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Committee of Experts on International Cooperation in Tax Matters
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Environmental tax issues

Note by the Secretariat

Summary

This note includes two draft chapters that it is proposed would form part of a handbook on carbon taxation, FOR DISCUSSION by the Committee.

The two chapters deal with the design of a carbon tax; and administrative issues arising from the introduction of a carbon tax.

The Subcommittee will also provide an oral presentation on the experience of Chile in implementing a carbon tax, to illustrate the relevance of the inclusion of country experiences in the handbook. Committee members are encouraged to liaise with the Coordinator in case they would like to facilitate the inclusion of additional case studies in the handbook.

1. The Committee, during its 16th Session (New York, 14-17 May 2018), endorsed the recommendation of the coordinator of the Subcommittee on Environmental tax issues (Subcommittee), for their work to initially focus on issues related to carbon taxation.

2. Within this framework, the Subcommittee presented the Committee, at its 17th Session (Geneva, 16-19 October 2018), with a summary outline of a handbook aimed to provide guidance on the design and implementation of carbon taxation. Such guidance would be primarily directed at developing countries which are considering the introduction of a carbon tax.

3. To advance discussion on the content of specific chapters of the handbook, the Subcommittee met in Paris on 21-22 January 2019, hosted by the International Chamber of Commerce). The following topics were discussed in detail:

a. Designing a carbon tax, including (i) issues related to taxing power; (ii) the definition of the scope and tax base; (iii) the determination of tax rates; and (iv) the identification of the taxpayer.

b. Interaction of carbon tax with other measures, including (i) other environmental policy instruments; (ii) other relevant taxes; (iii) tax subsidies and competition policies; (iv) consumption subsidies; and (v) existing international agreements.

c. Conceptual approach to carbon taxation, including economic theory framework, environmental issues, and the definition of carbon tax.

d. Administrative issues arising from the introduction of the carbon tax.

e. Country experiences: Chile and Sweden.

4. Following discussion, two draft chapters (on design and administration) were substantially advanced, and are ready for discussion by the Committee to provide guidance. Issues which will need further discussion within the Subcommittee are indicated in *[square brackets]* in the text below.

5. Additionally, for the information of the Committee, the Secretariat requested inputs from the Subcommittee in view of a capacity development *Workshop on Selected Issues in Tax Base Protection and Tax Measures in Support of the SDGs For Developing Countries*, to be held in Nairobi on 10-14 June 2019. The regional workshop will feature the participation of approximately 40 tax officials of countries in Sub-Saharan Africa, and include a peer-learning session on environmental taxation. The Secretariat will design a questionnaire, in consultation with the Subcommittee, to survey the experiences of participating countries in implementing taxes with an environmental component, and identify needs for capacity development. The questionnaire might also be a useful instrument to explore additional case studies to be included in the handbook.

6. During the Committee Session, the Subcommittee will also provide an oral presentation on the experience of Chile in implementing a carbon tax, to illustrate the practical relevance of the inclusion of country experiences in the handbook. Committee members are encouraged to liaise with the Coordinator in case they would like to facilitate the inclusion of additional case studies in the handbook.

Handbook on Carbon Taxation – Chapters for discussion

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Chapter VII: Designing a Carbon Tax

Motives for introducing carbon dioxide taxation, commonly referred to as a carbon tax, has been discussed in chapter xxx. Once a decision has been made to consider such a tax, the policymaker is faced with a number of choices, see a brief overview in figure below.

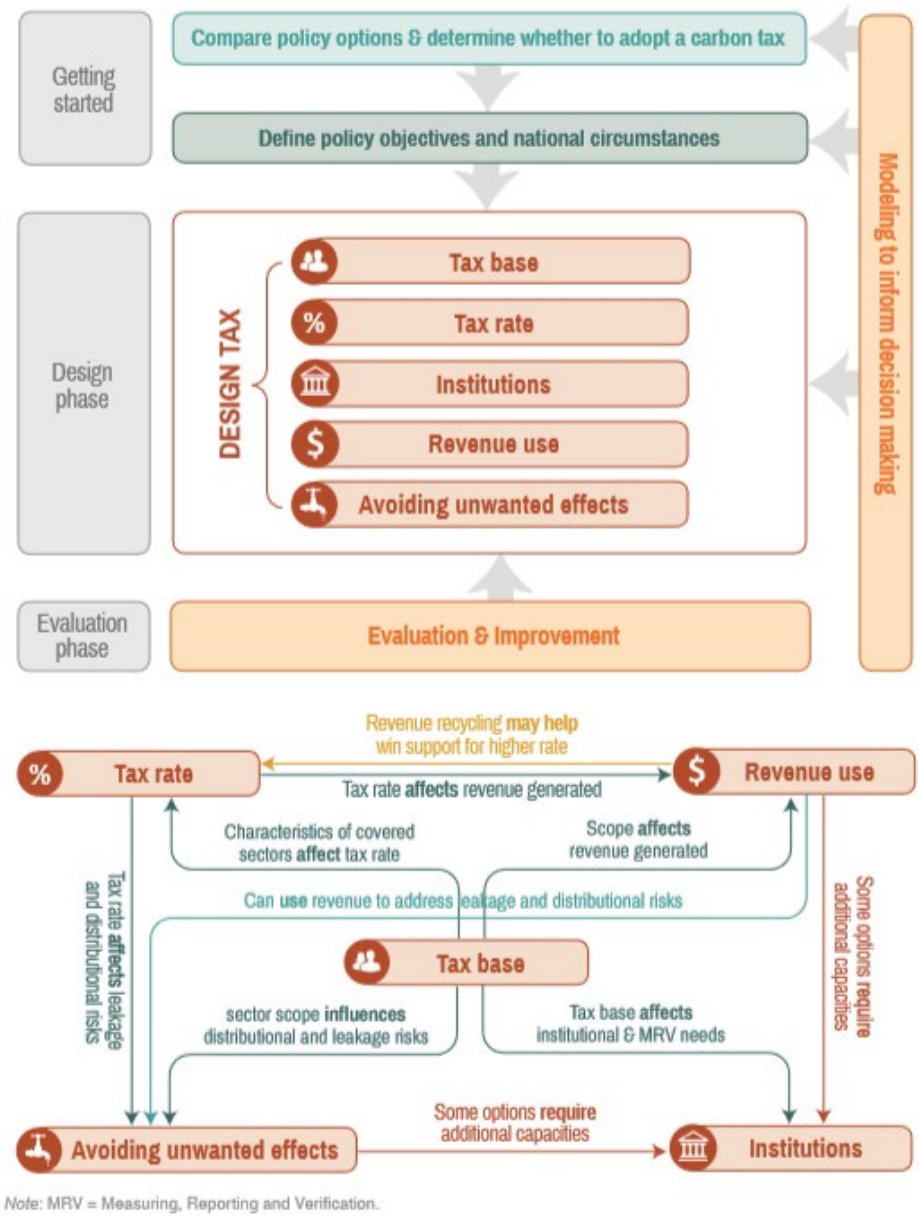


Figure: Stages of Carbon Tax Design and Interlinkages between Design Options
Source: Partnership for Market Readiness. 2017. Carbon Tax Guide: A Handbook for Policy Makers. World Bank, Washington, DC.

[Figure provisionally placed in this section; however, as it shows the whole process of designing a carbon tax, it might be moved to an earlier chapter (for example the conceptual framework) and referred to here.]

7.1 Taxing power *[Draft in progress]*

7.2 Scope of the carbon tax and defining the tax base *[Draft as of 28 March 2019]*

7.2.1. What are we going to tax?

The simple answer, to the question of what we are going to tax, is emissions of carbon dioxide. Carbon dioxide amounts to roughly 80 per cent of the total greenhouse gas emissions (GHG) emitted globally and already this fact speaks highly in favour of starting out by focusing taxation on these emissions. This limitation as to the type of emissions to be covered in this handbook has already been set in chapter II.

Figure Global Greenhouse Gas Emissions by Gas [to be updated with more recent graph and figure]

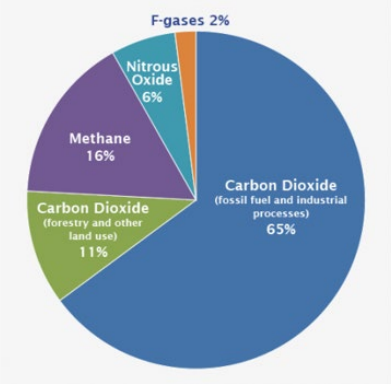


Figure: Global Greenhouse Gas Emissions by Gas
Source: IPCC 2010.

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 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. A discussion will follow below, where also examples will be given from tax systems currently in force in different jurisdictions.

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. 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 these other greenhouse gases in their tax scheme.

True enough, there are examples of jurisdictions, which have introduced taxation of also fluorinated greenhouse gases, so-called f-gases, the most common ones being hydrofluorocarbons (HFC) and perfluorocarbons (PFC).[1] 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.

7.2.2 The Fuel Approach

7.2.2.1 Basic concept

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 applicable today to some extent allow that the tax due upon extraction or importation is 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.

A general tax rate has been pre-calculated and laid down in the tax law, 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. It should be stressed, however, that in the case of fuel combustion there is a sufficiently close relation between carbon content and carbon dioxide emissions. The tax rates of different fossil fuels are usually presented in the national tax law expressed in commonly used trade units. This is a transparent and well-established practice to express tax rates on fuels. Such tax rates are easy to apply for operators as well as for the Tax Agency. The calculation of the tax rates will be further outlined in more detail in chapter 3.2.

Some jurisdictions have chosen to limit the scope to only certain fuels or cover only the consumption in certain sectors.

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

[1] 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.

7.2.2.2 What fuels can be taxed with the Fuel Approach?

Box: 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. 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. In India and the Philippines only coal is taxed, while Mexico taxes coal and petroleum products (not natural gas) and Costa Rica 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.

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

For the Member States of the European Union, there is a harmonized tax framework for taxation of fuels,[2] which the EU Member States are obliged to follow in their national tax implementation. 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. The current EU 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 as a duty covered by the harmonized EU tax framework.[3]

The EU Member States which have introduced a carbon tax have generally added it to an already existing general excise duty (sometimes referred to as an energy tax), either as part of the general excise duty (e.g. in France) or as a separate tax (e.g. in the Nordic countries[4]). The same situation can apply in non-EU jurisdictions, as taxing energy to some extent has over the years become a common source of revenue raising across the world. There are different

[2] 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.

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

[4] 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.

approaches of how to treat the interaction between these two different taxes. Sweden, for instance, over the years has 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 level – 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. Although the carbon taxes in Switzerland and Lichtenstein are not levied on road fuels, which are only subject to an excise duty not specifically based on the carbon content of the fuels.

The carbon tax base in Iceland consists of petrol, diesel and heating gas oil, as these are the only fossil fuels available in the market in that country. Outside the EU, 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 levy 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.

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, but rather by a percentage (currently 3.5) of the market price of the hydrocarbons.

The reasons behind these different approaches are often found in the national contexts, such as existent administration systems or the fact that the chosen fuels amount to the bulk part of carbon emissions. Competitive concerns for certain sectors or geographical parts of society can also play a role, see further discussion on possible tax exemptions below in section XXXX.

7.2.3 The Direct Emissions Approach

7.2.3.1 Basic concept

An approach, which has attracted increasing attention, is to rely on direct measurements of emissions from certain types of stationary installations/facilities. This is the case in Chile and Singapore.

Normally emissions from large electricity and industrial plants are targeted by the tax and those facilities may often already by subject to requirements to measure emissions by IPCC regulations or even more stringent national environmental codes.

[Maybe an illustration showing emissions from a stationary installation?]

Another approach is to structure a carbon tax to target carbon dioxide emissions regardless of the type of fuel being used, normally from a certain group of stationary installations such as factories, power plants and oil refineries. A variation on this approach 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.

7.2.3.2 What fuels can be taxed with the Direct Emissions Approach?

Box: 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 per cent of emissions affecting 94 facilities from a range of sectors. The carbon tax can be viewed as a Direct Emissions Approach carbon tax

In the San Francisco Bay Area 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.

An example can be found in 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 targets 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 per cent of the carbon dioxide emissions are covered by the 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), NOX (oxides of nitrogen) and SO2 (sulphur dioxide).

Although not as common as taxation of fuels, there are jurisdictions that have chosen to tax direct emissions of carbon dioxide. The already mentioned Chilean carbon tax affect the same establishments taxed for local emissions, excepting 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, the Chilean carbon tax only covers fossil carbon emissions.

Other examples include the San Francisco Bay Area, 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 also other greenhouse into carbon dioxide equivalents (CO2e) also such other greenhouse gases are included in the taxation scheme.

The San Francisco 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 tCO2e annually to register as a taxable facility and pay the carbon tax.

A similar approach is to focus on emissions from certain processes, as is done in South Africa, where a carbon tax will come into force on June 1, 2019. The South-African carbon tax[5] will target CO2e emissions above a certain level from fuel combustion, electricity generation and industrial processes as well as estimated fugitive emissions. While in principle using a Direct Emissions Approach, the emissions taxed will be 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.

These installations in many cases are 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 national tax administrating authorities 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 obliged from 2024 to report their emissions using the guidelines of the Paris Rulebook. Although developing countries with limited capacity initially may 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, while more difficult to implement, be that it will strengthen the countries' MRV capabilities which is required for a range of international commitments and local policies.

[For feedback by the Committee: as the direct emissions approach is less diffused, should the Subcommittee keep the current level of detail presented in this chapter throughout the handbook, or expand discussion further?]

7.2.3 When will the carbon tax be levied and who faces the price of the tax?

7.2.3.1 A carbon tax vs direct taxation

Box: Special characteristics of a carbon tax compared to a direct tax

[5] 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.

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

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

Figure Direct vs Indirect taxes

Taxes are generally divided into direct taxes and indirect taxes. Direct taxes are imposed upon a person or property and are normally paid directly by that person or property owner to a local or national tax authority. Examples are property tax, income tax and tax on assets. An indirect tax, on the other hand, is levied on particular goods or services and is collected and paid to the tax authority by an entity in the supply chain (usually a producer or retailer). However, being 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 a good or service. There are basically two kinds of indirect taxes, sales taxes (or value-added taxes) and excise taxes which are typically imposed in addition to a sales tax or value-added tax.

This means that a carbon tax – whether levied on fuels by weight or volume or on actual emissions – is an indirect tax and more precisely an excise tax (or in some jurisdictions is labelled an excise duty). An excise is typically 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 is that an excise tax typically applies to a narrow range of products (such as alcohol or tobacco products or petroleum products).

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

7.2.3.2 Methodologies to calculate the tax

Basing the tax on carbon content

The most generally used choice of tax base is the carbon content of fuels, what we in this handbook call the Fuel Approach. Such an approach has a high level of accuracy and can be

used to design an administratively simple tax system, which serves the policy purpose of being a cost-effective instrument to reduce emissions.

