Chapter 2. Carbon pricing trends – Reasons to be cheerful

This chapter describes the present state of carbon pricing and evaluates recent and ongoing developments. The gap between the minimum carbon prices that are needed to reach the targets of the Paris Agreement and those currently observed remains large and is only declining slowly. Nevertheless, there are signs that carbon pricing is gaining momentum.

This chapter presents estimates of how 42 OECD and G20 countries price carbon emissions from fuel combustion in 2018. Together, these 42 countries emit approximately 80% of global carbon emissions from fuel combustion; they also account for nearly 80% of global energy use (OECD, 2018[1]).

In order to arrive at an estimate for the state of carbon pricing in 2018, the estimates update detailed information on carbon emissions, energy taxes, carbon taxes and emissions trading systems (ETSs) in 2015 with information on recent developments in emissions trading systems, including expected developments in Canada and in China.

Table 2.1 lists, for each country with an emissions trading system, the assumed (at the time of writing this report) coverage of emissions and the price levels within the trading system. Coverage and price levels generally reflect the status of trading systems in 2018, but for China and Canada, the assumptions are forward looking in order to include the new national Chinese ETS and the carbon pricing backstop in Canada.

Table 2.1. Emissions coverage and permit price – assumptions for 2018

	Coverage	Permit Price
Canadian carbon pricing systems	New ETS in Ontario; Carbon levy and output-based systems for large polluters in Alberta; Federal backstop (consisting of a carbon charge and an output-based system for large polluters) in whole or in part in any province or territory that does not have a carbon pricing system that meets the benchmark (compliance required by 2018, implementation foreseen for 2019).	The federal benchmark requires a minimum carbon price of CAD10 (about EUR 7.50) for 2018, which increases by CAD 10 a year until reaching CAD 50 (EUR 40) in 2022. Assuming compliance by all provinces and territories, average carbon prices are expected to range between CAD 19 and CAD 23.5 in 2018, depending on sector.
Chinese ETS	National ETS covers 3 billion tonnes of CO_2 in the electricity sector in addition to emissions that have already been covered by the Chinese pilot systems; Coverage of Chinese pilot systems as in 2015	CNY 50 (about EUR 7.25) for electricity sector; CNY 11.39 (EUR 1.65) on average for the remaining sectors covered by the pilot systems
EU ETS	Same as 2015	EUR 7.60
Swiss ETS	Same as 2015	CHF 10.95 (about EUR 10.25)
Japanese ETS	Same as 2015	JPY 1320 (about EUR 9.75)
Korean ETS	Same as 2015	KRW 22000 (about EUR 17.60)
New Zealand ETS	Same as 2015	NZD 5.63 (about EUR 3.55)
ETS in the USA	Two additional systems are included: The Washington Clean Air Rule covers about 50 million tonnes of CO_2 from energy use; The Massachusetts ETS on emissions in the power sector covers about 9 million tonnes of CO_2 from energy use; Coverage for California and RGGI system as in 2015	USD 7.74 (about EUR 7.00) on average for the electricity sector, USD 14.67 (EUR 13.25) on average for industry and USD 14.89 (EUR 13.45) on average for all other sectors

Note: See the Annex for further detail.

Some countries have increased energy and carbon taxes since 2015 (OECD, 2017[2]), but data limitations prevent these changes from being considered here. The tax data used in this chapter are for 2015, because the process of collecting and allocating new tax rates to emissions is too time consuming to allow for quick updating. While these changes can have a significant effect on the share and level of priced emissions at the country level, their impact on the overall level and share of emission prices is likely to be limited. Nevertheless, the use of 2015 tax data implies that this chapter likely shows lower-end estimates of effective carbon rates for 2018.

The analysis combines the price information for 2018 with 2015 emissions data. Detailed data on carbon emissions from energy use are available only with a substantial time lag. The latest year for which detailed data was available at the time of production of this report is 2015. However, emission levels change generally only by a few percentage points a year at most, so that data from 2015 is still informative for emission levels in 2018.

Overall, the estimate for 2018 is detailed in its treatment of sectors and carbon pricing instruments. It accounts for recent developments, and for some expected developments, in emissions trading, while relying on 2015 data for taxes and for energy use.

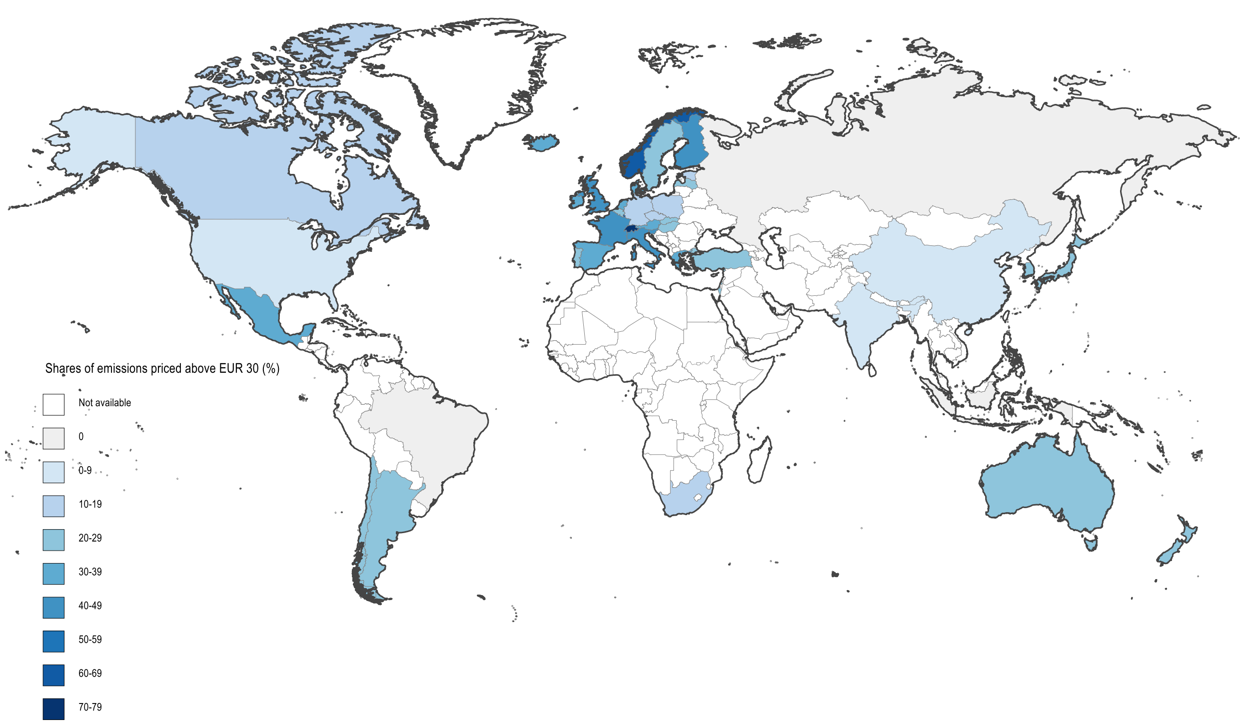
The current state of carbon pricing: a white shade of blue

