Effective Carbon Rates on Energy

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"We need an effective price on carbon emissions if we want to tackle climate change. Unfortunately, implementation of the polluter pays principle is woefully lacking. While lower-end estimates put the damage from emitting 1 tonne of CO_2 at EUR 30, 90% of all emissions from energy use are priced at less than that when we look at 41 countries representing 80% of world energy use. Moreover, 60% of emissions are not subject to any price whatsoever. We cannot continue like this if reducing greenhouse gas emissions in a cost-effective manner is a true policy objective."

Angel Gurría, OECD Secretary-General

1. HIGH LEVEL INSIGHTS

The effective carbon rate (ECR) is the sum of carbon taxes, specific taxes on energy use (mainly excises), and tradable emission permit prices, expressed in EUR per tonne of CO_2-emissions. It is the price on carbon emissions that energy users face as a result of market-based policies that increase the relative price of energy. The insights of this brochure apply to the ECR that was in effect in 2012 (for taxes) and that was either in effect in 2012 or shortly after 2012 (for emissions permits prices). Box 2 explains how the emissions permit price component was calculated.

The OECD has estimated the ECR for 41 countries, covering around 80% of global energy use and global CO_2-emissions in 2012. The full country and sector level results of this analysis are published in *Effective Carbon Rates: Pricing CO_2 through taxes and emissions trading systems* (OECD, 2016). The 41 countries include all OECD countries and Argentina, Brazil, China, India, Indonesia, Russia and South Africa.

Main findings:

- Considering all energy use, 60% of CO_2-emissions from energy use in the 41 countries are not subject to an ECR at all, 10% are subject to a rate between zero and EUR 5 per tonne of CO_2, 20% to a rate between EUR 5 and EUR 30 per tonne of CO_2, and 10% to a rate above EUR 30 per tonne. Hence, 90% of emissions are priced below the low end estimate of the climate cost of CO_2-emissions, being EUR 30 per tonne, and 70% of CO_2-emissions are priced at a rate of less than EUR 5, implying there is hardly any policy-driven price incentive to reduce these emissions.
- In road transport, only 2% of emissions in the 41 countries face a zero ECR, and 3% face a rate larger than zero, but less than EUR 5 per tonne of CO_2-emissions; 48% of emissions are subject to a rate of between EUR 5 and EUR 30, and 46% face a rate of more than EUR 30 per tonne of CO_2-emissions.
- Excluding emissions from road transport, for 70% of emissions, the ECR is zero; for 11%, it is above zero but below EUR 5, for 15% of emissions it is between EUR 5 and EUR 30; 96% of emissions from energy use are subject to an ECR of less than EUR 30 per tonne of CO_2.

Market-based instruments, as reflected in the ECR, are one among a range of climate policy instruments, and are particularly well-suited for bringing cost-effectiveness to the policy mix.

2. SCOPE OF THE ANALYSIS

CO_2-emissions from the use of coal, oil and gas accounted for 69% of global anthropogenic greenhouse gas emissions in 2010 (IEA, 2014). In addition to these fossil fuels, the analysis allows inclusion of CO_2-emissions from combustion of biomass for energy, which – if included – represent 12% of total emissions in the 41 countries covered. Global energy use is expected to grow strongly as the world economy grows. The need to abate CO_2-emissions from energy use to limit the costs of climate change is therefore clear.

Energy is an input into a wide range of consumption and production activities. Energy comes at a cost, so users have an interest in containing energy use, for example by investing in energy-efficiency as long as that costs them less than paying for additional energy use. However, the social interest in containing energy use outstrips energy users' private interests, because energy use has negative side effects that matter to society but that are not reflected in pre-tax prices of energy use, including emissions of local air pollutants and CO_2. Policy intervention is required to induce energy users to take these negative side effects into account in their decisions on how much and what form of energy to consume. Policy instruments that "make polluters pay" are very effective at accomplishing this task, because they achieve a better alignment of the polluters' and the social interest; see OECD (2015a).