Most jurisdictions having introduced a carbon tax have relied on emission factors expressed in terms of average carbon content of fuels to calculate the tax. What makes this simple, is that there is a sufficiently close relation between carbon content and carbon dioxide emissions. This major simplification does not imply any large errors in providing incentive to switch fuels to reduce carbon dioxide emissions. Calculations made by Government officials based on the average carbon content of the fuels can determine the tax rates laid down in the tax legislation. No measurements of actual emissions are necessary. A jurisdiction introducing a carbon tax can 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. These are standard trade units and such an approach facilitates tax administration. The method also broadly corresponds to the guidelines countries follow when reporting carbon dioxide emissions to the UNFCCC (IPPC National Greenhouse Gas Inventories).

Hands-on – how to do calculate the tax

It is often relatively straight forward for a jurisdiction to select the appropriate emission factors to be used for the tax calculations (see further box xx below[6]). This is the case if the number of fuel qualities available on the market are limited and it could thus make sense to use an average emission factor for several different heating gas oil products. 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 being a necessary component in certain industrial reduction processes or coal used in purification filters. However, the calculation method as such does not prevent taxing also the fuel products when used for such purposes.

To facilitate the understanding of implementing a carbon tax, an example is given in the box below of how to calculate a tax rate per litre of petrol, by way of the prevailing method used by jurisdictions having introduced a carbon tax.

[6] Carbon dioxide (CO_2) emissions can be expressed in kg/MJ since it is assumed that all the carbon content is transformed to carbon dioxide after combustion (complete combustion in dry air). The carbon content of the fuel is known. The emission factor is calculated by dividing the carbon content of the fuel (e.g. per m^3) with the percentage of carbon in carbon dioxide. The percentage of carbon in CO_2 is 27 per cent and is calculated by dividing the molecular weight of carbon with the molecular weight of CO_2. Since all carbon content in the fuel is assumed to be converted to CO_2, the same amount of carbon is present in CO_2 after combustion as in the fuel before combustion.

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

Calculation of tax rates when based on standard carbon content of fuels

The rationale is that the carbon tax is applied to fuels and the tax rate expressed in the tax legislation is calculated based on the fossil standard carbon content of the fuels but expressed in volume or weight units (such as litre for petrol).

Carbon content [kg /unit] / 0,27[7] = Emission of CO_2 [kg/unit]

Emission of CO_2 [kg/unit] * general CO_2 tax level [currency/kg fossil CO_2] = Tax rate [currency/unit]

The carbon content of respective fuel is divided with the share of carbon in carbon dioxide (0,27) in order to attain the emission factor of the fuel. The emission factor is then multiplied with the general tax level, expressed in terms of currency per kilo of fossil carbon. The tax rate is expressed as currency per unit.

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

General carbon tax rate: 1.15 SEK per kg fossil carbon (=approx. xxxx US cents)

0.627 kg/litre / 0,27 = 2.323 kg/litre

*2.323 kg/litre * 1.15 SEK kg/fossil CO_2 = 2.67 SEK/litre (= approx. xxxx US cents)*

The tax rates are in tax law expressed in weight or volume units

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 in Sweden in 1991, the relevant Government Bill thus contained a detailed description of the method and emission values used by the Government when calculating the actual tax rates for the description included a list of emission values used for the different fossil fuels.[8]

The actual tax rates in the law is expressed in commonly used trade units, which is a transparent and well-established method in Sweden. This means weight or volume units. Such tax rates are easy to apply for operators as well as for the tax authorities. The units used in Sweden are litre

[7] 0.27 is the share of carbon in CO_2, calculated by dividing the molecular weight of carbon with the molecular weight of CO_2.

[8] See Governmental Bill 1989/90:111 p. 150 (in Swedish), https://data.riksdagen.se/fil/0F185476-F338-4003-A794-012E457C3B52.

for petrol, m^3 (1 000 litres) for gas oil, kerosene and heavy fuel oil, 1 000 kg for LPG (liquefied petroleum gas), 1 000 m^3 for natural gas and 1 000 kg for coal and coke.

It is possible to differentiate based on fuel quality

If, on the other hand, different coal qualities with significant differences in carbon content 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. 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 biomass components add complexity to a tax system is, however, dependent on the choice of the taxable event. If a finished product is not established until it is leaving a fuel depot and is due to be taxed, regular bookkeeping will enable the tax payer to pay the correct tax. Such a system has been applied in Sweden for many years. An important political decision is whether the tax base ought to relate to the fossil carbon content of fuels (which is the way the current IPCC (Intergovernmental Panel on Climate Change) emission reporting is done today), or to carbon content in general, which also would include biomass-based fuels, as for instance ethanol and biodiesel.

Measuring actual emissions

An alternative to a tax based on the carbon content of the fuel would be to measure the actual emissions. 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. Also, in the case of taxes based on actual emissions rather than on the carbon content of fuels, jurisdictions often need to establish new systems for monitoring, reporting and verification. While such requirements already exist as regards to large industrial and power installations in the UNFCCC national reporting guidelines, this is not the case for emissions from either smaller plants or vehicles.

There are examples when a jurisdiction has chosen to let its carbon tax only cover emissions from certain kinds of stationary installations, where the consumption of fuels take place. This could be the case of large power plants. Here a tax on actual emissions may be an 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, are obliged to measure their emissions and using these values to determine the tax could be appropriate. However, if and when a jurisdiction decides to enlarge the scope of the tax to also e.g. propellants, the measurement of actual emissions arising from the combustion at the point of consumption would no longer be feasible.

Table. Some pros and cons of different methodologies to calculate the tax

	Pros	**Cons**
Average emission factors	Administratively simple Scope can include large part of CO_2 emissions, in stationary facilities as well as transport Incentive is clear – Polluter Pays (as tax is normally included in fuel price)	No incentive to choose higher quality fuels within the same tax group Other types of CO2e emissions are outside scope Does not develop MRV
Measuring actual emissions	Exact (not really) measurement is probably less exact Incentive is clear – polluter pays Develops MRV Possibility of developing other more complex instruments e.g. Offsets, this may be important for developing countries Scope of non-fuel combustion emissions	Costly to measure Cannot be applied to small facilities Cannot be applied to transport fuels Administratively complex

7.2.3.3 Who will pay the carbon tax and when?

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

Box: What determines the choice of who will pay the tax and when?

Who will pay the tax depends on national conditions, such as for example if already existing taxation of fuel exists, tax control capacity available, the organization of fuel distribution or the types of fuels targeted by the tax. Degrees of the complexity of tax administration vs the need to be able to carry out tax controls are key issues to consider.

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

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

Basics to consider when deciding on the tax payer

Emissions typically involves a range of actors operating at different points in the fuel supply chain. In addition to determining which sectors or activities will be subject to the tax, jurisdictions must also determine who will be responsible for paying the carbon tax to the authorities. 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 legislators considering how to design their tax legislation. This is essential, contrary to what up until now seems to have been the key focus of literature namely 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 tax payer to transfer the cost of the tax down the fuel supply chain and is not the key focus of this handbook.

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 administration structures in the jurisdiction and to what extent the jurisdiction would like to build on such existing administration. It can also be noticed 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.

Jurisdictions choosing to design a carbon tax levied on fuels are likely to explore existing excise duties on the relevant fuels and who is responsible for the tax payment. Choosing the same tax payer for the new carbon tax will mean low additional administrative costs for both the tax payers and the tax authorities.

If a Direct Emissions Approach is chosen for the design of a new carbon tax it would be natural to choose as the tax payer the entity that generates the emissions. However, such a tax system would most likely require new administrative practices for the tax authorities, including necessary cooperation with environmental authorities to be able to carry out tax control. The pros and cons of different administrative approaches will be further discussed in chapter xxx.

Ensure that there is a price signal

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 agents should respond by changing their behaviour. For a fuel distributor the price signal is passed on to the final consumer, as the tax normally is fully transferred to the retail price of the fuel. However, this is a consequence of trade agreements between sellers and buyers of the fuel and nothing that is regulated in a tax act. If no change in behaviour occurs the carbon tax will only raise revenues and not decrease emissions.

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 other official body.

When will the tax be due – point of regulation

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.

A general principle for carbon tax systems levying a certain tax amount on fuels by weight or volume unit, is that the fuels shall be taxed at the time of when the fuels enters the economy. This normally coincides with production or importation. A strict application of such a system is illustrated in figure xx 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.

Administrative simplicity along with good possibilities for tax control are key issues to consider. Keeping the number of tax payers to a minimum is another aspect to keep administrative costs low, which often is desirable to the authorities as well as to the tax payers. 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.

However, while choosing a tax point as illustrated in figure xx could offer administrative advantages in terms of a relatively few tax payers 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.). Although, here Colombia offers an interesting example.

Example Colombia's Carbon Tax[9] [May be put in a box]

Colombia introduced a carbon tax in 2017. The tax base consists of different refined petroleum products, namely natural gas, 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.

Possible to coordinate tax collection with import duties

[9] 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.

Coordinating tax collection with other tax objectives, such as import duties, could facilitate tax administration. For a country choosing to collect a carbon tax upon importation, to coordinate the collection with the collection of import duties due on the taxable fuels. Although not being an explicit carbon tax, Zimbabwe applies a Petroleum Importers Levy on petrol and diesel, which is collected in this way.10 Companies or individuals holding a procurement license to import petroleum products in bulk into Zimbabwe are liable to pay this levy, which amounts to USD 0.04 per litre.

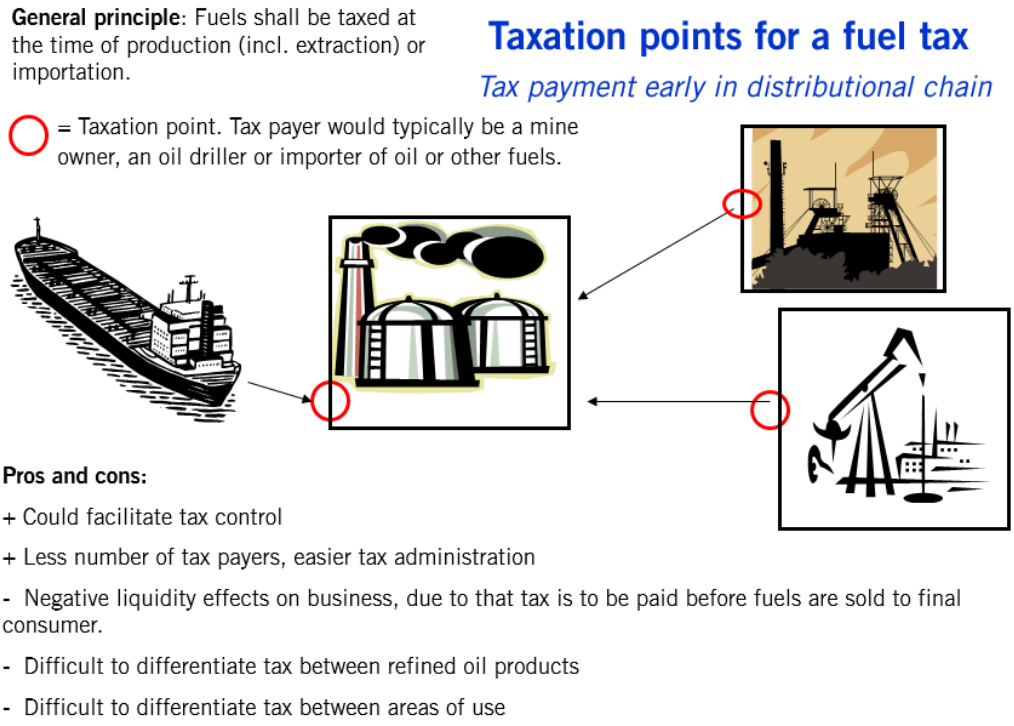


Figure Example of a fuel tax design – tax payment early in the distributional chain

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.

Let the tax be due later in the distributional chain

Choosing the same tax payer for the new 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 already existing excise duty and would not give rise to much more administration. As we have seen from the previous chapter, 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

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

also make it possible for a Government to more clearly advocate to the public that the tax is a climate tax.

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[11]. 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.

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

Norway[12] 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 tax payers 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.

Example Carbon Taxes within the EU Energy Taxation Framework

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 to do this. 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.

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.

[11] See example Sweden different carbon tax rates for heating fuels used by industry and households and service sector companies in chapter xxxx.

[12] For more information, see for example https://www.oecd.org/ctp/tax-policy/taxing-energy-use-2018-norway.pdf.

- 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.

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.

Some EU countries are applying rules which result in a relatively few tax payers, 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.

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

Example Sweden – a system with low administrative costs

Sweden is a country with a population of 10 million people and has about 900 000 registered business companies, among them about 55 000 industrial companies However only around 300 companies are registered warehouse keepers, who are authorised by the Tax Agency to produce, receive and hold fuels under tax suspension and may also move such products under the suspension regime to other warehouse keepers within Sweden or in other EU countries without tax becoming chargeable. Criteria which determine if a company may be approved a warehouse keeper status relates to for example its economic situation and being able to put forward a sound and reliable business idea. The fuels must be stored in a specially approved tax warehouse and the warehouse keeper must leave security, for example in the form of a bank guarantee, for each movement of energy products as well as for 10 per cent of the fuels stored on average for one year.

The fact that registered taxpayers are obliged to supply a guarantee to cover potential losses in storage or transport provides a secure and tested system for ensuring that tax obligations are met. Carbon taxes on fuels in other EU countries are also levied in this way.

Sweden is an example of a jurisdiction which extends the possibility to register as tax payers also to large consumers, notably heavy industrial companies. The Swedish system is illustrated in figure xx below. The Swedish system allows for these industrial companies to store fuels under tax suspension and declare the tax once the actual consumption has occurred. If the

consumption involves a tax exempted area of activity this means that the tax payer declares zero tax, thus avoiding negative liquidity effects for the company which would have arisen if the company would have had to buy the fuels at a price including the tax and ask for a tax reimbursement after the consumption has taken place. A non-tax payer would have bought the fuel at a price including the tax but can, if being eligible for a tax rebate, ask for a reimbursement of the tax paid.

The Swedish carbon tax is collected in the same way as the energy tax applicable to fuels. This means that the administrative costs can be kept low, both for the tax authority and for businesses. The administration costs for the tax Authority amounts to 0,1 per cent of the total revenues from energy and carbon taxes.