Figure 2.1 summarises the current state of carbon pricing at the country level. The darker the shade of blue, the higher the share of emissions from fossil fuel combustion that is subject to an effective carbon rate of at least EUR 30 per tonne of CO_2. EUR 30 is a low-end estimate of the damage that carbon emissions cause to society. Pricing emissions below EUR 30 means that emitters are not directly confronted with the full cost of emissions to society and that incentives for cost-effective abatement are too weak.

The map is predominantly pale blue fading to white. This shows that currently few countries price a significant share of their emissions above EUR 30 per tonne CO_2.

Figure 2.1 A cost-effective low-carbon transition requires higher carbon prices

Share of emissions from energy use priced above EUR 30 per tonne of CO_2, estimate for 2018



No country prices all emissions at EUR 30 per tonne of CO_2 or above, but several European countries price more than half of their emissions at or above this level (Figure 2.1). If the permit price in the EU ETS was to increase to EUR 30, e.g. through the introduction of a minimum price like in the United Kingdom or through a significantly faster decline of the aggregate emission cap, 68% of aggregate emissions from all EU countries covered in the study would be priced above EUR 30, compared to 31% today. Eight European countries would price more than three quarters of their emission above EUR 30: The Netherlands, Norway, Greece, Spain, Italy, Luxembourg, Ireland and Slovenia. The significant increase in the share of emissions priced above EUR 30 says that the coverage of the ETS is fairly broad, so that higher prices strongly affect effective carbon rates in Europe. As will be seen, this is the case particularly in the electricity sector and in industry.

In the African, American, Asian and Oceanian countries covered in the study, only small shares of CO_2 emissions are priced above EUR 30 per tonne. Mexico reaches the highest share in the Americas, with about 30% of emissions priced at or above this level. The national ETS in China substantially changes the share of emissions covered, but initial permit prices are expected to be below EUR 30, so that the share of emissions priced at EUR 30 or more remains below 20%. The section on the "carbon pricing gap" will discuss the impacts of the Chinese national ETS in more detail.

The marginal damage caused by one tonne of CO_2 increases with the accumulation of CO_2 in the atmosphere. Accordingly, integrated assessment models show carbon prices that increase significantly in real terms over time. On the basis of such models, the High Level Commission on Carbon Pricing (2017[3]) finds that carbon prices should amount to at least USD 40 – 80 per tonne of CO_2 by 2020 and USD 50 – 100 per tonne of CO_2 by 2030, to be able to reach the goals of the Paris Agreement.

In line with the estimates of the High Level Commission on Carbon Pricing (2017[3]), this report adopts EUR 60 as a second benchmark:[1] EUR 60 is the midpoint estimate of carbon costs in 2020 and a low-end estimate of carbon costs in 2030.

Figure 2.2. Share of emissions from energy use priced above EUR 60 per tonne of CO_2

