OECD Taxation Working Papers

Net Effective Carbon Rates

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Abstract

Building on an approach pioneered in the OECD's Taxing Energy Use for Sustainable Development report, this paper develops a methodology to estimate effective carbon rates net of pre-tax fossil fuel support; the Net Effective Carbon Rates (Net ECR). This exercise is made possible by combining the two OECD databases: the Taxing Energy Use and Effective Carbon Rates database (the backbone of the newly established OECD series on Carbon Pricing and Energy Taxation) and the Inventory of Support Measures for Fossil Fuels.

The paper then explores potential use cases of this new indicator. In particular, it explains how the Net ECR can be used to calculate fossil fuel support (FFS) against external carbon pricing benchmarks and why such an approach facilitates comparisons of FFS across countries and over time. The paper's conclusions include avenues for future research.

Résumé

S'appuyant sur une approche pionnière du rapport *Taxing Energy Use for Sustainable Development* de l'OCDE, ce document développe une méthodologie pour estimer les taux sur le carbone effectifs nets du soutien aux combustibles fossiles avant impôt; les Taux Effectifs sur le Carbone Nets (Net ECR). Cet exercice est rendu possible en combinant les deux bases de données de l'OCDE : la base de données sur la taxation de l'utilisation de l'énergie et les taux effectifs de carbone (l'épine dorsale de la nouvelle série de l'OCDE sur la tarification du carbone et la taxation de l'énergie) et l'inventaire des mesures de soutien aux combustibles fossiles.

Le document explore ensuite les cas d'utilisation potentiels de ce nouvel indicateur. En particulier, il explique comment le Net ECR peut être utilisé pour calculer le soutien aux combustibles fossiles (FFS) par rapport aux références externes de tarification du carbone et pourquoi une telle approche facilite les comparaisons des FFS entre les pays et dans le temps. Les conclusions de l'article incluent des pistes de recherches futures.

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1 Introduction

1. Explicit carbon prices, energy taxes, and support measures for fossil fuels (henceforth fossil fuels support (FFS)) are all policy instruments that affect carbon emissions. Explicit carbon prices are policy tools implemented with the stated objective to price greenhouse gas emissions and are typically expressed per tonne of CO_2 equivalent (CO_2e) emitted. They can take the form of a carbon tax or be the result of an emissions trading system that requires emitters to obtain permits for their emissions. Energy taxes are traditionally implemented to raise revenue, and rates are typically expressed per unit of energy content (e.g. GJ) or in physical units (e.g. litres or kg).[1] Fossil fuel support stems from a government intervention that reduces the net cost of fossil fuel production, delivery, or purchase, which, in most instances, reduces the effective price of energy. When measured, FFS is expressed in absolute monetary values.

2. The three sets of policy instruments overlap in practice. Many carbon taxes are levied on physical units in the same way as fuel excise taxes, and often apply on top of or as a component of pre-existing energy taxes.[2] Energy taxes not only include excise taxes on fuels, but equally electricity excise taxes. FFS includes measures that provide preferential energy and carbon tax rates to energy users. FFS additionally includes tax expenditures from other policy instruments, such as VAT, as well as budgetary transfers.

3. The OECD's Effective Carbon Rates (ECR) indicator (OECD, 2021[2]) measures the price on carbon emissions arising from the sum of taxes and tradeable permits, expressed per tonne of CO_2. Irrespective of the policy objectives for their introduction, all components of the ECR are defined over a tax base that is CO_2 emissions or is directly proportional to them (e.g. litres of diesel, or tonnes of coal). The three different components of the ECR are fuel excise and carbon taxes as defined in *Taxing Energy Use 2019* (OECD, 2019[1]) and tradeable carbon emission permits. ECRs are expressed net of relevant exemptions, rate reductions and refunds. As a result, the ECR accounts for tax expenditures resulting from relevant policy instruments (fuel excise taxes, carbon taxes, and emissions permit prices)[3] and are therefore widely regarded as the most comprehensive indicator measuring *positive* carbon prices.

4. However, the ECR does not account for government measures that decrease pre-tax prices of fossil fuels. Such measures that translate into *negative* carbon prices can, for instance, be the result of governments providing budgetary transfers to fuel suppliers. Detailed information on budgetary transfers

[1] There are also ad-valorem energy taxes, e.g. the Special Tax on Electricity (Impuesto Especial sobre la Electricidad) in Spain, which applies to electricity consumption by end users.

[2] Most countries administer explicit carbon taxes in the same way as fuel excise taxes (e.g. France, Sweden). Countries that follow this fuel-based approach do not actually tax CO_2 directly, but rather calculate the corresponding rate in common commercial units, for instance by reference to kilograms for solid fuels, litres for liquid fuels, and cubic metres for gaseous fuels. There are, however, a number of countries that tax greenhouse gases directly. Countries that pursue such an emissions-based approach include Chile, Estonia, Latvia and South Africa. Some countries also combine a fuel-based carbon tax on fossil fuels with an emissions-based tax on specific GHG emissions, notably F-gases (e.g. Denmark, Iceland, Norway).

[3] Similarly, *Taxing Energy Use 2019* translates all taxes on energy use into effective energy tax rates per unit of energy content (GJ).

can be found in the OECD Inventory of support measures for fossil fuels (OECD, 2022[2]), which provides the most comprehensive collection of FFS measures.

5. Building on an approach pioneered in Taxing Energy Use for Sustainable Development (OECD, 2021[3]), this paper develops a methodology to estimate effective marginal carbon rates net of pre-tax FFS measures: the Net ECR. Such an exercise is made possible by combining the two aforementioned OECD databases: the Taxing Energy Use and Effective Carbon Rates database (TEU/ECR) and the OECD Inventory of Support Measures for Fossil Fuels (the Inventory).

6. The paper then explores potential use cases of this new indicator. In particular, it explains how it can be used to calculate FFS against external carbon pricing benchmarks and why such an approach facilitates comparisons of FFS across countries and over time. The conclusions include avenues for future research.

2 The traditional OECD toolkit

2.1. Taxing Energy Use and Effective Carbon Rates database

7. The OECD series on Carbon Pricing and Energy Taxation and the associated TEU/ECR database take stock of how countries tax energy use and explicitly price greenhouse gas (GHG) emissions.[4] The TEU/ECR database systematically integrates all specific taxes on energy use and GHG emissions in a consistent framework that ensures cross-country comparability. It covers carbon taxes, excise taxes on fuels, taxes on the consumption of electricity, and determines permit prices on emissions that are subject to emissions trading systems (Table 2.1)

Table 2.1. Instrument coverage in Taxing Energy Use and Effective Carbon Rates

	Instrument definition	Instrument examples	Composite indicator
Carbon tax	All taxes for which the rate is explicitly linked to the carbon content of the fuel or where the tax is levied directly on GHG emissions (irrespective of whether the resulting carbon price is uniform across fuels and GHG.)	Most countries administer explicit carbon taxes in the same way as fuel excise taxes (e.g. France, Sweden). Countries that follow this fuel-based approach do not actually tax CO_2 directly, but rather calculate the corresponding rate in common commercial units, for instance by reference to kilograms for solid fuels, litres for liquid fuels, and cubic metres for gaseous fuels. Fuel-based carbon taxes are often levied as a component of fuel excise taxes. There are a number of countries that tax GHGs directly. Countries that pursue such an emissions-based approach include Chile, Estonia, Latvia and South Africa.	Component of both Effective Carbon Rate (ECR) and Effective Energy Rate (EER)
Fuel excise tax	All excise taxes that are levied on fuels and that are not carbon taxes.	Almost all countries tax gasoline and diesel used for road transport. The tax rate is typically specified per litre or gallon of fuel.	Component of both ECR and EER
Electricity excise tax	All excise taxes that are levied on electricity.	Mandatory for residential and commercial electricity use in the European Union. Often specified per kWh of electricity end use.	Component of EER only
ETS permit price	The price of tradable emission permits in mandatory emissions trading and cap-and-trade systems representing the opportunity cost of emitting an extra unit of CO_2e., regardless of the permit allocation method,	Emissions trading systems are most commonly used for larger emitters from the power and industry sectors and are e.g. in operation in Québec and California, the European Union, and China.	Component of ECR only

Note: Taxes are defined as compulsory, unrequited payments to the general government or to a supranational authority (OECD, 2021[4]). Excises are taxes levied as a product specific tax on a predefined limited range of goods (OECD, 2020[5]).
Source: (OECD, 2022[6]).