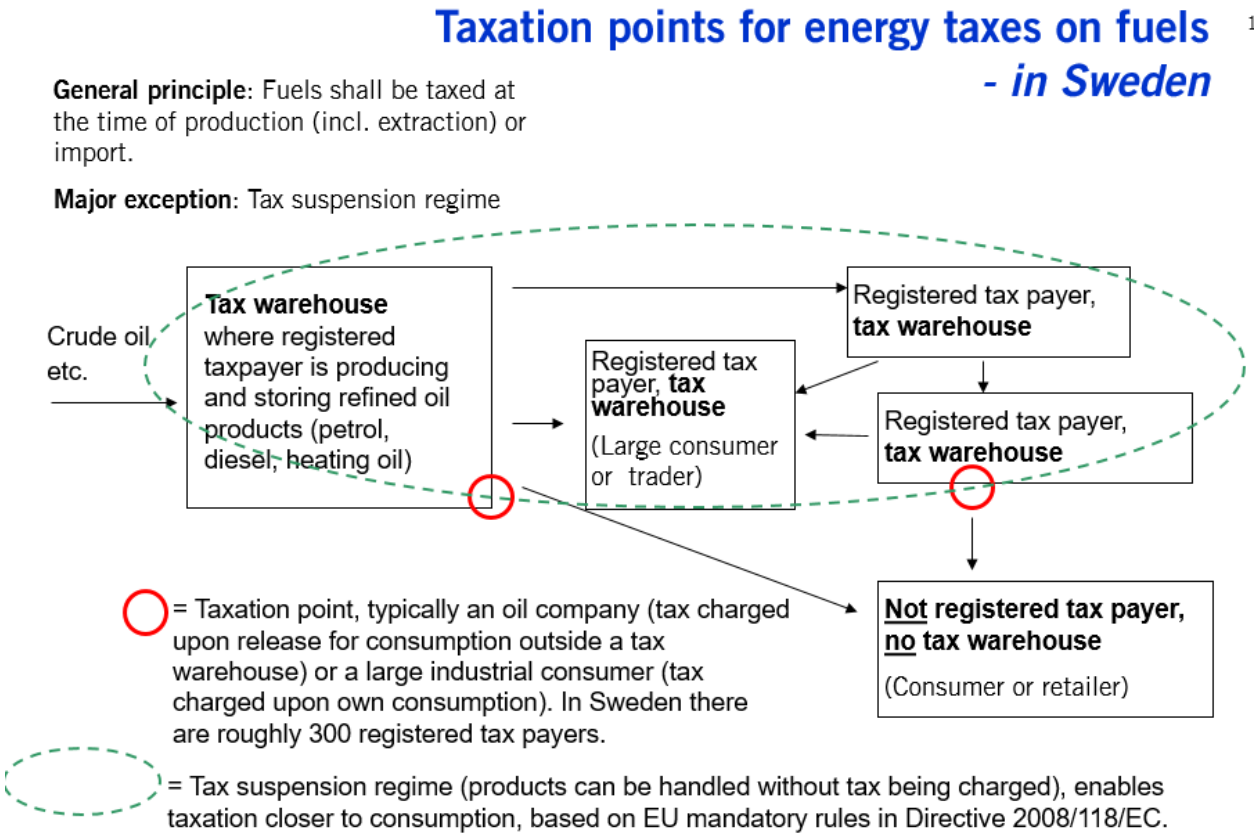


Figure Example Taxation points for the carbon tax in Sweden

Example – British Colombia's Carbon Tax

British Colombia[13] is an example of a jurisdiction that has moved the event when the tax becomes liable for payment and consequently also the tax payer down in the distributional chain, by enlisting the fuel distributors as tax collectors. Any natural gas retail dealer or fuel vendors must be appointed as tax collectors by the revenue authorities and are then responsible

[13] For more information about the carbon tax in British Colombia, please refer to http://www.bclaws.ca/civix/document/id/lc/statreg/08040_01.

for charging the tax to purchasers upon sale. Like the EU rules, the British Colombia scheme allows for sales between registered dealers or vendors without tax becoming chargeable.

When a carbon tax is based on the Direct Emissions Approach

A carbon tax based on a Direct Emissions Approach requires the measurement or estimation of actual emissions at the source. Therefore, the tax payers are likely to be those who controls 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.

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 a number of 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 such as compensation mechanisms, offsets, and/or an emissions trading system.

7.2.3.4 Who faces the price of a carbon tax?

Box: Difference between who pays the tax and who bears the cost of the tax

In a carbon tax legislation rules are laid down as to what legal entity that will be responsible to pay the tax to the Government (tax payer). A carbon tax is aimed to give consumers an incentive to change their behaviour and consume less fossil fuels. Whether this effect is achieved depends on if the tax payer can pass the cost of the carbon tax on to the consumers or not.

There is a difference between who is targeted by the tax and legally responsible for paying it, and who bears the incidence of the tax. In economics, tax incidence or tax burden is the effect of a particular tax on the distribution of economic welfare. 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 the group that ultimately bears 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, but on the price elasticity of demand and price elasticity of supply.

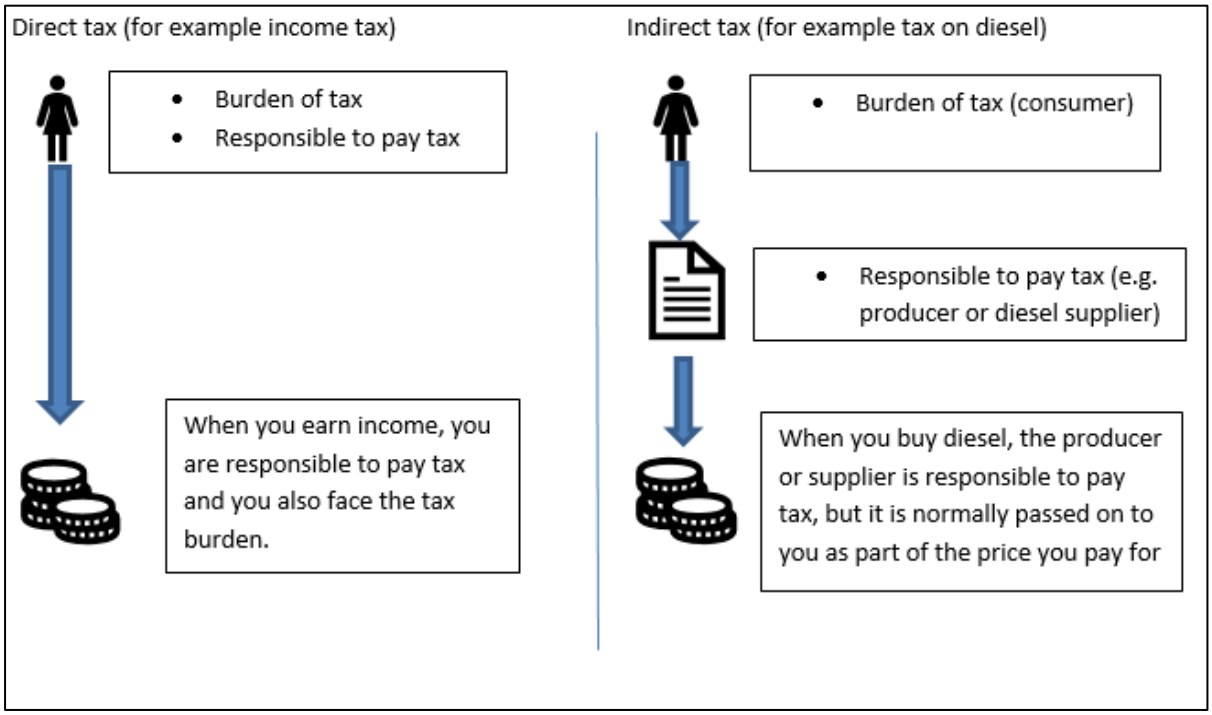


Figure Direct vs indirect tax – who pays the tax and who faces the tax burden

In the case of a carbon tax, the tax incidence depends on whether the entities obligated to pay the carbon tax can pass it on to consumers or not. If the entities can raise the product price to compensate for the full amount of the tax, the whole tax incidence can be considered to fall on the consumers. In this discussion, it is important to emphasize that changed 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.

There are several important issues to consider in this discussion. For instance, if a price regulation exists, the entities might not have the possibility to increase the price to pass on the burden of the tax. In this case the tax burden falls on the entities, reducing their profits. A carbon tax under these circumstances will not reduce emissions in the short term, but solely work as a fiscal tax. 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 entities and the consumers. There are, however, circumstances where companies are less able 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. These issues will be further discussed in chapter X.X.

7.2.4 Tax coverage, possible exemptions and thresholds

One way of deciding the carbon tax coverage is to base it on targeted sectors, subsectors or certain economic activities. In jurisdictions without any carbon pricing system already in place,

a broader carbon tax will typically provide more opportunities and thus a more efficient emission reduction. Circumstances will differ between jurisdictions and the most suitable coverage of the carbon tax will depend on a range of factors, including e.g. 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.[14] *[This section will be expanded in a later version of the draft]*

7.2.4.1 Theory and practice

Although economic theory suggests a uniform carbon tax with wider base in terms of its coverage would be the most efficient design, concerns commonly raised among stakeholders that additional tax burden would lead to adverse effects on the competitiveness of domestic industries – especially energy-intensive and trade-exposed firms – cause carbon taxes introduced in practice to deviate from the theoretically ideal carbon tax. Several jurisdictions have strived for a balance between fulfilling environmental objectives and accounting for the risks of carbon leakage and securing the competitiveness of certain sectors being subject to international competition. Despite 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 need therefore to be considered in the process of designing the tax. The impact of a carbon tax in different income groups and geographical regions are other factors determining the acceptability of the tax.

The table below illustrates how carbon taxes in selected jurisdictions are designed with regards to coverage and exemptions.

[14] The influence of differences in marginal abatement cost curves is further discussed in relation to the use of different tax rates in section 7.d.

Table Carbon pricing mechanisms in selected countries

Country	Year	Description	GHGs covered	Sectorial/fuel coverage	Competitiveness considerations or exemptions
Argentina	2019	The Argentina carbon tax was adopted 2017 as part of a comprehensive tax reform proposal, and entered into force on January 1, 2019. The tax partially replaces a fuel tax that was present before.	20 %	The Argentina carbon tax applies to CO2 emissions from all sectors and covers almost all liquid fuels and coal.	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 oil and raw materials in (petro)chemical processes. To offset the fuel price increase by the carbon tax, the tax on liquid fossil fuels are adjusted at the introduction. For mineral coal, petroleum, and fuel oil, the tax rate will start in 2019 at 10 percent of the full tax rate, increasing annually by 10 per cent to reach 100 per cent in 2028.
Colombia	2017	The Colombia carbon tax was adopted as part of a structural tax reform. The Colombia carbon tax was launched in 2017.	24 %	The Colombia carbon tax applies to GHG emissions from all sectors with some minor exemptions, and covers all liquid and gaseous fossil fuels used for combustion.	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. Income tax does not need to be paid over costs incurred as a result of the carbon tax.
Mexico	2014	The Mexican 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 CO2 emission content	46 %	The Mexican carbon tax applies to CO_2 emissions from all sectors. The tax covers all fossil fuels except natural gas.	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.

		compared to natural gas			
South Africa	2019	The South Africa carbon tax is scheduled to come into effect by June 1, 2019.	80 %	The South Africa carbon tax applies to GHG emissions from the industry, power, buildings and transport sectors irrespective of the fossil fuel used, with partial exemptions for all these sectors.	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.
Further examples…					

Source: The World Bank *Carbon Pricing Dashboard*

7.2.4.2 Policy options to address concerns over competitiveness, carbon leakage and distributional effects

There are several policy options that seek to address concerns related to the potentially adverse effects of a carbon tax, see table below. The most popular set of policies focus on different types of *carbon tax payment reductions* lowering the effective carbon tax via exemptions, thresholds and reduced rates. Another set of policies in use include different *support measures* to affected firms or sectors: output-based rebates or targeted support for resource efficiency and cleaner production. Also, non-carbon tax reductions can be included in this group of measures. A third category of policies consists of *trade-related measures*, such as border trade adjustments, consumption-based taxation and international cooperation. International experiences from this latter category is however limited, and it is in this discussion vital to review the relationship between potential border tax adjustment measures and WTO requirements.

Whereas the first two categories consist of measures that address both leakage and distributional risks, measures in the third category focus primarily on leakage risks only.

Table Overview of Measures to Address Leakage and Distributional Effects

Category	Measure	Strengths	Drawbacks	Examples
Reducing carbon tax payments	Exemptions	Relatively straight forward to implement Can be directly targeted at affected industries Unlikely to present international legal challenges	Negative price signal of tax Difficult to determine appropriate level and extent ex ante Risk of domestic legal challenge from non-exempted industry	British Columbia, Japan, South Africa, Switzerland
	Reduced rates	Can be made contingent upon emission reduction agreements	Loss of tax revenue	Sweden, France
	Rebates on carbon tax payments		Contrary to polluter pays principle	Denmark, Ireland, Finland
	Offsets	Incentive for emission reductions in uncovered sectors Incentivize private investment in emission reductions	Administratively complex Reduced tax revenues Environmental integrity challenges	Mexico, South Africa
Support measures	Output-based rebates	Retain price signal Strong leakage protection	High and uncertain costs to public budget Significant data requirements Reduce incentive to shift to other products	Sweden (NO_x tax)
	Support programs	Retain price signal and offer additional emission reduction incentive Popular with industry groups Flexible in design, as can take the form of grants of tax credits, loans, guarantees etc.	Costly to public budget (though often less than exemptions) May present challenges as far as complying with state aid rules is concerned	South Africa, Australia, Ireland, Switzerland, Japan

	(Non-carbon) tax reductions	Retain price signal Potential for net positive effect on business and economy	Cost to public budget Difficult to target directly at affected entities	British Columbia, France
	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	
Trade related measures	Border carbon tax adjustments	Maintain price signal for domestic industry Prevent free-riding by companies from non-taxing jurisdictions Do not put pressure on public budgets	Politically unpopular internationally and risk damaging international relations Administratively challenging Potential negative economic impacts on importers May be challenged as trade barrier under WTO or other trade law, though well-designed measures can likely be defended	California ETS
	Consumption-based taxation	Effectively address competitiveness and leakage risks Extend pricing to extraterritorial emissions Lower legal/political risks than border trade adjustment	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	None

	Internation al cooperation	Retains domestic price signal Leverages domestic carbon price to encourage carbon pricing in partner jurisdictions No domestic administration needs	Difficult to negotiate across many countries, so may be unworkable for sectors with large numbers of international competitors	None

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.

Exemptions and other measures to reduce carbon tax rates

Most jurisdictions have, for political reasons, either fully exempted or implemented a lower carbon tax rate in the case of some fuels and/or sectors. To ease the implementation of the tax some exemptions can be temporary or step-wise phased out, in some cases –depending on national circumstances– they can be part of a long-term policy design.

While concerns for reduced competitiveness and carbon leakage may justify that certain industries face different tax rates, exemptions also have unwanted side effects. The economic purpose of carbon taxes is based on the consideration 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. Exemptions undermine this aim, thereby limiting the efficiency and effectiveness of the tax. 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 was not consistent with the legislator's purpose.

Furthermore, countries without experience in carbon pricing may want to strive to grant the least exemptions/price differentiations possible in order to avoid administrative complexity and thereby reduce implementation costs. Key to the administration of a simple system, is to consult widely with the different actors within society (business, industry, consumers, economists, regulators from different fields) and get their input prior to introducing the tax, to avoid a web of exemptions.

It is thus crucial for policymakers to consider alternatives to exemptions and to balance the negative effects with the need to protect certain sectors of great 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 targeted exemptions and, if possible, timebound with regular reviews.

Box: 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 EU ETS.

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

Another example of a jurisdiction complementing the tax by a measure to reduce undesired distributional consequences is the British Columbia Climate Action Tax Credit, which helps offset the impact of the carbon taxes paid by individuals or families.

/More examples?/

7.2.4.3 Other measures to protect competitiveness and address distributional risks

In addition to 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 industries or have a broader coverage. For example, it might be possible to use reduce other taxes, lower employer contributions to labour costs, or implement other government programs in order to maintain the competitiveness of an important sector of the economy. The durability of measures can also differ, depending on their purpose. There may, for instance, be a need to combine short-term relief for industries and long-term incentives for them to adapt by adopting cleaner and more efficient technologies. Other policies to address concerns about adverse impacts may include various trade related measures such as border tax adjustments and consumption-based taxation.

