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DESIGNING FOSSIL FUEL SUBSIDY REFORMS IN OECD AND G20 COUNTRIES: A ROBUST SEQUENTIAL APPROACH METHODOLOGY

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Abstract

Reform of support for fossil fuels is often identified as a priority for a country's fiscal consolidation efforts and for climate action to align financial flows with low-carbon pathways. Its implementation, however, remains elusive for many countries as they face seemingly irreconcilable policy agendas of economic growth and sustainability coupled with potential political backlash against austerity and rising costs.

This paper provides a sequential approach that may assist in providing support for the analysis to a well-informed reform process. Deploying the suggested tools can help policy makers to identify the most distorting government support measures and alternative or complementary policies that deliver the sought-after objectives more efficiently and effectively. The work presented here draws on the OECD's longstanding experience and tradition in measuring and tracking support measures for fossil fuels, primarily in its *Inventory of Support Measures for Fossil Fuels* (*Inventory* hereafter) and accompanying reports.

The *Inventory* thus far identifies, documents, and estimates close to 1 200 individual support measures for fossil fuels for 44 countries: 36 OECD countries and 8 partner economies. It finds that for OECD countries, tax expenditures, as a mechanism to transfer government resources, represent 77% of total support identified; the rest of support is provided through direct budgetary transfers. These support measures rooted in complex fiscal legislations are difficult to unravel and necessitate periodic evaluation.

As countries introduce policies that facilitate the transition towards a cleaner energy system, a "just and inclusive" transition is often indispensable for the acceptance and resilience of the reform. The important role that energy plays in all economic activities implies that countries need to provide affordable, reliable and accessible energy, particularly for vulnerable parts of the population.

The sequential approach proposed in this paper hinges on transparency and measurement of the fiscal implications of government support for fossil fuels as a first step towards the analysis of the economic, social and environmental effects. Eventually, the analytical process would culminate in an assessment of the adverse effects of reform and alternative or complementary policies that can mitigate them. By carrying out the full suite of assessments, the resulting reform strategies would minimise the political backlash and the risk of backtracking that often accompanies reforms of fossil-fuel support.

The proposed multi-step approach makes for an ambitious research programme that involves the use of different analytical tools, hinting to the difficulties and complexities confronting policy makers when enacting such reforms. This paper should therefore serve as an overview of the tools available and examples of studies that have been undertaken to deliver insights and policy recommendations for reform processes. In this way, the different steps can very well be undertaken in isolation and the sequential approach, being modular by construction, can be tailored to address a country's specific needs and available capacity to conduct the analysis. Countries can scale at their own pace the breadth and depth of their analysis along the different steps of this approach. Enhancing transparency on the ways a government delivers support to fossil fuel users and producers remains an essential first step towards reform.

Keywords: Subsidies, fossil fuels, energy, reform, government support, fossil fuel subsidies, oil, gas, coal, fossil fuel subsidy reform, tax incentives, tax expenditures.

JEL codes: H23, E64, Q38, Q54, Q58.

Résumé

Réformer les mesures de soutien aux combustibles fossiles est souvent considéré comme une priorité au regard des efforts d'assainissement budgétaire mis en œuvre par un pays, mais aussi de l'action en faveur du climat visant à aligner les flux financiers sur des stratégies de développement sobres en carbone.

La phase de mise en œuvre reste toutefois problématique pour de nombreux pays qui sont confrontés à des enjeux apparemment irréconciliables entre croissance économique et développement durable, sans compter que des mesures d'austérité et un renchérissement des coûts risquent de se heurter à une opposition politique.

Ce document propose une approche séquentielle susceptible d'étayer l'analyse destinée à éclairer le processus de réforme. Grâce aux outils proposés, les décideurs peuvent identifier les mesures publiques de soutien qui induisent le plus de distorsions, et les politiques alternatives ou complémentaires qui permettraient d'atteindre les objectifs recherchés de manière plus efficace et efficiente. Les travaux présentés ici s'appuient sur la longue expérience et tradition de l'OCDE en matière de mesure et de suivi des mesures de soutien en faveur des combustibles fossiles, principalement dans l'Inventaire OCDE des mesures de soutien pour les combustibles fossiles (appelé l'Inventaire ci-après) et les rapports qui l'accompagnent.

À ce jour, l'Inventaire recense, documente et évalue près de 1 200 mesures de soutien pour les combustibles fossiles dans 44 pays : 36 pays de l'OCDE et 8 économies partenaires. Il conclut que dans les pays de l'OCDE, les dépenses fiscales, mécanisme permettant de transférer des fonds publics, représentent 77 % du soutien total identifié ; les transferts budgétaires directs forment le solde. Ces mesures de soutien ancrées dans des législations fiscales complexes sont difficiles à déchiffrer et nécessitent une évaluation périodique.

À mesure que les pays mettent en place des politiques qui facilitent la transition vers un système énergétique plus propre, une « transition juste et inclusive » s'avère souvent indispensable pour faire accepter les réformes et en assurer la résilience. En raison du rôle important joué par l'énergie dans toutes les activités économiques, les pays doivent pouvoir fournir une énergie abordable, fiable et accessible, notamment aux segments vulnérables de leur population.

L'approche séquentielle proposée dans ce document est axée sur la transparence et l'évaluation des implications pour les finances publiques des mesures de soutien aux combustibles fossiles, et constitue à ce titre une première étape de l'analyse des effets économiques, sociaux et environnementaux. À terme, le processus d'analyse permettra d'évaluer les effets négatifs des réformes et les politiques alternatives ou complémentaires susceptibles de les atténuer. Une fois toutes les évaluations effectuées, les stratégies de réforme élaborées minimiseront les conséquences politiques et le risque de retour en arrière qui accompagne souvent les réformes des aides aux combustibles fossiles.

