinguished according to the utilization of fuels (e.g. heating, transport) or according to various sectors (e.g. households, industries). Differentiation might be a practical necessity to get acceptance for introducing a tax at all. However, considerations regarding the application of several carbon tax rates are not covered in this chapter, as they are discussed in chapter 3 C.

6. In this chapter, we will look into different practical approaches, which have been discussed in literature to set a tax rate, complemented by country examples[10]. Those approaches are standard and price approach, revenue target approach and the benchmarking approach. The methods are not to be considered independently of each other since ideas of all methodologies could be integrated into the decision-making process. This is because input from various methodologies can help to find a tax rate, which is in line with a desired climate policy objective.

3. Setting the Rates

3.1. Pigouvian taxation – internalising external costs

7. The use of a carbon tax is encouraged through the economic considerations of the Pigouvian taxation[11].[12]. The theory behind the Pigouvian taxation involves reducing CO_2 emissions through the full internalization of external costs of environmental damages through taxes. It is based on the consideration that emitters of CO_2 impose costs and disservices on others, without paying for the resulting damage that occurs. Thus, market failure may occur, as the private and social cost and interests do not coincide. It is possible to internalize external costs by setting a tax rate which exactly represents the external costs of an action. Thereby, the tax equalizes the costs of an economic actor (private costs) to the costs of society (social costs). As a result, the polluters bear all costs occurring as a result of economic actions[13]. Although the Pigouvian tax faces practical limitations, as it requires a high quantity of economic data, it represents an interesting theory, which can help to set a proper carbon tax rate.

[8] Kettner-Marx, C., Kletzan-Slamanig, D., 2018, *Carbon Taxes from an Economic Perspective*, WIFO Working Paper 554/2018, p. 2.

[9] See for an overview Carbon Pricing Dashboard, The World Bank available at https://carbonpricingdashboard.worldbank.org/map_data.

[10] Partnership for Market Readiness. 2017. *Carbon Tax Guide: A Handbook for Policy Makers*, World Bank, p. 89.

[11] See chapter 2.

[12] Pigou, A. C, 1920. *The Economics of Welfare*.

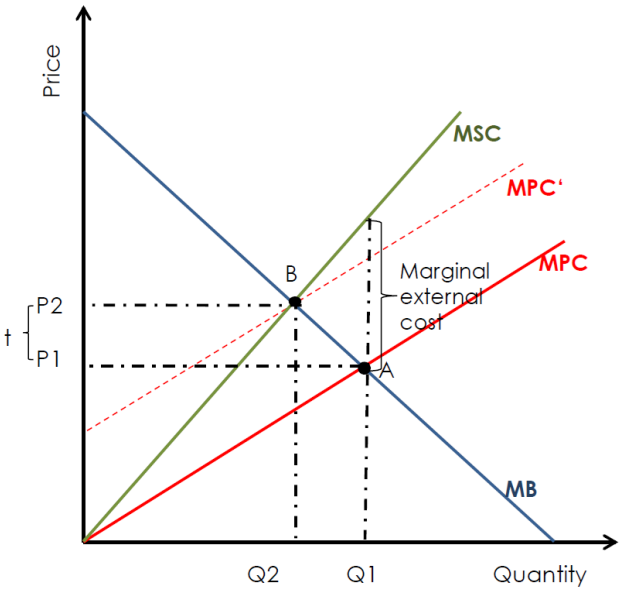
[13] Pearce, D., 2003. *The social cost of carbon and its policy implications*. Oxf. Rev. Econ. Policy 19 (3), 362-384; Pigou, A. C, 1920. *The Economics of Welfare*; Kettner-Marx, C., Kletzan-Slamanig, D., 2018, *Carbon Taxes from an Economic Perspective*, WIFO Working Paper 554/2018.

[Consider adding a picture of chimneys]

8. According to economic theory, the tax rate of a Pigouvian Tax should be set equal to the marginal social cost of the pollution[14]. In consequence, the price for the activity causing the pollution which is responsible for the external effects will rise. This results in a situation where the demand for the underlying activity decreases because of higher prices.

Box 9: Technical Note: Pigouvian Taxation

Figure XX Pigouvian Taxation



Source: Kettner-Marx/Kletzan-Slamanig 2018

The graph illustrates the working of a Pigouvian Tax. The horizontal axes represent the amount of output produced by the polluting factor. The vertical axis represents the market price. The marginal benefit curve (MB) measures the marginal benefit (benefit from the production of each additional unit) which arises for society for each level of production. The marginal private cost (MPC) represents the marginal costs (costs of each additional unit) which can be attributed to the producer. Finally, the marginal social cost (MSC) measures the marginal costs (costs of each additional unit) for the society. The MSC are 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 market 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. In order to correct 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

[14] See chapter 2.

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[15].

9. Although the Pigouvian tax makes sense from an economic perspective, the implementation of pure Pigouvian tax face limitations in reality. Ideally, the tax rate of a Pigouvian Tax exactly represents the external cost. However, it is important to mention that carbon tax rates do not necessarily have to correspond to the external costs in order to trigger an ecological steering effect. But the valuation of the externalities is a difficult task. This is because complex economic models are necessary to determine the social cost of carbon[16]. One difficulty in calculating the exact social costs of carbon is the necessity to combine the work of climate scientist and economists. Various assumptions and forecasts must be made to calculate the costs of climate change. These might include damages, which are directly related to climate change, as well as other costs, such as adaption and mitigation costs resulting from it. Moreover, assumptions regarding adaption and technological change and the choice of the discount rate[17] also, have a significant impact on the calculation. Thus, even the most complex model is not capable to fully reflect reality and is subject to uncertainty.

10. Although the practical implementation of the Pigouvian tax seems hardly achievable, the theory can play a crucial role when developing a practical solution, which may help to internalise the external costs. The core statement of the Pigouvian tax is that emitters of CO2 should contribute to cover the cost of the damage resulting from their action. The internalization of the costs of climate change is undoubtedly a promising measure for climate change mitigation. Accordingly, the ideas of the Pigouvian taxation can help policymakers to set an environmental effective carbon tax rate.

Box 10: Carbon Taxes and the Nobel Prize

William D. Nordhaus was one of the first economists who combined economic and climate-related models. Thereby, 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 has shown that carbon pricing via emission trading schemes or carbon taxes is an efficient way of lowering CO_2 emissions. In 2018, Nordhaus received the

[15] Kettner-Marx, C., Kletzan-Slamanig, D., 2018, *Carbon Taxes from an Economic Perspective*, WIFO Working Paper 554/2018, p. 2.

[16] Hope, C.W., 2006. *The marginal impact of CO2 from PAGE2002: an integrated assessment model incorporating the IPCC's five reasons for concern. Integr. Assess*. J. 6 (1), 19-56; Nordhaus, W., Boyer, J., 2000. *Warming the World: Economic Models of Global Warming*. MIT press, Cambridge, MA; Nordhaus, W., Yang, Z., 1996. *A regional dynamic general-equilibrium model of alternative climate-change strategies*. Am. Econ. Rev. 86, 741-765; Isacs, L., Finnveden, G., Dahllöf, L., Håkansson, C., Petersson, L., Steen, B., Swanström, L., Wikström A., 2016. *Choosing a Monetary Value of Greenhouse Gases in Assessment Tools: A Comprehensive Review*. Journal of Cleaner Production 127: 37–48.

[17] The discount rate refers to the rate that future costs and benefits are discounted relative to current costs.

Nobel Prize in Economics. The Nobel committee recognized with the award the economics of climate change, which underlines the relevance of a carbon tax[18].

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 IPCC, who referred to the work of Nordhaus when calculating the costs of climate change[19].

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

11. In practice, several practical approaches can be used to set a carbon tax rate. Thereby, it is possible to set the tax rate without an underlying economic theory. A more practical approach would be to set the tax rate corresponding to a specific carbon reduction target through the Standards and Price Approach (also known in literature as *Baumol/Oates* approach)[20]. Therefore, the focus of the Standard and Price Approach is not the determination of the correct social cost of CO2. The primary objective is rather the determination of a carbon tax rate, which helps to reach a specific emission reduction target. Using the Standards and Price Approach, inaccuracies in the economic determination of the carbon tax rate can be overcome. The basic idea is to set the carbon tax rate at a level that is expected to be necessary, in order to reach a specific emission reduction target.