Introducing a carbon tax as a part of a wider tax reform can also provide an opportunity to implement measures to be taken to address distributional (income and/or geographical) concerns related to the impact of the carbon tax.

Box: Country examples of carbon taxes being introduced and developed as part of a larger tax reform

Examples to be added: E.g. Sweden and examples from Latin America (Argentina, Chile, Columbia, Mexico), others?

7.2.4.4 Introducing a carbon tax: Two-level tax systems and setting of thresholds

To date, a carbon tax has been implemented in close to 30 national or subnational jurisdictions 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 many jurisdictions.

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 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: Country examples of a two-level carbon tax

When designing the Swedish carbon taxation system, two carbon tax levels were introduced. This was to avoid negative effects to the domestic industry and carbon leakage. The lower carbon tax level was applied to fuels used for heating purposes by the industry. The lower tax level has, since the introduction of the tax in 1991, been phased out in Sweden and was fully abolished in 2018. Such a lower tax level has been the prerequisite for a high tax level for other sectors and one important cause of the emission reductions achieved in the high taxed sectors.[15]

[15] 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.

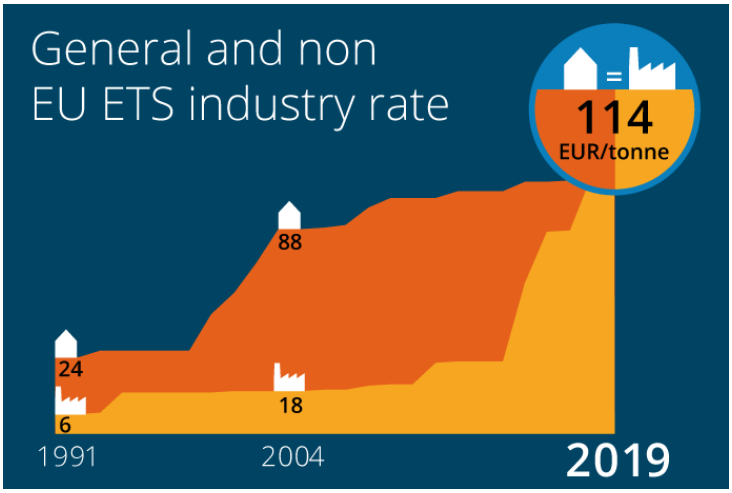


Figure Development of the Swedish Carbon Tax. General level and industry level. Industry level outside the EU Emissions Trading Scheme (EU ETS) since 2008. (Source: Government Offices of Sweden)

A two-level system can, as has been seen in Sweden, contribute to substantial emission reductions in the high taxing sectors. Also, Denmark has a differentiated carbon tax system, where business pays a lower carbon tax rate than households. The British Columbia Government provides carbon tax relief to commercial vegetable, floriculture, wholesale nursery and forest seedling greenhouses. The Greenhouse Carbon Tax Relief Grant (GCTRG) covers 80 per cent of the carbon tax paid on natural gas and propane used for greenhouse heating and carbon dioxide production to be used for crop fertilization. The UK as well as several jurisdictions applying a specific carbon tax, such as Denmark, also give businesses tax reliefs on the condition that they enter into voluntary agreements leading to the achievements of environmental protection objectives

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.

Box: 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 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 is only applied on 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.

/More examples/

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 provide small firms with incentives not to grow to avoid the tax.

In the case of carbon taxes thresholds applied directly to emissions are common and where a carbon tax is applied at a point where the number of actors is relatively high and their size and capabilities vary significantly. By contrast, jurisdictions that apply their tax to fuels at the level of distribution (downstream) 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.

7.2.5 How to treat carbon content in fuels of biomass origin?

Box: Fuels of biomass origin

This handbook does not aim to offer a recommendation as to whether a jurisdiction ought to include some or all fuels of biomass origin in their carbon tax base.

The focus in most jurisdictions having introduced carbon taxation has been to focus on fossil fuels. Therefore, fuels of biomass origin would not be 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 case legal constraints when combining a tax exemption with another policy measure. Some jurisdictions although take account of the biomass part when calculating the tax rate for the petrol and diesel mixture.

Maybe include illustration of liquid biofuels

An important political decision is whether the tax base ought to 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. Without making any formal recommendation the Subcommittee would like to highlight the implications of including biofuels in the tax base. Such a framework could give the carbon tax more of fiscal character as it prevents tax payers from switching fuel to lower their costs for taxation.

Some jurisdictions consider a switch to biofuels as part of the solution towards a low-carbon economy, while other jurisdictions are more inclined to see problem with an increased use of biomass fuels. It is outside the scope of this handbook, but it can be mentioned that concern about not subjecting biomass fuels to a carbon tax has been raised in the public debate. Motives for such an approach can, for instance, be found in the reports from the OECD concluding that policy support for biofuels contributes little to reduced greenhouse-gas emissions and other policy objectives, while it can be seen as one of several factors contributing to raise international prices for food.

7.2.5.1 IPCC Climate Change Emission Reporting

The current IPCC Intergovernmental Panel on Climate Change emission reporting[16] is done based on emissions from combustion of fossil fuels and the IPCC has stated that 75 per cent of the changes in the temperature in the atmosphere during the past 25 years relates to the combustion of fossil fuels. The remaining 25 per cent is due to changes in land use, primarily deforestation. Using biomass energy is not contributing to an increased atmospheric temperature, when biomass is continuously being rebuilt to an extent that in the long run corresponds to the emissions occurring at the combustion of biomass. By calculating a carbon tax on the content of fossil carbon in the fuels, the Polluter Pays Principle (PPP) is fully integrated in the design of the tax. It would not make sense to levy it generally on the carbon content of fuels, as this would not be an instrument targeted to reduce fossil carbon dioxide emissions. As only fossil fuels result in net increases of carbon to the atmosphere, such a tax helps to reduce the use of fossil fuels and thus reach set global climate targets.

Sweden is among those countries where the principle of not subjecting biofuels to a carbon tax has been prevailing since the introduction of such a tax back in 1991. A restriction to applying this principle only to biofuels fulfilling certain established sustainability criteria has since been introduced, following mandatory EU legislation. The reasoning behind the Swedish approach is – in line with the theory just outlined – that combustion of sustainable biofuels does not result in a net increase of carbon in the atmosphere and hence are not subject to carbon taxation. However, applying a carbon tax only on fossil emissions is not a Swedish invention. The EU has set climate targets and work is globally carried out based on the 2015 Paris Climate Agreement. Only consumption of fossil fuels increases the net emissions of carbon and therefore, there is a need to strive towards reducing the global use of fossil fuels.

7.2.5.2 Low blends of ethanol and biodiesel into petrol and diesel

While the general principle of only taxing emissions from fossil fuels seems to be prevailing in jurisdictions having introduced a carbon tax, some simplifications have been made for administrative reasons. This means that low blends of ethanol into petrol and FAME (biodiesel) into fossil diesel in many countries are taxed by the same rate per litre fuel, as if the fuel mixture would have been of 100 per cent 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 excise duties on petrol and diesel are the same, regardless of the content of biomass fuels in the propellant. EU state aid provisions put legal constraints on EU Member States' possibilities to combine a quota obligation scheme with tax exemptions.

[16] For further information see IPCC Guidelines for National Greenhouse Gas Inventories, https://www.ipcc.ch/report/2019-refinement-to-the-2006-ipcc-guidelines-for-national-greenhouse-gas-inventories/.

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 example 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.

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

In some countries, such as Sweden and France, the carbon tax per litre of such propellants have, however, been calculated to take account of the blend of biomass fuels following a quota obligation[17]. However, the use of pure or high blended liquid fuels of biomass origin, which as of yet amounts to low volumes in most countries, are often exempted from applicable carbon taxes. Another example is British Colombia, where the carbon tax since apples to ethanol at the same rate as petrol and to biodiesel and renewable diesel at the same rate as diesel or light fuel oil. However, wood and other solid biofuels are not subject to carbon tax neither in any EU country nor in British Colombia.

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

Finland was the first country in the world to introduce a carbon tax in the early 1990's and like the other Nordic countries, the carbon tax is in Finland a key component in the country's pathway to a low-carbon and eventually carbon neutral society. An increased use of sustainable biofuels as part of the national energy and climate strategy comes natural for a country with major natural forest resources. Starting out with one single carbon tax rate based on the fossil carbon content of fuels, Finland has during the last decade step-wise differentiated its carbon tax according to the performance of biofuels, 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[18].

The key parameter in the Finnish system is still emissions of fossil carbon dioxide. However, when classifying biofuels in three levels of the carbon tax, the legislator has based these levels on life cycle values[19] providing how much life cycle carbon dioxide emissions reduction is

[17] For Sweden, see for example PPP presentation from September 2017 available at www.government.se/carbontax.

[18] 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.

[19] 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. From

achieved relative to equivalent fossil fuels. Biofuels that fail to meet set sustainability criteria are subject to the same carbon tax as the equivalent fossil fuel, as there is deemed to be no savings in fossil carbon dioxide emissions. Biofuels that meet set sustainability criteria (e.g. agriculture origin/first generation biofuels are subject to a carbon tax rate corresponding to 50 per cent 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 50 per cent. The current Finnish carbon tax design may not be the first choice for a country starting out designing a new national carbon tax system, due to the complexity of an LCA approach when setting tax rates for different fuels, but it shows the possibilities of adapting a Fuel Approach tax system along the way.

7.2.6 Checklist for defining a tax base

In the previous sections, several important choices when designing a carbon tax have been highlighted. These are summarized below.

1. **Subject of the tax** – the decision of whether to measure and tax direct emissions or use the more common method of taxing fuels.
2. **Point of regulation** – at which point in the supply chain are the actors responsible for paying the tax.
3. **Legal entity** – connected to the point of regulation is the matter of which legal entity who will be responsible for paying the tax.
4. **Sectors and activities –** the discussion of which sectors and activities in the economy that are subject for the tax and what the consequences will be.
5. **Exemptions and thresholds –** the point of creating a general tax design without negative side effects, for instance in form of carbon leakage.
6. **Treatment of biomass –** the issue of how to treat emissions from biofuels.

After deciding on the approach in the issued 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, in order to achieve the desired effects.

an environmental point of view this approach may seem desirable, especially as it could give incentives to reduce emissions from production of the fuel.

7.3 Tax Rates *[Draft as of 1 April 2019]*

7.3.1 Introduction

Implementing a carbon tax is a learning by doing process because the impacts of the tax are difficult to predict in advance. Hence, it is better to start a carbon tax at any level before waiting any longer, because it is not necessary to find an accurate tax rate right from the beginning. However, if the desired goal will not be reached after a certain period it is crucial to adjust the tax rate. Therefore, the tax rate needs an adjustment, if a specific reduction goal was not achieved during the past period. This trial-and-error approach could help to increase the accuracy of the tax rate. There are also economic theories and approaches that could be used in determining the tax rate.

Setting the rate of a carbon tax is an essential decision when designing this tax. The level of the tax rate has direct implications for both its effectiveness the economy as it influences market prices. As a consequence, setting the tax rate merits careful consideration and this chapter will point out key aspects to consider when making this decision.

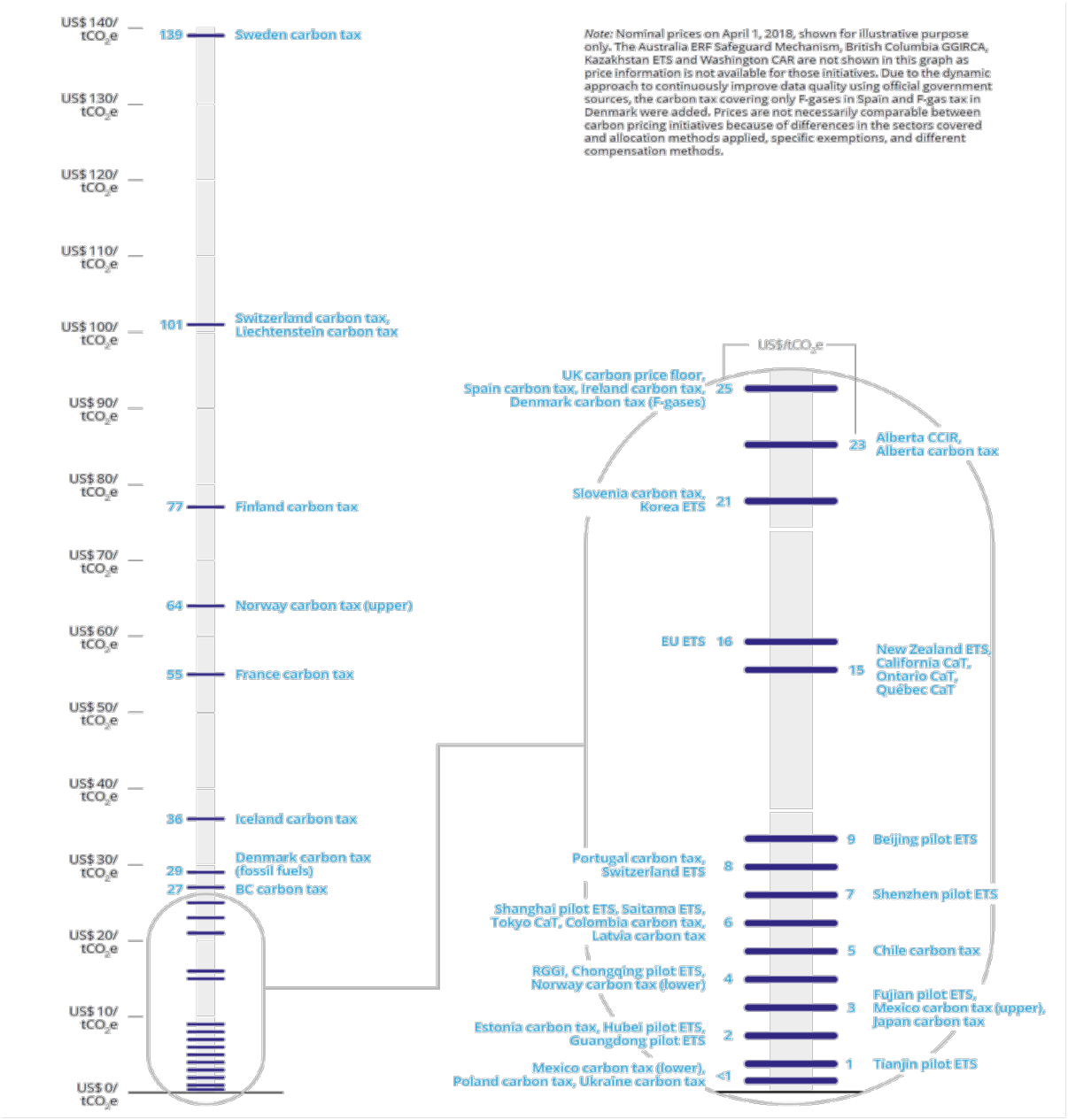


Figure XX: Prices in implemented carbon pricing initiative
Source: World Bank, Ecofys (2018). *State and Trends of Carbon Pricing 2018.* © World Bank. https://openknowledge.worldbank.org/handle/10986/29687 License: CC BY 3.0 IGO.