L'approche en plusieurs étapes proposée s'inscrit dans le cadre d'un programme de recherche ambitieux faisant appel à différents outils d'analyse, qui illustrent les difficultés et les complexités auxquelles sont confrontés les décideurs lors de la mise en œuvre de telles réformes. Ce document a donc pour but de donner un aperçu des outils disponibles et des exemples d'études réalisées afin d'enrichir la réflexion et de formuler des recommandations concernant les processus de réforme. De cette manière, il est tout à fait possible d'entreprendre les différentes étapes séparément et l'approche séquentielle, intrinsèquement modulaire, peut être adaptée pour répondre aux besoins spécifiques de tel

ou tel pays et aux capacités disponibles pour réaliser l'analyse. Les pays peuvent ainsi avancer à leur propre rythme dans ce processus et moduler l'ampleur et la profondeur de leur analyse. Une plus grande transparence quant aux modalités d'octroi des aides publiques aux utilisateurs et aux producteurs de combustibles fossiles reste une première étape essentielle sur la voie de la réforme.

Codes classification : H23, E64, Q38, Q54, Q58.

Mots-clés : subventions, combustibles fossiles, énergie, réforme, aides publiques, subventions aux combustibles fossiles, pétrole, gaz, réforme des subventions aux combustibles fossiles, incitations fiscales, aides fiscales.

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1. Introduction

1.1. Context on support for fossil fuels and their reform in OECD and G20 countries

Government support for the consumption or production of fossil fuels can have various and wide-reaching adverse economic and environmental effects. Such interventions may hamper the transition to a low-emission economy, distort energy prices, generate economic inefficiencies, and put pressure on scarce public resources. Various points in the fossil fuel value chain may benefit from support measures, including exploration, development, extraction and refining, bulk transport (e.g. by pipelines and tankers), or final use by industry, households, and the government. Because energy plays such a central role in OECD and G20 countries, the economic, social and environmental effects of fossil-fuel government support typically spread far beyond the energy sector and its consumers.

Countries invoke different policy objectives for introducing and maintaining measures that support the use or production of fossil fuels. Public authorities, especially in developing countries, sometimes claim that fossil-fuel support measures are a social policy geared to provide energy access and lift households out of poverty. For many advanced countries, fossil-fuel support is claimed to be necessary for ensuring a level-playing field for industries that are exposed to international competition, to prevent carbon leakage, to support new technology deployment, or to maximise resource rent in the case of producer support.

The impetus for reforming fossil-fuel subsidies has been felt around the globe as mounting fiscal pressure and climate ambitions have called such government policies into question. However, progress towards achieving the international commitments that countries have taken in G20, G7 and APEC forums to phase out inefficient fossil fuel subsidies, has been mixed. Unfinished business includes an internationally agreed definition of fossil-fuel subsidies, whether and when a subsidy is inefficient and developing guidance to support successful reform processes tailored to countries' circumstances.[1]

The crosscutting nature of the fossil-fuel support measures, compared with support given to a specific sector like agriculture and fisheries, can render understanding their effects on economic decisions and environmental outcomes a daunting task. In addition, several mitigating factors accompany reforms, often discouraging countries from pursuing changes in their policies. The distributional and competitiveness implications of reforms are perhaps the biggest deterrents and warrant accompanying compensatory measures. The differentiated effects of support measures might imply that not all support is created equal. Some support measures may not be a priority for reform as they are important for achieving a government's social or investment objectives with no viable alternatives. The reform of fossil-fuel support measures therefore requires a whole-economy approach with careful considerations of adverse effects. It should also be conceived within a country's national development plans, especially for developing G20 countries.

It is in this context that the OECD Secretariat started reflecting on frameworks for analysing the effects of fossil-fuel support measures in order to inform reform processes. The main objective of the paper is to assist OECD member countries and G20 economies with evaluating their own policies and in designing tailored reform processes. It provides

[1] The SDG methodology to track indicator 12.c.1 developed by UN Environment, OECD and the International Institute for Sustainable Development (IISD) draws on existing methods from the OECD, IEA and the IMF for quantifying and tracking fossil fuel subsidies to formulate an international taxonomy (UN Environment, OECD and IISD, 2019[8]).

elements of a framework for analysing the effects of government support and the consequences of their reform. It addresses the specificities of support in OECD countries and G20 economies and suggests an economy-wide approach that can account for unintended consequences and second-order effects of reforms, identifies gaps in methodologies and proposes avenues for future analysis. Countries can tailor the reform process to their own circumstances, underpinned by qualitative and quantitative assessments, including the suggested tools in this paper. This framework does not, however, address explicitly, the extent to which these support measures may interact with other existing support programme, such as those for the agriculture and renewable energy. This framework can therefore be extended to account for distortions that may emanate such support programmes.

1.2. Key features of support measures in OECD and G20 countries

The OECD has a long tradition in measuring and tracking support measures for fossil fuels. The 2019 OECD *Inventory of Support Measures for Fossil Fuels* (*Inventory* hereafter) identifies, documents, and estimates close to 1 200 individual support measures for fossil fuels for 44 countries: 36 OECD countries and 8 partner economies.[2] These policies are categorised according to their transfer mechanism, their statutory incidence, and the individual fuels they benefit (see matrix). The *Inventory* and its accompanying reports, provide a comprehensive picture of the policy environment governing the production and use of fossil fuels and the corresponding budgetary cost of such policies. Other organisations providing guidance include the IMF and the World Bank. Their work is mainly addressed to developing countries and is covering subsidies that lower prices for end-use fossil fuel consumers, as in the case of the World Bank Energy Subsidy Reform Assessment Framework, (ESRAF). Other actors including The Global Subsidies Initiative (GSI), Oil Change International (OCI), Overseas Development Institute (ODI), and Stockholm Environment Institute (SEI) provide insightful research and policy advice.