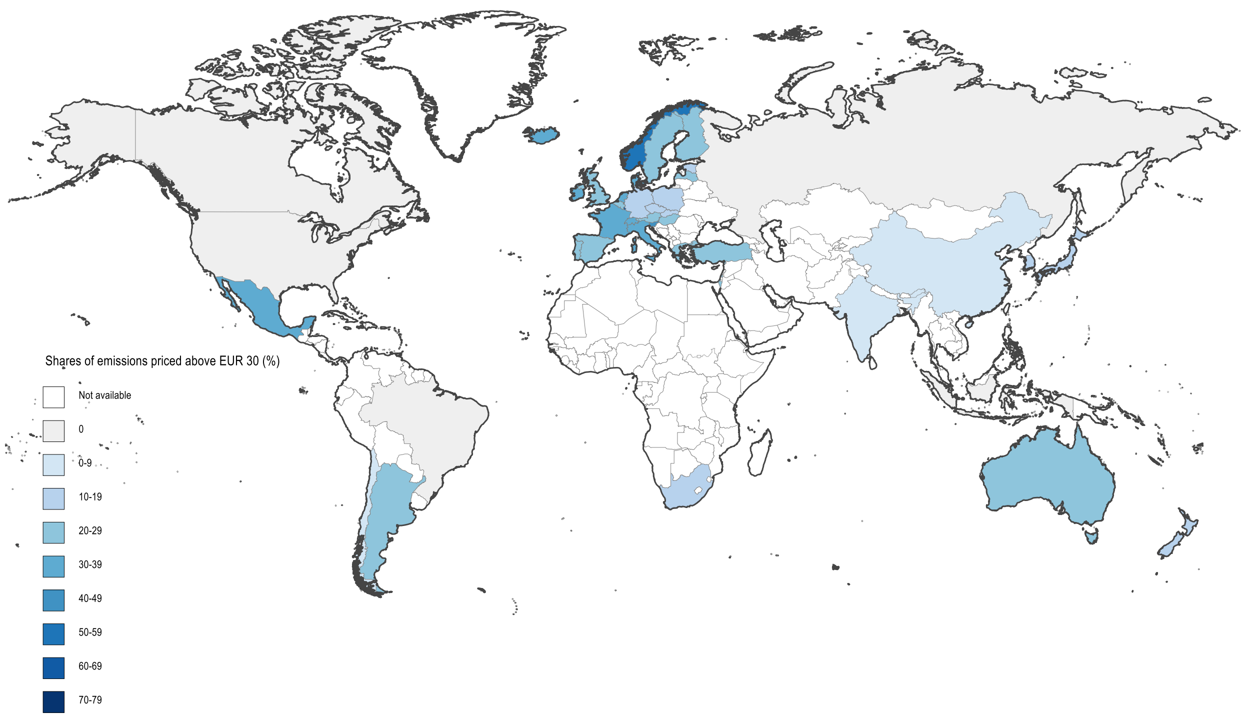


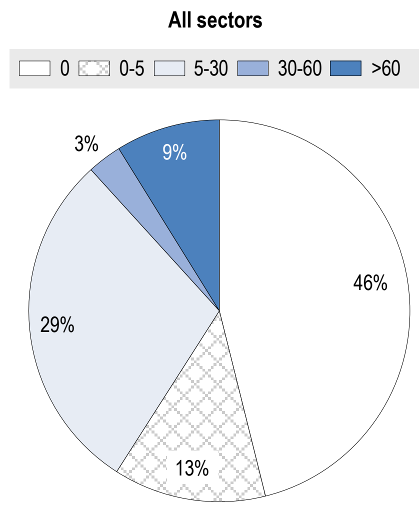
Figure 2.2 shows the percentage of emissions priced at EUR 60 per tonne of CO_2 or more, by country. It is clear that all countries need to raise carbon prices soon and significantly to reach the goals of the Paris Agreement. Currently, only three countries price more than 40% of their emissions above EUR 60 per tonne CO_2, namely Luxembourg, Norway and Slovenia. Most of these emissions are from road transport. Emissions from other sectors are priced at significantly lower rates, or not all, as will be discussed in the coming paragraphs. In the Americas, Mexico is the only country that prices more than 30% of its emissions above EUR 60.

Carbon pricing trends: expanding coverage, persistently low rates

Figure 2.3 shows that in 2018, 54% of CO_2 emissions from fuel combustion are estimated to be subject to a positive carbon price, across all the 42 OECD and G20 countries covered in this report. This is 10 percentage points more than in 2015. The Chinese national ETS and carbon pricing in Canada drive this development. Subnational emissions trading systems in the United States have also contributed to the increase in coverage of emissions by a carbon pricing system.

Figure 2.3. Estimated proportion of CO_2 emissions priced at different price levels

Price levels in EUR per tonne of CO_2



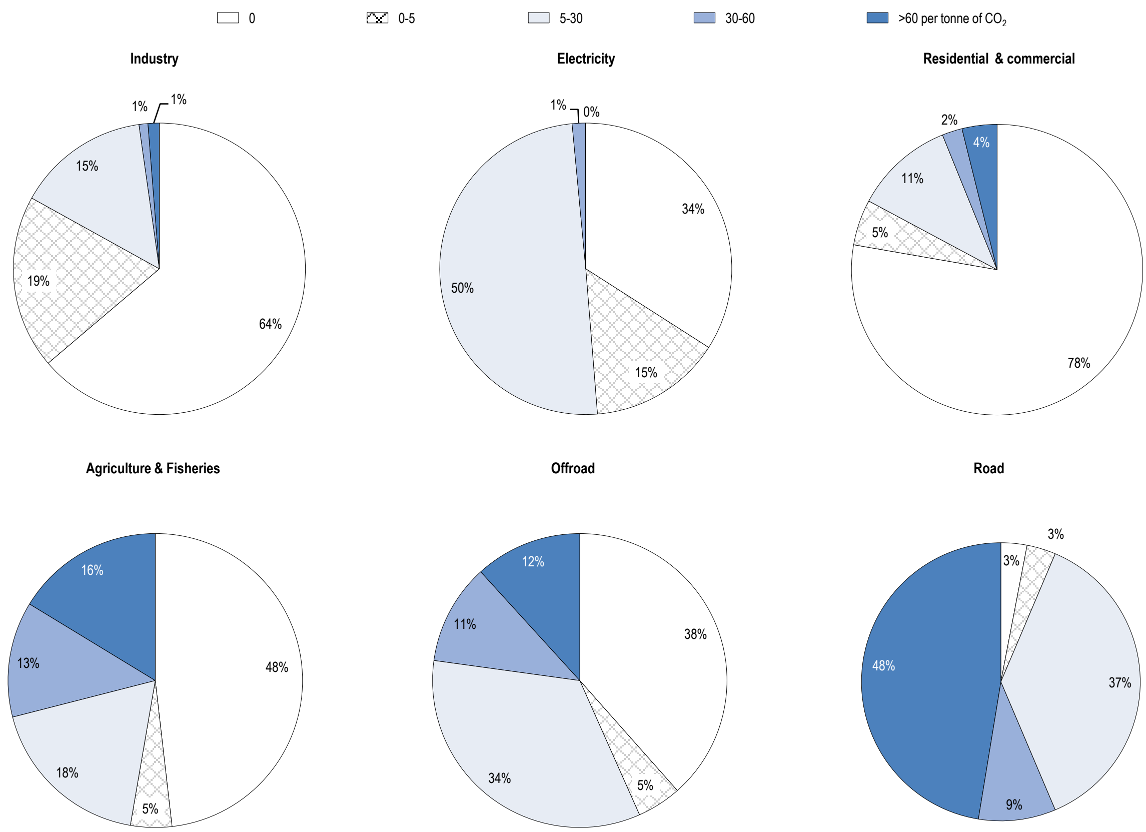
While the overall share of priced emissions has increased significantly, price levels remain low. By the estimates for 2018, 13% of emissions face a price between EUR 0 and 5, and 29% are priced between EUR 5 and 30 per tonne CO_2. Only 12% of emissions face a price above EUR 30 – this is the same share as in 2015; the share of emissions priced above EUR 60 has also remained stable at 9%.