The figure above shows carbon tax rates in force in 2018. Thus, examples of various policy strategies followed by different jurisdictions can be seen from the figure. The variety of tax rates in force ranges from less than one US $ / tCO2e to over one hundred dollars. It is worth remembering that the higher tax rates currently applicable in some jurisdictions were not set at once, but rather achieved in a step-wise manner over longer periods of time. Despite that, most initiatives levy relatively low carbon tax rates below US $ 30.

However, in order to reach the temperature target agreed upon by the Paris Agreement, the High-Level Commission on Carbon Prices proposed a carbon price of at least US $ 40 – 80 / tCO2 by 2020 and US $ 50 – 100 / tCO2 by 2030. 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 why it is important to start right away. 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, getting the system started with a low initial carbon tax rate could create the basis for a – from an environmental perspective – successful carbon tax.

We will in the following chapter look at the different techniques and practical discussions in literature to define a tax rate in numerical terms. In order to provide guidance, the following chapter deals with technical criteria regarding the determination of the tax rate. In addition, both, the abatement costs and the cost curve are relevant factors to consider in this respect. Moreover, it will also deal with technical questions regarding the development of the tax rate over time and with various political issues, such as increasing or reducing the rate. Subsequently, the chapter also discusses certain country specific characteristics of carbon taxes.

7.3.2 Setting the Rates

7.3.2.1 Pigouvian Approach – internalising external costs

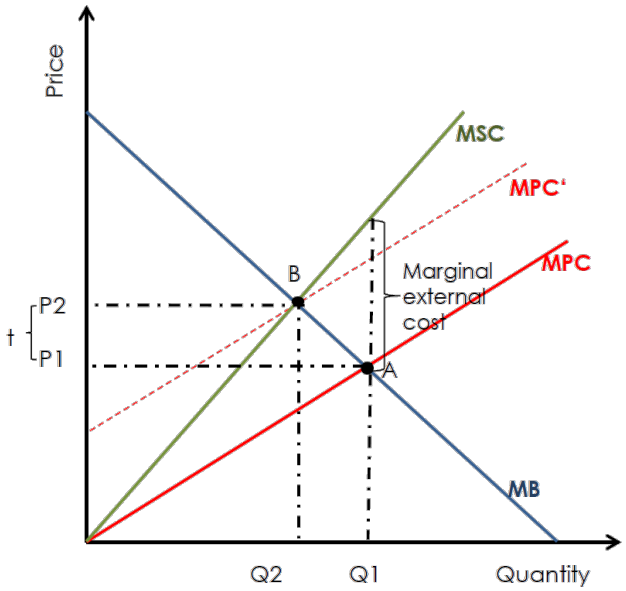
Emitters of CO2 emissions are responsible for the climate change. However, the emitters are not usually held accountable for the costs which are caused by climate change. Therefore, there are hardly any monetary incentives to reduce emissions. One approach to solving this problem is to implement a carbon tax which follows the Polluter Pays Principle. The tax must correspond to the amount of the costs incurred by the actions of the polluter. Thereby, the carbon tax imposes a charge on CO2 emissions equivalent to the potential cost of climate change in future. Thus, the polluter finally bears the costs of climate change. As a consequence of the tax, financial incentives are created, to minimize CO2 emissions. The Pigouvian approach can help to determine the tax rate of a carbon tax in order to follow the Polluters Pays Principle.

Although the Pigouvian approach only works in theory and has not been used for setting the tax rates in any jurisdiction, it represents an interesting theory. This theory involves reducing CO2 emissions through the full internalization of external costs of environmental damages through taxes. It is based on the consideration that emitters of CO2 emissions impose costs and disservices on others, without paying for the resulting damage that occurs. External costs occur as a result of the actions of economic actors, which affect other parties (e.g. society). If there is no price signal on pollution the polluter does not pay for the damage. 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 finally bear all costs occurring as a result of economic actions.

According to economic theory, the tax rate of a Pigouvian Tax should be set equal to the marginal social cost of the pollution. This marginal social cost of pollution represents the damage that occurs by producing an extra unit of a specific good (e.g. one-ton CO2). 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 as a result of higher prices.

Box XX: Technical Note: Pigouvian Approach



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 costs (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 considered 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

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.

Although the Pigouvian Approach makes sense from an economic perspective, the implementation of a Pigouvian Tax faces many limitations in reality. Ideally, the tax rate of a Pigouvian Tax represents **exactly** the external cost. 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. 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 in order to calculate the costs of climate change. This 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[20] also, have a significant impact on the calculation. However, even the most complex model is not capable to reflect reality and is subject to uncertainty. (see Annex 1 for further reading)

Many economists have tried to calculate the costs of climate change. Regarding the social costs of one-ton CO2, the calculations ranges from 10 $ to several hundred $ per ton CO2. The wide spectrum shows how difficult it is to define the "exact" tax rate for a carbon tax. This is because it is unrealistic that even the most complex economic models are capable of calculating the cost of climate change, as there are many uncertainties. However, in order to follow the Pigouvian Approach the determination of the "exact" tax rate is necessary. Therefore, the Pigouvian Approach can only exist in theory. Hence, it is questionable if the Pigouvian Approach is feasible in practice because it is very technical and will take a great resource effort to calculate. Although the practical implementation of the Pigouvian Approach seems unrealistic, 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 Approach is that emitters of CO2 should contribute to 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. However, a more practical approach, which does not follow the exact mathematical solution, may be feasible to determine the tax rate of a carbon tax.

Box XX: Carbon Taxes and the Nobel Prize

William 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 ETS or carbon taxes is an efficient way of lowering CO_2 emissions. In 2018, Nordhaus received the Nobel Prize in Economics. The Nobel committee recognized with the award the economics of climate change, which underlines the relevance of a carbon tax.

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

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. (IPCC 2018).

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

Moreover, it is also 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). This approach is 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, see chapter XX on the administration of the tax. Moreover, an emission reduction target can be based on the nationally determined contributions under the Paris Agreement within the United Nations Framework Convention on Climate Change. 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.

The economic idea behind the Standards and Price Approach corresponds to the Pigouvian Approach. The first step is to define an emission reduction target (Standard). After the 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. Thereby, the initial carbon tax rate could be determined by any economic model or on a technology-based approach (e.g. Marginal Abatement Costs Curves (MACC) – see Annex for further reading). The main advantage of this method, compared to the Pigouvian Approach, is that it is not necessary to find the mathematically exact tax rate, as the emission reduction goal is the focus of this approach.

Box XX: 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.

Source: Andersen, M. & Dengsøe, N. J Mater Cycles Waste Manag (2002) 4: 23.

Thus, implementing a carbon tax is a learning by doing process because the impacts of the tax are difficult to predict in advance. However, adjustments are crucial, if a specific reduction goal was not achieved during the past period. Therefore, a trial-and-error approach could help to increase the ecological effectiveness of the tax. This policy could overcome economic modelling limitations, by following a trial-and-error policy. Although the Standard Price Approach helps to overcome economic limitations, the approach seems to be difficult to implement in practice. As politicians must follow this approach over several periods.

7.2.2.3 Revenue Target Approach

Different policy objectives may encourage jurisdictions to implement carbon taxes. Besides environmental considerations, the main motive for some jurisdictions to implement carbon taxes is to generate considerable tax revenues. In 2018, the total value of all carbon taxes and ETSs which are worldwide in force was US $ 82 billion, which represent a 56 % increase compared to the 2017 value of US $ 52 billion. In British Columbia, the carbon tax amount to 3 % of the province`s budget. Therefore, carbon taxes could serve as a substantial source of government revenue, which could be spend in different ways. One example would be to spend the revenue on social programmes for poor households in order to avoid unwanted effects of the carbon tax. Moreover, the revenue can help to fund public transport systems, R&D programmes for low carbon technologies, or for grants to switch to renewable energy systems (see chapter V).

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

One of the main reasons for the implementation of the carbon tax in Chile was to raise tax revenue to fund education programmes. The Chilean carbon tax was 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.

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 in order 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). 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.

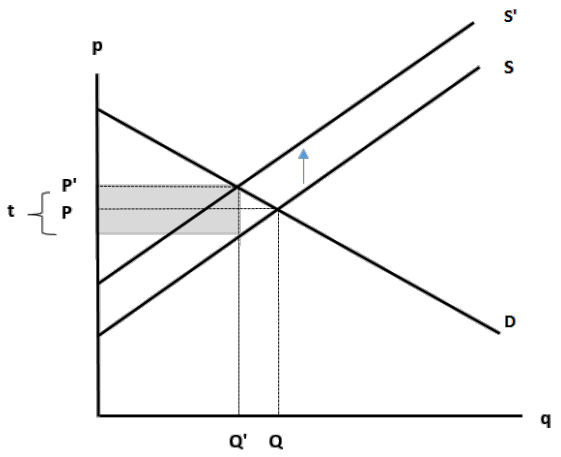
Box XX: Price Elasticities

In order 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 price elasticity measures the responsiveness of the demand after a change in the 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 (Abenezer Zeleke, A., 2016).

Economists need this data to calculate and estimate a tax rate, which generates a targeted level of revenue. However, it is unrealistic to predict the tax revenue of a specific tax in advance. This is one of the biggest downfalls as the revenue target approach is quite complex. Therefore, it is arguable that the revenue target approach is not appropriate for jurisdictions with a lack of resources, which are planning to introduce a carbon tax, because of its high degree of complexity and uncertainty. Besides that, the revenue target approach may be a useful policy strategy as the increased tax revenue may be used for funding social programmes to reduce poverty.

Box XX: Revenue target approach

The revenue target approach is based on the 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, because the tax revenue depends on many economic factors (price elasticity, market power, economic situation), which have to be taken into account. (For more information see Annex.)



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

However, once the CO_2 emissions decreases the tax base of a carbon tax may eroding. Therefore, a targeted tax revenue cannot be maintained over time (see Annex for further reading). 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. Limiting global warming at 1.5° C would require an emission reduction pathway which reaches zero net emissions around 2050. Following this pathway would mean that the carbon tax revenue would be zero in 2050. This example shows that the revenue target approach is – at least in the long term – in conflict with emission reduction targets. However, in the short- to medium-term carbon taxes may generate a considerable amount of tax revenue. Therefore, the revenue target approach could be a useful tool for countries that consider implementing carbon taxes.

7.2.3.4 Benchmarking Approach

Setting a carbon tax rate requires significant economic data. An alternative approach to a highly time consuming and costly process is to base the tax rate on a benchmark analysis. Overall, around 30 jurisdictions impose taxes on carbon in 2019. Those jurisdictions could serve as a model by setting a tax rate for carbon taxes. Thereby, policymakers can rely on the work of the OECD and The World Bank who publish carbon tax rates and trends of carbon pricing from several jurisdictions on a regular basis (OECD, 2018; The World Bank, 2018). The table below illustrates a selection of carbon tax rates, which are currently in force (see a complete list in the Annex).

Jurisdiction Covered	Nominal tax rate in November 2018 US $ / tCO_2
British Columbia	26.74
Chile	5
Colombia	4.92
Denmark	27.07

Finland	70.64
France	50.81
Japan	2.56
Mexico	2.73
Norway	59.87
Singapore	3.7
Sweden	126.83
Switzerland	99.71
Ukraine	0.01

Figure XX: Selection of nominal carbon tax rates in November 2018
Source: Data based on Carbon Pricing Dashboard, Data based on The World Bank available at https://carbonpricingdashboard.worldbank.org/map_data.

According to the table, the carbon rates ranges from US $ 0.01/ t CO_2e (Ukraine) to around US $ 127 / tCO_2e (Sweden). The wide spectrum of tax rates which are in force is an indicator that different policy strategies are followed by carbon taxes.

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. In addition to that, some carbon taxes are levied on certain transactions while others are directly related to emissions (see chapter XX). Moreover, also jurisdictions by itself are hardly comparable as they have different framework conditions, policymakers should consider which jurisdictions are in a comparable situation when designing their tax rates. For example, it would not be appropriate for a country to set the tax rate on the basis of the data of another country with a completely different background or national prerequisites. Regarding the selection of comparable jurisdictions, the following factors may be taken into account:

- policy objective
- economic background
- purchasing power
- demographic factors
- political background
- energy production
- geographic distribution
- tax system

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 discussions on a national level. Generally, the number of carbon taxes in force have increased considerably over the last years

(see Figure XX). Thereby, jurisdictions with completely different background have implemented carbon taxes. The rising number of carbon taxes in force indicates the crucial role that carbon taxes have as a climate policy instrument. In the meantime, carbon taxes are widespread, which facilitates the application of the benchmarking approach considerably. Policymakers all over the world can rely on more examples of carbon taxes or at least carbon tax initiatives, which are implemented in comparable jurisdictions.

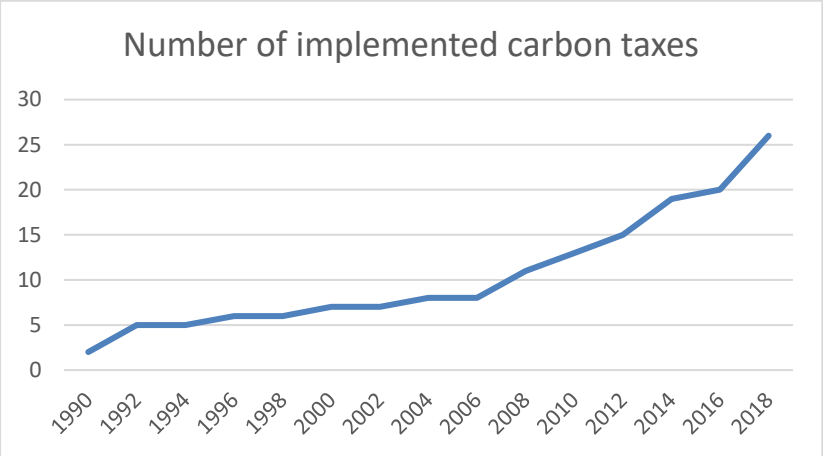


Figure XX: Number of implemented carbon taxes
Source: State and Trends of Carbon Pricing 2018
https://openknowledge.worldbank.org/bitstream/handle/10986/29687/9781464812927.pdf?sequence=5&isAllowed=y

Another interesting aspect is that studies from the OECD have shown that taxes on fossil fuel products have been rising over the past years. For example, Alberta, British Columbia, 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 an ambitious carbon tax rate.

Box: Examples of carbon tax rate changes 2018:

- 2017/2018: Alberta's carbon tax from CAN $ 20 / tCO_2e (US $ 16/tCO2) in 2017 to CAN $ 30/ tCO2 in 2018;
- British Columbia's carbon tax increased from CAN $30 / tCO_2e to CAN $ 35 / tCO_2 2018 in 2018;
- Finland's carbon tax rate increased from € 58 / tCO_2 to € 62 / tCO_2 in 2018;
- Iceland carbon tax increased to approximately ISK 3500 / t CO_2 in 2018;
- Switzerland's carbon tax increased from CHF 84 / tCO2e to CHF 96 / tCO2

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

However, the benchmarking approach is questionable from an environmental perspective, because the carbon tax rates in jurisdictions, which have already implemented a carbon tax, are in most cases significantly lower than the tax rates, which would be required to achieve the Paris temperature target. The OECD concluded that at the current pace of time, carbon prices would only meet the real social costs in 2095. Therefore, much more ambitious tax rates are needed. Consequently, it is questionable if the current carbon tax rates are appropriate for a benchmarking analysis.