Box 1. The climate cost of CO_2-emissions – and a note on terminology*

If effective carbon rates are to send appropriate price signals to emitters of CO_2, the rates should be aligned with the marginal cost of climate change (in short, the 'climate cost') of CO_2-emissions. Estimating the climate cost of CO_2-emissions is difficult given uncertainties over the climatic and economic processes involved, and the long term over which these processes will play out. As a consequence, available estimates cover a range of values. This note uses EUR 30 per tonne of CO_2 as a lower end estimate of climate costs This is in line with the values, derived from a review of recent evidence, in Alberici et al. (2014). The same study arrives at a central value of EUR 50 per tonne of CO_2. Smith and Braathen (2015) find that the unweighted average cost of carbon used in policy appraisal in 2014 was slightly above USD 50. However, given the high uncertainty underlying point estimates, this note works with the lower bound of EUR 30 only.

Putting a price on CO_2 can produce important co-benefits, for example reductions in air pollution or other negative side-effects of energy use, or raising valuable public revenue. These co-benefits are not quantified here, but their existence further supports the idea of charging at least the climate cost of CO_2-emissions from energy use.

* Carbon costs are not CO_2-emission costs, as 3.67 tonnes of CO_2-emissions are equivalent to one tonne of carbon. ECRs here are always expressed in EUR per tonne of CO_2, even if reference is made to carbon costs or carbon prices for ease of language.

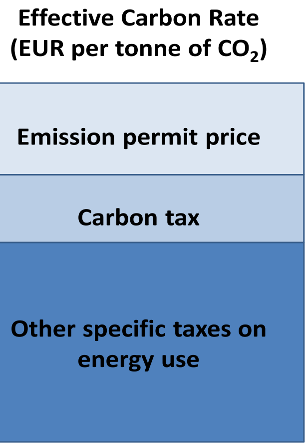
Price-based or market-based policies can take the form of taxes or emissions trading systems. For CO_2, controlling the level of emissions at any one particular point in time is less critical than controlling the stock over time. In addition, decarbonisation will require long-term investments in emission reduction technologies and infrastructure, which will be undertaken in response to credible and stable price signals. Taxes are well-adapted to these circumstances. Where smooth markets are feasible and not too costly to obtain, and where price volatility can to some extent be managed, emissions trading mechanisms can also perform well.

The ECRs in this note are the sum of prices put on CO_2-emissions from energy use through market-based mechanisms, including (a) emissions trading systems (permit prices), (b) carbon taxes, and (c) specific taxes on energy use; see Figure 1.

Specific taxes on energy use include excise taxes levied on the consumption of energy and a range of other, quantitatively less important, taxes (value-added tax is not included since it is usually not specific to energy, and transport tolls are excluded because they are not directly related to energy use). Many of the specific taxes may not have been introduced to curb carbon emissions, but they do put a price on CO_2 and therefore are included in the ECRs. If an emissions trading system is in effect and its cap is binding, then carbon taxes or other specific taxes on energy use will have no effect on total CO_2-emissions within the emissions trading system. Components of the ECRs can, and often do, equal zero. The base considered is all CO_2-emissions from energy use in 41 OECD and G20 countries.

Leaving regulation aside, the ECRs are a measure of the extent to which countries apply market-based instruments, which are cost-effective policy instruments to abate CO_2-emissions from energy use.

Figure 1. Components of effective carbon rates



OECD (2013) and OECD (2015a) provide full country-level detail on explicit carbon taxes and all other specific taxes on energy use that impose a price on carbon emissions. The OECD estimates of carbon prices resulting from emissions trading systems are new; see Box 2. With their inclusion, the effective carbon rates provide a comprehensive estimate of the price on carbon from market-based mechanisms across 80% of global CO_2-emissions from energy.