[4] In addition to CO_2 emissions, the 2022 edition of TEU covers Methane (CH_4), Nitrous oxide (N_2O), Fluorinated gases (F-gases), which include hydrofluorocarbons (HFCs), perfluorocarbons (PFCs), and sulphur hexafluoride (SF_6).

8. The most widely used aggregate indicator of the TEU/ECR database is the ECR – the sum of fuel excise taxes, carbon taxes and ETS permit prices.[5] Fuel excise and fuel-based carbon taxes – which are typically specified in various physical units, such as litre or kilogrammes – are converted into tax rates per tonne of CO_2e based on the carbon content of the fuels on which they apply. Emissions-based carbon taxes and emissions permit prices do not need to be converted since they are usually specified per tonne of CO_2e.[6] Electricity excise taxes generally do not treat fossil fuels in a differential manner compared to other clean sources and are therefore excluded from the ECR indicator (OECD, 2019[1]).

9. Another relevant aggregate indicator is the Effective Energy Rate (EER), which adds electricity tax rates to the components included in the ECR indicator.[7] The EER indicator is expressed per gigajoule (GJ) based on the energy content of the products on which they apply because electricity taxes also apply to energy sources that do not emit CO_2, such as hydro, wind and solar, as well as nuclear. This approach allows tax rates to be aggregated across all energy sources and energy uses.

10. The ECR captures carbon price signals (resulting from taxes and emissions trading systems), whereas the EER measures energy price signals (resulting from the ECR components plus electricity taxes). Tax policy instruments included in the ECR and EER indicators are rarely directly applied to the actual emitters, but typically levied on fuel suppliers.[8] Therefore, final energy users are exposed to price signals captured by the ECR and EER indicators to the extent that these costs are passed through to them. Although evidence on pass-through is fragmented and mixed, there are indications that pass-through is high when competition is strong and supply is elastic. In addition, pass though tends to be stronger in the case of tax rises than tax cuts (Alm, Sennoga and Skidmore, 2009[7]; Harju et al., 2022[8]; Benzarti et al., 2020[9]; Marion and Muehlegger, 2011[10]).

11. The TEU/ECR database accounts for tax exemptions, reductions and refunds, which are pervasive in energy tax systems. Frequently, energy users or GHG emitters enjoy preferential treatment that effectively reduces prices on energy or emissions. Prices measured by the TEU/ECR database are adjusted accordingly, irrespective of whether countries report such policy measures as tax expenditures – a different approach from the Inventory (see next section).

12. The TEU/ECR database focuses on pricing instruments that specifically apply to a base defined by energy use or GHG emissions and therefore excludes taxes and fees that are only partially correlated with energy use or GHG emissions. Common examples of policy instruments that fall outside the scope of TEU include vehicle purchase taxes, registration or circulation taxes, and taxes that are directly levied on non-GHG emissions, such as the Danish tax on SO_X. Some countries also apply production taxes on the extraction or exploitation of energy resources (e.g. severance taxes on oil extraction). Since such supply-side measures are not directly linked to domestic energy use or emissions, the TEU/ECR database does not cover these taxes either.

[5] In the ECR database, taxes and emissions permit prices are mapped to the emissions base they apply to using highly disaggregated data on GHG emissions. To give an example, if a firm benefits from a reduced tax rate because it is subject to the EU ETS, the ECR (for one tonne of CO2e emitted by this firm) would be the sum of the reduced tax rate and the ETS permit price. The ECR can then be aggregated to different levels to e.g. calculate the emissions-weighted average ECR at the country level (OECD, 2022[6]).

[6] Where this is not the case, as for certain F-gas taxes, CO_2-equivalent rates are calculated using the best available information.

[7] Taxing Energy Use for Sustainable Development (OECD, 2021[3])was the first publication to include permit prices resulting from emissions trading system in this indicator.

[8] This is different for emissions trading systems (and emissions-based carbon taxes), where it is usually the regulated entities who need to remit emission permits (also called allowances) for the greenhouse gas emissions of their facilities.

13. Similarly, the TEU/ECR database does not include value added taxes (VAT) or sales taxes. As VAT in principle apply equally to a wide range of goods, they do not change the relative prices of products and services – i.e. they do not make carbon-intensive goods and services more expensive than cleaner alternatives. In practice, differential VAT treatment and concessionary rates may target certain forms of energy use, thereby encouraging their consumption (OECD, 2015[11]). However, quantifying the effects of differential VAT treatment is outside the scope of the TEU/ECR database as such an exercise would entail extensive price information, which is generally not available for all energy products.[9] Reduced VAT rates, zero-ratings or exemptions are noted where relevant and data are available.[10]

14. Finally, neither ECR nor EER has traditionally accounted for government measures that decrease pre-tax prices of energy products – e.g. budgetary transfers to fuel suppliers. Focussing on a subset of developing countries, Taxing Energy Use for Sustainable Development (OECD, 2021[3]) has pioneered an approach to calculate the extent to which such measures lead to negative carbon prices (hence affecting ECR) or negative energy prices (hence affecting EER). Expanding this exercise to OECD and partner economies is possible by relying on the detailed information on budgetary transfers in these countries that can be found in the OECD Inventory of support measures for fossil fuels, which is discussed in the next section.

2.2. The OECD Inventory of Support Measures for Fossil Fuels

15. The OECD Inventory of support measures for fossil fuels identifies (hereafter “the Inventory”) documents, and estimates government measures that provide a benefit or preference for fossil-fuel production or consumption relative to alternatives (OECD, 2015[12]). Its primary objective is to enhance transparency by casting a wide net on such public policies, which may result in more production and consumption of fossil fuels than absent government intervention. The Inventory should be considered a tool for policy makers to identify potentially distortive support measures – the first step of a sequential approach to reform fossil fuel support (Elgouacem, 2020[13]). It does not provide an analysis of the effects of covered measures on prices and quantities and does not assess whether they are inefficient, encourage wasteful consumption, or are environmentally harmful (OECD, 2015[12]). Rather, it allows a stocktaking of individual support measures that invites assessment of their relevance and the extent to which alternative, more efficient, equitable and environmentally-friendly measures could potentially meet intended policy objectives (OECD, 2021[14]). In its latest version, it includes around 1 300 measures in 50 OECD countries and selected partner economies (OECD, 2022[2]).

16. While support measures for fossil fuels can take many forms depending on their incidence and their transfer mechanism (Table A A.1), the Inventory currently covers budgetary transfers and tax expenditures because of data availability. The primary data sources are official government documents such as budget reports and reviews, public accounts, and budget statistics. Such documents typically report budgetary transfers and tax expenditures – with a varying degree of estimation quality and coverage – but hardly any other forms of support.[11] Therefore, the Inventory essentially covers (for now) the first two

[9] In addition, given that TEU and ECR take a territorial approach to emissions and energy accounting, adding information on a destination-based tax such as VAT is not straightforward (e.g. for export-based industries).

[10] Import tariffs are not included, but similar to VAT and sales taxes, they may affect relative prices of energy products to the extent that they do not apply widely to other goods.

[11] One exception is price support through market regulation, which mandates producers to sell their fuel at a lower than the opportunity-cost price (UNEP, 2019[23]). Such regulations are generally well documented in official government documents published by regulatory agencies. This type of support is sometimes compensated by budgetary transfers to producers, in which case it is captured by the Inventory. When it does not – a situation that

rows of Table A A.1, with the addition of certain elements from rows three and four such as royalty reductions and government buffer stocks (OECD, 2015[12]).

17. Budgetary transfers are generally well documented and estimated in budget reports, revised on a budget cycle, and subject to legislative scrutiny (Elgouacem, 2020[13]). Such policies are therefore easy to compile in an inventory of support measures. They are also internationally comparable as they are estimated by the corresponding amount of direct spending programmes. They are a reliable source of information that can be directly exploited from the Inventory.

18. By contrast, the quality of tax expenditure estimations reported in official documents is of a varying degree because tax expenditures undergo less scrutiny than direct spending programmes (Elgouacem and van Dender, 2019[15]). Some countries report detailed estimates of their support measures through tax expenditures while others provide (almost) no information.[12] In addition, cross-country and over-time comparisons of tax expenditures are challenging for several reasons. First, countries estimate tax expenditures from specific tax provisions against their own benchmark tax system. As benchmarks vary across countries and over time, it is difficult to correctly interpret factors driving cross-country and over-time variation in tax expenditures.[13] Second, countries have diverging accounting and budgetary approaches to tax expenditures. Certain countries consider lower tax rates on a subset of fuels – typically lower excise tax rates – as a reduction of tax liability but others consider them as tax differentiation on different products or economic activities.