For example, the High-Level-Commission on Carbon Prices proposed a carbon price level of US $ 40–80 / tCO_2 by 2020 and US $ 50–100 / tCO_2 by 2030. In practice, low carbon tax rates are the result of political compromises. Currently, only the tax rates in six countries (Finland, France, Liechtenstein, Norway, Sweden and Switzerland) are higher than US $ 40. Accordingly, most jurisdictions, which have implemented a carbon tax, are facing a gap in order to reach the Paris goals.

Box: OECD Effective Carbon Rates

The OECD publishes the effective carbon rates for 42 OECD and G20 countries, on a regular basis. The effective carbon tax rate is the sum of three components: specific taxes on fossil fuels, carbon taxes and prices of tradable emission permits. 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.

Source: OECD, Effective Carbon Rates 2018: Pricing Carbon Emissions Through Taxes and Emissions Trading

7.2.3.5 Benchmark comparison with trading partners

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, compared to carbon taxes applied in those jurisdictions, where the key trading partners operate, very high. Comparably high taxes may have a negative impact on a state's economy (see chapter VIII v.). 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. Thus, setting a carbon tax rate is finally a political decision. For example, the initial tax rate for the Norwegian carbon tax rate was entirely based on political negotiations. Furthermore, the political landscape in a jurisdiction is crucial in the decision-making process. Policymakers should accompany the political decision-making process by providing economic input and data. This input could be based on the benchmark approach as well as on the other approaches covered in this report. However, the choice of methodology is not important as long as the carbon tax policy is developed and deployed over time until it gets to a level that is sufficient to meet the Paris Agreement commitments.

7.3.3 Temporal Development of the Tax Rate

7.3.3.1 The role of politics

The chapter has discussed various approaches for setting a carbon tax rate. Those approaches can help jurisdictions to create a policy strategy. Thereby, it is clear that 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.

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. Moreover, a long term strategy will impact also other areas of government administration, like for example the policies administered for the exploration of mineral resources, if it is a resource rich country, environmental goals, and contracts signed by the public administration.

7.3.3.2 Tax Rate during the Initial Phase of a Carbon Tax

It is important for policymakers to consider the temporal dynamics of the tax rate during the introduction phase of a carbon tax. 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. In order to do, so policymakers may decide to apply a lower tax rate in its initial year (“ramp up introduction”). 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. Ideally, the desired carbon tax rate is effective from an environmental point of view. This is the case if the tax rate is capable to contribute to an emission reduction pathway, which is in line with the Paris agreement. 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.

For example, British Colombia followed a ramp up strategy. British Colombia 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. Another approach is taken by France, which introduced a carbon tax in 2015. Thereby the legislator determined the rising tax rate for each year up to 2021 when it will reach € 56 / t CO2. The French legislator also defined the tax rate for 2030 at € 100. The tax rates between 2021 and 2029 are not defined yet, which leaves the legislator room to respond to economic developments. 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 $ 5 - 10 / tCO2 in 2030. 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. 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.

Therefore, jurisdictions may decide to follow strategy static carbon tax rate, which means that the carbon tax rate stays the same after its introduction. The biggest advantage of a static carbon tax rate is that it maximizes the anticipation effect of the carbon tax: If the carbon tax would be implemented without a ramp up strategy, emitters will start to adjust their behaviour immediately. Moreover, a static carbon tax rate gives the market a stable and predictable price signal, which facilitates investments. The price stability of carbon taxes is one of the advantages of a carbon tax compared to an ETS in which the price depends on market forces. Consequently, the carbon tax triggers its full impact earlier in time. Therefore, a static carbon tax rate is more effective from an environmental point of view. However, the environmental effectiveness depends mostly on the amount of the tax rate. A low tax rate is not effective from an environmental point of view independent from the policy strategy after its implementation.

However, one argument opposing a static carbon tax rate is that the implementation of a carbon tax can trigger an economic shock in carbon-intense industries or among poor households (see chapter XX). Sudden increases in prices after the implementation of a carbon tax would be the consequence. Emitters would not have time to adjust their behaviour in advance in order to avoid negative consequences for their business. Another argument against a static carbon tax rate is that it may face more political opposition than a ramp up strategy by those who are affected by the tax. Moreover, another argument against the turkey approach is that individuals should act without trying to predict sudden future government policies. Taxpayers should rely on current law, which means that it would be unfair to change the compliance obligations. This argument is more a political than a legal argument because tax law is changing all the time and

there is probably in most jurisdictions no legal basis which hinders the legislator of changing the law. However, it is thinkable that the constitutional law in some jurisdiction restricts the (sudden) implementation of taxes, which are not covered by constitutional empowerment.

7.3.3.3 Development of the Tax Rate after its implementation

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 trial and error 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 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) or recent international developments on carbon taxes may change basic assumptions, which were made in the past (see Box XX). Furthermore, changes in a jurisdiction's climate mitigation target or a change in public support may occur. Hence, setting tax rates for carbon taxes is an ongoing process that never ends. However, from a practical point of view changing the tax rate will always be a time-consuming process, as it requires negotiations and a political decision-making process.

Box XX: 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. To maintain the effect of the carbon tax, adjustments are necessary to compensate inflation. Therefore, for example, the Netherlands, Denmark and Sweden have indexed their carbon and energy taxes to inflation in order to maintain the price signal of their tax rates.

Therefore, policymakers may decide to implement predetermined adjustments formulas within the law. 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. The exact predomination of the adjustment formula is crucial in order 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 adjustment formulas may raise constitutional concerns in some jurisdictions.

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. For example, Norway is reviewing its carbon tax rate on a yearly basis. During this process, the Norwegian carbon tax rate has been increased over the last years. Also, Ireland reviews the status of their national carbon tax rate on a yearly basis.

Thereby, Ireland reviews the performance of the tax and takes into account international trends of carbon pricing. One advantage of reviewing processes is that it provides for more flexibility compared to a strict adjustment formula. However, annual reviews require also a political process. Therefore, a broad political commitment to the reviewing process could help to shield tax rate adjustments from political interventions. Hence, tax rate changes for carbon taxes should rather be based on environmental than on political considerations in order to realise the full potential of carbon taxes. Furthermore, overall stable political conditions are crucial for a favourable investment climate in green technologies.

7.3.4 Tax Rates and Country Specific Considerations

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, less developed countries, which may have a weak economic performance and a low Human Development Index, are not comparable to rich countries. Therefore, especially for less developed countries, certain characteristics must be taken into account. For example, they may suffer from a development lag, which limits their taxing ability. Economic growth and development are essential for poor countries to fight widespread poverty. Therefore, some countries might be concerned that high carbon taxes may potentially slow down the future economic development. This is because extremely poor countries need access to basic services and infrastructure. 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, countries have special economic and demographic characteristics, which need to be taken into account when setting a tax carbon tax rate.

However, carbon taxes may be essential for countries, which are poverty stricken. The revenues from a carbon tax can support poverty reduction to develop their infrastructure in an environmentally friendly way. Well-designed carbon taxes could support economic poverty reduction. In addition to that, recent technology developments (e.g. massive cost reductions for renewable energy sources) have also created the opportunity for countries with a high expansion requirement for power plants to benefit from environmentally friendly technologies and leapfrog fossil fuel technologies. For example, small-scale solar energy and wind grids offer new possibilities to provide energy to remote rural areas, at lower costs than gridded electricity or small-scale diesel generators. Thereby, carbon taxes can support countries to

establish an innovative energy infrastructure in a cost efficient and environmentally friendly way. Therefore, carbon taxes can also stimulate 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. Building a low-carbon infrastructure could help to avoid negative side effects of fossil-based development, such as air pollution, which is a severe problem in some countries.

However, 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. 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 in some countries may also be justified by the lower purchasing power in those countries. A lower purchasing power would lead to the situation that a given tax rate, which is derived from the tax rate of a developed country would be more burdensome for countries who are poverty stricken. Therefore, carbon tax rates, which are applied in rich countries, may not be suitable or overshooting for less developed countries. 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 higher on price changes. Therefore, lower carbon tax rates may be justified by the specific economic situation of some less developed countries as the impact of a price change in fuel prices is higher than in rich countries.

Summing up, various factors support the idea of lower carbon tax rates in some countries. However, this conclusion does not mean that also poor countries should not implement carbon taxes. Well-designed carbon taxes can play a major role in a sustainable development in all countries. Therefore, carbon taxes are promising tools in achieving the UN Sustainable Developments goals by 2030.

7.3.5 Key Considerations

- Setting a tax rate for a carbon tax is one of the most important decisions in designing a carbon tax. 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 trial-and-error strategy may be feasible as there is a lack of clarity about the exact social costs of carbon. In addition to economic approaches, policymakers may also design a carbon tax via a benchmarking analysis or by designing the tax rate with the purpose of achieving a specific revenue target.
- As implementing a carbon tax rate is a learning by doing task and new information are available on a regular basis, carbon tax rates may be subject to an ongoing evaluation process. It is important that environmental considerations are superficial in order to achieve the full potential of a carbon tax. However, all approaches within this chapter

should not be seen in isolation. Policymakers should balance the different approaches in order to reflect country-specific considerations.

- It does not really matter at an initial stage, whether the price is set at a low or a high level as compared to other countries, or to the international targets. In fact, most countries will start at a low price and increase it over time. What is important is for countries to have well defined carbon pricing policies that they can rely on for the next 10 to 50 years.
- Countries will price carbon according to their historic commitment to pricing carbon. Therefore, being prepared to adopt and commit to a carbon price now may be determinant to the country's furtherance of a higher and more significant carbon tax rate in the middle to long-term.
- However, at the end, setting the tax rate is a political decision. From an environmental point of view, instead of waiting any longer to find the most appropriate tax rate, which will be enormously challenging in practice, a rate should be agreed upon. This rate should subsequently be evaluated and adjusted accordingly if necessary.

Chapter IX: Administrative Issues in the context of Carbon Taxation *[draft as of 1 April 2019]*

9.1 Introduction

A substantial shift in the conceptualization of domestic tax systems is necessary to redirect them towards sustainable development, coherent with both the UN Agenda 2030 and the Addis Ababa Action Agenda. This is urgent and will affect both the domestic and the international tax architecture. All the available administrative means must serve these common goals.

The recent inter-institutional collaboration among all competent international organizations (e.g. Inter-agency Task Force on Financing for Development[21]) should be followed in a similar way at a national level. The full capability of well-interrelated tax systems, applied by cooperative administrations, should be neither under nor over-estimated. Leaving aside an optimistic or pessimistic approach, now there is a real chance to jointly devise domestic instruments that help reaching global sustainability.

The design and implementation of environmental policies should be in line with the country's international commitments (i.e. such as the UNFCCC Paris Agreement). Improving taxation requires the political will to adopt the right mix of tax policies, and to develop the administrative capacity to implement them effectively[22]. A strong political will is often required and some decisions may affect the status quo of the administrations involved. Administrative reform is costly and usually there is resistance. However, for the success of green initiatives this process cannot be avoided. Any proposed change will probably shake the inertial distribution of powers, to public authorities operating in newly convergent areas. Therefore, to achieve a more efficient administration, determination is crucial, both internally and through international cooperation.

Having decided to introduce a carbon tax, what are the important administrative issues to consider? This chapter will outline those issues and give practical examples on how they have been dealt with by different jurisdictions. It is essential for a jurisdiction to develop an efficient administrative capacity to meet national objectives as well as international commitments. This can be done, both internally and through international cooperation, as mutual administrative assistance could be expanded to cover environmental taxation. Eventually this mechanism could support the introduction of a global CO_2 tax in the long run.

9.2 Types of administrative issues to consider

Broadly, domestic issues can be considered separately from international ones. Once the domestic structure to implement the environmental tax effectively is in order and functioning,

[21] See http://www.un.org/esa/ffd/ffd-follow-up/inter-agency-task-force.html#5

[22] Committee of Experts on International Cooperation in Tax Matters: The Role of Taxation and Domestic Resource Mobilization in the Implementation of the Sustainable Development Goals, Seventeenth session, Geneva, 16-19 October 2018, Item 3(c)(x) of the provisional agenda. Other matters for consideration E/C.18/2018/CRP.19, p.4.

then cooperation with other countries can be pursued and adequately fitted in the existing international system (e.g. exchanging relevant information for tax purposes).

9.2.1 Domestic issues

Tax administrations have a central role in the design of a carbon tax (see chapter 7 for a discussion on design). It surpasses traditional tax schemes focused mainly on discovering/auditing, determining and collecting/recovering the tax debt by including environmental considerations. The adoption of a more extensive approach is now critical. The administrations when exercising their competences should consider, to the extent possible the environmental impacts (i.e. negative or positive externalities) caused by economic activities. The amount of revenue collected should somehow reflect the environmental costs or savings produced.

To achieve this broader objective the existing tax structure can be adapted progressively, considering the administrative capabilities in each organization/agency. National circumstances are influenced by historical evolution. Notwithstanding this, some paths for further administrative development are discussed below.

It may be useful to centre initial efforts on administrative collaboration: from the more technical, through the sector oriented, to the intra-territorial one.

Administrative collaboration may be built up stepwise:
1. Technical
2. Sectoral
3. Intra-territorial

Internally, the ***collaboration*** of the tax administration/agency with other financial authorities[23] would be advisable. These responsibilities may be organised differently. In some jurisdictions the tax collection and auditing may be handled by independent tax authorities, while in other jurisdictions those tasks are handled by special sections within the Ministry of Finance. Working hand in hand with the national authority in charge of budgetary administration is of interest in the case of environmental taxes, or other taxes with an environmental incentive (e.g. encouraging certain environment-friendly behaviours in income taxes). It clearly affects two main issues: the determination and assessment of the environmental tax expenditures, and the effect of any implemented earmarking policies.

In addition, it is may be necessary to explore the opportunities to ***strengthen and develop effective the relations with other administrations*** with relevant competence. This is especially important if the tax design chosen is the Direct Emissions Approach, where the tax base depends on measured emissions. The strategic partners are those authorities experienced in the

[23] In this context, "financial authorities" are intended to include all the administrative bodies that intervene in the procedures, both from the revenue and the expenditure side at the Ministry of Finance.

sector where the tax is meant to have an impact. This may entail joint work with environmental experts, or even with more detailed areas of specialization: energy, transport, agricultural, timber, housing, waste or health, among others. The interconnectedness of carbon taxation with the goals outlined in the 2030 Agenda is clear, and tax policies are considered supportive of the SDGs if they help realize one or more SDGs without jeopardizing others.

> Example: If the tax is targeting transport fuels, avenues for cooperation can be found in the interaction with port and airport authorities, e.g. Landing and Take-off (LTO manoeuvres) in commercial aviation and possible reductions in case of using winglets (or sharklets).