According to the *Inventory*, OECD countries deliver the bulk of support for fossil fuels through the tax code (OECD, 2018[1]). For OECD countries, tax expenditures, as a mechanism to transfer government resources, represent 77% of total support identified; the rest of support is provided through direct budgetary transfers.[3] In non-OECD G20 economies, the use of direct outlays is more prevalent as a means of transferring funds to producers for selling their products below-market prices or to provide cash to households for their fossil-fuel consumption, particularly for transportation fuels. Still, tax expenditures, on average, sum up to 40% of government support for this group. Therefore, the widespread use of tax expenditures in OECD countries and G20 economies to provide preferential treatment to the use and production of fossil fuel warrant the use of tools suitable for studying their role in influencing economic decisions along the fossil-fuel value chain. At the same time, the analysis should take into account the diversity of tax systems across OECD and G20 countries and should nuance its conclusions accordingly. This paper suggests a sequential approach to undertake analytical work supporting the implementation of well-informed reform processes. Given their extensive use in OECD and G20

[2] OECD partner economies are: Argentina, Brazil, the People's Republic of China, Colombia. India, Indonesia, Russia, and South Africa.

[3] The Inventory records tax expenditures as estimates of revenue that is foregone due to a particular feature of the tax system that reduces or postpones tax relative to a jurisdiction's benchmark tax system, to the benefit of fossil fuels. Hence, (i) tax expenditure estimates could increase either because of greater concessions, relative to the benchmark tax treatment, or because of a raise in the benchmark itself; (ii) international comparison of tax expenditures could be misleading, due to country-specific benchmark tax treatments.

economies, understanding how tax benefits influence economic decisions and environmental outcomes along the fossil-fuel value chain is an integral part of well-designed reform packages.

OECD efforts to study the effects of fossil-fuel support and their reform have previously given way to qualitative tools to guide users in identifying factors that determine the links between removal of support and its environmental consequences. An early attempt to look into the implications of fossil-fuel subsidies under the larger umbrella of environmentally harmful subsidies put forward a checklist for determining the likelihood of environmental benefits from subsidy reform (OECD, 2005[2]). An integrated assessment framework was later introduced to map out the objectives, cost-effectiveness and incidental and long-term consequences to the subsidy reform (OECD, 2007[3]). This work has been presented to the G7 as part of a report produced at the request of Italy to the G7 discussions for the Environment stream of its 2017 G7 Presidency.[4]

While these tools provided an organising framework for investigating the effects of such government intervention, they fell short of suggesting analytical and quantitative tools that deliver complementary information on the implications of support policies and the consequences of their reforms. To fill this gap and build on the existing knowledge in the OECD, this sequential approach suggests a toolkit for each step along the reform trajectory to build the needed evidence base.

The sequential approach starts with the identification, quantification, and the understanding of the objective and design of each policy. Following this stock taking exercise, an evaluation of the economic, social and environmental effects of support measures and their incidence is proposed to prioritise subsidies for reform. This prioritisation is followed by an assessment of the implications of reform to identify the winners and losers of the change and a consideration of alternative policies with better economic, environmental, or distributional outcomes. The different steps and the tools that could be deployed to carry out the analysis are summarised in Table 1.

Countries can be at different stages of reform processes and therefore might tailor this sequential approach to address their needs for assessing domestic support policies. Policy makers might initiate their assessment process at any one of the stages in this approach provided that they maintain a wide scope for the support policies they consider for reform. Table 1 provides a list of tools that could assist the evaluation of government interventions at each stage of the sequential approach, but countries may not be limited to nor constrained by this list when reforming their support measures. Moreover, as countries move to more ambitious climate targets and greater fiscal discipline, the instruments and reforms they put in place to operationalise their programmes need to be considered as one part of a broader policy package. Policy interactions should not be neglected; complementarities and redundancies should be identified and addressed along the way (Gundlach, Minsk and Kaufman, 2019[4]). These considerations go beyond the scope of this paper, but policy makers should heed attention to the broader policy environment as they deploy these assessment tools.

[4] See: https://www.minambiente.it/sites/default/files/archivio/allegati/sviluppo_sostenibile/background_paper_4_G7_env_OECD_Towards_G7_target_to_phase_out_EHSs.pdf.

Table 1. Ensuring resilient reform processes through a sequential approach to reform

	Step in sequential approach	Objective	Analytical tools	Availability of the tool
1	Identify support measures, document their objectives and estimate their budgetary cost.	Measure the cost to government for providing support for fossil fuels.	OECD taxonomy of support measures for fossil fuels PSE-CSE framework	OECD Inventory, IEA and IMF pre-tax price-gap estimates.
2	Measure the relative distortiveness of support measures.	Rank support measures by their level of distortiveness on fossil-fuel production, investment, consumption and CO_2 emissions.	Effective tax rates Sectoral models: extraction model of oil and gas, and a two-sector model of energy intensive and non-energy intensive industries	A quantitative extraction model and sectoral model is to be developed in the OECD Harberger's triangle measurement of deadweight loss using supply and demand elasticity estimat es is to be developed in the OECD Sufficient statistic (R^2) for measuring the welfare loss.
3	Identify the winners and losers of fossil fuel reform processes.	Analyse the distributional impact and other adverse effects of fossil-fuel subsidy reform.	Micro-simulation models (based on household and firm surveys) CGE models	OECD micro-simulation model for energy taxes. Commitment to Equity (CEQ) Institute assessment tool. OECD ENV-Linkage, OECD METRO, UCL Energy Institute models.
4	Evaluate alternative policies that accompany reform of fossil fuel support.	Identify policies that increase the efficiency and improve the distributional impact of government intervention.	Micro-simulation models (based on household and firm surveys) CGE models	OECD ENV-Linkage, OECD METRO, UCL Energy Institute models.