19. Tax expenditures included in the Inventory are typically provided through lower tax rates, exemptions, or rebates on value-added taxes (VAT) and excise taxes. Tax expenditures are usually targeted towards: i) specific groups of consumers; ii) specific types of fuel; iii) specific use of fuels (OECD, 2015[12]). For instance, residents of regions deemed economically disadvantaged can benefit from lower taxes on their fuels use. Or, as observed in the transport sector in many countries, diesel fuel can benefit from a lower tax rate relative to gasoline. Finally, some tax rebates can also be applied if fuels are used for specific activities such as trucking, commercial aviation[14], farming, fishing, forestry, maritime transport and mining.

generally arises in countries not covered by the Inventory – it may be included in TEU/ECR dataset, which covers more than 70 countries as of 2022.

[12] Nevertheless, the majority of measures the Inventory documents are tax expenditures (60% of total support by USD value). In some countries, all reported support takes this form.

[13] That said, tax expenditures reported by countries still represent a revenue loss estimation based on their own objective function – i.e. given each country's circumstances and preferences (Elgouacem and van Dender, 2019[15]). Cross-country comparisons of reported tax expenditures are therefore comparisons of what countries consider to be revenue losses from tax provisions, which are evaluated as deviations from countries' benchmark tax system. The latter is assumed to be the appropriate reference to conduct such estimations. See (Elgouacem and van Dender, 2019[15]) for a discussion.

[14] Domestic use of aviation fuels is sometimes taxed but tax exemptions and reduced rates are widely applied. Fuel or carbon taxes generally do not apply to international aviation. In contrast to what is often suggested, taxing fuels for international flights is not as such ruled out by the Chicago convention, but it will in many cases require renegotiating bilateral air service agreements (Teusch and Ribansky, 2021[24]).

Box 2.1. The price-gap approach to measure government support for fossil fuels

The IEA approach to estimate fossil fuel subsidies

The International Energy Agency (IEA) relies on a "price-gap" approach to estimate fossil fuel subsidies. It calculates the gap between the average final consumer price for a given fuel and its reference price, which is the full cost of supply or, where appropriate, the international market price, adjusted for the costs of transportation and distribution and value-added tax (IEA, 2014[16]). The value of fossil-fuel subsidies is estimated as such a price gap multiplied by the volume consumed (for each fuel in each sector). A price gap can be created through various government interventions including price controls or direct budget transfers (such as grants) that result in (end- or intermediate) users paying prices below market levels. The main advantage of the price-gap approach is that it avoids the need to compile detailed information on different types of government intervention by focusing on the combined net effects on prices (IEA, 2014[16]). The principal drawback is that it captures only interventions that collectively result in final prices lower than those that would have prevailed in a competitive market (Koplow, 2009[17]). Therefore, it does not directly identify individual measures that lead to the price gap. Such information is, however, crucial for reforming such policies. In addition, the price gap approach will fail to properly identify the price effect of measures that not (only) affect domestic prices, but equally lower reference prices.

There is little overlap between the OECD Inventory and the IEA fossil fuel subsidies database because the country coverage of the two datasets is different (OECD, 2018[18]). Most OECD countries do not apply price controls on fossil fuels and tend to charge consumer taxes that result in domestic prices higher than the reference prices considered by the IEA. Therefore, most OECD countries are excluded from the IEA dataset. Since 2018, a joint IEA-OECD estimation of fossil fuel support has been released annually and covers 81 economies (in its 2022 version) – see (OECD, 2018[18]) for more details.

The IMF approach to estimate fossil fuel subsidies

The International Monetary Fund (IMF) distinguishes between explicit and implicit fossil fuel subsidies (Parry, Black and Vernon, 2021[19]). Similar to the price-gap approach of the IEA, the explicit subsidy is defined by the difference between a reference price (called unit supply cost) and the price effectively paid by fuel users, multiplied by the volume consumed. The implicit subsidy is accounted for by non-priced environmental costs and non-applied general consumption taxes. In their framework, the IMF considers environmental costs to include global climate and local outdoor ('ambient') air pollution damages, and traffic congestion and accidents due to the use of road fuels. General consumption taxes is assumed to be set in accordance to standard IMF guidance and to apply the same value added tax – or other forms of general consumption taxes – to all household products in order to avoid distorting relative consumer prices.

Because they include many types of externalities, the IMF estimates of fossil fuels subsidies are typically larger than the OECD and IEA estimates. The IMF estimated that fossil fuel subsidies amounted to USD 5.9 trillion in 2020 (Parry, Black and Vernon, 2021[19]). Although the country coverage differs slightly, the OECD-IEA jointly estimated that amount be USD 351 billion.

Source: (IEA, 2014[16]); (OECD, 2018[18]); (Parry, Black and Vernon, 2021[19])

3 Incorporating pre-tax support measures into the OECD series on Carbon Pricing and Energy Taxation

20. As explained above, while the ECR and EER indicators account for tax exemptions, reductions and refunds pertaining to the instruments covered in the TEU/ECR database,[15] they do not incorporate direct budgetary transfers that decrease pre-tax energy prices – with the exception of countries covered by Taxing Energy Use for Sustainable Development (OECD, 2021[3]). That is, while tax expenditure measures covered by the Inventory are already integrated in the TEU/ECR framework, direct budgetary transfers are not.

3.1. Integrating budgetary transfers from the Inventory into the TEU/ECR framework

21. Direct budgetary transfers to fossil fuel suppliers or fossil fuel end users can be assumed to decrease pre-tax fossil fuel prices domestically if they increase proportionally with fossil fuel use. A typical example are budgetary transfers that compensate fuel suppliers for providing fossil fuels at prices that are regulated below market levels (Box 3.1 provides examples of measures that were integrated in the TEU/ECR database). They effectively reduce pre-tax fossil fuel prices. As a reduction in per unit fossil fuel prices automatically translates into a price reduction of CO_2 emissions resulting from their use, such measures can be considered negative carbon prices – similar to the way fuel excise taxes are expressed as positive carbon prices in the ECR indicator (see above).[16]

22. Such support measures can be integrated into the TEU/ECR framework to construct effective carbon rates net of pre-tax support measures (Table 3.1). The Inventory provides estimates of direct budgetary transfers and information that allows for the identification of their beneficiaries. Transfers can therefore be mapped to the amount of energy consumed by their ultimate beneficiaries (assuming pass-through to domestic energy end users) and to the associated CO_2 emissions – using the energy base information from the TEU/ECR database (which in turn relies on the IEA's Extended World Energy Balances). Dividing the monetary value of a given budgetary transfer by the amount of emissions for which

[15] That is, carbon taxes, excise taxes on fuels, taxes on the consumption of electricity, and permit prices on emissions subject to emissions trading systems.

[16] The assessment as to whether the FFS measures decrease domestic pre-tax fossil fuel prices was primarily made based on the 'long description' of the measure that is publicly available as measure metadata on OECD.stat, complemented by desk research where necessary.

it effectively decreases pre-tax prices yields a rate per tonne of CO_2. This rate, effectively a negative carbon price, is then used to calculate the Net ECR indicator, i.e. the ECR minus the CO_2-equivalent of pre-tax fossil fuel support. The Net ECR is thus defined in the same unit and mapped onto the same base as the ECR.