Box 2. Emissions trading systems included in the ECR estimates

The following emissions trading systems are included in the calculation of effective carbon rates: the Beijing Emissions Trading System (China), the California Cap-and-Trade Program (United States), the Chongqing Emissions Trading System (China), the European Union Emissions Trading System (which operates in 31 countries, of which 23 are OECD member countries), the Guangdong Emissions Trading System (China), the Hubei Emissions Trading System (China), the Korea Emissions Trading Scheme, the New Zealand Emissions Trading Scheme, the Québec Cap-and-Trade System (Canada), the Regional Greenhouse Gas Initiative (RGGI, covering nine north-east and mid-Atlantic US states), the Saitama Prefecture Target Setting Emissions Trading System (Japan), the Shanghai Emissions Trading System (China), the Shenzhen Emissions Trading System (China), the Swiss Emissions Trading Scheme, the Tianjin Emissions Trading System (China) and the Tokyo Cap-and-Trade Programme (Japan). The systems operate in 29 of the 41 countries and cover approximately 13% of total CO_2-emissions from energy use in the 41 countries included in the analysis.

The share of CO_2-emissions from energy use and the emission permit prices have been estimated from detailed system data for 2012. Emissions trading systems that started operating at a later date have been evaluated as if they were operational in 2012. This is different from the treatment of taxes, where all rates are as at 2012. This applies to the emissions trading systems in Beijing, California, Guangdong, Shanghai, Shenzhen, Tianjin and Québec, which started operation in 2013, Chongqing and Hubei, which started in 2014, and Korea starting in 2015. The year in which these systems were operational that is closest to 2012 was used to construct the estimate for 2012, with prices corrected for inflation.

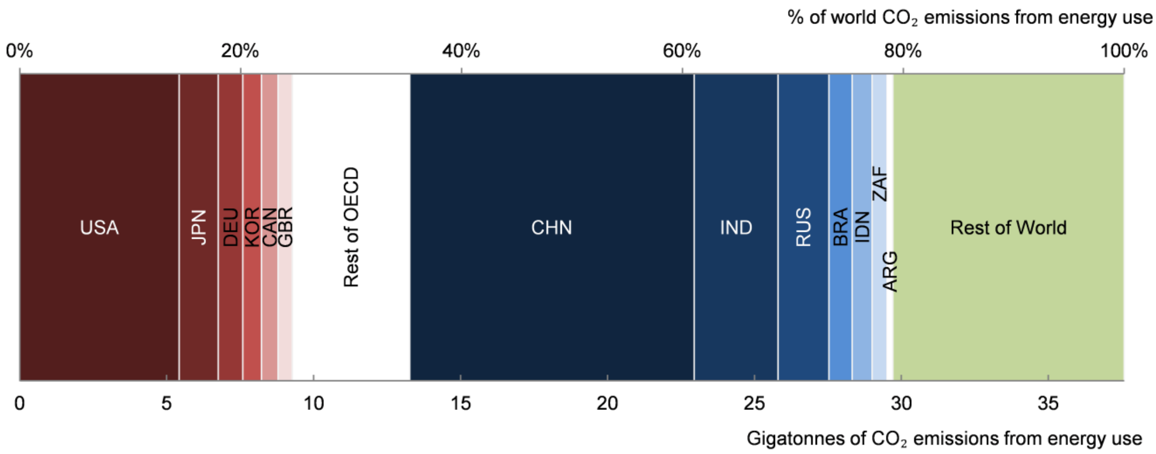
Where possible, permit prices are calculated as the yearly average at auctions. Where auctions were not conducted or the data were unavailable, the permit price was calculated based on secondary market data (Korea and the Chinese systems) or information on the price of offset credits (New Zealand and the Japanese systems). Where more than one emissions trading system operates in the same country (China, Japan and the United Sates), an average permit price per country and sector is used, weighted by the coverage of each system within each sector. An emissions trading system generally applies to only a portion of a country's emissions. Its coverage is calculated by country and sector as a share, dividing the sector emissions subject to the emissions trading system by the country's total emissions in that sector. This is done independently of whether the system applies to the country as a whole or to a subnational jurisdiction.