It is important to decide which Ministry takes the lead in implementing environmental taxation, and the relationship with other Ministries if another ministry/agency acts as a coordinating agency for the tax. For example, in terms of tax administration, the Chilean Ministry of the Environment oversees the administration of the Register of Boilers and Turbines, for the purpose of identifying the facilities subject to green taxes.

Another relevant point is who has been tasked with drawing up any guidelines (protocols) that establish the rules that must be followed by the tax payers.

In the case of Chile, where the tax base is emissions it is necessary to monitor, report, and verify the emissions of the facilities subject to the tax, the Office of the Superintendent of the Environment stipulates minimum operating requirements, quality control specifications, and assurance mechanisms for emissions monitoring or estimation systems used for emissions declarations; it is also responsible for compiling all information necessary for calculating the tax payable.

[Text will later be added with more examples, in particular related to the Fuel Approach tax design]

9.2.1.1 Regions and municipalities

In a context of territorial regional decentralization (e.g. regions or municipalities), there is an obvious need to stress collaboration – as noted above, horizontally at each level of government, and at the same time, vertically ensure coherence.

9.2.1.2 Utilize the existing taxation systems

The Ministry of Finance is normally in a privileged position to design the carbon tax, as the budgetary process allows the interactions with relevant agencies. It has contacts with many competent authorities for distinct substantive matters (such as, agriculture, energy or transport), and information is already being channelled through inter-territorial levels of government. Accordingly, reinforcing certain pillars, utilising information already collected, and, if needed, asking for some more details, may be a good strategy.

9.2.1.3 Capacity building

The investment in the continuous qualification of human resources enrolled in the Administration is necessary, promoting new broad views and relational abilities among tax officials. Moreover, the different needs of countries at different levels of development and in different situations, and the different levels of capacity of tax officials must be recognized. At certain point, tax authorities probably will need to acquire specialized expertise.

9.2.1.4 Stakeholder involvement

However, one cannot rely exclusively in a closed administrative circuit to achieve the successful implementation of a carbon tax. To comply effectively, the tax administration should ensure the inclusion of other stakeholders in the process, as they may adjust their own administrative or management structure to better apply the tax.

To be successful, the implementation of environmental taxation requires the support of consumers as well as business operators and NGOs. In practice their participation is relevant to manage the system fluently. Here the risk of capture by strong groups cannot be ignored. In this sense, public authorities operating in the same sector are more easily captured than tax authorities, which are somehow distant from all the economic agents. At the end of the day, the process of educating taxpayers and consumers in the transition to a green economy, though slow, is the key to success. Accomplishing the maturity of a well-informed public opinion takes time, to promote understanding of a new tax approach. This task should be started as quickly as possible to pave the way for future environmental reform.

9.2.1.5 Clarify roles and expectations, communicate

When developing the initiative, it is always important to clarify the expected distribution of roles and to facilitate public awareness of the process (e.g. Who does what? Where to make an application, or show proof of action required?). If an administrative structure is already set to manage indirect taxation of fuels, it can be easily used to implement carbon taxation (see chapter 7 for a detailed discussion).

Some efforts on capacity building can be made through workshops on the registry, quantification, and emissions reporting systems, or on the progress of the project (for Public Relations representatives from various organizations). The dialogue with the stakeholders can explain the scope of the reform to the public and discuss the challenges the new processes might present (e.g. even through webinars on carbon pricing instruments and the CO_2 tax).

9.2.2 International

As countries are not isolated when facing the desire to utilize carbon pricing to develop in a greener direction, it is convenient to look for other useful comparative experiences and share efforts. This could be the case both for governmental and legislative bodies preparing the carbon tax legislation, as well as for the Tax Authorities when implementing the legislation.

Here the participation in several specialized fora with a global perspective may facilitate the interaction with other entities (administrations, chambers of commerce, inter-governmental meetings, conferences, academia, etc.). In this sense, regional organizations in the Network of Tax Organisations to enhance the efficiency and effectiveness of tax administrations worldwide and could be useful[24].

It is necessary to identify the existing domestic administrative structures familiarised with taxation and environmental issues, maintaining simultaneously a connection with the international sphere. This is valid either for the fuel approach or the emissions approach, and should be considered in parallel both from Government decision-making bodies and the administrative units charged with the implementation.

In this sense, lessons can be learnt on how to integrate policies smoothly, also bearing in mind the international arena, from the National Contact Points established in the framework of the OECD Guidelines for Multinational Enterprises, as they are able to deal with environmental and taxation matters. In the same line of thinking, the investment authorities are often assessing the conditions to attract Foreign Direct Investment and are used to explain the applicable legal regime combining several economic, environmental and social factors.

Lastly, in a regional framework it is quite common that mainstreaming policies find areas of intersection (e.g. environmental and fiscal policies in the European Union). The decision-making bodies and procedures that allow the concerned administrative representatives' intervention should not be neglected at all. The process for composition of interests to deliver fair rules, caring for their practicability, is essential. This shows that already existing regional cooperation instruments (such as a trade zone) can serve to jointly build a carbon tax on, for instance, common energy taxation.

As a result of prior legislative coordination among States, international tax cooperation may be growing in scope to address urgent goals in the global political agenda. The most efficient tax administrations will soon show their impact on society through the management of environmental taxation, communicating the green-related funding results. These efforts in the field of the international tax cooperation should be universal in approach and scope and should fully consider the different needs and capacities of all countries[25].

9.3 When to address the administrative issues

Once there is political will to introduce an environmental tax, administrative issues immediately appear as a continuum in time that cannot be overlooked (e.g. margin for discretion, timing, combination with other schemes or possible review).

[24] The members represent tax administrations in Africa, the Caribbean, members of the Commonwealth, Europe, Francophone countries, Islamic countries, Latin America, the Pacific and West Africa. E/C.18/2018/CRP.19, p.7.
[25] E/C.18/2018/CRP.19, p.5.

9.3.1 Before implementation

One initial guideline for the development of environmental taxation is ***simplicity***. This value should be defended at every level, being adapted to the different capabilities of Small and Medium Enterprises, or Multinational Enterprises. Keeping in mind the proportionality in the requirements leads to ***acceptability*** by the citizenship, and helps public administrations to render a better service, avoiding unnecessary workload (devoting their efforts only to deal directly with the useful data acquired for the purpose sought). ***Fairness*** depends, to a great extent, on the time spent and the quantity of management efforts demanded to reach the objectives, both seen from the public and the private perspective[26].

Preparing an overview of ***present tools that might be useful*** for implementing a new environmental tax must be considered. It is wise to check the efforts made in a certain field due to some policies already in force. For example, if there is already a fuel tax in place it may be a simple task to also apply a carbon tax. If you, on the other hand, have decided to base your tax on emissions, some minor adaptations to accessible reporting obligations (e.g. register or book-keeping), and the option to take advantage of some measurement modes (by comparison of certificates or logbooks) may be key for the administrative implementation.

9.3.1.1 Regulation

The ***type of regulation to approve*** is another relevant point of discussion, as it relates to the margin left for administrative discretion and may hinder the need of certainty. The legal order in each country must be considered, finding a balance between flexibility and equality (reflecting carefully on the value of prior administrative resolutions and their publicity). It is useful to count on a strengthened legal framework that enables the policy design and administration reform, to the extent politically possible, to help balance revenue agency powers and the rights of taxpayers. The tax rules should be ***understandable by taxpayers***, and they should be able to easily obtain clear indications on how they should comply with them in specific cases.

9.3.1.2 Data availability

In order to set the necessary administrative procedures for applying the tax, it may be convenient to check if the administrative data available is sufficient to develop a manual for the registration, or to offer guidance documents pointing out the administrative requirements necessary for correct implementation[27].

9.3.1.3 Timing

Provided that a relatively simple scheme, benefiting from some formal declarations, is defined to give the authorities the green light, the next question is ***when*** to put the environmental tax

[26] For a more detailed explanation on the design, please, see chapter 7.
[27] See also chapter 7 on data intensity of different design choices.

measure in place[28]. The convenience of offering an adaptation period cannot be denied (not only for companies, but also for the public administrations involved). Once the determination of the Government to make a move towards the sustainability through green taxation is shown, a sensible calendar for implementation helps in the transition. The changes in the private organizations to fit a new scenario can even be made with the sole official announcement of the implementation of an environmental tax in the following years at the end of the legislature term.

9.3.2 During implementation

The clarity in the designation of the competent authorities, and spreading information about any eventual change affecting them is decisive. ***The public perception of proximity and transparency may be as important as the content of the regulation itself.*** A frequent dialogue with the agents may be beneficial to better understand the needs and the improvements made in each specialized sector. Ultimately it can result in a modification to make rules more suitable in accordance with actual business life.

Along the implementation phase, the possible combination with other economic instruments operating in the same field should be considered (e.g. replace or add CO_2 instruments).

9.3.2.1 Tax audit and collection

Another realistic question is how to collect the environmental tax. Thinking about the tax payment is also relevant when implementing the polluter pays principle. Additionally, the compensation for environmentally-friendly behaviours can be anticipated through justified tax expenditures. To make political decisions to that end, gathering precise information is necessary. The tax expenditures may help the introduction of the tax in a soft mode. Later, by reducing them, it can be elevated. Additionally, the tax expenditures may reflect certain valuable contributions made to protect the environment as provided by the legislator, and should be taken into account accordingly by the tax administration when managing the collection process, checking that the justified reduction is applied in a proportionate manner in the tax debt.

A balance should be made with the pros and cons for the administrations and the taxpayers involved in the design phase. Depending on the point of regulation and the tax approach (fuel or emissions) they will face different obligations. If needed, a reporting period can be decided in the tax law or in other relevant regulation issued by the competent authority. It may vary depending on the country's tax traditions (a month, quarter of a year, or even yearly can be considered). Probably, from an administrative perspective and due to some common taxpayers' practice with other indirect taxes (such as value added tax), a periodic tax can be easier to manage through quarterly returns. It allows adjustment to the real circumstances of the activity carried out. I.e. in case of starting the polluting activity after or ending before the calendar year

[28] See also discussion about the proper timing for implementation in chapter 2 (to be written).

a proportional adjustment can be made in the payment finally required. Alternatively, the Government gets revenues more often if it is set monthly, as well as cash flow.

Taxpayers care that the collection system is fair and that evasion is effectively dealt with, as well as whether revenues are used in areas that they value. For example, in Chile, the process has also entailed expanding and strengthening the capacity of environmental agencies, establishing protocols for determining procedural responsibilities, creating more robust information systems, and improving inter-ministerial coordination. The new institutional infrastructure implements the tax in an effective manner and brings with it an institutional shift, allowing the development of new capacities, knowledge, and tools to improve the quality and efficiency of environmental management, which may be used in the future to pursue more sophisticated environmental protection mechanisms.

9.3.3 After implementation

The tax measure applied by the Administration must be subject to a process of monitoring. There might already be suitable systems in place that can be utilised for this, or a review mechanism for evaluation can be established. The authorities in charge to do so and the effects of the review must be stated. This review could even originate an adjustment of the tax rate.

In a process of sustained improvement, not only the auditing of correct data given in tax declarations, but also the checks done by the administrations to deliver better environmental results are monitored by different institutions (such as statistical bodies or departments within the ministries). Therefore, it is important to clarify to whom the tax administration will report on this topic.

For example, where it exists, the Court of Auditors may help with the control of efficiency of the administrative actions, e.g. when reviewing the tax incentives granted for environmental purposes. If there is a regional body (such as the European Union Court of Auditors) a coherent approach among the competent auditing institutions can be sought.

In order to ensure that the carbon tax fulfils its objectives, certain checks need to be made at every stage in the implementation. This relates to checking the environmental effectiveness, the burden on companies and their competitiveness, the distributional effects to be socially fair, the overall economic efficiency and the feasibility. In an ever-changing environment that affects taxpayers and tax administrations, the existing structures should be recalibrated to confront real risks.

Remember to consider these issues:

1. Environmental effectiveness
2. Burden on companies
3. Competitiveness
4. Distributional effects

5. Overall economic efficiency
6. Feasibility

In Chile the new taxes have resulted in the design and construction of a new institutional structure, which includes the implementation of a registration system for sources subject to taxation and a system to measure, report, and verify emission levels. Once the new measures are in place, the government expects continued discussion over future tax increases or other possibilities such as sophisticated carbon pricing instruments like offsets and/or tradable emission permits.

Other delicate issue for administrative consideration is the possibility to enforce the regulation, in economy-sensitive sectors (e.g. mining in certain developing countries). Political considerations may influence the design of the rules, but the technical application must follow the administrative procedures, unless a carve-out clause is inserted. In addition, the regulatory consistency regarding regulations applicable to different sectors is a virtue. See chapter 7 for a discussion on exclusions or phase-ins.

Another topic that deserves a brief mention is the need to open administrative windows for the revision of claims (prior to judicial review), to avoid conflicts that are time and resources consuming.

9.4 Operational hints

9.4.1 Optimize the process of digitalization

The digitalization of the economy and new technologies provides opportunities to increase efficiencies and save costs in public financial management. Supporting tax administration and collection, access to more and better data, as well as improved data management systems can also lead to better policy design. While digital information supports administrations in improving the enforcement of existing rules and facilitates compliance, access to broader information can also drive better tax policies and offer opportunities to reduce inequalities through a fairer allocation of the tax burden among citizens.

The digitalization may support domestic resources mobilization and the transition to a low carbon economy. Nowadays it is producing changes both in private and public organizations. They are refining their strategies in accordance with the new possibilities to carry out their missions better.

Several national experiences of a fuel approach tax show, with a clever design, the tax administration can manage a carbon tax at a low administrative cost (e.g. Sweden).

In the future, with intelligent systems, the amount and nature of the available data could even better ensure knowledge of real costs and benefits through the connectivity of financial and non-financial information. And the increase in data granularity will be the key to fight inequality, once greater traceability becomes feasible in many sectors (regarding consumption

or emissions). To achieve the Sustainable Development Goals, a legitimate and smart use of tax data will be possible.

The role of an integrated digital international tax administration could be devised, exploiting pilot experiences that some regional organizations are currently providing.

At the national level, administrations would need to ensure sufficient investments not only in their own capacities to take advantage of digitalization, but also in ensuring access and inclusiveness of all individuals and businesses.

9.4.2 Enhance Corporate Social Responsibility in the private sector

It is true that the administrative schemes should be proactively adapted and re-characterized to better contribute to sustainability. However, social responsibility is not only a matter of concern for public administrations. Joint efforts are needed and a greater involvement of the private sector should be explicitly sought by administrations.

Somehow, a door should be opened to appraise individual and collective interests as well. This could be embraced either in the strictly fiscal area, or in extra-fiscal domains by means of sound coordinated tax incentives for private activities investing in global public needs.

This demand is in line with the public-private partnership necessary for achieving the Sustainable Development Goals (under SDG 17). The constructive approach counting on responsible stakeholders has already proved right in other sectors. In addition, transparency is an important attribute of national institutions (SDG 16).

CSR strategies of cooperative compliance for paying the tax due can be extended to other edges, e.g. by providing data that affect the tax treatment in accordance with the environmental impact. Instead of suffering the so-called indirect tax pressure referred to registers, reporting obligations, use of labels and certificates, the digital information duly connected may do the rest.