Table 3.1. Classification of FFS and correspondence in TEU/ECR framework

	Classification of FFS measure	Definition in TEU/ECR framework	Mapping to TEU/ECR base	Composite indicator	Unit
Pre-tax fossil fuel support ("fossil fuel subsidy" in Taxing Energy Use 2022)	Budgetary transfer to fuel supplier or fuel end user (if it increases proportionally with fossil fuel use)	Negative carbon price resulting from fossil fuel support that lowers pre-tax prices domestically	Mapped to all domestic energy use directly affected by measure (measured in tonnes of CO_2 for the ECR dataset and in joules in the EER dataset).	Component of Net ECR and Net EER indicator	Currency per tonne of CO_2 (Net ECR) and Currency per GJ (Net EER)
Pre-tax electricity support ("electricity subsidy" in Taxing Energy Use 2022)	Budgetary transfer to electricity supplier or electricity end user (if it increases proportionally with electricity use)	Negative electricity tax resulting from pre-tax electricity support	Mapped to all domestic energy use in TJ directly affected by measure	Component of Net EER indicator	Currency per GJ (Net EER)
Out of scope	Budgetary transfers for which the impact of the measure on domestic energy prices is not tractable, e.g. because it does not increase proportionally with domestic energy use.	-	Implicitly assumed to not affect domestic energy use and levels of emissions	-	-

Source: Authors

23. The Inventory also records information on budgetary transfers to electricity suppliers or electricity end users. Such budgetary transfers lower pre-tax prices of electricity from both fossil and non-fossil energy sources and do not change relative prices in favour of any source of power generation (Box 3.1). As with electricity taxes, they are therefore not included in the Net ECR and only included in the Net EER.[17]

24. Two types of budgetary transfers recorded in the Inventory were not incorporated into TEU and ECR. First, measures for which the impact on domestic energy prices is not tractable. This includes budgetary transfers that benefit production factors such as labour, land and natural resources (other than energy sources), capital, knowledge and R&D, which may indirectly affect energy prices; and budgetary

[17] The Inventory takes a different approach and rather deducts the amount of budgetary transfers that is assumed to benefit non-fossil fuel users based on the electricity generation mix. To allocate budgetary transfers that include non-fossil energy sources to the TEU tax base, these amounts were therefore reinstated.

transfers to energy users that do not increase proportionally with domestic energy use and levels of emissions. Budgetary transfers for infrastructure development including, for example, rural electrification are equally excluded. Second, very small budgetary transfers corresponding to less than 0.001% of domestic GDP were excluded to keep the analysis manageable.

25. In total, 73% of the amount of budgetary transfers recorded in the Inventory for the 45 countries covered in both the Inventory and the TEU/ECR framework were incorporated in the latter (Table 3.2). Approximately 54% of the amount of budgetary transfers included in the Inventory for 2018 were classified as pre-tax fossil fuel support and were therefore included in both Net ECR and Net EER indicators. An additional 19% of budgetary transfers were classified as pre-tax electricity support – i.e. they did not change relative prices of power generation sources – and were included in the Net EER indicator only.

Table 3.2. Share of budgetary transfers from the Inventory incorporated in TEU and ECR in 2018

	Support estimate in nominal billion USD (Inventory)	% classified as pre-tax fossil fuel support (included in both Net ECR and Net EER)	% classified as pre-tax electricity support (included in Net EER only)	% mapped in total
Budgetary transfers classified as consumer support estimates in the Inventory	54.47	60%	24%	84%
Budgetary transfers classified as producer support estimates in the Inventory	9.28	50%	0%	50%
Budgetary transfers classified general services support estimates in the Inventory	6.07	5%	0%	5%
Total budgetary transfers recorded in the Inventory	69.81	54%	19%	73%

Note: Budgetary transfers were summed up over the overlapping sample of 45 countries covered by the Inventory and the TEU/ECR framework – i.e. 37 OECD countries (Costa Rica is not yet covered in the Inventory), 7 non-OECD G20 members (Saudi Arabia is not covered in either Inventory or TEU/ECR), and Ukraine. The report is based on data and information that pre-date the war that began with Russia's offensives into government-held territories in Ukraine in February 2022.
Source: Authors.

26. In the Inventory, budgetary transfers are further broken down into consumer support, producer support, and general services support. Approximately 84% of budgetary measures classifying as consumer support – the vast majority of budgetary transfers – were incorporated in the TEU/ECR framework (Table 3.2). Only 50% of producer support measures could be included in TEU/ECR framework as their impact on domestic energy prices is often hard to quantify – which is necessary to calculate their negative carbon price equivalent. Finally, budgetary transfers that are classified as general services support in the Inventory are generally out of scope of this exercise because they do not affect energy prices directly.

Box 3.1. Examples of pre-tax support measures that were incorporated in TEU/ECR based on the Inventory

Pre-tax fossil fuel support:

The principal form of pre-tax fossil fuel support that was integrated in TEU and ECR is classified as **consumer support estimates** (CSE) according to the Inventory (Box 3.1). Examples of such support measures include the following:

- The "Winter Gas Concession" is the State of Victoria, **Australia**: The concession provides eligible concession cardholders with a 17.5% discount on their natural-gas bills.
- The "Heating Allowance for Households for Space Heating Purposes" in **Greece**: This measure provides support to Greek households to cover part of their residential heating costs. Eligible households must meet certain income and asset criteria and the allowance is conditional on fuel use.
- The "Compensation for Below-Market Prices for Premium, Solar, LPG and Kerosene" in **Indonesia**: The Indonesian government has set the retail prices for premium (motor gasoline), solar (diesel fuel), and kerosene below corresponding market price levels since 1967. In order to compensate state-owned Pertamina for the losses the company incurs as a result of the lower selling prices, the government regularly provides direct financial compensation to the downstream operator.
- "Coal Aid to Poor Families" in the **Republic of Türkiye**: A significant number of households burn lignite for heating purposes. Coal is supplied by Turkish Coal Enterprises (TKI) and Turkish Hard-Coal Enterprises (TTK) and distributed by local governments. The Undersecretariat of Treasury funds the programme within duty loss payments.

Sometimes measures classified as **producer support estimates** (PSE) also directly affect relative prices for domestic fossil fuel use:

- The "Diesel Fuel Differential Price for Public Transport" in **Argentina:** The government has reached agreements with oil refining companies to ensure the supply of diesel fuel at an agreed (lower than the market) price to public passenger transport companies. These companies have received a compensation for the corresponding decrease in revenues.
- "Operating Aid to Coal Producers" in **Spain**: Price support to domestic coal producers to compensate them for the difference between their operating costs and the prices at which they sell their output to local power plants, which are negotiated directly.

General services support estimates (GSSE) typically do not affect relative prices for domestic fossil fuel use.

- The exception is the "Financial Aid for Natural Gas Distribution Through Networks" in **Argentina** that established financial support aimed at offsetting the lower revenues earned by natural gas network distribution companies (as a result of the benefits granted to consumers in compliance with current gas rates regulations) and the higher costs of compressed natural gas as compared to those established in gas rates.

Pre-tax electricity support:

CSE are the only form of support incorporated as pre-tax electricity support in TEU/ECR (Box 3.1).

- As is the case for petroleum fuels, the **Indonesian** government sets electricity prices for all consumer types (i.e. households, industries, and commercial and government services). The government provides the state-owned electricity operator an annual compensation for the losses the company incurs as a result of the lower selling prices. The amounts for this compensation are recorded in the government budget under "electricity subsidies" and are equivalent to the difference between the subsidised retail prices and the average cost of power generation.
- In **Mexico** pre-tax electricity support results from direct transfer by the federal government to the cover part of the electricity that are lower than production costs.

Source: Authors

27. In total, a sample of 45 countries resulted from the integration of budgetary transfers included in the Inventory into the TEU/ECR framework – i.e. the overlapping sample of countries covered by the Inventory and the TEU/ECR framework. This sample includes 37 OECD countries (Costa Rica was not yet covered by the Inventory), 7 non-OECD G20 members (Saudi Arabia is not covered in either Inventory or TEU/ECR), and Ukraine. A list of countries is provided in Annex B.

3.2. Assumptions and caveats

28. Unlike the rates of the components of the standard ECR (and EER), negative carbon prices (and negative electricity taxes) are generally not directly observed and need to be estimated. Rates from energy or carbon taxes are directly specified by the government. In the case of emissions trading systems, rates are observed in the market. By contrast, negative carbon prices and negative electricity tax rates need to be estimated using the information on budgetary transfers.

29. To be consistent with the TEU/ECR framework, only budgetary transfers that modify the marginal carbon rates and marginal electricity tax rates are considered for this exercise – i.e. transfers that are proportional to energy consumption. Information from the description of the measures found in the Inventory enables validation of this assumption by verifying that that such proportionality is found in practice. Only measures that pass this test are incorporated in the TEU/ECR framework.

30. If the mapping of a support measure to the corresponding energy use is not precise, the resulting negative carbon price or negative electricity tax will not be correct. However, at higher levels of aggregation – e.g. at the sector or country-level – such imprecise mapping will often be averaged out. For example, if a budgetary transfer that only benefits natural gas used for heating by low-income households is allocated to all residential natural gas consumption, the resulting negative carbon price would be underestimated for low-income households, and overestimated for residential natural gas users that do not actually benefit from the transfer. Nevertheless, the emissions-weighted negative carbon price for all residential natural gas users would still be consistent with the budgetary transfer.

31. In the common case where budgetary transfers are not directly paid out to energy end users, it is assumed that they are fully passed through to them. This is consistent with the assumptions on pass-through made for energy and carbon taxes, which are also typically not directly levied on energy end users as discussed above.