12. In the first step an emission reduction target (Standard) is set. After this target is set, a tax (Price) will be implemented in order to reach the goal. The tax rate will then be adjusted according to a "trial and error" policy in order to reach the set standard. Following the iterative approach of the Standard and Price Approach helps to reach specific emission reduction targets since the price signal is getting more and more accurate. Thereby, the initial carbon tax rate could be set by any economic model or on a technology-based approach (e.g. Marginal Abatement Costs Curves (MACC))[21]. The main advantage of this method, compared to the Pigouvian Taxation, is that it is not necessary to find the economic optimal tax rate, as the emission reduction goal will

[18] For further reading on the contribution of William Nordhaus, see http://www.nobelprize.org/uploads/2018/10/advanced-economicsciencesprize2018.pdf.

[19] *IPCC, Mitigation Pathways Compatible with 1.5°C in the Context of Sustainable Development in Special Report: Global Warming of 1.5 ºC above pre-industrial levels and related global greenhouse gas emission pathways, in the context of strengthening the global response to the threat of climate change, sustainable development, and efforts to eradicate poverty* IPCC (2018), p. 150.

[20] Baumol, W.J., Oates, W.E., 1971, *The use of Standards and Prices for Protection of the Environment*, The Scandinavian Journal of Economics 31, 42-54; Walker, M., Storey, D.J., 1977, *The "Standards and Price" Approach to Pollution Control: Problems of Interaction*, The Scandinavian Journal of Economics 37, 99-109.

[21] Vogt-Schilb, A., Hallegatte, S., 2014 *Marginal abatement cost curves and the optimal timing of mitigation measures*, Energy Policy 66, 645-653.

be reached following a dynamic tax rate trajectory. However, the disadvantage of the Standard and Price Approach is that there needs to be a strong political commitment to follow this strategy over several years, because regular tax rate adjustments are crucial for the Standard and Price Approach. Those adjustments must be solely based on environmental, rather than on political considerations.

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

Box 11: Standards and Price Approach in practice

A Standard and Price Tax on waste helped Denmark to achieve a solid waste reduction of 26 % between 1987 and 1998. The tax was levied per ton of solid waste, which was produced, for example, from the industry or construction activities. The purpose of the tax was merely to affect the behaviour. The tax was introduced to support a national plan to increase the recycling rate to 54 % 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 40 / ton to DKr 375 / ton in 2000. Therefore, the tax can be seen as a tax that followed the principles of the Standards and Price Approach[22].

3.3. Revenue Target Approach

14. Different policy objectives may encourage jurisdictions to implement carbon taxes. Besides environmental considerations, one of the main motives for some jurisdictions to implement carbon taxes is to generate considerable tax revenues[23]. In 2018, the total value of all carbon taxes and emission trading schemes which are in force in jurisdictions worldwide was US $ 44 billion, which is an increase of nearly US $ 11 billion[24]. Therefore, carbon taxes contribute to the budget in general or to reduce unwanted distributional effects of the carbon tax itself (see chapter on revenue use, yet to be drafted).

[22] Andersen, M. & Dengsøe, N., 2002, *A Baumol–Oates approach to solid waste taxation*, Journal of Material Cycles and Waste Management 4: 23.
[23] Partnership for Market Readiness. 2017. *Carbon Tax Guide: A Handbook for Policy Makers*, World Bank, p. 93.
[24] World Bank Group. 2019. *State and Trends of Carbon Pricing 2019*. Washington, DC: World Bank. © World Bank. https://openknowledge.worldbank.org/handle/10986/31755 License: CC BY 3.0 IGO, p. 6.

Box 12: Tax revenue - a driver for the implementation of a carbon tax

Although Chile has no earmarking of tax revenues, the possibility of using revenues to desirable purposes was of interest when implementing the carbon tax within the framework of a broader fiscal reform in Chile. The fiscal reform modified the income tax system considerably and implemented a carbon tax. The fiscal reform was estimated to collect US $ 8.3 billion in total. The government experts calculated in advance that the carbon tax will generate a tax revenue of US $ 168 million. However, the government did not define a specific revenue target in advance, which had to be met with the carbon tax[25].

15. Moreover, it is possible that jurisdictions set the tax rate in a way that maximises their tax revenue or that generates a specific level of revenue. Therefore, jurisdictions could try to adjust the tax rate of a carbon tax to reach a targeted tax revenue. For example, a jurisdiction may decide in advance to reach a specific tax revenue with the carbon tax. This decision has a strong impact on the tax, because the choice of the tax rate has a direct impact on the tax revenue. Thereby, the tax rate can be set within the dedicated market forces (supply and demand). In order to actively shape and influence the tax revenue, the revenue target approach also requires a lot of economic data to be available in order to reach a specific revenue target (see Box XX Price Elasticities)[26]. This is because the level of tax revenue generated from a specific tax rate depends on the demand and supply curve of carbon-intense products.

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 responds disproportionately low to changes in the price. This is partly due to the fact that emitters can hardly change their habits in the short term. However, in the long-term, studies have shown that the elasticity is higher, which means that the demand responds to price changes[27].

[25] 4echile.cl, 1 Strategy – Chile´s Green Tax, available at: https://www.4echile.cl/4echile/wp-content/uploads/2018/05/1.-Strategy.-Chile´s-Green-Tax.pdf

[26] Abenezer Zeleke, A., 2016., G*asoline and diesel demand elasticities: A consistent estimate across the EU-28*, Swedish University of Agricultural Sciences, Working Paper 11/2016.

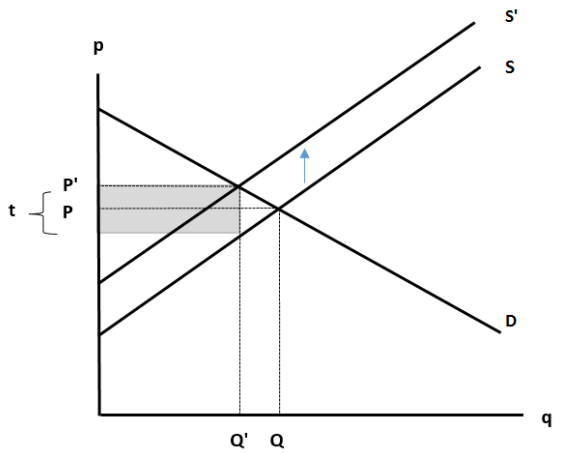
[27] Abenezer Zeleke, A., 2016., G*asoline and diesel demand elasticities: A consistent estimate across the EU-28*, Swedish University of Agricultural Sciences, Working Paper 11/2016.

16. Economists need this data to calculate and estimate a tax rate, which generates a targeted level of revenue. Carbon taxes can be a stable source of revenue over the usual planning horizons of fiscal policy[28]. Although carbon taxes are primarily intended for climate reasons, carbon taxes can generate a considerable amount of tax revenue. However, once the CO2 emissions decreases the tax base of a carbon tax may be eroding. Therefore, a targeted tax revenue cannot be maintained over time. Moreover, the revenue target approach could be seen in a critical light from an environmental point of view. According to economic theory, the primary aim of carbon taxes is to internalise external costs and not to raise the tax revenue for the government. Hence, the generation of specific revenue targets through carbon taxes could thus contradict environmental objectives in the long term.

Box 14: Revenue target approach

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 supply 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 XX Price Elasticities



Source: Partnership for Market Readiness. 2017. Carbon Tax Guide

[28] Partnership for Market Readiness. 2017. *Carbon Tax Guide: A Handbook for Policy Makers*, World Bank, p. 120.

3.4. Benchmarking Approach

3.4.1. Benchmarking comparison with carbon tax rates

17. Overall, around 30 jurisdictions around the globe impose taxes on carbon in 2019[29]. Jurisdictions which have already implemented a carbon tax could to some extent serve as examples for policy makers to study when setting a tax rate for carbon. The OECD and the World Bank publish carbon tax rates and trends of carbon pricing from several jurisdictions on a regular basis[30].

18. The table below illustrates a selection of current carbon tax rates, ranging from US $ 2.65/ t CO_2e (Japan) to around US $ 121.29 / tCO_2e (Sweden). The wide spectrum of tax rates is an indicator that different policy strategies are followed by carbon taxes[31].