The opportunity to work together to create a new technical mechanism should be taken. The new deal fosters the development of working relationships between ministries and agencies, forges new public-private relationships, and forms robust foundations of knowledge and information for implementation of the environmentally related tax measure.

9.4.3 Other hands-on hints

Other hands-on hints could include the following activities:

- Explore and make an alternative use of data already available, though collected for other purposes.
- Maximize the use of existing administrative systems, allowing wise flows of information and providing place and time for foreseeable beneficial interactions.
- Tag carbon tax onto existing legislation.

- Use regional cooperation as basis for joint tax introduction and save on administrative cost and competitiveness concerns.

9.5 Solutions found in a comparative analysis

9.5.1 The Swedish fuel approach

While an assumption could be that a carbon tax needs to include measuring emissions, this is not the case if a carbon tax is designed based on a fuel tax approach (See further in chapter 7) Such a design can give a jurisdiction an equally efficient, and less costly, tax system.

The Fuel Approach way of carbon taxation is to pre-calculate tax rates in tax law based on average fossil carbon content for different fuels. There are significant administrative advantages by this approach, low administrative costs, can build on existing tax administration in many cases. An example of a copy of a Swedish carbon tax declaration shows the simplicity of it all (text and example will be further elaborated at later stage).

In the Fuel Approach Design the need for environmental knowledge for the Tax Authority is small, if even non-existent. What the Tax Administration basically needs is how to calculate and audit the number of litres sold by the taxpayer. This is an ordinary task Tax Authorities are familiar with. Of course, the need for further expertise may be more significant if a country chooses to implement exemptions or reimbursement schemes, e.g. for business performing a certain environmentally-friendly activity, carbon capture and storage, etc., but that is not the prime objective for a country starting out with a carbon tax.

9.5.2 The Emissions Approach in Chile

For the sake of simplicity, some indirect indicators whose existence is easy to verify can be adopted initially e.g. number of boilers & turbines, and maintained until reporting obligations are improved with the passage of time. The move from an objective estimation of the taxable base to a more exact direct determination depends on the capability to promote a better adjustment of measurement operations.

In the long run, the inclusion of some benefits in the taxable base can be considered to install devices as desired by the administration, to make the control easier and adapt the amount due to the real circumstances.

Alternatively, labelling, certification procedures and voluntary standards (e.g. EMAS Eco-Management and Audit Scheme or ISO 14000) can be used as a reference.

Apart from the obligation to file the forms approved by environmental authorities, or to keep a book of records with respect to emissions, automatic analysers may help verifying the deduction of actual costs in more accurate manner.

9.6 Conclusion

The above-mentioned administrative issues are key to successful implementation of a carbon tax, either following a Fuel or an Emissions Approach. Therefore, policy makers should pay careful attention to the adaptation of the existing organizational structure and invest in improving the capacity of the personnel. This will allow tax authorities to work more efficiently with the other stakeholders in this process towards sustainability.

Carbon taxation promotes positive behavioural changes. An approach involving the whole Government offices is convenient, counting also with the private sector collaboration and other stakeholders to devise a sound administrative strategy in accordance with what has been explained above.

The United Nations Tax Committee may place greater emphasis on aspects of taxation, which aim to promote positive behavioural patterns. Taxation plays a fundamental role in the achievement of the SDGs, which goes beyond financing. That is the case of environmental taxation.

Whole-of-government approaches take on additional significance because implementing environmentally related taxes requires cooperation amongst many different agencies and ministries (as it happens with Illicit Financial Flows). To achieve relevant benefits, there also needs to be cooperation between the private and the public sector, and appropriate support by government authorities.

Environmental taxes allow State agencies to consolidate their information exchange mechanisms. They can create a new institutional architecture through the development of technical and administrative capabilities, which lays the foundation for the development of more sophisticated tools in the field of environmental management. The tax administration should track all these changes.

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Annex 1 – Economic theory background

A1.1 Pigouvian Approach: Theory versus reality

Although the Pigouvian Approach makes sense from an economic perspective, attention should be paid to several difficulties associated with its implementation. First of all, it is important to define which types of externalities it should be covered (Chapter Tax Base). Therefore, it is important to determine the tax base carefully, as it has a considerable impact on the tax rate. However, the more difficult part is to determine the marginal value of pollution. Assuming that the tax tackling all externalities deriving from CO2, following the Pigouvian Approach means that the rate should exactly represent the MSC of one ton CO2, which occurs at any point in future.

The valuation of externalities will be the most difficult task if policymakers follow the Pigouvian Approach. The MSC of CO2 are usually calculated with Integrated Assessment Models (IAM). Those models combine economic models with climate/environmental related system models. IAM simulates the expected costs along various emission pathways, due to increases in CO2 emissions. The most important IAM are PAGE (Hope 2011), DICE (Nordhaus and Boyer 2013), FUND (Tol, 1997) and Rice (Nordhaus and Yang 2013). Regarding CO2 emissions social costs of carbon range from 10 $ to several hundred $ per ton CO2. However, this wide spectrum of results shows how difficult it is to find the tax rate which represents the exact marginal external costs. This is due to the fact that even the most complex model is subject to uncertainty, as it does not reflect reality. Therefore, it is unrealistic to find the "exact" tax rate, which, however, would be necessary in order to apply the Pigouvian Approach. Uncertainty is one of the main reasons why tax rates do not usually follow the Pigouvian Approach.

The broad range of estimations of the MSC usually is challenging for policymakers, as it is difficult to agree on a specific rate. However, the government concluded that the approach is not feasible as no rate could be agreed upon. Finally, the government followed the benchmarking approach, as the international carbon tax rates which are currently in force are the result of political and economic considerations. Besides the uncertainty, it is necessary to adjust the tax rate over time, as the MSC will rise due to increasing concentrations of CO2 in the atmosphere. Therefore, following the Pigouvian Approach requires raising tax rates over time. Moreover, the Pigouvian Approach requires monitoring each individual emitter which is crucial for the rate setting. However, this is unrealistic as it would require complete documentation of all CO2 emission. In addition to that, policymakers are at risk of receiving biased information by the polluters, which would further lead to uncertainty regarding the cost estimations which are crucial for the Pigouvian Approach.

A1.2 Marginal Abatement Cost Curves

MACC represent the costs that occur in order to reduce the pollution by one unit. MACC usually compare various options/technologies that may be part of following a decarbonisation pathway and shows the impact of these alternatives. MACC are derived from engineering-style analyses of the costs of individual technologies of practice. The costs of each available technology are estimated together with the proposed emission reductions which are predicted for it. In a second step, all technologies will be sorted in ascending order of cost. Each technology will then be plotted to sum

the cumulative predicted emissions abatement at or below any specific abatement costs at a specific point in time. Policymakers may rely on MACC which are published by economists, research organizations or consultancies (Nauclér, T., Enkvist, P. A., 2009). In 2013, the World Bank published a MACC for the power sector of Nigeria, which could serve as a reference MACC for countries with a comparable economic background (Cervigni, Raffaello, Rogers J. A., Henrion M., eds. 2013). However, jurisdictions may also develop own MACC for certain sectors/industries of their economy by estimating the abatement costs of GHG in their jurisdiction.

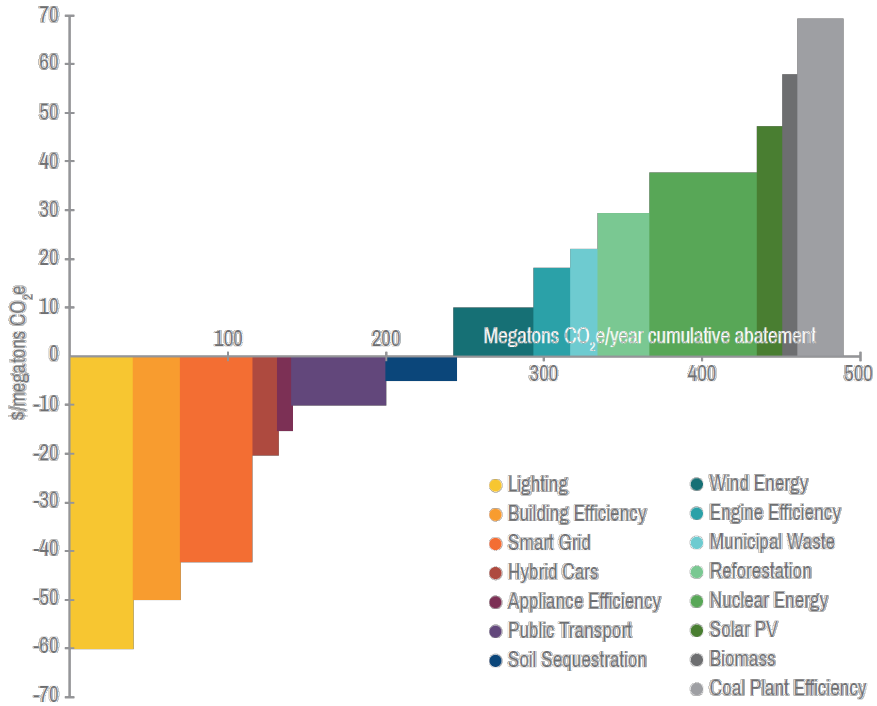

Figure XX: Hypothetical MACC
Source: Partnership for Market Readiness. 2017. Carbon Tax Guide

Graph 2 shows a hypothetical MACC pathway for a specific point in time. Each bar represents a technology, in which the width is dependent on the annual emissions reduction potential which results from the use of each technology. The bars are sorted from the lowest to the highest marginal abatement costs. MACC also includes technologies with negative abatement costs, which means that the application of those technologies could help save money. The biggest advantage of MACC is that the curves inform policymakers about the range of technical options which are available and the cost of each technology.

For example, if a jurisdiction aims at reducing 400 megatons CO2, a tax rate of US $ 40 / t CO2 would be necessary. The target will be reached, as it is cheaper for economic actors to mitigate their emissions by using technologies which have lower abatement costs than to bear the tax rate of US $ 40 / t CO2. According to economic theory, the acceptable level of pollution will be reached in a least-cost approach. This is due to the fact that the total abatement costs in the economy will be minimised by setting a tax rate which achieves the predetermined emission reduction goal.

Market forces will make sure that economic actors reduce their emissions as long as their abatement reduction costs are lower than the implemented tax rate. As a result, cost-efficient technologies will be implemented. In case the MACC of an economic actor is higher than the tax rate, it is cheaper for the actor to pay taxes. The height of each graph describes the average cost of reducing the emissions by one ton CO2.

However, it is difficult to determine the MACC of a specific jurisdiction as the MACC is a relatively simple approach which focuses on technologies. The starting point for the creation of the MACC is the formation of an initial emission baseline and the selection of a baseline technology, which will be replaced by alternative technologies. However, defining a baseline technology is not an easy task as there are many carbon-based technologies available, which makes assumptions necessary. Secondly, it is necessary to make assumptions regarding the specific abatement options (lifetime, price e.g.) and how to price future costs and benefits of those technologies, which requires the determination of a discount rate. Besides those considerations, the model can also miss important factors such as the interactions between various technological alternatives as well as interactions between producers or consumers and the market power of certain actors. For example, MACC curves do not cover behavioural and transaction costs, such as cultural constraints, acceptance of new technologies, or access to financial resources. Moreover, it is hard to predict how economic players react in reality. This is because of asymmetric information between the economic actors and market failure due to imperfect competition. For instance, it is possible that some economic actors will use their market power in order to influence the market outcome according to their wishes. However, those microeconomic feedbacks, as well as macroeconomic factors (economic development) are not covered by the MACC curves. Thus, more complex models taking into account additional factors (eg systematic approaches which also consider interactions of different elements) could be used. Moreover, also the most complex model cannot fully reflect reality. Therefore, it is unrealistic to predict the exact emission reduction which results from a specific tax rate.

According to the Standard Price Approach it is, however not necessary to find a model which accurately reflects economic reality. This is due to the fact that the Standard Price Approach follows a trial-and-error policy which means that the tax rate will initially be set according to the MACC.

A1.3 Revenue Target Approach wrestling with Theory

If policymakers follow a specific revenue target approach it is crucial for them to know the supply and demand curves, as they have a strong impact on how the market responds to taxes. Different tax levels lead to a change in the quantity of tax revenue. However, it is not possible to always increase the tax revenue through higher tax rates. This is due to the fact that two contrary effects are responsible for changes in revenue. First, the tax base decreases because higher tax rates result in a lower level of demand. In contrast to this effect, higher tax rates lead to higher tax revenue. Both factors have an impact on the total tax revenue. If the effect of the decline in demand as a result of higher taxes is higher, it is possible that the total tax revenue decreases when increasing the tax rate. Having said that, it is also possible that the tax revenue increases by raising tax rates in situations in which the effect of the higher tax rate is higher than the decline in demand. This

statement holds true for situations in which the tax rates are relatively low. The tax revenue can be maximized by setting the tax rate at a level at which the additional tax revenue from the higher rate equals the loss in tax revenue from the decrease of the quantity.

Another relevant contrary effect which can affect the total tax revenue is the interaction in the demand of other products as a result of the implementation of a carbon tax. As mentioned above the elasticity of fuel products is at least in the short time low. This means that the demand does not immediately responds disproportionately to price changes. However, each economic actor has only a limited amount of money available for spending. As a result, it is possible that the demand for other products after the implementation of a carbon tax, may decrease. This could lead to the situation that the tax revenue which results from the consumption of other products (eg VAT) may – in the short-time – decreases through the implementation of carbon taxes. Policymaker should, therefore, also consider changes in the consumption of other products in order to reach the desired revenue target in total.

Moreover, it is important that carbon taxes are levied on various different types of fuel and carbon intense products such as diesel, petrol, gas and coal. As the carbon content of each product differ and each product has its own demand curve, the impact of a carbon tax may vary. Therefore, maximizing the tax revenue for one product through a specific tax rate does not necessarily maximize the revenue for different products. One solution would be the application of different carbon tax rates for each product. However, from an environmental point of view, this approach is inefficient as it undermines the controlling effect of a carbon tax. In addition to that, different tax rates for different products are also inconsistent with the least-cost approach as the price signals are not applied consistently. In addition to that different tax rates would raise the complexity in the administration of the tax, which may be difficult for some countries with a lack of resources to monitor as this would require additional resources.

A1.4 Carbon Tax Rates

The following graph gives an overview of all nominal carbon tax rates which were in force in November 2018. [Note that this is a provisional list which is subject of an ongoing revision by the authors.]

Jurisdiction Covered	Tax rates November 2018 US $ / tCO_2
Alberta	22.92
Argentina	10
British Columbia	26.74
Chile	5
Colombia	4.92
Denmark	27.07
Estonia	2.28
Finland	70.64

France	50.81
Iceland	28.87
Ireland	22.79
Japan	2.56
Latvia	5.13
Liechtenstein	95.71
Mexico	2.73
Newfoundland and Labrador	15.27
Norway	59.87
Portugal	7.80
Singapore (in force 2019)	3.7
Slovenia	19.71
Spain	22.79
Sweden	126.83
Switzerland	99.71
United Kingdom	23.25
Ukraine	0.01

Carbon Pricing overview

Source: Data based on Carbon Pricing Dashboard, Data based on The World Bank available at https://carbonpricingdashboard.worldbank.org/map_data.

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