In sectors other than road transport and electricity generation, few emissions are subject to a price

Figure 2.4 shows that price coverage and price levels differ strongly across sectors. In the road transport sector, which accounts for 16% of total emissions, 97% of emissions are priced. Fifty-seven percent face an effective carbon rate above EUR 30, and 48% a rate above EUR 60, per tonne of CO_2. In short, emissions from the road transport sector face significantly stronger carbon rates than emissions from other sectors

Figure 2.4 Proportion of CO_2 emission priced by sector

Price levels in EUR per tonne of CO_2



The electricity sector accounts for 31% of total CO_2 emissions from fuel combustion. Two-thirds of these emissions face a positive effective carbon rate. In 2015, this share was only one third – the Chinese national ETS has strongly expanded carbon pricing coverage in the electricity sector.

For 15% of emissions from the electricity sector, the carbon rate is below EUR 5 per tonne of CO_2. Half of the emissions face a carbon rate between EUR 5 and 30. The effective carbon rate is above EUR 30 for only 1% of emissions.

In the industry sector, the source of more than a third of total emissions from fossil fuel combustion, about two-thirds of emissions are unpriced. Price levels remain low for the remaining third of industrial emissions. Only 2% of emissions are priced above EUR 30. Furthermore, compared to 2015, there has hardly been any change.

In the residential and commercial sector 78% of emissions are not subject to a carbon price. Sixteen percent are priced between EUR 0 and EUR 30 per tonne of CO_2, and 6% above EUR 30. Carbon price coverage and price levels have also remained stable between 2015 and 2018. The residential and commercial sector accounts for 13% of total emissions.

About half of emissions in the agriculture and fisheries sectors face a positive price, and nearly 30% of emissions are priced above EUR 30. In the offroad transport sector, 38% of emissions are unpriced, while 18% face a price of at least EUR 30 per tonne CO_2.[2] Relatively high effective carbon rates in these sectors are due to relatively high tax rates for oil products used in these sectors. Compared to 2015, few changes are observed. The agriculture and fisheries sector contributes 1%, and the non-road sector 2%, to total emissions.

Taxes dominate the composition of effective carbon rates

In most sectors taxes clearly are the largest component of effective carbon rates, see Table 2.2. Over 93% of the overall carbon price signal stems from taxes in the agriculture and fisheries sector, the road and offroad transport sectors and in the residential and commercial sector. Permit prices from emission trading systems contribute significantly to the effective carbon rates in the industry sector, but across the 42 countries, 62% of the effective carbon rate nevertheless results from taxes.

Table 2.2. Taxes dominate the composition of ECRs

Sector	Share of tax component in total ECR
Agriculture & fisheries	98%
Electricity	19%
Industry	62%
Offroad transport	96%
Residential and commercial	93%
Road transport	99%

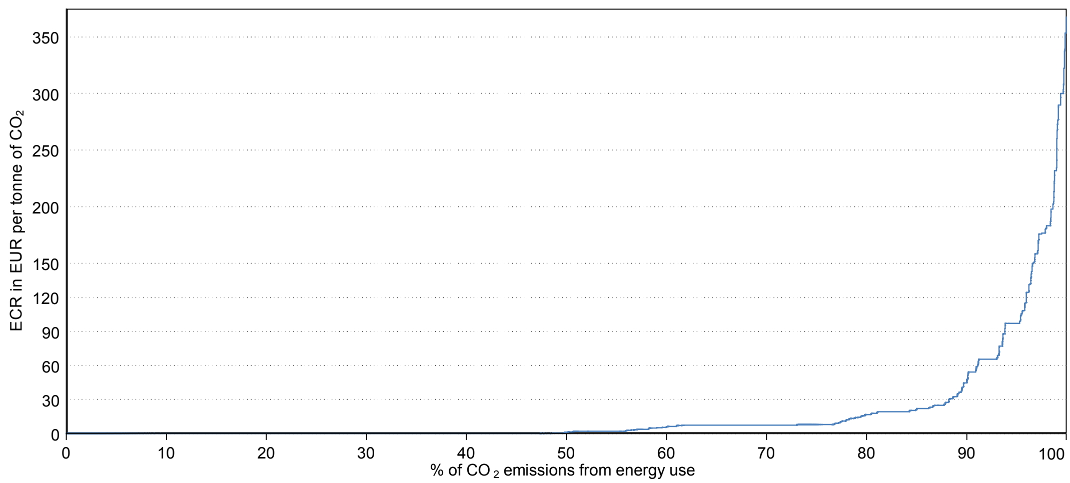
In the electricity sector, emissions trading systems drive carbon pricing efforts. Permit prices are by far the largest component of the ECR, at 81% across the 42 countries. As discussed, coverage is broad and expanding, but price levels remain low.

The distribution of effective carbon rates is strongly skewed

Figure 2.5 shows the cumulative distribution of effective carbon rates for all 42 OECD and G20 countries combined. The distribution is skewed to the right, i.e. a small share of emissions face a high effective carbon rate, while many emissions face no or a very low rate. This shape has implications for the interpretation of evidence on effective carbon rates, as the following paragraphs explain.