Jurisdiction Covered	**Nominal tax rate in November 2019** **US $ / tCO_2**
Argentina	6.24 (most liquid fuels)
British Columbia	30.26
Chile	5
Colombia	4.99
Denmark	25.91 (fossil fuel)
Finland	68.43 (transport fuel)
France	49.23
Japan	2.65
Mexico	3 (Upper)
Norway	57.14 (Upper)
Singapore	3.63
South Africa	8.29
Sweden	121.29

[29] See chapter 2.

[30] World Bank Group. 2019. *State and Trends of Carbon Pricing 2019*. Washington, DC: World Bank. © World Bank. https://openknowledge.worldbank.org/handle/10986/31755 License: CC BY 3.0 IGO; OECD, 2018. *Effective Carbon Rates 2018: Pricing Carbon Emissions Through Taxes and Emissions Trading*.

[31] See chapter 2.

Switzerland	96.57

Table 5: Selection of nominal carbon tax rates in November 2019
Source: Data based on Carbon Pricing Dashboard, The World Bank available at https://carbonpricingdashboard.worldbank.org/map_data.

19. The benchmarking approach relies on an analysis of the tax rates as well as the tax design of other jurisdictions. It is important to mention that the implemented taxes differ from each other. For example, they are levied on different levels of the production chain, some of them include exemptions for certain industries, while others have not implemented any exemptions. Furthermore, carbon taxes differ regarding the scope of the taxes as some carbon taxes might have a limited coverage while other taxes have a broad coverage. In addition to that, some carbon taxes are levied on certain transactions while others are directly related to emissions. Moreover, as jurisdictions have different framework conditions, policymakers should consider which jurisdictions are in a comparable situation when designing their tax rates. Regarding the selection of comparable jurisdictions, the following factors may be taken into account[32]:

- policy objective
- similar economies/politics
- demographic factors
- energy production
- geographic distribution
- potential for coordination
- tax system

20. The list only shows some examples and ideas, which factors may be relevant in order to identify jurisdictions that are appropriate for benchmarking. It is also important to consider current trends and international developments of carbon taxes in a benchmarking analysis. This could help policymakers to connect international developments with discussion on a national level.

21. Another important factor to consider is the carbon tax level of key trading partners and competing jurisdictions. Policymakers may be concerned about introducing carbon taxes, which are high compared to taxes applied in those jurisdictions, where the key trading partners operate. The benchmark approach also takes into account the tax rate level of competing jurisdictions in order to reduce the risk of carbon leakage. Political concerns regarding carbon leakage and competitiveness are in practice key factors for setting the tax rate.

[32] Partnership for Market Readiness. 2017. *Carbon Tax Guide: A Handbook for Policy Makers*, World Bank, p. 95.

22. While it can be useful for policymakers to be informed about existing carbon tax rates in other jurisdictions, it should at the same time be noted that current carbon tax rates in most cases are significantly lower than the tax rates required to achieve the Paris temperature target. For instance, the High-Level-Commission on Carbon Prices, as mentioned earlier, proposed on the basis of policy experience, and relevant literature, a carbon price level of US $ 40–80 / tCO_2 by 2020 and US $ 50–100 / tCO_2 by 2030[33]. Currently, only the tax rates in six countries (Finland, France, Liechtenstein, Norway, Sweden and Switzerland) are higher than US $ 40 / tCO_2. In other words, most jurisdictions which have implemented a carbon tax are facing a gap in order to reach the Paris goals. From an environmental perspective, it is therefore questionable if the current carbon tax rates are appropriate for a benchmarking analysis.

23. At the same time, studies from the OECD have shown that taxes on fossil fuel products have been rising over the past years in many jurisdictions. For example, Alberta, British Columbia, in Canada, Finland, France, Iceland and Switzerland have increased – some of them significantly – their carbon tax rates in 2018. This recent development could encourage the implementation of a more ambitious carbon tax rate.

Box 15: Examples of carbon tax rate changes made in 2018 and 2019:

- British Columbia's carbon tax increased from CAN$ 30 / tCO_2 (US $ 23 /tCO2) to CAN$ 35 / tCO_2 (US $ 26 /tCO2) in 2018. The government in British Colombia announced that it will continue to increase the tax rate annually by CAN $ 5 / tCO2e until the rate is CAN § 50 / tCO2 (US $ 38 /tCO2) in 2021;
- Iceland carbon tax increased by 10 percent to approximately ISK 3850 / tCO2 (US$ 36 /tCO2) on January 1, 2019;
- The Portugal carbon tax rate almost doubled from € 6.85 /tCO2 (US $ 8 /tCO2) to € 12.74 / tCO2e (US $ 14 /tCO2) on January 1, 2019.
- Switzerland's carbon tax increased from CHF 84 / tCO2 (US $ 85 /tCO2) to CHF 96 / tCO2 (US$ 97 /tCO2);

Source: The World Bank, 2018. State and Trends of Carbon Pricing 2018 and The World Bank, 2019. State and Trends of Carbon Pricing 2019.

3.4.2. Benchmarking comparison with other market-based instruments

24. The benchmarking analysis does not have to be limited to the comparison of carbon tax rates exclusively. Including other market-instruments in the analysis can provide important context considering that such instruments indeed also can contribute to the aggregated price signal on carbon in a given jurisdiction. In this respect specific taxes

[33] High-Level Commission on Carbon Prices. 2017. *Report of the High-Level Commission on Carbon Prices. Washington, DC: World Bank.*

on fuel (excises tax) can also be relevant to consider in a benchmarking analysis, as well as prices observed in emissions trading systems[34].

25. Although they do not explicitly price carbon, special taxes on fuels can in many ways show close resemblance to carbon taxes. Adding specific taxes on fuels to the benchmark analysis requires some precision however as tax rates on various fuels as well as for various users may differ strongly within a given jurisdiction. Consequently, it is not always clear which concrete tax rate should be used for benchmarking, e.g. the tax rate for diesel, petrol, coal? This is especially difficult when doing benchmarking analyses for carbon taxes as the basic idea of carbon taxes is to apply a uniform tax rate for carbon, which does not depend on fuel types. Another additional context for benchmarking analyses may also be provided from carbon prices which are observed in emission trading schemes. For example, Portugal and Iceland use the allowance prices within the EU Emission Trading Scheme as one factor, which is used to set the carbon tax rate[35].

26. 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 – are calculated by the OECD for a large number of countries[36].

Box 16: OECD Effective Carbon Rates

The OECD publishes the effective carbon rates for 42 OECD and G20 countries, on a regular basis[37]. In its report, the OECD measures the carbon pricing gap, which represents the difference between actual effective carbon rates and a benchmark rate. Today, the benchmark is EUR 30 and it is estimated to increase to a midpoint of EUR 60 in 2020. EUR 60 also serves as a low-end estimation for 2030. The carbon pricing gap indicates to which extent the benchmark is not reached. A small gap is an indicator that the effective carbon tax rate is close to the benchmark.

According to the OECD, carbon prices are too low to slow climate change to the degree countries have pledged. In 2018 the effective carbon tax rates in all 42 jurisdictions are priced 76.5 % below even the lowest benchmark of EUR 30. Therefore, most jurisdictions do not reach even the lowest estimated costs of society. However, the carbon pricing gap has improved from 83 % in 2012. But 46 % of the emissions 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, also emissions from biomass are 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 the OECD estimates indicate.

[34] OECD, 2018. *Effective Carbon Rates 2018: Pricing Carbon Emissions Through Taxes and Emissions Trading*.
[35] Partnership for Market Readiness. 2017. *Carbon Tax Guide: A Handbook for Policy Makers*, World Bank, p. 95.
[36] OECD, 2018. *Effective Carbon Rates 2018: Pricing Carbon Emissions Through Taxes and Emissions Trading*.
[37] OECD, 2018. *Effective Carbon Rates 2018: Pricing Carbon Emissions Through Taxes and Emissions Trading*.

4. Temporal Development of the Tax Rate

4.1.The role of politics

27. We have in this chapter discussed various approaches for setting a carbon tax rate. Those approaches can help jurisdictions to create a policy strategy. Thereby, this will include the involvement of political compromise. However, economic theories and various approaches will play an important role in the political process. Even more important is the strategy that was agreed upon. Thereby, the broadest political consensus should be found in order to avoid that the tax rate does not become subject of short-term political considerations.