4 Estimating pre-tax support in countries not covered by the Inventory

32. Original data collection on relevant pre-tax support measures is required for the set of countries included in the TEU/ECR database that are not in the Inventory – which only covers OECD countries, G20 countries and EaP partner economies. Such measures were first integrated in the TEU and ECR framework in the *Taxing Energy Use for Sustainable Development* report, which focused on 15 developing and emerging economies (OECD, 2021[3]). *Taxing Energy Use and Effective Carbon Rates 2022* cover 71 countries in total, 26 of which are not covered in the Inventory (see Annex B). The 26 countries are Burkina Faso, Bangladesh, Costa Rica, Côte d'Ivoire, Cyprus, Dominican Republic, Ecuador, Egypt, Ethiopia, Ghana, Guatemala, Jamaica, Kenya, Kyrgyz Republic, Madagascar, Malaysia, Morocco, Nigeria, Panama, Paraguay, Peru, Philippines, Rwanda, Sri Lanka, Uganda, Uruguay.[18]

33. The support measures that fall within the scope of the exercise as explained above are identified and quantified relying to the extent possible on budgetary transfers recorded in official government documents, emulating the Inventory approach. As for countries covered by the Inventory, pre-tax support measures are then mapped to the energy use of their beneficiaries. Measures are again either classified as pre-tax fossil fuel support or as pre-tax electricity support.

34. To the extent possible, pre-tax support is estimated using official government data on budgetary transfers. However, if no quantitative data on budgetary transfers are available, but policy measures that amount to pre-tax fossil fuel or electricity support were in place, the price-gap approach detailed in Box 2.1 is exceptionally used as a proxy for the unidentified budgetary transfer. This was for instance necessary for Ecuador in 2018 and 2020, as well as for Madagascar and Nigeria in 2018 where no data could be obtained on how the deficit for fuel suppliers was compensated. Another case is the Kyrgyz Republic, where electricity tariffs are set below the cost of generation, and the corresponding amount of pre-tax electricity support was estimated by using IMF price gap data.

35. Many countries have price stabilisation funds that are designed to protect energy users from oil price fluctuations. They typically charge contributions during periods of low international oil prices and use these funds to lower prices when oil prices are high. Deficits in price stabilisation funds are considered a form of pre-tax support. On a given year, pre-tax support is recorded in TEU/ECR database if the fund experienced losses while nothing is recorded if the fund is in excess.[19]

[18] Table A B.1 in Annex B provides the list of countries included in the TEU/ECR database but not in the Inventory.

[19] In Peru, the Fuel Prices Stabilization Fund (*Fondo para la Estabilización de Precios de los Combustibles Derivados del Petróleo - FEPC*), created in 2004, sets price bands to prevent the high volatility of international oil prices from being transferred to Peruvian consumer prices. In absence of data on aggregated yearly balances of the fund, fossil fuel support recorded in TEU and ECR are currently the average of per unit value of compensation fixed by the Fuel

Box 4.1. Examples of pre-tax support measures in non-Inventory countries

Examples of pre-tax fossil fuel support

Ethiopia

Several mechanisms are in place to lower the cost of petroleum products, which are sold below their cost. In particular, a fuel price stabilisation fund was established in 2001, has been in deficit since 2016/2017. The losses of the fuel price stabilisation fund for 2018/2019 and 2020/2021 have been allocated to all domestic energy consumption of gasoline, biogasoline, naphtha, kerosene, diesel, jet fuel and fuel oil. Due to data constraints, the losses were allocated proportionately to the energy base of each fuel, i.e. one GJ is subsidised equally independently of the petroleum product combusted to produce it. *Malaysia*

After elimination in December 2014, pre-tax fossil fuel support was reintroduced in June 2018 for all consumers of gasoline (RON95) and diesel. Petroleum subsidies were significantly lower in 2020 due to the continued decline in global crude oil prices following the global economic uncertainty caused by the COVID-19 outbreak. Fuel subsidies are also in place for LPG and fishing vessels. The amount of fishing fuel subsidies has been allocated separately to all the gasoline and diesel consumption reported for fishing. The total amount of subsidies, less specific fishing subsidies, was equally allocated across all diesel and gasoline consumption reported, except diesel used for electricity generation and RON 97 consumption. LPG subsidies were allocated across all residential LPG consumption.

Morocco

The price of LPG (butane) is regulated and the state compensates importing companies and filling centres for the difference against import prices while it also reimburses transport costs. A per unit (kg) subsidy for LPG has been computed by allocating the total amount of the subsidy across all consumption of LPG (including agriculture, industry, residential, commercial and public services) using the 2018 IEA Energy Balances.

Examples of pre-tax electricity support

Nigeria

Electricity end-user tariffs that distribution companies are allowed to charge their customers fall short of cost-reflective tariffs. According to the updated Power Sector Recovery Plan (PSRP) a transition to full cost recovery is envisaged by end of 2021 and the federal government is covers the shortfall in the interim. The shortfall in electricity tariffs is modelled as a negative electricity tax across all electricity consumption without distinguishing between users due to consumption data constraints.

Panama

Two funds – the *fondo de estabilización tarifaria* (*FET*) and the *fondo tarifario de occidente* (*FTO*) - help to stabilise prices, and are financed by the government. The government transfer was allocated across all electricity consumption from households and commercial sectors.

Source: (OECD, 2022[6])

price stabilization fund as of the first day of each month in 2018 and 2020 according to data from the Ministry of energy and mines. No data were recorded for 2020, as the fund in average levied more in contribution than it paid out in support.

5 Applications

5.1. Tracking effective carbon prices net of pre-tax fossil fuel support

36. The Net ECR adds value to the OECD series on Carbon Pricing and Energy Taxation as it allows to further broaden the scope of policy instruments that are being tracked and provides more accurate estimates of effectives prices because these indicators are net of pre-tax fossil fuel support. This section briefly discusses how negative carbon prices from pre-tax fossil fuel support have enriched some of the popular summary indicators of the series:

- **Share of GHG emissions subject to a positive Net ECR, in %**: Traditionally this indicator tracked the share of energy-related CO_2 emissions that were subject to positive forms of carbon pricing (ETS permit prices, carbon taxes and fuel excise). In the latest report, titled Pricing *Greenhouse Gas Emissions* (OECD, 2022[6]), an extended version of the indicator also tracks the share of emissions that is subject to a positive Net ECR, thus accounting for pre-tax fossil fuel support.[20] Results are broken down by policy instrument, enabling assessment of progress achieved through the use of individual policy instruments as well. The indicator is equally available for carbon pricing benchmarks other than zero and can e.g. be used to assess for which share of emissions the Net ECR is at least EUR 60 per tonne of CO_2e (tCO_2e) - a mid-range estimate of current carbon costs (OECD, 2021[2]) (see also next Section).
- **Average effective carbon prices in EUR per tCO_2e:** The Net ECR indicator enables the calculation of average effective carbon prices net of pre-tax fossil fuel support at various levels of aggregation, e.g. at the country or sector level. This enables a comprehensive assessment of changes in price levels. The broad instrument coverage of the Net ECR database avoids misinterpretations such as reforms where positive changes (e.g. the introduction of a carbon tax) are offset by negative changes (the introduction of pre-tax fossil fuel support) but are mistaken for increased policy stringency.
- **Revenue potential from fossil fuel subsidy and carbon price reform:** The precise impact of phasing out pre-tax fossil fuel support and introducing positive carbon prices on public revenue will change over time and will depend on how fast the tax base erodes. Nevertheless, it is useful to provide some indication of how much revenue reforms could raise, at least in the short to medium term. Even if the revenues are not durable over time, they can play an important role in the period of transition. The Net ECR enables integration of the revenue potential of phasing out pre-tax fossil fuel support into revenue estimates of carbon price reform. These calculations account for behavioural responses drawing on recent OECD work that estimated the long-run responsiveness of CO_2 emissions from fossil fuel use to carbon pricing (D'Arcangelo et al., 2023[20]).

[20] The report additionally broadens the emissions base to all GHG emissions, hence going beyond energy-related CO_2 emissions.

5.2. Measuring fossil fuel support against an external benchmark

37. While fossil fuel support comes in many forms, they are usually provided through tax expenditures and budgetary transfers in OECD countries and partner economies (OECD, 2015[12]). In 2020, the overlapping sample of countries covered by the TEU/ECR framework and the Inventory – 45 countries in total – have provided USD 110.05 billion in the form of tax expenditures and USD 72.35 billion in budgetary transfers (Table 5.1).