Figure 2.5. Proportion of CO_2 emissions from energy use subject to different levels of effective carbon rates in 42 OECD and G20 countries

Estimate for 2018



First, average effective carbon rates provide little information about the state of carbon pricing within a country. Average carbon rates would be relatively high, as the few emissions that face a high carbon rate strongly impact the calculation of average rates. For example, if country A charges an effective rate of EUR 2.5 for 90% of emissions and of EUR 227.5 for 10% of emissions, the average rate is EUR 25 per tonne, but this price is very different from what applies to any given tonne of emissions in country A. In practice, average rates hide the reality that the vast majority of emissions face prices near or equal to zero.[3]

Relying on average rates can also muddy the waters for intercountry comparisons. Assume, for example, that country B charges a uniform rate of EUR 25 per tonne for all CO_2 emissions from combustion. The average rate then is the same as in country A above, but the actual rate pattern is very different.

Second, for making statements about the polluter-pays principle, i.e. to what extent polluters pay for the damage their emissions cause to society, the share of emissions priced above and below the social cost estimate needs to be known. Comparing average carbon rates to social cost estimates does not allow any systematic assessment of how far the polluter-pays principle is implemented. As average carbon rates are strongly influenced by the small share of highly priced emissions, see Figure 2.5, comparisons would be misleading.

Third, average effective carbon rates allow no appreciation of the cost effectiveness of carbon abatement.[4,5] If some emitters face no or a very low carbon price, while other emitters face a very high carbon price, abatement will not be cost effective (as in country A above, in contrast to country B which applies a uniform rate). Emitters with a high price undertake expensive abatement options while those with no carbon price forego low-cost abatement opportunities. Average rates do not allow for an appreciation of whether any two emitters face the same or a different carbon price, only the average carbon price for both of them is visible. Hence, inferences about the cost effectiveness of abatement that can be drawn using average carbon are limited.

For the reasons mentioned above, this publication shows either the full distribution of effective carbon rates as in Figure 2.5, or pie charts that summarise the distribution at several benchmark values, or at the very least breaks down averages by sector. For example, Figure 2.3 on page 25 summarises Figure 2.4 by showing that 47% of emissions are unpriced, 89% of emissions are priced below EUR 30 and 91% of emissions have an effective carbon rate below EUR 60.

The carbon pricing gap

The *carbon pricing gap* is a summary indicator of countries' use of carbon pricing. It compares the distribution of actual effective carbon rates to a benchmark rate. This report uses two benchmark values, EUR 30 and EUR 60 per tonne of CO_2. The first is a low-end estimate of the carbon costs today, the second a midpoint estimate of carbon costs in 2020, as well as a forward looking low-end estimate of carbon costs in 2030. This section discusses the structure of the indicator, how it can be interpreted, and how it can be reduced.

The carbon pricing summarises the state of carbon pricing

The carbon pricing gap shows the extent to which countries price carbon emissions below the benchmark value, by measuring the difference between the benchmark and the actual rate for every percentile, and summing all positive differences. The gap is measured as a percentage. If the ECR on all emissions was at least as high as the benchmark value, the gap would be zero, and if the ECR was zero throughout, the gap would be 100%.

The carbon pricing gap can be calculated at the level of countries or across aggregates of all or groups of countries. Within these groups, it can be considered across all economic sectors, or at the level of individual sectors. This report considers the carbon pricing gap across all countries and sectors, and presents country level and sector level estimates across countries.

The aggregate carbon pricing gap indicates how advanced the 42 countries are with the implementation of market-based, cost-effective tools to decarbonise their economies. The measure describes the state of carbon pricing, and can be tracked across time and compared across companies and sectors (noting that higher prices in transport are common, and are not directly indicative of sufficiently high fuel prices, given the presence of other external costs). It can also be seen as indicative of countries' effort, through cost-effective policies, to reduce CO_2 emissions from energy use.

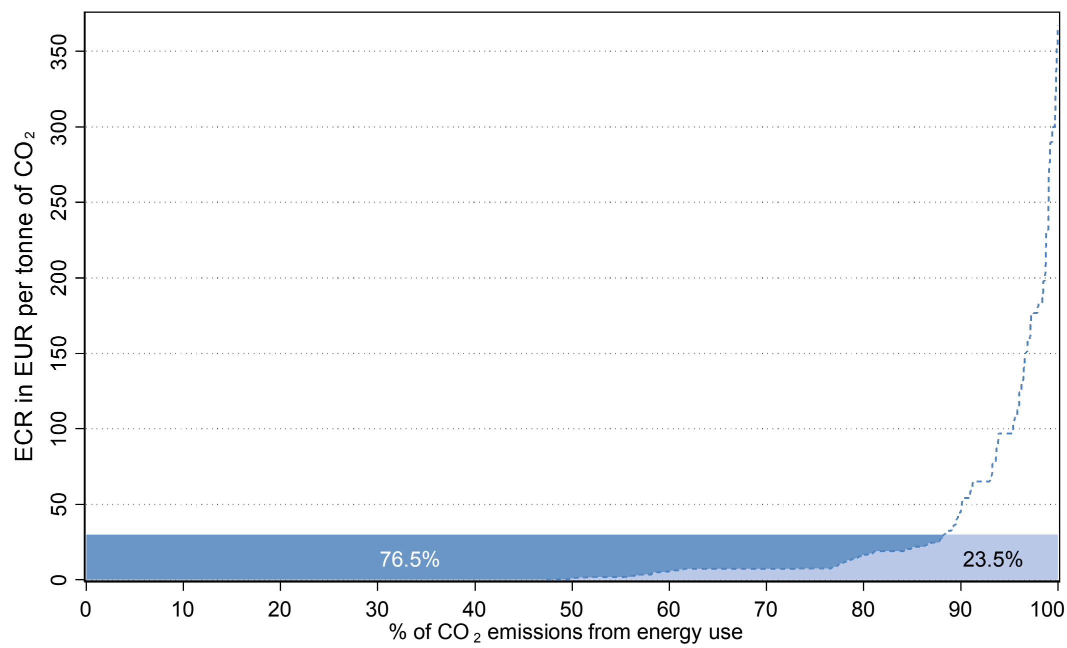
The carbon pricing gap considers only market-based policies, not the full spectrum of measures, and in that sense does not capture all climate policy effort related to energy use. A high gap suggests limited overall effort or, given that alternative policies are very likely more costly, effort at relatively high costs. Given commitments to decarbonisation, it therefore is interpretable of the risk countries are subject to by not focussing on cost-effective decarbonisation. At the country level, the gap also can be seen as an indicator of long-run competitiveness. This is discussed in the next subsection.