28. A long-term implementation is crucial for the effectiveness of a carbon tax, since only with a long-term strategy planning security for investors can be ensured. This is because investors and actors must rely on the political commitment to support the green development for the next 10 to 50 years.

4.2.Tax Rate trajectory

29. It is important for policymakers to consider the temporal dynamics of the tax rate during the introduction phase of a carbon tax[38]. There are different policy strategies behind imposing a carbon tax rate and its modification in the first periods: One strategy is to introduce an initial tax rate, which remains on the same level for the next periods ("static carbon tax rate"). Another strategy is to adjust the tax rate over time to soften the impacts of the sudden implication of a carbon tax. This is the strategy that has been most often applied by the jurisdictions leading the application of carbon taxes worldwide. To do so, policymakers may decide to apply a lower tax rate in its initial year ("ramp up introduction")[39]. If a jurisdiction has decided to apply a slow ramp up strategy the tax rate would be gradually increased until the tax rate has reached 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 and environmentally friendly technologies and would not face major economic shocks.

30. For example, British Columbia, Canada followed a ramp up strategy. British Columbia introduced a carbon tax at a rate of CAD $ 10 / tCO2 in July 2008. The province then gradually increased the tax rate within the next four years per CAD $ 5 each year, reaching its target level at CAD $ 30 in 2012. Further, the British Columbia carbon tax increased to CAD $ 35/tCO2 on April 1, 2018 and increases by $ 5/tCO2 on every April 1 until hitting CAD $ 50/tCO2 on April 1, 2021[40]. A similar approach was taken by France, which introduced a carbon tax in 2015. The legislator set the rising tax rate for each year up to 2021 when it is planned to reach € 56 / t CO2. The French legislator

[38] Partnership for Market Readiness. 2017. *Carbon Tax Guide: A Handbook for Policy Makers*, World Bank, p. 95.
[39] Institute for European Environmental Policy (IEEP). 2013. *Evaluation of Environmental Tax Reforms: International Experiences*, p. 58.
[40] World Bank Group. 2019. *State and Trends of Carbon Pricing 2019*. Washington, DC: World Bank. © World Bank. https://openknowledge.worldbank.org/handle/10986/31755 License: CC BY 3.0 IGO, p. 32.

also laid down the goal for the tax rate to reach € 100 in 2030 without defining the actual tax rates between 2021 and 2029 from the outset. However, in response to major national protests the trajectory was temporarily stopped in 2018, to give the authorities time to further consider the coordination between the carbon tax policy and other measures. Singapore has also implemented a carbon tax with an initial tax rate of S $ 5 /tCO2 in 2019. The intention of Singapore is to increase the tax rate gradually to S $ 10 to 15 / tCO2 in 2030[41].

31. It is not necessary to define the exact trajectory to a specific tax level. However, it is from an environmental point of view important to define the future targeted tax level when introducing a carbon tax. Only then, emitters will respond to the future carbon price from the beginning of the implementation of the carbon tax. A gradual increase of the carbon tax rate seems politically desirable, as it is easier to gain political support for a gradual implementation. Moreover, it also gives investors and business operators time to phase-out carbon intense facilities. Nevertheless, the ramp up strategy has also notable risks. First, the environmental effect is limited in its initial phase, due to relatively low tax rates. Second, low initial tax rates may stick due to political considerations.

32. The alternative would be to follow a strategy with 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, in order to be effective from an environmental point of view, the tax rate would need to be set at a sufficiently high level, which can trigger sudden increases in prices after the implementation of a carbon tax. The consequence could be an economic shock in carbon-intense industries. Emitters would also have less time to adjust their behaviour to avoid negative consequences. 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[42].

4.3.Regular adjustments of the Tax Rate

33. Setting the rate of a carbon tax is not a one-time task in the initial phase. It is an ongoing process which requires constant adjustments. This is because setting a carbon tax rate is always subject to uncertainties, since the exact impact of the tax is not predictable in advance. Therefore, it is crucial to change and evaluate carbon tax rates over time. Thus, tax rate adjustments in consequence of a dynamic tax rate trajectory policy are crucial for policymakers. Moreover, new available scientific data and information could help to re-shape the tax rate in order to reach a specific goal with a carbon tax. For example, the underlying assumptions or economic models, which have served as

[41] World Bank Group. 2019. *State and Trends of Carbon Pricing 2019*. Washington, DC: World Bank. © World Bank. https://openknowledge.worldbank.org/handle/10986/31755 License: CC BY 3.0 IGO, p. 41.
[42] Partnership for Market Readiness. 2017. *Carbon Tax Guide: A Handbook for Policy Makers*, World Bank, p. 95.

a basis for modelling the carbon tax could be outdated because of new scientific results. From an environmental point of view, it is essential to adjust the tax rates over time. Economic developments (e.g. inflation[43]) or recent international developments on carbon taxes may change basic assumptions, which were made in the past (see Box 17). Furthermore, changes in a jurisdiction's climate mitigation target or a change in public support may occur[44].

Box 17: 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 of inflation, which could lead to the situation that a constant tax rate weakens over time. Therefore, for example, the Chile, Colombia, Denmark, Mexico, Netherlands and Sweden, have indexed their carbon and energy taxes to inflation in order to maintain the price signal of their tax rates.

The effect of not indexing the tax rate according to inflation can be verified under the Argentine example. As previously denoted, Argentina currently applies a carbon tax that is valued at US $ 6.25 t/CO_2e. Worthy to note is the fact that the Argentine carbon tax was originally priced at US $10 t/$CO_2$e 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/CO2e. 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[45].

34. Therefore, policymakers may decide to implement predetermined adjustments formulas within the law[46]. The law could include specific criteria or scenarios which could trigger changes in the tax rate. One example could be that the tax rate automatically increases if specific reduction targets are not meet. Moreover, economic factors like GDP growth or exchange rates developments could be used as triggering factors. Switzerland has implemented reduction targets in its national carbon tax. The tax rate is raised by a predetermined formula in advance[47]. The exact predomination of the adjustment formula is crucial to avoid another legislative procedure by the parliament. In the case of Portugal, the national carbon tax has incorporated an annual adjustment, which is dependent on economic criteria. However, predetermined

[43] World Bank Group. 2019. *State and Trends of Carbon Pricing 2019*. Washington, DC: World Bank. © World Bank. https://openknowledge.worldbank.org/handle/10986/31755 License: CC BY 3.0 IGO, p. 21.
[44] See para 66 in chapter 2.
[45] World Bank Group. 2019. *State and Trends of Carbon Pricing 2019*. Washington, DC: World Bank. © World Bank. https://openknowledge.worldbank.org/handle/10986/31755 License: CC BY 3.0 IGO, p. 29.
[46] See para 66 in chapter 2.
[47] See Article 10 *Verordnung über die Reduktion der CO2-Emissionen (CO2-Verordnung)* vom 30.12.2012 (Stand 19.02.2019), AS 2012 7005.

adjustment formulas may raise constitutional and political concerns in some jurisdictions.

35. Furthermore, policymakers may decide to periodically review the carbon tax rate for example via a special committee. Thereby, experts may report the impacts of the carbon tax within the past periods on an annual basis. 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. Those committees may only be composed of experts or of various stakeholders, which are involved. Reviewing the carbon tax rate can also be part of the general political considerations normally taking place within Government Offices. For example, Norway is reviewing its carbon tax rate on a yearly basis, as the Norwegian tax law constitutionally is presented as part of the annual national budget. During this process, the Norwegian carbon tax rate has been increased over the last years[48]. Also, Ireland reviews the status of their national carbon tax rate on a yearly basis. Thereby, Ireland reviews the performance of the tax and may consider international trends of carbon pricing[49]. One advantage of reviewing processes is that it provides for 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 no doubt varies greatly between jurisdictions.