Note: The list of analytical tools is not exhaustive but enumerates the mostly frequently used tools in this policy area and those available at the OECD.
Source: Author's elaboration.

Spending reviews are widely used as a budgeting tools in OECD countries to improve spending efficiency and reprioritise expenditures for a better alignment with a government policy and fiscal objectives (OECD, 2019[5]). Since fossil-fuel subsidies and tax expenditures result in forgone revenue, they might be evaluated as part of a country's spending review, for which the scope, frequency and evaluation methods vary from one country to another. While there are countries that undertake annual reviews of spending programmes in a specific policy area, as is the case of Denmark and the Netherlands (Box 1), others carry out comprehensive policy reviews every few years, for instance the United Kingdom and Ireland. But, as fossil-fuel support is delivered through different policy instruments, both through tax and non-tax measures, with different policy objectives, they are a seldom assessed in a single review.

Box 1. Spending reviews in the Netherlands

Periodic evaluation practice has proven to be an important driver for policy reform in the Netherlands. As the budgetary process requires an evaluation of the different schemes every four to seven years, ministries have the opportunity to review and eventually reform those policies they deem insufficiently effective or no longer relevant. Evaluations can be carried out for specific policy area, through an impact assessment of an individual measure or a cost-benefit analysis (OECD/IEA, forthcoming[6]).

In addition to policy reviews, the government of the Netherlands has interdepartmental policy reviews (interdepartementale beleidsonderzoeken or IBOs). The IBOs are forward-looking as they identify options for policy adjustments and unlike the target policies reviews, they are not confined to a specific policy area as defined in the budget law; they can address broader social problems. Some ministries can choose to combine an IBO with a policy review in which case both backward-looking and forward-looking evaluations are undertaken.

Requirements for policy reviews in the Periodic Evaluation Research Regulations (RPE)

A definition of the policy area to be evaluated in terms of time period examined, the associated budgetary cost and the part(s) of the budget law article to which it relates.

- The motivation of the policy and the objectives pursued by the policy.
- A description of the policy area and justification of the associated expenditures.
- An overview of previously conducted research into effectiveness and efficiency and reasons for the chosen evaluation approach.
- The effects of policies and analysis or assessment of their effectiveness and efficiency.
- A consideration of measures that can be taken to improve the efficiency and effectiveness of policies;
- A description of policy options in case there is significantly less budget (20% less) available.

Source: http://www.rijksbegroting.nl/beleidsevaluaties/evaluaties-en-beleidsdoorlichtingen/handreiking.

More generally, efforts to integrate environmental considerations in the budgeting process have multiplied over the recent years. The Paris Collaborative on Green Budgeting (PCGB), launched under the One Planet Summit in 2017, is a multilateral initiative to institutionalise the tracking and evaluation of public expenditure to ensure a better alignment with climate and other environmental goals. In 2019, France, as a founding member of this initiative, put forth, a framework that would be used to deliver a green budget statement as an annex to the general budget starting with the 2020 budget. Other countries, such as Ireland, have also taken important steps towards implementing such an initiative. The more recently formed Coalition of Finance Minister on Climate Action has lent further support to the efforts under the PCGB as it encourages countries to take climate change into account in their macroeconomic and fiscal and budgeting planning. Together, these undertakings can help governments understand the short-term and long-term implications of budgetary decisions on climate and other environmental outcomes.

2. Key elements of the framework

This section lays out the main steps in analysing government support measures. It discusses a sequential approach to inform reform processes that is split into four phases of analysis: 1) identifying and estimating support measures for fossil fuels and documenting their objectives; 2) measuring the relative distortiveness of support measures and prioritising them for reform; 3) evaluating the distributional effects of reform; 4) identifying alternative policies. For each step, this paper suggests tools that can be deployed to carrying out the requisite analysis.

It is worth noting that the tools recommended henceforth vary in their level of ambition, difficulty, as well as data and resource intensity. The unavailability of resources to complete one of the steps of the approach does not preclude the policy maker from proposing and going forward with a reform agenda. Instead, this approach may be viewed as a comprehensive research programme against which to gauge the depth and breadth of the evaluation process. In this sense, it can be used as an assessment for gaps in the evidence base that might need to be filled or that could be a source of weakness in the design stage of the reform. Additionally, each step of the sequential approach should be tailored to each country's circumstances to deliver adequate solutions for its populations and development agenda.

2.1. Identifying support measures, documenting their objectives and estimating their budgetary cost

Reporting individual support programmes and their associated fiscal cost is a crucial first step towards fossil-fuel subsidy reform. The fossil fuel government support landscape can be organised into four different transfer mechanisms through which governments policies can benefit fossil fuels: 1) direct spending, 2) tax expenditures and other government revenue forgone, 3) induced transfers, and 4) transfer of risk to the government. These policies can target different parts of the fossil fuel supply value chain and change the cost structure for producers and the price for end users.[5]

The OECD *Inventory* approach (Box 2) provides an organising framework for tracking government support that allows for a wide and comprehensive scope for government support for fossil fuels. Not only are individual government policies classified by how public resources are transferred to their beneficiaries, but also by the formal incidence of the measures along the fossil fuel value chain, i.e. whether it benefits producer output returns, enterprise income, cost of intermediate inputs, factors of production, or final consumer prices and incomes (OECD, 2015[7]).