The carbon pricing gap is a better summary measure than the average effective carbon rate because it is sensitive to the distribution of the rates, but not heavily influenced by extreme values. Consider the example of the previous section, where country A charges an effective rate of EUR 2.5 for 90% of emissions and of EUR 227.5 for 10% of emissions (leading to an average rate of EUR 25 per tonne), and country B applies a uniform rate of EUR 25. The carbon pricing gap against a EUR 30 benchmark in country

A is 82.5% (reflecting the large gap between actual rates and the benchmark for 90% of emissions) and is much lower, at 16.7%. in country B (because all emissions are priced at a rate close to the benchmark). That said, the carbon pricing gap does not capture the full characteristics of the shape of the distribution, and it can be equal across countries that in fact have differing carbon pricing patterns. For example, the carbon pricing gap is 50% in a country that charges zero rates for half its emissions and rates above EUR 30 for the other half, and it will be 50% in a country that charges EUR 15 per tonne for all emissions.

Figure 2.6. The carbon pricing gap

Shown in dark blue



Note: Estimate for 2018.

Figure 2.6 illustrates the *carbon pricing gap against a EUR 30 benchmark* for effective carbon rate estimates for 2018. The dashed line shows the distribution of carbon rates across the 42 economies as a whole, the same as in Figure 2.5. The proportion of emissions below the dashed line is subject to a positive carbon rate (coloured light blue). The proportion of emissions between the dashed line and the horizontal line at EUR 30 per tonne of CO_2 (coloured dark blue) is either not priced by any price instrument, or is priced at a level below EUR 30 per tonne of CO_2. The area in dark blue is the *carbon pricing gap* across the 42 countries today, and it equals 76.5%.

The *carbon pricing gap at EUR 60* is 83%.

The carbon pricing gap as an indicator of long-term competitiveness

With the Paris Agreement, countries decided to decarbonise their economies by the mid to end of this century. Given this commitment, strategic incentives are now in favour of comprehensive and significant carbon prices. Carbon prices are the most cost-effective tool to reduce emissions, (see page 11 and OECD, 2016[1], Chapter 2 for an in-depth explanation). This means that countries with few emissions priced or with low effective carbon rates pay too much for abatement today or that they delay abatement. Delaying abatement until it is unavoidable severely risks increasing the costs, since carbon-intensive capital can suddenly become obsolete (European Systemic Risk Board, 2016[4]).

Against this background, the *carbon pricing gap* can be seen as an indicator of long-term competitiveness during the low-carbon transition. A low or zero gap signals to investors that a country seeks to decarbonise at lowest cost and that its companies are being incentivised to compete and thrive in a low-carbon economy. A high gap indicates either of two undesirable states of the economy, excessively costly effort or low effort, as explained in the following paragraphs.

First, a high gap can signal that a country spends too much money on abatement. Relying mainly or only on non-price mitigation policies means that firms and households spend more or invest less, or that the government runs higher deficits, for the same level of abatement compared to the case where it had priced carbon emissions. This risks lowering economic growth and, more broadly, welfare, as resources are allocated inefficiently. Pursuing mitigation policies in a way that is more costly than necessary can increase sovereign risk and reduce productive potential. Given the size of effort required to become fully carbon neutral in the second half the century, these risks are considerable.

Second, a high gap can reflect a country's limited effort towards a low-carbon economy. Firms are then more likely to forego the opportunities that arise in a low-carbon economy and face higher transition risks. In addition, the country's overall economy is more likely to face economic adversity and become less competitive due to lack of climate policy or late action.

Foregone opportunities include not increasing resource efficiency, not taking advantage of ever-cheaper clean energy, missing out on developing and selling low-emission goods and services, not being present in emerging low-carbon markets and not becoming more resilient to climate shocks (TCFD, 2017[5]). This likely diminishes long term growth, even if such an approach can lead to short run gains. Aiming to take advantage of the low-carbon transition, ever more companies are adopting in-house carbon pricing systems and are procuring low-carbon energy (Ceres (2017[6]), Kersting and Stratmann (2018[7])).

Transition risks consist of technology risks, market risks, reputation risks, litigation and policy risks (TCFD (2017[5]);). Technology risks arise when new low-carbon technologies become cheaper than traditional high-carbon technologies. The value of high-carbon assets can then suddenly drop. Market risks refer to changes in customer preferences (from existing high-carbon to new low-carbon products and services) and the possibility of increased raw material prices (through ever more difficult access or stricter regulation). Reputation risks include increased negative stakeholder feedback as well as the stigmatisation of carbon-intensive firms and sectors.

Hunt et al. (2017[8]) argue that fossil fuel disinvestment campaigns already increased investor's awareness of climate change risks, while it is too early to say how much disinvestment and asset devaluation this has caused. Litigation risks cover cases of loss and damage brought forward against highly polluting firms as well as citizens suing to hold their governments accountable for climate commitments (see UNEP (2017[9]) and Nachmany et al. (2017[10]) for recent reviews). Policy risk refers to unexpected measure of stricter greenhouse gas regulation, for example in response to extreme climate events (Zenghelis and Stern, 2016[11]).