4.4.Setting Tax Rates under challenging circumstances

36. Special consideration may occur when setting a carbon tax rate for a specific country because it may not be in a comparable situation with other countries that have implemented a carbon tax. For example, some countries may face the challenges of a weak economic performance and a low Human Development Index, which are factors that merit special considerations when designing a carbon tax. Choosing a tax design which is easy to administer would thus often be a key issue for countries in such circumstances. Economic growth and development are essential to fight widespread poverty. Therefore, concerns might exist that high carbon taxes could slow down future economic development which might hamper access to basic services and infrastructure. However, it can also be argued that tax increases, help countries to strengthen their social and educational systems, which could help to reach a higher growth path. Additionally, resource-rich countries may feel dependent on carbon-intense industries like, coal, oil, cement, steel and aluminium. Therefore, they might be concerned that climate protection counters their economic growth and development. In practice, all countries have special economic and demographic characteristics, which need to be considered when setting a tax carbon tax rate.

[48] Partnership for Market Readiness. 2017. *Carbon Tax Guide: A Handbook for Policy Makers*, World Bank, p. 97.
[49] Report of the Joint Committee on Climate Action. 2019. *Climate Change: A Cross-Party Consensus for Action.*

37. However, carbon taxes may be essential not only for protecting the environment but also for enhancing development[50]: The revenues from a carbon tax mobilizes domestic revenues, which can support poverty reduction to develop infrastructure in an environmentally friendly way[51]. Carbon taxes can also stimulate development of the energy sector and innovation, which could create economic opportunities for countries with a variety of different backgrounds. For example, Singapore mentioned the stimulation of low-carbon innovation as an additional objective of its carbon tax.

38. Another example can be given from the Colombian context. The Colombian government implemented a carbon tax on all liquid and gaseous fossil fuels used for combustion as part of a broad tax reform package in 2017. The carbon tax can help Colombia to steer its economy towards a lower-carbon development path. Colombia also uses the tax revenue of the carbon tax to finance for example investments in low carbon projects, adaptation and technological innovation. The initial tax rate of the Colombian carbon tax was determined with US $ 5. The tax is set to increase annually by 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. Analyses by the Colombian government has shown that the carbon tax is not regressive in Colombia, which means that households with higher income are more affected by the tax.

39. Trade-offs between economic development and emission reduction may exist in some countries. Examples would be countries, which are strongly dependent on carbon-based energy resources and on energy imports[52]. In such cases, the imperative of development and poverty reduction may justify lower carbon tax rates in the short time. 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 would 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. Moreover, empirical studies have shown that the price elasticity of fuel products in poor countries is higher than in rich countries, which means that the demand for fuel products reacts stronger on price changes. Therefore, lower carbon tax rates may be justified by the specific economic situation in countries where the impact of a price change in fuel prices is higher.

[50] See chapter 2.
[51] High-Level Commission on Carbon Prices. 2017. *Report of the High-Level Commission on Carbon Prices*. Washington, DC: World Bank, p. 18.
[52] High-Level Commission on Carbon Prices. 2017. *Report of the High-Level Commission on Carbon Prices*. Washington, DC: World Bank, p. 19.

40. Summing up, various factors support the idea of lower carbon tax rates under some circumstances and in some countries. However, this conclusion does not mean that some 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 by 2030.

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Table of Contents

Chapter 3C: Addressing undesired effects for households and firms

1. Check-list for addressing undesired effects for households and firms

- Policy makers should first carefully assess the risks of competitive effects and carbon leakage as well as undesired distributional effects in the particular jurisdiction.
  - Energy-intensive and trade-exposed firms are more likely to suffer from adverse competitiveness effects than others.
  - Energy intensive and trade-exposed firms in general also face the largest risk of carbon leakage.
  - Distributional effects often depend on household income, but there can be considerable heterogeneity within income groups which also may need to be considered.
- Next, appropriate measures to mitigate impacts can be chosen, for instance:
  - Measures that reduce carbon tax payments (exemptions, reduced rates, tiered systems, thresholds etc.).
  - Support measures to alleviate negative effects (support programs, flat payments, reductions of other taxes than the carbon tax, wider economic policy reforms etc).
  - International coordination and cooperation.
- While designing measures to address undesired effects of a carbon tax, policy makers should seek to:
  - Avoid undue administrative complexity.
  - Preserve the environmental integrity of the tax.
  - Be attentive to the perception of fairness of the tax among both different social groups as well as sectors.
- Regularly assess implemented measures to ensure that they remain relevant and appropriate

2. Introduction

1. The economic purpose of a carbon tax is based on the conception that emitters of carbon dioxide impose costs on others, without paying for the resulting damage that occurs. A carbon tax provides a price signal that gives incentives to emission reductions. However, concerns over undesired effects on firm competitiveness and carbon leakage, together with fear of unwanted distributional impacts, can constitute significant political obstacles for the implementation of a carbon tax and therefore such concerns need to be considered in the process of designing the tax.

2. Like any policy intervention, carbon taxation can give rise to undesired side effects. While introducing a price on carbon dioxide that is emitted into the atmosphere, carbon taxes may also lead to price increases for goods and services which in turn can have negative impacts on households as well as on firms. Policy makers may – for a wide range of reasons – want to avoid, or at least mitigate, as much of these negative impacts

as possible. Addressing concerns over e.g. distributional effects, social equity and fairness, employment and firm competitiveness is also important for getting public acceptance for a carbon tax and can make implementing the tax easier. 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 policy makers to protect domestic firm competitiveness may serve as a means to avoid carbon leakage.

3. In this chapter we will discuss some of the issues jurisdictions may want to consider when trying to mitigate possible negative side effects of a carbon tax. An account is given for the concerns generally raised, including brief accounts of the current knowledge of the actual occurrence and size of negative effects on households and firms. Next, the chapter presents an overview of possible measures different jurisdictions have undertaken to address undesired impacts of a carbon tax. Finally, examples of how jurisdictions have introduced a carbon tax using two-level tax system and thresholds are given.

3. Possible adverse effects from carbon taxation

3.1. Concerns over negative impacts on households

4. Introducing a carbon tax will most likely have implications, both direct and indirect, for households in the jurisdiction. The impact of the tax on households is also often at the centre of the public debate when carbon taxes are on the agenda. Such discussions are important and 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.

5. Moreover, fear of negative effects for households and individuals can take the form of public protests. The French nation-wide demonstrations organized by the “Gillets Jaunes” movement expressed dissatisfaction over a range of economic policies was indeed sparked in late 2018, among other things, by concerns for the effect of increasing carbon taxation on fuel prices and how this would affect households that are dependent on their cars in daily life.

6. It is clear that concerns over e.g. distributional impacts, social justice and equity implications of a carbon tax in many cases are not only legitimate and important to address as such, but also require the attention of policy makers in order to secure the success of the tax. It is also important to take into consideration the wider policy context of those affected or the public may find it difficult to accept the carbon tax. It is for instance advisable to evaluate other economic policies in conjunction with implementing or making changes to the tax.

7. The most common way to measure distributional effects is to study the impact on different income groups. The empirical literature has predominately investigated distributional effects from general excise duties on energy sources, rather than from carbon taxation specifically. However, the impacts on households from general excise duty taxation and carbon taxation are likely to be very similar, which means that the

conclusions drawn from studies on distributional impact from the former are all in essence transferrable to the latter.

8. Conventional wisdom regarding the distributional effects of taxation of energy sources has been that it is regressive, i.e. that such taxes affect households with lower income more than those with higher income. As the knowledge-base has grown this has changed and today a somewhat different picture has emerged. The evidence now shows that taxes on energy no longer can be viewed as universally regressive, but instead that the tax incidence, or the ultimate distribution of the burdens of the taxation, depends on a variety of factors. These factors include, among other things, the type of energy commodity being taxed, the social, physical and climatic characteristics of the jurisdiction, and how household income is measured[1].

9. For instance, taxation of vehicle fuels has been found to be neutral or even progressive in several middle and lower-income countries, which can be explained by the fact that motor vehicle ownership is less likely in poorer households in these countries and hence these households will to a lesser extent be directly affected by a tax on diesel or petrol. However, households may be affected by a carbon tax not only through having to pay for their own emissions (e.g. from the burning of fuels for transport or heating). In addition, they may also face increased overall costs for their consumption as taxation of emissions that arise in the production of goods and services gets passed through to consumer prices. These indirect costs to households are sometimes less tangible and hence more difficult to measure. Nevertheless, when looking at the social effects of a carbon tax, it is important to take into account both the direct and indirect effects.

10. In addition to the distributional effects and the possible regressive or progressive nature of a carbon tax in a given jurisdiction, other dimensions of the social impacts of the tax include the perception of fairness, equity social and justice in the design and implementation of the tax.