The level of difficulty in measuring government support varies across these different transfer mechanisms, starting with the ease of quantifying the cost of direct spending programmes, to the estimation of induced transfers due to government regulation and the revenue forgone from providing tax benefits, to quantifying the support element of transferring risk to the government through concessional finance. With the exception of direct spending programmes, the estimation for the other support measures hinges on measuring the difference between either applied tax rates, regulated price, interest rate and realised equity return, and their reference counterparts.

[5] A comprehensive discussion of the taxonomy of support measures can be found in the Companion report to the OECD Inventory of Support Measures for Fossil Fuels (OECD, 2015[10]).

The key to building an inventory of support measures is to start by creating a comprehensive list of government policies and programmes that could be providing preferential treatment or benefits to fossil fuel consumers and producers using the transfer mechanism taxonomy. The inventory can then be populated with the corresponding estimates using readily available information and internationally established methods. Reporting measures in the inventory for which there are no estimates still contributes to enhanced transparency on government policies and serve as a basis for future improvements.

2.1.1. Estimating the cost of direct spending and tax expenditures as the starting point for building an inventory of support measures

The most straightforward government programmes to identify and measure are direct spending programmes. These are well documented, revised on a budget cycle, and subject to legislative and executive branch scrutiny. Tax expenditures, on the other hand, are often under reported by many jurisdictions. Tax expenditure reports, whereby the revenue forgone from providing tax benefits is reported, are not systematically issued across OECD and G20 countries. Only 26 of the 44 countries included in the OECD *Inventory* produce such reports and among those that do, not all provide estimates of revenues forgone, and the scope of what constitutes a tax expenditure can be different substantially from one jurisdiction to another. In addition, among the reported tax expenditures in the *Inventory*, a third do not have estimates for the incurred revenue forgone. Tax expenditures are not subjected to regular evaluation procedures and therefore they remain opaque; a main reason explaining the lack of estimates of tax expenditures, in contrast with budgetary programmes,

It remains that direct spending programmes and tax expenditures are the more easily measurable forms government support for fossil fuels and thus should be a priority in this process. As the first building blocks towards mapping the policy landscape of support, an inventory of budgetary transfers and tax expenditures helps to understand how governments use fiscal instruments to conduct energy, social and economic development policies. International efforts to tracking the SDG target for phasing out inefficient fossil-fuel subsidies adopted the OECD inventory method to estimating fossil fuel subsidies (UN Environment, OECD and IISD, 2019[8]).

The OECD has a comprehensive *Inventory* of direct transfers, induced transfers, and tax expenditures largely drawn from publically available budgetary and other government documents. It comprises more than 1 200 individual measures for 44 countries: 36 member countries and 8 partner economies. Recently, the OECD published a combined IEA-OECD estimate of fossil fuel support that extends country coverage to 76 economies (OECD/IEA, 2019[9]).[6] Given the lack of producer support estimates for largest fossil-fuel exporting developing countries and the lack of financial support estimates, the OECD and the IEA combined estimate of support represents a lower bound.

Government support through the financial system remains underreported despite its scale and potential for affecting the allocation of capital across sectors. For example, there exists no official government reporting of concessional loans and below-market equity to fossil-fuel related projects, with the exception of the OECD reported grant equivalent of

[6] Given that the IEA estimates of support identify consumer price support in economies that maintain low domestic fuel prices (below an international reference price), they do not account for producer support or other consumer support in these countries. The two methods for tracking support, subsumed under the PSE-CSE framework, can therefore complement each other.

Overseas Development Assistance flows. Data requirements for tracking the value of potential subsidies associated with concessional loans or risk transfers are more demanding and would need to be measured at a project level.[7] The OECD has proposed a practical approach to measuring below-market lending by using a credit-rating-based method for evaluating the under-pricing of government credit assistance (OECD, 2018[1]).

Box 2. OECD Inventory of Support Measures for Fossil Fuels

For several years, the OECD has identified and quantified support for fossil fuels provided by governments through either direct budgetary transfers or through tax benefits that induce forgone revenue for public authorities relative to the prevailing statutory tax system. These measures have provided information on public financial flows directed to the benefit of fossil fuels. Thus far, the *Inventory* and its *Companion* report have presented a broad view of the data and have not made any judgements on which support measures might be usefully kept in place, and which ones a country might wish to consider for possible reform or removal (OECD, 2015[10]) (OECD, 2018[1]).

The OECD has a comprehensive Inventory of direct transfers, induced transfers, and tax expenditures that benefit fossil fuels throughout the fossil fuel value chain. It comprises close to 1 200 individual measures for 44 countries: 36 member countries and 8 partner economies.

However, the *Inventory* does not represent a global figure of fossil-fuel subsidies and has yet to cover the full gamut of government measures that can benefit fossil fuels. Recently, the OECD and the IEA published a combined IEA-OECD estimate of fossil fuel support that extends country coverage to 76 economies. Given that the IEA estimates of support identify consumer price support in economies that maintain low domestic fuel prices (below an international reference price), they do not account for producer support or other consumer support in these countries. The two methods for tracking support are complementary and together provide a more global picture of government support (OECD, 2018[1]).

2.1.2. Understanding the rationale of government support measures

It is not enough to estimate the fiscal cost a governments incurs. Part of the stock taking exercise is also to understand the objective of each measure and its intended beneficiaries. Such information would eventually be useful for identifying alternative measures that can be employed to meet the same policy objectives, in a more efficient, equitable, and environment-friendly manner. Unlike direct budgetary transfers for which evaluation processes exist and can inform the effectiveness of different spending programmes in reaching their goals and beneficiaries, tax expenditures often go unnoticed.