Table 5.1. Fossil fuel support provided in 45 economies (in USD billion)

	2015	2016	2017	2018	2019	2020
Budgetary transfers	102.62	92.02	71.30	69.81	77.50	72.35
Tax expenditures	114.07	110.59	114.73	125.12	125.58	110.05
Total	216.69	202.61	186.03	194.93	203.08	182.40

Note: Fossil fuel support estimated for the overlapping sample of 45 countries covered by the Inventory and the TEU/ECR framework – i.e. 37 OECD countries (Costa Rica is not yet covered in the Inventory), 7 non-OECD G20 members (Saudi Arabia is not covered in either Inventory or TEU/ECR), and Ukraine.
Source: The OECD Inventory of support measures for fossil fuels.

38. As explained in Section 2, interpreting the amount provided through tax expenditures can be challenging because countries use different benchmark tax systems to estimate the revenue forgone through these measures. For instance, the forgone fiscal space associated with a tax concession on diesel fuel used for road transport is typically evaluated against the applied tax rate on gasoline, which is country specific.[21] As a result, even small deviations from high tax benchmark rates translate into large amounts of support and countries with ambitious climate policies seemingly provide much support, which complicates cross-country comparisons.[22]

39. To overcome this issue, benchmarks could be harmonised across (selected) countries by using a single reference price on carbon emissions[23] – following the approach used to track the share of emissions subject to a positive Net ECR (see above).

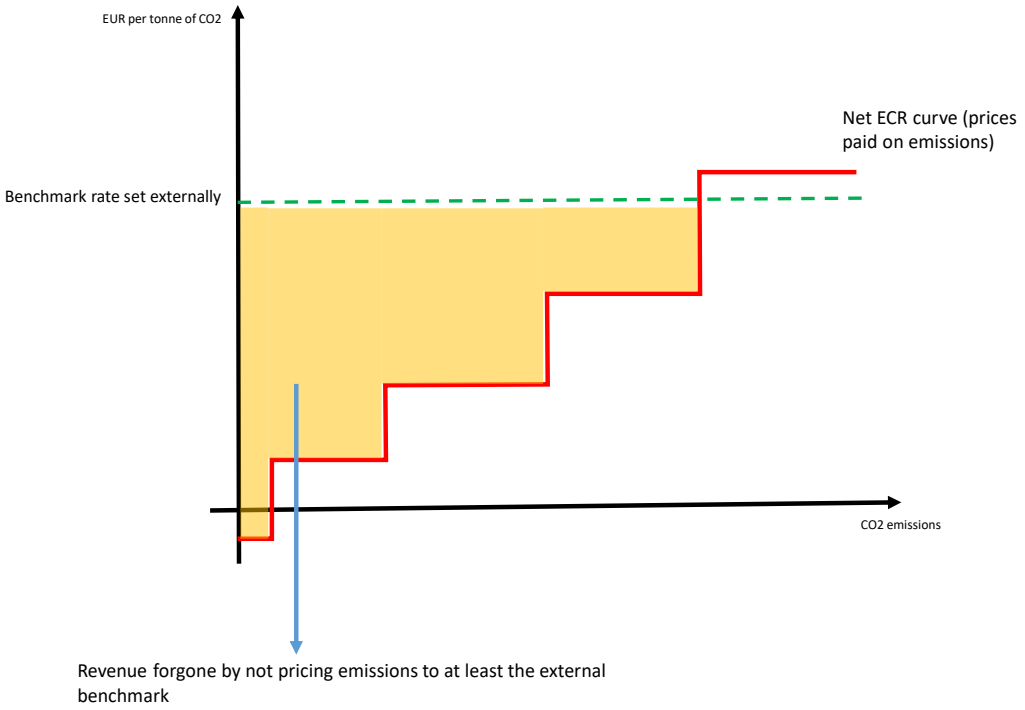
40. Revenue forgone by not pricing emissions to at least this external benchmark can be readily estimated using the Net ECR dataset. Abstracting from behavioural responses, it is the difference between actual revenues – calculated from prices paid along the entire emissions base, as provided by the Net ECR indicator – and potential revenues raised if all emissions were priced to at least the benchmark rate (Marten and van Dender, 2019[21]). In the fictitious example of Figure 5.1, the revenue forgone is the area between the external benchmark and the Net ECR curve.

[21] Some countries do not report it as tax expenditures at all considering that diesel and gasoline fuels are two different products subject to two different tax rates.

[22] However, as argued in Section 2, considering tax expenditures evaluated with countries' own benchmarks is still relevant to estimate the revenue forgone associated with these measures. The issue lies with cross-country comparability.

[23] This is not to say that all countries should adopt a uniform carbon price. According to the principle of common but differentiated responsibilities and respective capabilities (CBDR–RC) agreed in the Paris Agreement, the level of ambition to reduce carbon emissions can differ across countries. The underlying dataset would equally allow to calculate revenue foregone using benchmarks that are differentiated by country or region, e.g. based on the level of economic development.

Figure 5.1. Revenue forgone calculated against an external benchmark



Note: Illustrative example.
Source: Authors' elaboration.

41. The main advantage of such a methodological approach is its transparency and interpretability. For a given country, fossil fuel support is estimated from only three parameters – i.e. its emissions base, its net effective carbon rates on emissions and an external benchmark – which are factual data. Therefore, holding the external benchmark and the emissions base constant, observed variations in the amount of fossil fuel support can be traced back to variations in the Net ECR. The interpretation of such variations is straightforward: a decrease (resp. increase) in the amount of fossil fuel support corresponds to a progress (resp. a receding) towards the goal of pricing all energy-related CO_2 emissions from fossil fuels at a certain benchmark.

42. The main limitation of such a methodological approach is that it abstracts from behavioural responses. Increases in fuel taxation, carbon taxation, or tradeable emission permit prices (and therefore in Net ECR) are likely to result in changes in fuel consumption, which are not captured by these estimations since the emissions base is assumed to remain constant. However, behavioural changes can only be estimated by relying on assumptions about price elasticities of energy demand or carbon price elasticities. This might prove particularly challenging as such elasticities vary across countries and even across groups of users within countries. In addition, energy demand and carbon emissions are found to be (much) more inelastic in the short term than in the long term (Labandeira, Labeaga and López-Otero, 2017[22]).[24] Such

[24] The literature has estimated a price elasticity of energy demand in the short term of −0.21, and −0.61 in the long term (Labandeira, Labeaga and López-Otero, 2017[22]). The responsiveness to effective carbon rates equally varies across sectors. In three of the main sectors – road transport, industry and electricity – an ECR increase of EUR 10 reduces emissions by around 4%, even though the percentage *price* changes differ strongly. The responsiveness is

a result suggests that keeping the emissions base constant to estimate the revenue forgone is not a heroic assumption from a short-term perspective – and the only pragmatic option.

43. In sum, there is a trade-off between a simplified methodological approach that abstracts from these considerations and a comprehensive one that attempts to integrate such parameters. This paper takes the stance that the simplified approach is preferable for the purpose of fossil fuel support estimates.[25] This approach avoids the challenges around finding consensus on the appropriate elasticities that ought to be used. Last but not least, it is in line with general principles of tax expenditure reporting, which typically does not account for behavioural responses.