If a transition risk materialises, this can suddenly decrease the value of high-carbon assets considerably, possibly triggering a "Climate Minsky moment". Bank of England Governor Mark Carney describes a Climate Minsky moment as a situation where for a long time investors are insufficiently taking account of transition risks and ultimately find the cost of adjusting to the low-carbon economy to be higher than expected (Shankleman and Lacqua, 2017[12]).[6] Such sudden and elevated adaptation costs have the potential to trigger a severe economic crisis.

Carbon pricing mechanisms help prevent Climate Minsky moments and the *carbon pricing gap* shows the extent to which countries are utilising them. Carbon prices encourage cost-effective climate change mitigation by ensuring that all economic actors take the costs of emissions into account in their business and investment decisions. Carbon prices make it more costly to sustain the behavioural bias of ignoring the low-carbon transition. Increasing carbon prices gradually allows asset prices to adjust smoothly and reduce the risk of high economic costs following a sudden devaluation of carbon-intensive assets.

How countries can reduce the carbon pricing gap

Compared to 2015, the current carbon pricing gap at EUR 30 across all 42 OECD and G20 countries decreased by 3 percentage point, from 79.5% to 76.5%. In 2012, the gap was more than 6 percentage points higher, at 83%. While the gap is narrowing, the process is slow. If the decrease was to continue by 1 percentage point a year, the gap would close by 2095. This means that carbon prices need to increase considerably more quickly than they have done in recent years in order to ensure a cost-effective low-carbon transition.

While aggregate progress has been slow, current and planned actions by individual countries can lead to a substantial decline. The expected development of the Chinese ETS is an example. In addition to covering electricity generation in its national ETS (NDRC, 2017[13]), China announced its intention to include industry emissions. Carbon market experts expect low permit prices around Yuan 50 per tonne of CO_2 (about EUR 6.4) for the start of the national ETS, but substantial price increases to about Yuan 200-300 (EUR 25 to 38) are expected over time (Rathi, Akshat and Huang, 2018[14]). Assuming that Chinese emission permits would trade at Yuan 250 per tonne of CO_2 (about EUR 32) and that the national ETS would cover 1.5 billion tonnes of CO_2 from the industrial sector, the carbon pricing gap at EUR 30 for the group of 42 countries would decline to 63%, from its current level of 76.5%. The carbon pricing gap for China itself would contract from 83% to 43%.

A recent reform of the EU ETS introduced a market stability reserve that will reduce the large surplus of emission permits in the trading system (European Union, 2018[15]). While price expectations for future permit prices are still moderate (see, e.g., ZEW (2018[16])), the EU directive allows to tighten the cap more strongly after 2024. A robust cap tightening could increase permit prices, as could the introduction of an auction reserve price, or a carbon floor price (as applicable in the United Kingdom (see Chapter 3).

Box 2.1. The carbon pricing gap

The carbon pricing gap measures how much OECD and G20 economies together, as well as individually, fall short of pricing carbon emissions in line with a benchmark value.

The carbon pricing gap measures the difference between a benchmark value and the actual effective carbon rate (ECR) for every percentile of emissions, summing all positive differences. The report presents the carbon pricing gap as a percentage: If the ECR on all emissions was at least as high as the benchmark, the gap would be zero, and if the ECR was zero throughout, the gap would be 100%. Throughout the report two benchmark values are applied, EUR 30, a low-end estimate of the carbon costs today, and EUR 60, a midpoint estimate of the carbon costs in 2020 and a low-end estimate for 2030.

The report presents the carbon pricing gap across the aggregate of all 42 OECD and G20 economies as well as at the level of individual countries. Within these groups, it can be considered across all economic sectors, or at the level of individual sectors.

The aggregate carbon pricing gap indicates how advanced the 42 countries are with the implementation of market-based, cost-effective tools to decarbonise their economies. The measure describes the state of carbon pricing, and can be tracked across time and compared across companies and sectors. It can also be seen as indicative of countries' effort, through cost-effective policies, to reduce CO_2 emissions from energy use.

At the country level, the gap also can be seen as an indicator of long-run competitiveness. A zero or very low gap signals to investors that a country seeks to decarbonise at lowest cost and that its companies are being incentivised to compete and thrive in a low-carbon economy. A high gap indicates either of two undesirable states of the economy. One, overly costly effort. The carbon pricing gap only considers market-based policies, alternative policies very likely reduce fewer emissions for each Euro invested in abatement. Two, limited overall effort. Firms are then more likely to forego the opportunities that arise in a low-carbon economy and face higher transition risks.

Countries that pursue overly costly mitigation effort or no effort at all may also increase sovereign risk. A collapse in demand for fossil fuel, be it technology, consumer, litigation or policy driven could spark a global financial crisis (Mercure et al., 2018[17]). Carbon prices ensure that all economic actors account for carbon costs in their business decisions, making it costly to sustain the behavioural bias of ignoring the low-carbon transition. Increasing carbon prices gradually allows for a smooth reduction in the demand for fossil fuel, lowering the risk of an economic crisis caused by a collapse in demand for fossil fuel and the resulting devaluation of carbon intensive assets.

An increase in permit prices to at least EUR 30 would diminish the carbon pricing gap at EUR 30 from 52% today to 25% for the 22 EU countries participating in this study. The overall gap would decline by three percentage points. This may sound modest, but reflects the relatively higher starting point in the European Union as well as its share in aggregate emissions. Nevertheless, such a reform would contribute positively to overall carbon pricing momentum. Countries or regions can signal to investors that their climate policies are prudent yet ambitious, and that adaptation to a low-carbon economy goes hand in hand with strong economic performance.