3.2. Concerns over adverse effects on firms

11. As shown above, a carbon tax can cause, both directly and indirectly, increased costs. For a firm operating in a jurisdiction with a carbon tax, the increased direct cost is partly due to the actual tax expenditure that a firm has to pay as a result of its emissions, but the cost increase can also arise from the fact that a firm's other inputs become more expensive as the cost of emissions is getting passed on to the price of goods and services needed for the firm to operate.

12. Apart from the increased direct cost of emissions, goods and services, the firm may also face increased costs from its own emissions reduction measures. In the short run,

[1] See e.g. Flues, F., & Thomas, A. (2015). The distributional effects of energy taxes (p. 0_1,2-3,6-74). Paris, France: Organisation for Economic Cooperation and Development (OECD)., or William A Pizer & Steven Sexton, 2019. "The Distributional Impacts of Energy Taxes," Review of Environmental Economics and Policy, vol 13(1), pages 104-123., and references therein.

measures to decrease emissions can entail e.g. fuel switching or energy efficiency improvements. There is also the possibility that some firms may choose to avoid the tax by simply reducing production. In the short run, it is likely that the range of possible mitigation options firms can choose from is somewhat limited due to capital constraints, current technologies and production processes etc.

13. In the medium to long run on the other hand, other type of mitigation efforts can be expected as firms will have had more time to raise capital, invest in R&D and adopt new technologies. More long-term investments by firms can be focused on reducing emissions within the existing production technologies and processes, or be aimed at changing entire production processes. Either way, the more profound mitigation measures a firm undertakes, the more resources are likely to have been invested and hence the larger the direct cost for the firm.

14. In addition to the direct investment cost in mitigation measures, firms may also face an indirect cost, measured as the loss in profits that follows from the fact that investment in mitigation activities 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 more long-term negative effect on e.g. future competitiveness.

15. Firms that produce a homogeneous product for an international market normally compete through the price of their goods (rather than quality) and will consequently find it difficult to pass on costs from increased taxation to its customers. Under these circumstances, an increase in production costs therefore risks leading to reduced market shares for the domestic firms. The competitiveness of such firms is, in theory, likely to be more negatively 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.

16. Firms that have the ability to transfer a significant portion of its costs through their product prices without losing market shares are in general more likely to be less exposed to adverse competitiveness effects. Knowing ex-ante which firms and sectors that are most vulnerable in this respect requires a careful assessment as it depends on the particular 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.

17. It could be noted here that having to invest in less polluting technologies sometimes is considered to have a positive effect on e.g. firm productivity, profits and competitiveness as investments will lead to enhanced resource efficiency, spur innovation and open new markets. Although there is a considerable amount of research

on the topic the empirical evidence to support the existence of the so-called Porter hypothesis, according to which environmental regulation enhances innovation and competitiveness, is not conclusive. While regulation indeed seems to spur innovation, it is less clear to what extent stricter regulation also enhances business performance.[2]

18. There is an extensive economic literature trying to shed light specifically on the interaction between environmental taxes (such as carbon taxes), energy prices and trade and how these factors affect competitiveness.[3] Ex-ante studies indicate the effects can be rather large, depending on which sectors are being investigated and what method is used for the analysis. Although, when it comes to establishing theses effects ex-post, there is less evidence to support significant adverse effects from environmental taxes on firm competitiveness in general. As expected, ex-post studies do confirm that negative impacts are more likely to occur in energy intensive trade exposed sectors than others. The observed impacts have been found to be relatively small and short-term.

19. 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 any such negative impacts have been limited. There are several possible explanations for this, e.g. the fact that carbon taxation only is one out of a multitude of factors that affect the choices made by firms. Careful policy design may also have prevented or mitigated possible negative impacts.

3.3. Concerns over carbon leakage

20. Closely related to the question of adverse competitive impacts is the notion of carbon leakage. Carbon leakage can be said to occur when the introduction of carbon pricing, through e.g. a carbon tax, in one jurisdiction results in increased emissions in another jurisdiction. While the effects of carbon taxes discussed above are manifested as increased costs for economic agents, carbon leakage is instead related to the effectiveness of the tax as an instrument to reduce global carbon emissions. There are several channels through which such leakage can arise, but here the so-called competitiveness channel is the most relevant to consider.

21. As a carbon tax will increase the cost of domestic production in a given jurisdiction, foreign goods gain a competitive advantage and as a result consumption may switch towards imported goods. As production and emissions decrease domestically, they are

[2] Se e.g. Ambec et al (2011) *The Porter Hypothesis at 20. Can Environmental Regulation Enhance Innovation and Competitiveness?* Review of Environmental Economics and Policy, Volume 7, Issue 1, Winter 2013, Pages 2-22

[3] See e.g. discussion in Coste et al in Pigato (ed) (2019) *Fiscal policies for development and Climate Action*. International development in focus. Washington, DC. World Bank, and references therein. 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.

likely to increase abroad. Since the effect on climate change from carbon dioxide emitted into the atmosphere is the same regardless of where the emissions occur, the overall climate effect cannot solely be measured by the domestic emission reductions. If the domestic production is less polluting than the foreign production, the reduction in domestic emissions will be more than offset by increased emissions abroad. The opposite can of course also be true, i.e. that foreign production is in fact cleaner and hence that only some of the domestic emission reduction is offset, but this is less likely to happen as it is reasonable to assume that production will move to jurisdictions with less stringent climate policy.

22. Carbon leakage can occur in the short run as an effect of firms choosing to reduce current production volumes in existing plants. In the longer run it can also arise as investments, in anticipation of reduced profits or lower rates of return, shift away from the domestic industry and thereby also affecting future production capacity. In both cases there is a risk the overall emissions will increase. Hence, addressing concerns over potential adverse effects of a carbon tax on competitiveness may also at the same time strengthen the environmental integrity of the carbon tax.

23. The empirical literature on carbon leakage – and especially through the competitiveness channel – coincides to a large extent with the literature on trade, competitive effects and environmental taxation. The evidence for carbon leakage to date is rather weak.[4] While ex-ante studies show leakage rates varying from negligible to close to 100 per cent (depending on analytical framework and sectors studied), there is less support to be found for significant carbon leakage in ex-post evaluations. As noted above, the reasons for this may be many. One explanation can be found in the fact general excise duty taxation on energy or carbon taxation is but one out of a long list of factors that influence the decisions of firms and investors. Design features, in existing carbon taxes and other pricing mechanisms, that aim at protecting firm competitiveness and carbon leakage may certainly contribute as well. Furthermore, carbon leakage has likely also been limited by the fact that carbon taxes to date have been set at rather modest rates.

4. Assessing the risk of negative effects

24. Before deciding on what measures to implement, however, the extent of possible carbon leakage, adverse competitive effects and distributional risks need to be properly assessed. Such an assessment should try to answer where in the economy (e.g. sectors or groups of actors) the risks are more pronounced, and why. Understanding the unique challenges and specific context where the carbon tax is to be introduced will enable policy makers to design appropriate measures to avoid or counter unwanted negative effects. It will also help to ensure that actors are not given unnecessary compensations.

[4] References to empirical studies can be found e.g. in Coste et al in Pigato (ed) (2019).

Properly assessing and communicating how the proposed carbon tax may affect different actors can also be helpful in gaining public acceptance for the tax.