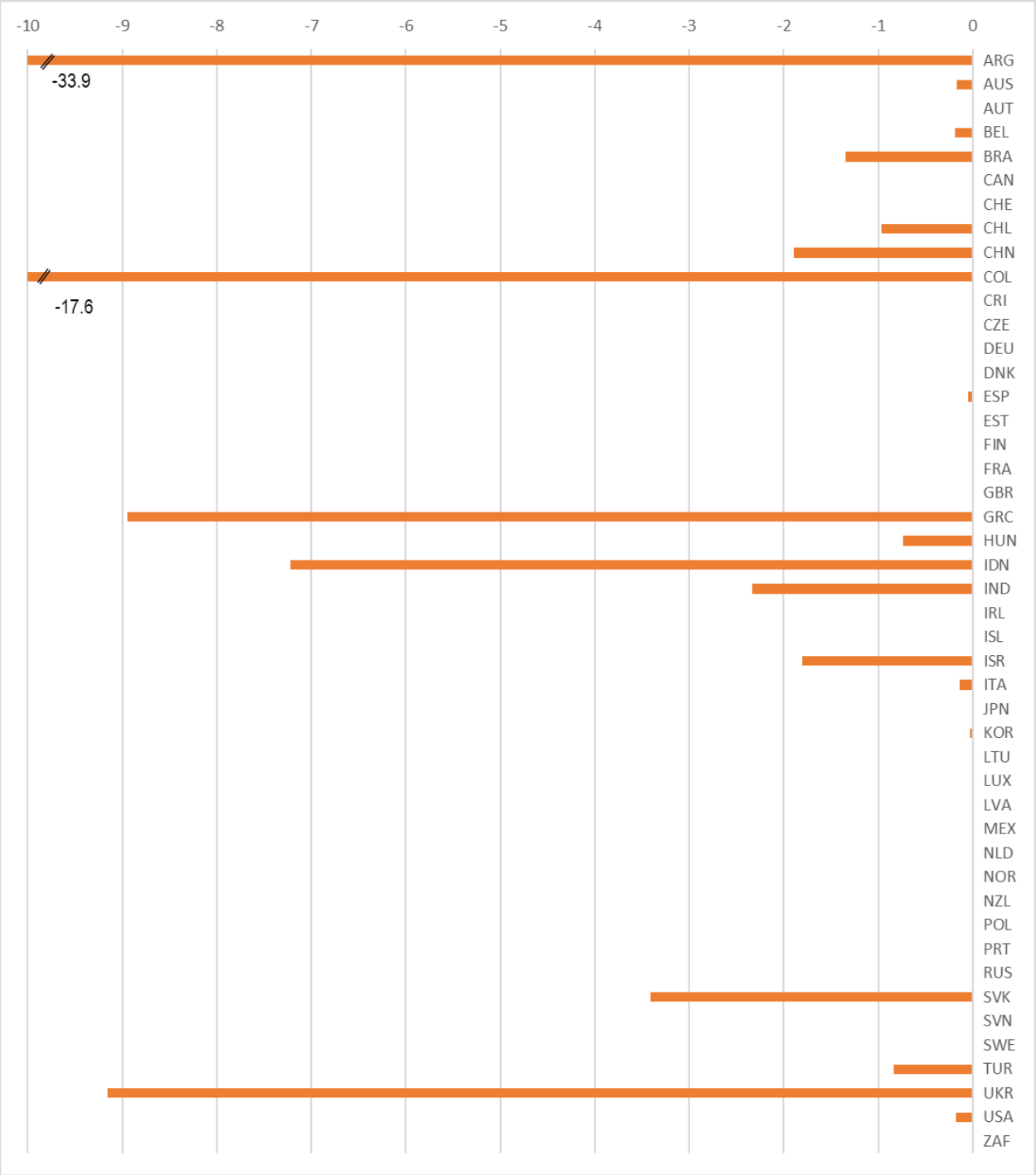
5.3. An initial analysis of the Net ECR indicator

44. In many countries, certain measures translate into a negative carbon price (Figure 5.2), which results in an average Net ECR indicator lower than the (traditional) ECR indicator. Such finding raises questions about the consistency of government policies to achieve climate goals. Measures that put a high price on carbon emissions – thereby aiming to reduce them – can be offset by other policies that benefit a subgroup of users who face low (or even no or negative) incentives to cut emissions.

much higher in the agriculture and fisheries sector. It is a bit lower than 4% for a EUR 10 increase in ECR in the buildings sector and zero in the offroad transport sector (D'Arcangelo et al., 2023[20]).

[25] By contrast, studies attempting to quantify the revenue potential of carbon price and subsidy reform would usefully account for behavioural responses using elasticities, as e.g. done in (OECD, 2021[3]).

Figure 5.2. Negative carbon prices in OECD and G20 in 2018 (EUR per tCO_2)

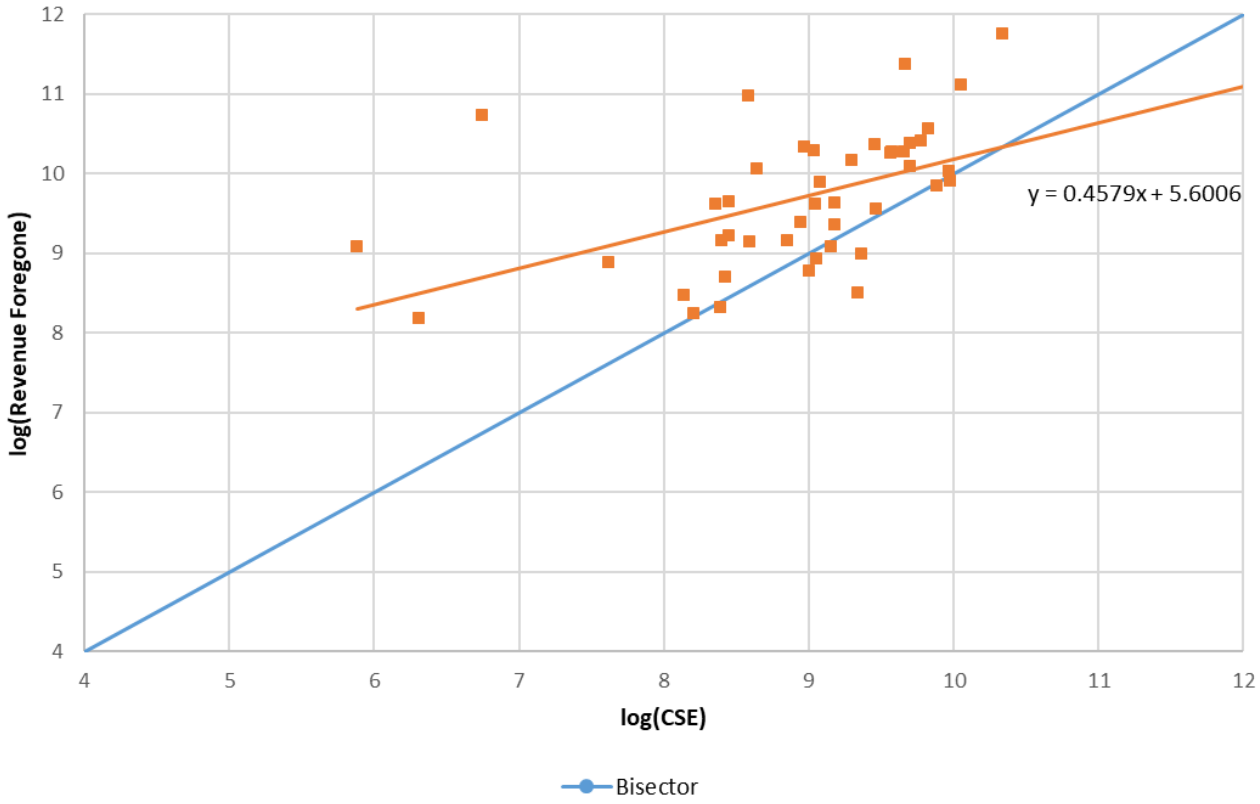


Note: Negative carbon prices account for direct budgetary transfers that decrease pre-tax fossil fuel prices. Positive carbon prices (not shown in the figure) account for the three different components of the ECR: fuel excise taxes, carbon taxes and tradeable carbon emission permits. They are expressed net of relevant exemptions, rate reductions and refunds, thereby accounting for tax expenditures resulting from such policy instruments. See Section 3 for methodological details.
Source: Authors' elaboration.

45. Next, there is a strong cross-country correlation between the revenue forgone estimated from the Net ECR indicator – as explained in Section 5.2 – and estimated amounts of consumer support provided by the OECD Inventory (Figure 5.3). In addition, the revenue forgone for not pricing all emissions at EUR

60[26] per tCO_2e is generally larger than the aggregate consumer support reported by the Inventory: most of the observations lie above the 45° line where the CSE equals the revenue forgone. This finding suggests that estimations of consumer support reported by governments (and therefore included in the Inventory) are an order of magnitude smaller than an estimation method that assumes a benchmark of EU 60 per tCO_2e. It is also likely to be driven by the fact that countries tend to only report selected rate reductions, refunds and exemptions as tax expenditures. As an illustration, the Inventory's aggregate consumer support in the 45 countries of the Inventory-Net ECR overlapping sample amounts to EUR 127 billion, while the revenue forgone with a carbon price benchmarked at EUR 60 is estimated to be EUR 1 383 billion.

Figure 5.3. Revenue forgone from Net ECR vs consumer support estimate of the OECD Inventory – cross-country correlation



Note: Revenue forgone estimated from the Net ECR indicator against an external benchmark of EUR 60 in 2018 – see Section 5.2. for an explanation. Consumer support estimates by country extracted from the Inventory for 2018. Estimations are for 44 countries: the overlapping sample of 45 countries covered by the Inventory and the TEU/ECR framework – i.e. 37 OECD countries (Costa Rica is not yet covered in the Inventory), 7 non-OECD G20 members (Saudi Arabia is not covered in either Inventory or TEU/ECR), and Ukraine – minus Iceland, which has a CSE of 0 in the Inventory.
Source: Authors' elaboration and (OECD, 2022[2]).