To construct the ECR, coverage and price signals of emissions trading systems are combined with those of taxes from the *Taxing Energy Use* publications (OECD 2013 and 2015a). A country's CO_2 emissions from energy use (disaggregated at a user-fuel level) are partitioned in two groups, non-ETS-covered and ETS-covered, the former receiving the applicable tax rate as only price signal, the latter receiving the sum of tax rates and permit prices that apply.

3. COVERAGE

Effective carbon rates are calculated for all energy use in 41 countries, which together account for just over 80% of world energy use, and global CO_2-emissions in 2012, the most recent year for which detailed energy use data are available; see Figure 2. The 41 countries are the 34 OECD countries and seven selected partner economies (SPE), namely Argentina, Brazil, China, India, Indonesia, Russia and South Africa. In 2012, the OECD share in global CO_2-emissions from energy use equals 35% and that of the SPE countries 44%. The share of the SPE countries is expected to grow rapidly, along with their share in world output: on the basis of current membership, the OECD's share in global output may be expected to decline from 62% in 2013 to 43% in 2050 (Johanssen et al., 2013).

Figure 2. OECD and selected partner economies account for the bulk of CO_2 emissions from energy use

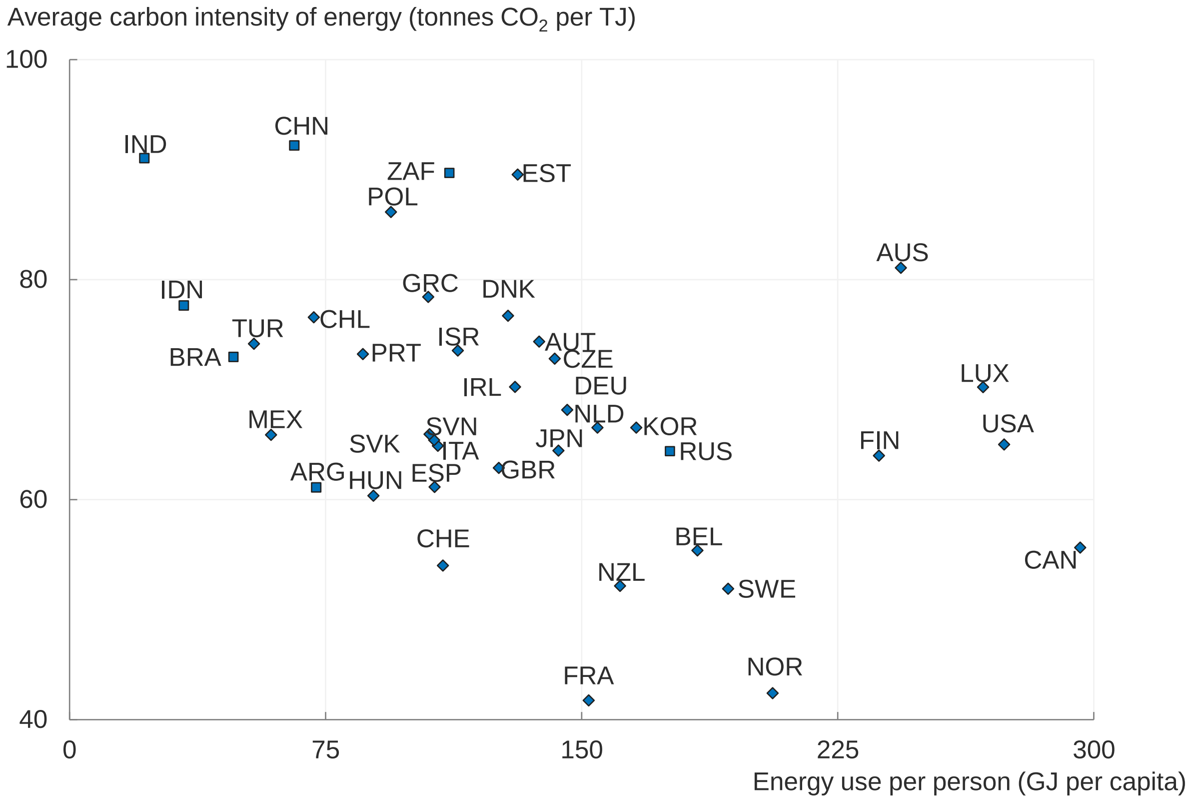


Note: CO_2 emissions data for 2012

Source: OECD calculations based on *Taxing Energy Use 2015: OECD and Selected Partner Economies* (OECD, 2015a)