25. There are many ways by which the effects of a carbon tax can be analysed. Assessments by experts and broad public consultations can for instance be valuable sources of input to the design of the tax and help policymakers in identifying the need for complementary measures (see further chapter 4). However, economic and/or energy system models are often crucial to the analysis as modelling tools offer the possibility to explore the effects of alternative tax designs and complementary measures in more detail. There are a wide range of different modelling approaches. What kind of models to use depend to a large extent on the questions that need to be answered. Economic partial equilibrium models, for example, can help explain how a carbon tax would affect 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 given emission targets can be explored using energy system modelling. There are also other modelling approaches.[5]

26. As different analytical tools will provide insights from different perspectives, adopting a set of multiple approaches can be valuable. At the same time, modelling can be rather resource demanding and the lack of funding, availability of data and limited personnel skills may narrow down the number of alternatives. Regardless of the means available for the assessment, careful planning using available resources as wisely as possible will likely provide policy makers with more useful information for the design of complementary measures. To some extent international organizations may also provide some assistance in the analysis of domestic mitigation policies.[6]

5. Policy options to address concerns over unwanted adverse effects

27. Economic theory suggests a uniform carbon tax with a wide base in terms of its coverage to be the most efficient design. At the same time, stakeholders commonly raise concerns that additional tax burden would lead to adverse effects on the competitiveness of domestic firms – especially in energy-intensive and trade-exposed sectors – causing carbon taxes introduced in practice to deviate from a theoretically ideal carbon tax. Many jurisdictions have strived for a balance between fulfilling environmental objectives on the one hand and accounting for the risks of carbon leakage and securing the competitiveness of certain sectors being subject to

[5] For a general overview of different modelling approaches, their strengths and weaknesses see e.g. Miria A. Pigato, Editor. 2019. Fiscal Policies for Development and Climate Action. International Development in Focus. Washington, DC: World Bank and Partnership for Market Readiness (PMR) 2017. *Carbon Tax Guide: A Handbook for Policy Makers*. World Bank, Washington, DC.

[6] E.g. the IMF has developed a spreadsheet tool to help countries evaluate progress towards their Paris mitigation pledges. See IMF (2019), "Fiscal Policies for Paris Climate Strategies - from Principle to Practice", *IMF Policy Paper*, No. 19/010, International Monetary Fund, Washington D.C.

international competition on the other hand. Despite that the risk of undesired effects from carbon taxes on firm competitiveness and carbon leakage in many cases are limited, such risks can constitute significant political obstacles for the implementation of a carbon tax and therefore need 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 its unique design to address such concerns. The box below shows examples of how different jurisdictions in recent years have designed their carbon taxes with regards to coverage and various mechanisms to minimize adverse impacts[7].

Box 18: Country examples of carbon tax designs with various degrees of exemptions

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 carbon dioxide emissions from all sectors and covers almost all liquid fuels and coal, in total 20 per cent of all the Argentinean greenhouse gas 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 were adjusted at the introduction. For mineral coal, petroleum, and fuel oil, the tax rate started in 2019 at 10 per cent of the full tax rate, increasing annually by 10 per cent to reach 100 per cent in 2028.

The *Colombian* carbon tax was adopted as part of a structural tax reform and was launched in 2017. The tax applies to greenhouse gas emissions from all sectors with some minor exemptions. It covers all liquid and gaseous fossil fuels used for combustion, accounting for 24 per cent of all greenhouse gas 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 carbon dioxide emission content compared to natural gas. 46 per cent of all greenhouse gas emissions in Mexico are covered. The tax is capped at 3 per cent of the fuel sales price. Since 2017, companies liable to pay the carbon tax may choose to pay with credits from 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 greenhouse gas emissions from the industry, power, buildings and transport sectors irrespective of the fossil fuel used. 80 per cent of the South African greenhouse gas emissions are covered. For many sectors tax exemptions starting from 60 per cent up to 95 per cent 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 per cent offset allowance to reduce their carbon tax liability.

[7] More information about these, and other, carbon tax schemes around the world can be found at the World Bank Carbon Pricing Dashboard (https://carbonpricingdashboard.worldbank.org/).

27. There are several policy options available that seek to address concerns related to possible adverse effects of a carbon tax, and the measures can be targeted towards both firms as well as households. The most popular set of policies in jurisdictions that have implemented a carbon tax focus on different types of *tax-reducing measures* lowering the effective carbon tax via exemptions, thresholds or reduced rates. Another set of policies in use include different *support measures* to affected households, firms or sectors: output-based rebates or targeted support for resource efficiency and cleaner consumption and production. Also, reductions from other taxes than the 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.

28. Many of the different measures have the potential to contribute to the implementation of a carbon tax by increasing its public acceptance. The political economy aspects of carbon taxation are indeed important to acknowledge and the question of how to gain public acceptance for a carbon tax is further investigated in chapter [xx]. A carbon tax will undoubtedly raise tax revenues, 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 more detail in chapter [xx].

5.1 Tax-reducing measures

29. Most jurisdictions that have already implemented a carbon tax have chosen to lower the carbon tax rate for some fuels and/or sectors, or exempt them altogether. Measures that reduce the carbon tax, such as exemptions, thresholds, reduced rates or tax payment refunds, can be temporary or phased out step-wise, or they can be part of a long-term policy design. These kinds of measures can in many cases be relatively straight forward to implement and can be directly targeted at specific sectors or groups in society. In addition, they are easy to communicate and popular with groups benefitting from the measure. Some examples of how exemptions have been applied in various jurisdictions are found in [Box 19].

30. An immediate result of reduced carbon tax rates and exemptions is the loss in public revenues which, of course depending on the magnitude of the implemented measures, can be rather substantial. Another important disadvantage with introducing reduced tax rates or exemptions is the fact that the price signal of the tax, and consequently the Polluter Pays Principle, is compromised. As the price signal differs between sectors abatement 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 are likely to increase. If sustained, such measures may also prove counter-productive as sectors benefitting in the short-term face the risk of being less adapted to compete in a low-carbon economy in the longer term.

31. As it may be difficult for policy makers to determine the appropriate scope, level and duration for the reduced rates careful ex-ante analysis can provide valuable input to the decision process. Measures to reduce the carbon tax payment nevertheless risk to be questioned by those excluded from the tax reductions which, in turn, may contribute to negative perceptions in society regarding 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 it deemed that multiple tax exemptions and thus differences of treatment were not consistent with the legislator's intentions.

32. 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.

33. 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 to some extent be viewed as a broadening of the tax base. Examples of this can be found in Chile as well as in Colombia.

Box 19: What sectors to exempt – some examples

To be able to properly address any potential adverse effects of a carbon tax, it is important to thoroughly 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 scheme, as consumption of fuels in such installations are already covered by another economic instrument aimed to incentivize less emissions of carbon dioxide. This line of action has been chosen by for example Denmark, France, Ireland and Portugal regarding emissions covered by the European Emission Trading Scheme.

In other jurisdictions fuels or sectors considered to be of certain importance 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.

5.2 Support measures

34. In addition to tax exemptions and rebates, various types of support measures can be used to reduce the overall financial burden of entities subject to the carbon tax. Such measures can be targeted to specific sectors or have an even broader coverage. For

example, it might be possible to reduce other taxes, lower employer contributions to labour costs, or implement governmental grants or programs in order to maintain the competitiveness of particularly vulnerable sectors. Examples of the latter can be 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.

41. The durability of measures can differ, depending on their purpose. There may, for instance, be a need to combine short-term relief for firms and long-term incentives for them to adapt by adopting cleaner and more efficient technologies. As support schemes most often are easier to implement than to withdraw, policy makers may want to announce up front for how long or under what circumstances a particular measure will be in force.

42. Support measures can also be targeted to households in terms of e.g. (non-carbon) tax reductions or flat payments. In certain jurisdictions in Canada for instance, revenues from the Federal Carbon Pollution Pricing System is being redistributed to households and individuals via their income tax and benefits return. 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 another scheme for allocating carbon tax revenues to households can be found in Switzerland where part of the revenue from the Swiss CO_2 levy is redistributed uniformly to all residents through an annual discount in the compulsory health insurance premium.

43. Other support schemes for households can involve direct or indirect subsidies to reduce emissions by e.g. support for improved energy efficiency in housing or subsidies for public transport. Properly designed, such measures will contribute to incentivize households to shift towards less polluting consumption patterns, and thereby also help them lower their carbon tax expenditure. At the same time care should to be taken to ensure that support is given where it is needed the most; subsiding high-end electric vehicles will likely benefit households in higher income groups and may prove both cost-ineffective and counter-productive from a public acceptance perspective.

44. Similar to the tax-reducing measures discussed above, support measures imply a direct cost to the public budget. Yet 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 very costly in relation to the overall carbon tax revenue. Again, it is important that measures are designed with care, preferably supported by ex-ante analysis of the need for and effects of possible support policies.

45. Jurisdictions may choose to implement a carbon tax as part of a wider tax reform. 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 has helped package the implementation of the new rates. Other countries that more recently have taken the opportunity to introduce carbon taxes whilst undergoing a larger tax reform are Argentina and Colombia.

46. Introducing or increasing a carbon tax as a part of a more general tax reform not only gives policy makers 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 other parts of the tax system as well, the latter possibly resulting in a 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).