The economic rationale for government intervention is often based on the need for government action to correct for market failures, such as imperfect competition, public goods, externalities, incomplete markets, and informational asymmetries. Additional arguments are made for government intervention particularly when market outcomes, even if Pareto efficient, do not deliver socially equitable income distribution. Therefore, in understanding the *raison d'être* of support measures, it would be important to identify which market failure or distributional motivations are behind their implementation and

[7] Methods for calculating the support element of government credit programmes are discussed in (OECD, 2018[1]).

eventually explore possible alternatives that are more cost effective and efficient in addressing these objectives.

Countries can engage in a self or peer review process to evaluate their support measures for fossil fuels. Several countries pursued peer reviews under the auspices of the G20 and APEC as part of their commitment to phase out inefficient fossil fuel subsidies that encourage wasteful consumption. These peer reviews culminate in reports by a reviewing panel comprised of representatives from different countries, IOs and NGOs. The peer reviews discuss the overall policy environment in the country, enumerate the different support measures, their objectives and their effectiveness and propose opportunities for reforms. Such a review mechanism can therefore be adopted to take stock of government support and jump start reform efforts.

2.2. Measuring the effects of support measures for fossil fuels and prioritising them for reform

An inventory and a review of government support measures for fossil fuels are useful starting points for subsequent analysis of their economic, environmental and distributional implications and possible reforms through alternative policies that can deliver the same policy outcomes. Identifying those measures that result in the most important changes to economic decision and environmental performance can orient reform efforts towards tackling the most economically and environmentally distortive ones.

2.2.1. Definition of distortiveness resulting from support for fossil fuels

The analytical frameworks in the following sections can be deployed to examine how government interventions affect different segments of the fossil-fuel value chain: the upstream and midstream sectors (i.e. exploration and development, production, processing and refining), down to industrial, commercial, and residential end-users.

By changing the cost structure for upstream investments and by lowering input costs for consuming industries, support for fossil fuels can have structural effects, encouraging excessive development of resources and the accumulation of long-lived capital assets. As a result, such government interventions facilitate lock-in of emissions-intensive infrastructure and slowdown the transition towards a greener economy.[8]

Further downstream, support to end users often leads to wasteful consumption since it brings end-user energy prices below cost recovery or market prices, or confers preferential treatment to a select group of beneficiaries.[9] By distorting relative prices, support measures for fossil fuels induce behavioural responses that modify economic, social, and environmental outcomes and this results in a bias towards carbon-intensive production processes. In the same way as producer support, consumer support locks-in capital in CO_2 emitting industries, thereby undermining their long-term competitiveness in a carbon-constrained world.

Therefore, distortions considered in this report are defined as economic or environmental outcomes that deviate from a benchmark case with no support instruments. They reflect changes in economic decisions or environmental outcomes resulting from government

[8] The potential for fossil-fuel outputs to be used as part of a circular economy system as feedstock (in chemical industries) or injection material (instead of water) should also be taken into account when relevant.

[9] Efficient fossil fuel pricing can include both economic efficiency, but also environmental considerations.

support.[10] The next section presents an analytical toolbox that can help inform on the distortions emanating from different government support measures. Decisions that are influenced by government policies targeting fossil fuels in the upstream and downstream sectors are examined first, then a discussion of distortions emanating from household behavioural responses follows.

2.2.2. Evaluating support to the upstream fossil-fuel sector

Countries use tax incentives and other forms of government support, such as concessional finance or direct budgetary transfers, to attract domestic and foreign investment. Investments in the fossil fuel extractive sector have the potential to be important drivers for economic growth, but when not managed properly, they can fail to deliver the desired outcomes and instead cause economic, social and environmental harm. Government support to the sector can be designed to effectively and efficiently deliver benefits to its economy, but it can erode a government's ability to generate the requisite revenue to fund other public services and investments. Government support can also be distortive as it may tilt the playing field towards fossil-fuel energy sources locking in carbon-intensive assets, slowing down the uptake of less carbon-intensive technologies and crowding out investments in other industries.

Thus far, policies to address climate change and to reign in government expenditure on fossil fuels have focused on demand-side policy instruments that target emissions and fossil fuel use. Little has been done to explore opportunities for supply-side policies, despite governments' plans for changing energy markets to integrate less emitting sources. Several experts, (Green and Denniss, 2018[11]), (Piggot et al., 2018[12]) and (Faehn et al., 2017[13]), have called upon policy makers to consider policies that restrict fossil-fuel supply as part of the climate change mitigation policy package and already several countries have committed to cut fossil-fuel supply by phasing out coal power generation (e.g. signatories to the Powering Past Coal Alliance) and halting new exploration oil and gas resources (e.g. New Zealand and Costa Rica).

2.2.3. Effective tax rate analysis to measure the distortiveness of support in the fossil fuel upstream sector

This section provides a method for quantifying the extent to which different tax incentives and support measures influence investment decisions in the upstream fossil-fuel sector compared with a reference benchmark fiscal system.[11] Given the diversity in fiscal regimes (including tax incentives and other support measures) used to raise revenue from the sector, a synthetic indicator is proposed, via effective tax rates (ETR) analysis, that allows for comparison across different fiscal regimes in an international context. Effective tax rates differ from statutory tax rates in ways that differ across firms, depending on the access they have to various forms of preferential tax treatment. Larger gaps between effective and benchmark tax rates can be seen as measure of distortions in the sense that uniform treatment under the benchmark system would be more efficient.