The 41 countries differ strongly in terms of energy use per capita and in the carbon-intensity of energy use; see Figure 3. Many of the countries for which energy use per capita is set to grow strongly currently rely on relatively carbon-intensive energy and have low ECRs on carbon emissions from energy. More generally, some countries face the challenge of moving 'left' in Figure 3 (reducing energy use per person), and decarbonisation requires moving 'down' (reducing the carbon-intensity of energy use).

Figure 3. Energy use per capita and carbon intensity vary widely across countries



Source: Taxing Energy Use 2015: OECD and Selected Partner Economies (OECD, 2015a)

A tax that is set at a rate based on the energy content of the fuels it applies to works directly on reducing energy use (which indirectly reduces carbon emissions), whereas a tax which is set based on the carbon content of the fuels directly targets carbon emissions, which can be cut by reducing energy use or by reducing the carbon intensity of the energy mix. For example, a tax set based on the carbon content of a unit of energy from bituminous coal would be around 1.75 times as high as a tax on the carbon content on a unit of energy from natural gas, whereas a tax on energy content would be the same per unit of energy. Taxing the carbon content at the same rate for both fuels would increase the price of both forms of energy use, but would constitute a stronger signal to move to natural gas than would a tax on energy content, as natural gas would be relatively less-taxed than bituminous coal under the tax based on carbon content.

Excise taxes can be set to act as pure energy taxes, or pure carbon taxes, or a combination of both. In current practice, however, they are not usually aligned with either principle, and this reduces their effectiveness from an energy and climate point of view.

4. RESULTS ON EFFECTIVE CARBON RATES

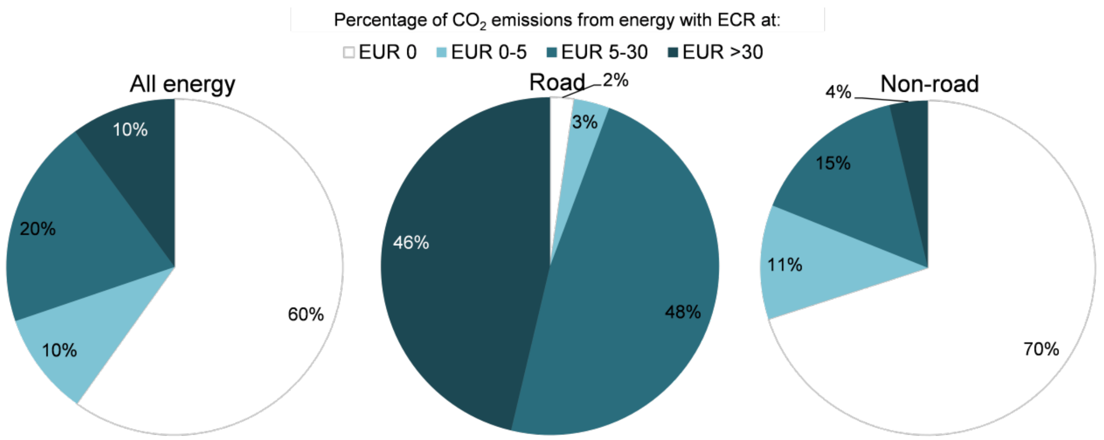
Effective carbon rates, averaged at the economy-wide level (on a weighted basis by the quantity of emissions subject to each individual carbon rate), differ strongly between countries, ranging from approximately EUR 105 per tonne of CO_2 to just over zero when biomass emissions are included in the CO_2-emissions base (the maximum is EUR 127 when biomass emissions are not included). In 14 of the 41 countries (12 countries excluding biomass emissions), the ECR is less than EUR 30, a low-end estimate of the climate cost of one tonne of CO_2-emissions.