Canada has increased carbon prices significantly in recent years. Design features, including the choice between taxes and trading systems, vary across provinces, but the federal carbon pricing backstop guarantees a common minimum of ambition across the country (Environment and Climate Change Canada, 2018[18]). As a result, the Canadian carbon pricing gap is expected to drop from 65% in 2015 to about 43% in 2018.[7] If all emissions are covered and the minimum carbon price increases as planned to CAD 50 (about EUR 32.5) per tonne of CO_2 by 2022, the carbon pricing gap at EUR 30 would reduce significantly.

The above-mentioned policies strongly reduce the carbon pricing gap within countries, meaning that they make substantially faster progress than others in reducing emissions through cost-effective action. There is substantial heterogeneity across countries. The aggregate carbon pricing gap at EUR 30 for the ten best performing countries is 44%. The ten countries that lag most behind have an aggregate gap of 85%.

The carbon pricing gap across sectors

The carbon pricing gap varies substantially across sectors. The gap at EUR 30 is lowest for road transport, at 21%, and highest for industry, at 91%. The gap is above 80% in the electricity and the residential and commercial sectors. In the electricity sector, 66% of emissions are now priced (see Figure 2.4). Closing the gap in the electricity sector is as much about pricing the remaining third of emissions as it is about increasing the price of already priced emissions. If permit prices in the Chinese national ETS increased to Yuan 250 per tonne of CO_2 (Rathi, Akshat and Huang, 2018[14]), the gap would decrease to 56%. In the industry sector and the residential and commercial sector, more than two thirds of emissions are still unpriced (Figure 2.4). Implementing carbon prices through taxes or emissions trading would be a first step towards closing the gap.

Table 2.3. Carbon pricing gap by sector

Carbon pricing gap in 42 OECD and G20 countries by sector

Sector	Carbon Pricing Gap at EUR 30	Carbon Pricing Gap at EUR 60
Agriculture & fisheries	64%	78%
Electricity	84%	92%
Industry	91%	95%
Offroad transport	56%	75%
Residential and commercial	87%	93%
Road transport	21%	58%

At EUR 60, the carbon pricing gap is wide in all sectors. It is lowest in road transport at 58%, and 90% or more in the electricity, the industry and the residential and commercial sectors.

While the carbon pricing gaps are smallest for road transport this does not necessarily mean that the road sector is necessarily best positioned to transition smoothly to a low-carbon economy without supplementary policies. Countries with relatively high carbon prices in transport tend to have significantly lower transport-related emissions at the same level of economic development (Sterner, 2007[19]), but transport-related emissions tend nevertheless to be significant even in countries with relatively high carbon rates. This reveals that abatement costs for fully decarbonising the sector have been high, and suggests that action needs to be taken now if decarbonisation is to materialise.

The existing transport infrastructure has generally been developed for the needs of fossil fuel-based vehicles. Upgrading the infrastructure to the needs for zero-carbon transport services seems necessary to enable further abatement (e.g. by easing access to zero-carbon vehicles, charging and fuelling stations, expanding zero-carbon mass transit, and encouraging shifts to more carbon-efficient transport modes).

By comparison, a carbon price of EUR 30 in the electricity sector can enable a fuel switch from coal to natural gas, which is half as emissions intensive. Emissions can decline quickly as the carbon price floor in the United Kingdom has shown (see Chapter 3). Deeper decarbonisation in the electricity sector requires appropriate market designs in addition (IEA, 2016[20]).

Fuel switches in the industrial sector and in the residential and commercial sector can also cut emissions significantly (e.g. from coal to gas, from oil and gas to carbon-neutral fuels, or directly from coal to carbon-neutral fuels). The carbon prices needed to enable fuel switches depend on the existing fuel mix and infrastructure (e.g. age and type of boilers to generate heat, availability of carbon-neutral fuels, etc.) and may thus vary across countries.

As a side effect of fuel switches, carbon pricing revenues at current effective carbon rates could decline, if in the short to medium run they are likely to rise. As carbon rates are significantly higher for petrol and diesel than for electricity, a switch to electric vehicles could lead to a significant drop in revenues, if carbon rates do not increase in the electricity sector. Charging per kilometre travelled is also a possibility to prevent the transport tax base from eroding over time (Van Dender, 2018[21]). Similarly, charging per kilowatt hour for electricity and heat services allows sustaining revenues from energy use.

Notes

[1] EUR – USD parity is assumed.

[2] The emission base includes domestic aviation, but excludes international aviation.

[3] Note that a right-skewed distribution with 90 % of emissions unpriced and 10% of emissions priced at EUR 350 implies an average rate of EUR 35. Such a distribution is very different from a uniform distribution where 100% of emissions are price at EUR 35, which also implies an average rate of EUR 35. Policy implications are also very different. In the first case, 90% of emissions are clearly priced below their social cost, while in the second case all emissions are priced above the low-end estimate of social costs.

[4] In the presence of only the global warming externality cost-effective abatement would call for all emissions facing the same price. Accounting for other externalities on top of global warming (e.g. local air pollution; noise, etc.) all emissions should face at least a certain price for cost-effective abatement.

[5] Note that if carbon prices are equal across emitters, yet expected to increase over time, it can be beneficial for emitters to invest in long-lived low-carbon assets with abatement costs higher than

the current carbon price (cf. Vogt-Schilb et al. 2018). Investors in low-carbon assets will benefit from not having to pay much higher carbon prices in the future.

[6] More generally, the Minsky moment refers to a situation where apparent economic stability breeds economic instability. In stable economic times investors take on more and more debt as it is seemingly safe. The increase in debt levels, however, makes the economy more prone to financial crisis, see the Economist (2016[91]). By analogy, a Climate Minsky moment can be characterised as a situation where investors continue to invest in high-carbon assets as they currently receive good returns. The continuation of financing of high-carbon assets, however, increase the risk of economic crisis when low-carbon technology becomes competitive or the carbon budget becomes stricter.

[7] It is assumed that the federal carbon pricing backstop will be implemented as announced in January 2018.

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