[10] An alternative benchmark that internalises the social cost of carbon can also be useful for measuring jointly economic and environmental distortions.

[11] The choice of the benchmark fiscal system warrants its own discussion and is addressed in Box 2.

For producers of fossil fuels, the user cost of capital plays an important role in allocating their resources in investments for exploration, development, and production.[12] It represents the marginal product of capital (or return) that a firm should earn in order to pay the return required by investors, to pay for the marginal tax on its income and the depreciated capital. In analysing how the user cost of capital is affected by changes in a fiscal regime, we can infer the degree of distortiveness of fossil fuel support. Building on the concept of user cost, the effective marginal tax rate (EMTR) exposes the extent to which a fiscal regime affects firms' user cost and therefore investment and production incentives.[13] It represents the wedge between the pre-tax return and the post-tax return of capital as a share of the pre-tax return.

The EMTR focuses on marginal investments and can be used to study how fiscal regimes affect investments at the margin, i.e. those for which the return on capital is just sufficient to cover economic cost of investment. Therefore this indicator speaks to the effect of the fiscal regime, on investments for projects already in place.

[12] The concept of *user* cost of capital introduced in (Jorgenson, 1963[49]) is widely used to study the impact of government policies on investment incentives in the tradition (Hall and Jorgenson, 1967[50]). Several papers have used this concept to analyse the impact of tax reform, for instance (Congressional Budget Office (CBO), 1985[51]) and (Metcalf, 2010[65]). It is a broader concept of the cost of capital, that in addition to the cost of funds (equity and debt), it accounts for asset depreciation and adjustment costs. It represents the implicit rental price of capital.

[13] EMTR = (pre-tax user cost – post-tax user cost)/(pre-tax user cost).

Box 3. Benchmark fiscal regimes for oil and gas extraction

The choice of a benchmark fiscal regime is essential for the evaluation of different government spending programmes. The benchmark is a fiscal regime against which to measure behavioural responses of producers to different government incentives.

From an economic efficiency perspective, a neutral fiscal regime has been identified as a useful benchmark whereby investment decisions at the margin are not impacted by the prevailing fiscal regime. Under such system, oil and gas producers are liable for taxes, a combination of corporate income tax (CIT) and a resource rent tax (RRT), levied on their net profits. For such a system to be neutral, this RRT is only levied once a project has recovered all its exploration and development expenditures and reached a hurdle rate of return. At that point, the project pays a high marginal tax rate.

Such neutral benchmark fiscal regime is considered to be symmetric, whereby its marginal tax rate on income is the same as its marginal tax reduction rate on all costs related to the different phases of production in the oil and gas sector. (Daubanes and Andrade de Sá, 2014[14]) and (Gaudet and Lasserre, 2015[15]) layout the conditions under which an RRT is neutral vis-à-vis the firm's investment decisions. The economic efficiency of this profit-based tax might be violated if we consider that the government, as the resource owner, has the objective of raising the requisite revenue to ensure that it is compensated for the opportunity cost it incurs from extracting an exhaustible resource. (Conrad, Hool and Nekipelov, 2018[16]) underline this divergence in incentives between the producer and the resource owner and propose that a royalty could capture the scarcity value of the resource.

The opportunity cost of depleting an exhaustible resource cannot be ignored when constructing a benchmark system as it characterises the economic trade-offs facing this sector and the welfare implications for intergenerational equity. It is therefore useful to show whether the government, as the resource owner, recovers the asset value of the in situ resource through its tax system in order to ensure that future generations are treated equally to the current ones. In the same spirit, the opportunity cost of the environmental implications of production can also be integrated into a benchmark fiscal regime to reflect the constraints facings producers.

An alternative and widely used approach to designating the benchmark fiscal regime is to take the prevailing corporate tax system as the benchmark against which to compare the fiscal regime applied to the fossil fuel sector. Such a benchmark would abstract from the economic efficiency discussion of the fiscal system and focus on the preferential tax system conferred to the sector using the country-specific baseline.

For example, if an investment in a rig for drilling a new oil well earns 10% and taxes took 2% of that return, 8% would be the return investors get after taxes. The 2% is the tax wedge and the EMTR would be the ratio of the tax wedge over the pre-tax return – in this case 20%. The higher it is the more discouraging is the fiscal regime towards additional (or marginal) investment. When the EMTR is zero, it implies that the taxes levied and fiscal incentives (e.g. depreciation rules, expensing, and credits) have no effect since they do not influence the marginal investment decision; a negative EMTR indicates that the tax system

encourages investment.[14] This metric can be relatively easy to interpret since it converts the information contained in the user cost (pre- and after-tax) into a tax rate equivalent.

The EMTR can account for most of the incentives granted to corporations, including those in the upstream fossil fuel sectors.[15] (McKenzie and Mintz, 2011[17]), for example, apply the method to measure the extent to which the fiscal regime encourages investments in Canada's upstream sector at the provincial level and find that on aggregate, oil and gas production in Canada is still discouraged by the overall fiscal regime (positive EMTR). But, they do find that exploration and development are benefitting from a negative EMTR, evidence that the fiscal regime provides more benefits than levies taxes on these activities. This particular paper falls short of showing how the aggregate EMTR for the oil and gas industry in Canada compares with the EMTR in other sectors, to ascertain whether the prevailing fiscal regime for oil and gas indeed confers a preference for investment in this sector relative to other sectors.[16]