[26] The benchmark of EUR 60/tCO2e is a mid-range estimate of current carbon costs. See (OECD, 2021[2]) for a discussion.

6 Conclusions and outlook

46. Building on an approach pioneered in Taxing Energy Use for Sustainable Development (OECD, 2021[3]), this paper has developed a methodology to estimate effective carbon rates net of pre-tax FFS measures that can be considered negative carbon prices: the Net ECR. This exercise was made possible by combining two OECD databases: the Effective Carbon Rates and the OECD Inventory of Support Measures for Fossil Fuels. Negative carbon prices were estimated for 54% of the amount of budgetary transfers included in the Inventory. An additional 19% of this amount was translated into negative electricity tax rates.

47. The Net ECR indicator was used to calculate the revenue foregone from not pricing carbon emissions at a common external carbon price benchmark of EUR 60 per tCO_2. Such an approach avoids the need to use tax expenditure data from national sources, which are notoriously difficult to compare across countries. The analysis reveals that the revenue foregone is generally larger than the aggregate consumer support reported by the Inventory. A principal reason for this is that countries often do not report such underpricing as tax expenditures. This is disconcerting from a climate perspective as tax expenditure reporting can be an important step in the FFS reform process.

48. As the preliminary analysis of this paper has shown, the amount of tax expenditures reported by the Inventory only accounts for a small proportion of the revenue forgone estimated using the Net ECR dataset. Quantifying the share of revenue foregone that is officially reported as tax expenditures in the Inventory could be conducted more systematically at the country level. This could be part of a follow-up project highlighting tax expenditure reporting practices and their comparability across countries.

49. Fossil fuel support may also take the form of VAT reductions, which are currently not captured in the TEU/ECR framework. It would appear worthwhile to explore how to integrate such measures. The Inventory contains information on tax expenditures resulting from VAT reductions on fossil fuels, which could be a potential starting point.

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Annex A. Matrix of support measures for fossil fuels

Table A A.1. Matrix of support measures for fossil fuels (with examples)

	Statutory or formal incidence (to whom and what a transfer is first given)								
	Production							Direct consumption	
	Output returns	**Enterprise income**	**Cost of intermediate inputs**	**Cost of value-adding factors**					
				Labour	**Land and natural resources**	**Capital**	**Knowledge**	**Unit cost or consumption**	**Household or enterprise income**
Direct transfer of funds	Output bounty or deficiency payment	Operating grant	Input-price subsidy	Wage subsidy	Capital grant linked to acquisition of land	Grant tied to the acquisition of assets	Government R&D	Unit subsidy	Government-subsidized life-line electricity rate
Tax revenue foregone	Production tax credit	Reduced rate of income tax (including full exemption if state-owned)	Reduction in excise tax on input	Reduction in social charges (payroll taxes)	Property-tax reduction or exemption	Investment tax credit	Tax credit for private R&D	VAT or excise-tax concession	Tax deduction related to energy purchases that exceed given share of income
Other government revenue foregone		Free allocation of emissions permits	Under-pricing of a government good or service	In-kind labor from government staff	Under-pricing of access to government land or natural resources	Debt forgiveness or restructuring; direct state funding of energy infrastructure	Government transfer of intellectual property rights	Under-pricing of access to a natural resource harvested by final consumer	
Transfer of risk to government	Government buffer stock	Third-party liability limit for producers	Provision of security (e.g., military protection of supply lines)	Assumption of occupational health and accident liabilities	Credit guarantee linked to acquisition of land; lax reclamation bonding	Credit guarantee linked to capital; equity conversions	Advance purchase guarantees for unproven technologies	Price-triggered subsidy	Means-tested cold-weather grant
Induced transfers	Import tariff or export subsidy; local-content requirements and discriminatory government procurement	Monopoly concession; capacity payments (no full consensus)	Monopoly concession; export restriction	Wage control	Land-use control	Credit control (sector specific)	Deviations from standard intellectual property rights rules	Regulated price; cross subsidy	Mandated life-line electricity rate

Note: Non-exhaustive examples are provided in each cell.
Source: (OECD, 2015[11]); (OECD, 2022[6]).

Annex B. Country coverage

Table A B.1. Country coverage of the Net Effective Carbon Rates database

Country Code	Country Name	OECD member	G20 member	Covered in Inventory	Covered in TEU/ECR
ARG	Argentina	No	Yes	Yes	Yes
AUS	Australia	Yes	Yes	Yes	Yes
AUT	Austria	Yes	No	Yes	Yes
BGD	Bangladesh	No	No	No	Yes
BEL	Belgium	Yes	No	Yes	Yes
BRA	Brazil	No	Yes	Yes	Yes
BFA	Burkina Faso	No	No	No	Yes
CAN	Canada	Yes	Yes	Yes	Yes
CHL	Chile	Yes	Yes	Yes	Yes
CHN	China	No	Yes	Yes	Yes
COL	Colombia	Yes	No	Yes	Yes
CRI	Costa Rica	Yes	No	In its next version	Yes
CIV	Côte d'Ivoire	No	No	No	Yes
CYP	Cyprus	No	No	No	Yes
CZE	Czech Republic	Yes	No	Yes	Yes
DNK	Denmark	Yes	No	Yes	Yes
DOM	Dominican Republic	No	No	No	Yes
ECU	Ecuador	No	No	No	Yes
EGY	Egypt	No	No	No	Yes
EST	Estonia	Yes	No	Yes	Yes
ETH	Ethiopia	No	No	No	Yes
FIN	Finland	Yes	No	Yes	Yes
FRA	France	Yes	Yes	Yes	Yes
DEU	Germany	Yes	Yes	Yes	Yes
GHA	Ghana	No	No	No	Yes
GRC	Greece	Yes	No	Yes	Yes
GTM	Guatemala	No	No	No	Yes
HUN	Hungary	Yes	No	Yes	Yes
ISL	Iceland	Yes	No	Yes	Yes
IND	India	No	Yes	Yes	Yes
IDN	Indonesia	No	Yes	Yes	Yes
IRL	Ireland	Yes	No	Yes	Yes
ISR	Israel	Yes	No	Yes	Yes
ITA	Italy	Yes	No	Yes	Yes
JAM	Jamaica	No	No	No	Yes
JPN	Japan	Yes	Yes	Yes	Yes
KEN	Kenya	No	No	No	Yes
KOR	Korea	Yes	Yes	Yes	Yes
KGZ	Kyrgyzstan	No	No	No	Yes
LVA	Latvia	Yes	No	Yes	Yes
LTU	Lithuania	Yes	No	Yes	Yes
LUX	Luxembourg	Yes	No	Yes	Yes
MDG	Madagascar	No	No	No	Yes
MYS	Malaysia	No	No	No	Yes
MEX	Mexico	Yes	Yes	Yes	Yes
MAR	Morocco	No	No	No	Yes

NLD	Netherlands	Yes	No	Yes	Yes
NZL	New Zealand	Yes	No	Yes	Yes
NGA	Nigeria	No	No	No	Yes
NOR	Norway	Yes	No	Yes	Yes
PAN	Panama	No	No	No	Yes
PRY	Paraguay	No	No	No	Yes
PER	Peru	No	No	No	Yes
PHL	Philippines	No	No	No	Yes
POL	Poland	Yes	No	Yes	Yes
PRT	Portugal	Yes	No	Yes	Yes
RUS	Russia	No	Yes	Yes	Yes
RWA	Rwanda	No	No	No	Yes
SVK	Slovak Republic	Yes	No	Yes	Yes
SVN	Slovenia	Yes	No	Yes	Yes
ZAF	South Africa	No	Yes	Yes	Yes
ESP	Spain	Yes	No	Yes	Yes
LKA	Sri Lanka	No	No	No	Yes
SWE	Sweden	Yes	No	Yes	Yes
CHE	Switzerland	Yes	No	Yes	Yes
TUR	Türkiye	Yes	Yes	Yes	Yes
UGA	Uganda	No	No	No	Yes
UKR	Ukraine	No	No	Yes	Yes
GBR	United Kingdom	Yes	Yes	Yes	Yes
USA	United States	Yes	Yes	Yes	Yes
URY	Uruguay	No	No	No	Yes

Note: Last updated 1 September 2022.