5.3 Trade-related measures

47. Trade-related measures that address carbon leakage and competitiveness concerns arising from carbon taxation are rare in practice. In the EU Emission Trading System, the risk of carbon leakage has been addressed by allocating free emission permits to installations in the most exposed sectors. A measure that has been discussed for long in the academic literature, as well as among policy makers, as a promising tool specifically for addressing the risks of carbon leakage is Carbon Border Adjustments (CBA). CBA aim at putting domestic firms facing a carbon price on an even footing with importers operating under a lower carbon price, or no carbon price at. Charging a levy on imports corresponding to the difference in carbon price between the jurisdictions would be an example of such a measure.

48. If and how CBA can be used in practice as a tool against carbon leakage is still an open question. No countries to date have tried to implement such measures at their borders and hence there is no international experience. 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 legal framework, are but a few of the challenges often mentioned in relation to CBA.[8] The instrument has gained renewed attention in 2019 as the European Commission announced that it will draft a proposal for a CBA mechanism covering the import of

[8] For an overview of the economic and legal challenges see e.g. Cosbey et al (2019) *Developing Guidance for Implementing Border Carbon Adjustments: Lessons, Cautions, and Research Needs from the Literature*. Review of Environmental Economics and Policy, volume 13, issue 1, Winter 2019, pp. 3–22

certain products to the EU in order to reduce the risk of carbon leakage, to be presented in 2021[9].

49. Consumption-based taxation (CBT) means that a carbon tax would be levied on the domestic consumers, rather than on the producers, and products would be taxed on their carbon intensity regardless where they are produced. While common in e.g. tobacco and alcohol taxation, CBT with an application to climate is yet to be introduced. As for CBA there are many uncertainties surrounding the practical feasibility of consumption-based carbon taxation.

50. Climate change is a global challenge that requires international cooperation. Economist repeatedly claim that a global price on carbon, e.g. through a global carbon tax, is the most cost-effective policy instrument to reduce carbon emissions in line with the Paris agreement. Still the international community has so far fallen short to coordinate any kind of global carbon pricing. Coordinated action in a smaller international context, through bilateral or multilateral agreements, is therefore more likely to succeed. This could e.g. be in 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.

51. 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 X] below.

Table 1: Overview of measures to address unwanted adverse effects of carbon taxes

Measure	**Advantages**	**Drawbacks**
Tax-reducing measures		
Exemptions Reduced rates Tax payment refund	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

[9] 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.

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		
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 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 BCA and CBT (but better than for exemptions)
Flat payments	Retain price signal Simple for citizens to claim Popular with general 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		
Carbon border adjustment (CBA)	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 Extends pricing to non-domestic emissions Lower legal/political risks than BCA	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 Leverages domestic tax to encourage equivalent effort in partner jurisdictions No administrative cost or legal risk	Not controlled by domestic policy makers only Difficult to negotiate across many countries and in sectors with many competitors Only regional examples to date, no global ones.

Adapted from Miria A. Pigato, Editor. 2019. *Fiscal Policies for Development and Climate Action*. International Development in Focus. Washington, DC: World Bank and Partnership for Market Readiness (PMR) 2017. *Carbon Tax Guide: A Handbook for Policy Makers*. World Bank, Washington, DC.

6. Administrative simplicity, environmental integrity and fairness

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

53. Whereas concerns of losses in firm competitiveness and distributional effects often must be addressed, the indiscriminate concession of exemptions and tax reductions can lead to increased complexity in the carbon tax legislation, 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 the administration of a simple 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.

54. The economic purpose of carbon taxes is based on the notion that emitters of carbon dioxide impose costs on others, without paying for the resulting damage that occurs. Carbon taxes aim to equalize private costs with 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 behavioural responses, like fuel switching, which could in

fact defeat the purpose of the tax in the first place and increase the country's carbon footprint.

55. In spite of that, governments will at times see the need to resort to tax exemptions and rebates in order to gain popular support, particularly while discussing the introduction and implementation of the tax. As carbon taxes become more popular and widely used, so does the tax fairness and equity debate[10]. In fact, the notion of fairness is greatly perceived through the intended use of revenues from the carbon tax (see further chapter xx). Stakeholders are more prone to support carbon taxation when they understand that the revenues derived therefrom are spent in projects that are high in the public agenda, are returned to the general public according to 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[11]. What is considered high on the agenda of a given society depends on their level of understanding of climate change, civic engagement, level of inequality, and of economic development. Therefore, these issues are to be tailored depending on the country context. The question of how to gain public acceptance for a carbon tax is discussed in more detail in chapter xx.

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

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

57. In a *two-level carbon tax system* different carbon tax rates apply to different parts of the economy, and such a system is easier to administer than lowering the tax rates for individual sectors and companies in the economy. A two-level tax system can be a feasible design leading to over-all better environmental results, as the politically acceptable alternative could be a general carbon tax for all operators set at low level to protect the domestic industry, which is subject to international competition.

Box 21: Country example of a two-level carbon tax

When designing the Swedish carbon taxation system, in order to avoid negative effects to the 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

[10] Tatiana Falcao and Jacqueline Cottrell *A Climate for Fairness: Environmental Taxation and Tax Justice in Developing Countries*, Vienna Institute for International Dialogue and Cooperation (VIDC), November 2018.
[11] A. Baranzini, M. Caliskan and S. Carattini *Economic Prescriptions and Public Responses to Climate Policy*, Haute École de Gestion de Gèneve, 2014.

for other sectors and one important cause of the emission reductions achieved in the high taxed sectors[12].

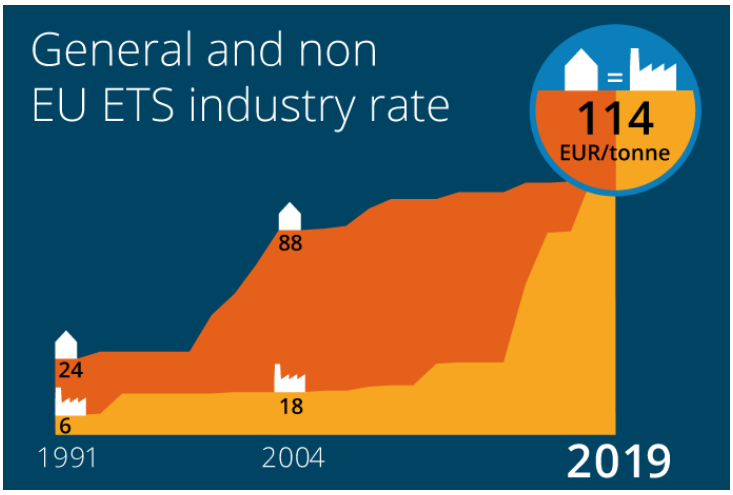

Figure Development of the Swedish Carbon Tax. General level and industry level. Industry level outside the EU Emissions Trading Scheme (EU ETS) since 2008. (Source: Government Offices of Sweden)

58. A *threshold* is a minimum level of activity that will trigger responsibility for paying the tax, that is, a minimum level of emissions per entity for the taxation to apply. The purpose of a threshold is often to reduce the costs of reporting and administration.

59. To examine the potential need of a threshold several characteristics can be analysed. One of them 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 small firms deciding not to grow to avoid the tax and counteract the establishment of large-scale operators.

60. In the case of carbon taxes, thresholds applied directly to emissions are rather common. 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 less necessary. Applying thresholds in these cases could also create market distortions by encouraging consumers to purchase from smaller wholesalers.

Box 22: Country examples of thresholds

An example of thresholds is the later abolished Australian Carbon Pricing Scheme, where emissions were taxed at the point where they were released into the atmosphere. The

[12] Hammar & Åkerfeldt, *CO_2 Taxation in Sweden – 20 Years of Experience and Looking Ahead*, 2011, https://www.globalutmaning.se/wp-content/uploads/sites/8/2011/10/Swedish_Carbon_Tax_Akerfedlt-Hammar.pdf.

threshold was decided to 25,000 tCO_2e in order not to burden smaller facilities with reporting obligations.

Another example is Chile, where the carbon tax was initially only applied to fuels used in industrial and power generation plants of a certain capacity (above 50 MW). Such a technical condition is easily observable, whereas an emissions threshold require that a level of reporting is already in place.