In all countries, the ECR consists predominantly of specific energy taxes other than carbon taxes. In some countries, explicit carbon taxes are a significant component of the ECR, notably in countries with above average ECRs.

The prices of emission trading permits, again weighted over the entire base, represent only a small part of total ECRs. Continued extension of coverage of emissions by specific carbon pricing mechanisms and raising the rates has the potential to significantly increase the weight of these specific mechanisms in the ECRs, as well as increasing the level of the ECRs.

Economy-wide effective carbon rates hide considerable differences in rates across sectors. The average ECR in road transport is much higher than in other sectors. The ECR on non-road emissions is low on average – less than EUR 30 in 37 countries (36 countries if biomass emissions are excluded), and less than EUR 5 in 14 countries (13 countries when biomass emissions are not included). This is because specific taxes on energy use are higher in road transport than in other sectors. Carbon taxes and emissions permit prices have the potential to bring more balance to ECRs across sectors, and can help increase transport rates where necessary. This would better align carbon prices with climate costs and would improve their cost-effectiveness, but would also require considerably higher carbon taxes or permit prices than currently applied in most countries.

Figure 4.A. Share of CO_2-emissions from energy use subject to ECRs of zero, zero to EUR 5, EUR 5 to EUR 30, and more than EUR 30, for all emissions (left), road transport emissions (middle), and all emissions except road transport emissions (right), 2012 – biomass emissions included



Source: OECD (2016) Effective Carbon Rates: Pricing CO_2 through taxes and emissions trading systems.

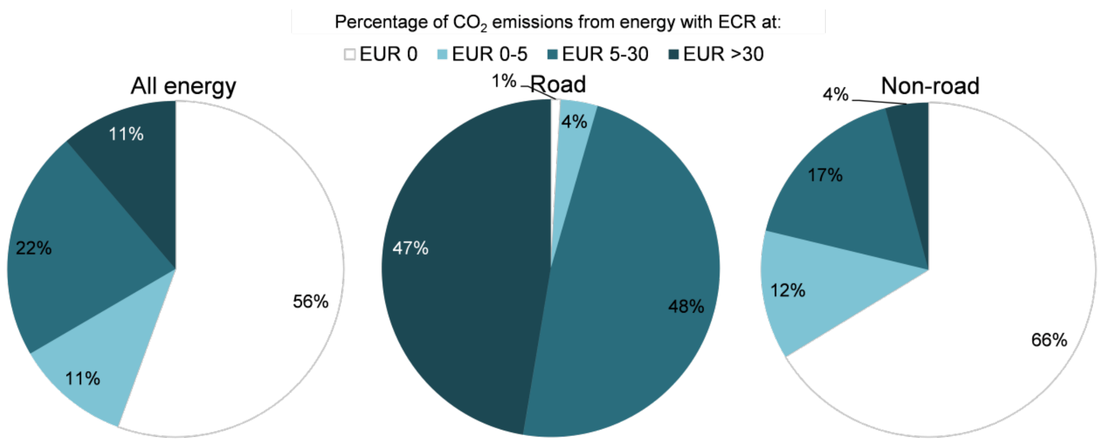
Figure 4.A shows the shares of CO_2-emissions from energy use in the 41 countries that are subject to specific ECR intervals. The left panel applies to all emissions in these countries, the middle panel to road transport emissions, and the right panel to all emissions except road transport CO_2-emissions from energy use. Considering all energy use (left panel), 60% of CO_2-emissions from energy use in the 41 countries are not subject to an ECR at all, 10% are subject to a rate between zero and EUR 5 per tonne of CO_2, 20% to a rate between EUR 5 and EUR 30 per tonne of CO_2, and 10% to rate above EUR 30. Hence, 90% of emissions are priced below the low end estimate of the climate cost of carbon of EUR 30, and 70% of emissions are priced at a rate of less than EUR 5, implying there is hardly any policy-driven price incentive to reduce emissions.

The middle and right panels of Figure 4.A show large differences in ECRs between transport and non-transport emissions. In road transport (middle panel), only 2% of emissions in the 41 countries face a zero ECR, and 3% of emissions face a rate larger than zero but less than EUR 5 per tonne of CO_2-emissions; 48% of emissions are subject to a rate of between EUR 5 and EUR 30, and 46% of emissions face a rate of more than EUR 30 per tonne of CO_2-emissions. These relatively high rates may not have been introduced to mitigate CO_2, but still provide an incentive to reduce the tax burden by cutting CO_2-emissions.

Excluding emissions from road transport (right panel of Figure 4.A), for 70% of emissions, the ECR is zero, for 11% of emissions it is above zero but below EUR 5, for 15% of emissions it is between EUR 5 and EUR 30, and for 4% of emissions it is at least EUR 30.

Figure 4.B shows results for the ECR base excluding biomass emissions. While the treatment of CO_2-emissions from combustion of biomass can have a large impact for some countries, the differences are less pronounced at the level of aggregation considered in this note. The share of zero rates is 4%-point lower in the case where biomass emissions are excluded (Figure 4.B) than in the case where they are included (Figure 4.A) for non-road emissions (right panel) and for total emissions (left panel), but it remains at 66% and 56% respectively.

Figure 4.B. Share of CO_2-emissions from energy use subject to ECRs of zero, zero to EUR 5, EUR 5 to EUR 30, and more than EUR 30, for all emissions (left), road transport emissions (middle), and all emissions except road transport emissions (right), 2012 – biomass emissions excluded



Source: OECD (2016) Effective Carbon Rates: Pricing CO_2 through taxes and emissions trading systems.

CONCLUDING REMARKS

Making polluters pay for CO_2-emissions from their energy use can be achieved through taxes on energy use (both carbon and other energy taxes) and through emissions trading systems. The total price on CO_2 resulting from the combination of these mechanisms is presented in this note as the effective carbon rate (ECR). The OECD has estimated the ECR for 41 countries, including all OECD countries and Argentina, Brazil, China, India, Indonesia, Russia and South Africa. These countries represent around 80% of global CO_2-emissions from energy use.

The evidence on ECRs leaves no doubt that carbon pricing policies are not being utilised to their potential. Where stringent alternative policies are in place, this means that CO_2-emissions abatement policies are likely to be more costly than necessary. Where alternative policies are lacking or weak, it means that current policies do not reflect the climate cost of CO_2-emissions. In either case, increased reliance on carbon pricing will allow more ambitious climate policy and better economic outcomes. Increases in ECRs are needed to reach climate goals, and will often engender domestic co-benefits, e.g. by reducing air pollution or raising valuable public revenue.

At present, excise taxes are the main drivers of ECRs. Carbon taxes and emissions trading systems currently contribute only modestly to effective carbon rates, because of their limited sector and geographical coverage and their comparatively low rates. If coverage continues to expand and rates increase, carbon taxes and emissions trading systems will play a more prominent role in ECRs in the future.

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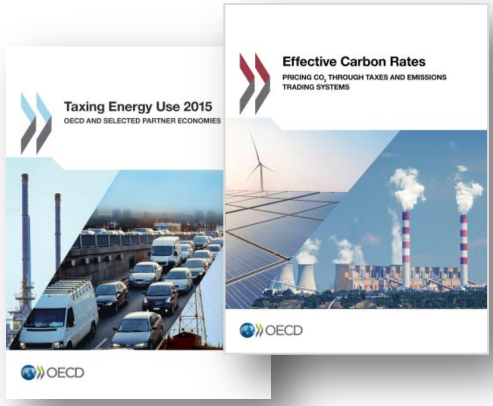

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For more information:
ctp.contact@oecd.org

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