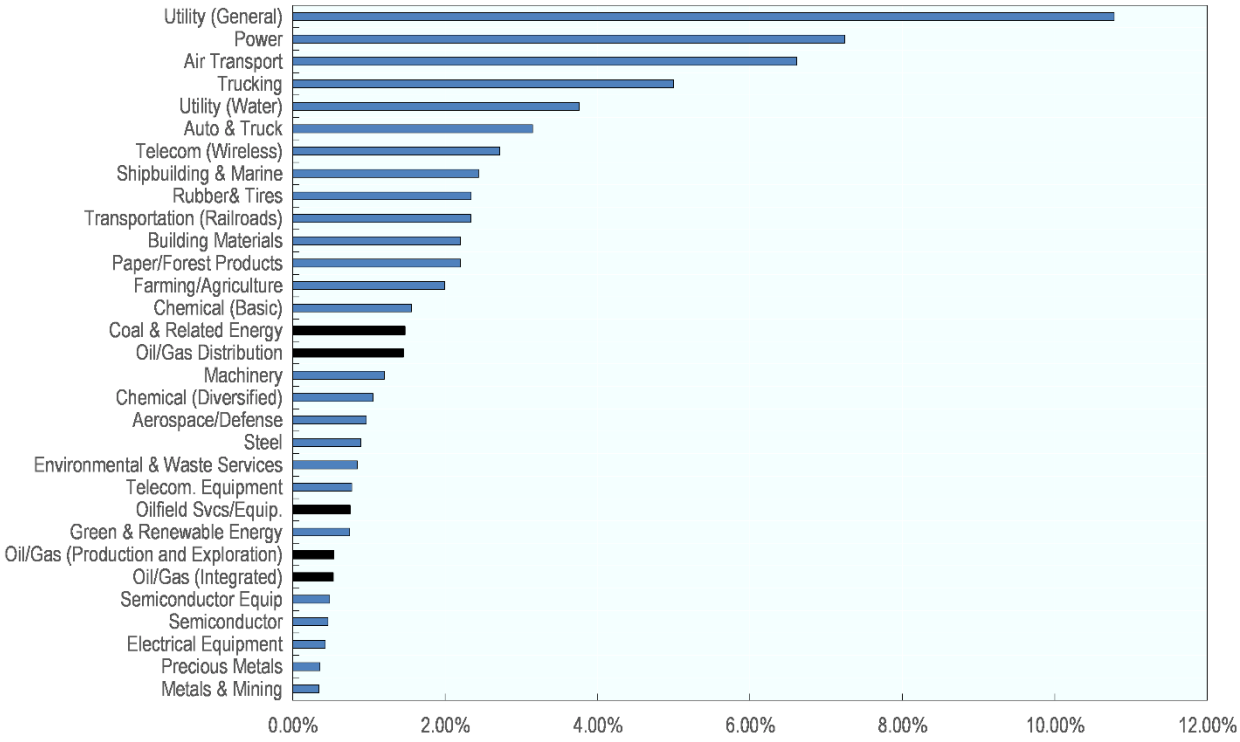
The EMTR can thus be used as a first approximation of whether a country's prevailing fiscal regime encourages investment via its impact on the user cost. When measured against a benchmark fiscal system – or the EMTR facing other sectors – it can also be used to quantify the magnitude of the distortion emanating from a particular fiscal design relative to others. One study, using available data in the United States on the cost of debt and equity financing, shows that it is straightforward to derive the cost of finance, (i.e. the required return for investors), for different sectors. Taking a ratio of the pre-tax and after tax cost of finance only, a component of the user cost of capital, for each sector shows that different fiscal regimes can deliver substantially different cost of finance across sectors (Figure 4). From this exercise, it is evident that the impact of fiscal policy on the cost of financing investment in the oil and gas production and exploration is among the lowest in the sample of sectors.

[14] (Boadway et al., 1985[53]) and (Boadway et al., 1987[52]) provide an analytical framework to derive these rates. (McKenzie and Mintz, 2011[17]) calculate the EMTR at the provincial level in Canada for oil and gas production and exploration and development.

[15] Royalties are often included along with tax measures for calculating the EMTR. Since the rationale for collecting royalties (i.e. as property rights) may be regarded as fundamentally distinct from that for taxes, their inclusion in the EMTR may not be warranted, thus distorting the resulting tax burden.

[16] The EMTR is one type of effective tax rates that can be used to study the effects of fiscal regimes. (Fullerton, 1984[46]) provides a taxonomy of effective tax rates and discusses how to interpret each type.

Figure 1. The effect of taxation on the cost of raising funds through a combination of equity and debt in the United States can differ substantially from one sector to another (2018)



Note: The effect of taxation on the sector-level capital cost is calculated as an average across firms in each sector using the average cost of capital for each sector and not the user cost of capital, which would take into account the depreciation rate for assets used in the sector. This measure indicates how taxation influences the cost of raising funds through equity and debt for firms and does not take into account the tax incentives nor the depreciation of assets in the sector. Thus, it is a narrower measure. The tax rate used for this calculation is the effective tax rate, defined by the total taxes paid divided by taxable income, and not the marginal tax rate, which would have been the more appropriate tax rate. Firms included in the samples to calculate industry-wide average are publically-traded firms.
Source: Aswath Damodaran: http://pages.stern.nyu.edu/~adamodar/New_Home_Page/.

The EMTR can also be used for cross-country comparison to identify fiscal regimes that favour more than others the expansion of the extractive industry. Unlike tax expenditure estimates, which do not allow for cross-country comparisons because they are based on country-specific benchmarks, the EMTR circumvents this problem. The EMTR is limited to marginal investment decisions and does not capture location-based or discrete investment decisions for initiating a brand new project.

Another effective tax rate indicator that can be used to complement the information delivered by a marginal analysis or that can be used as a stand-alone indicator is the average effective tax rate (EATR). Unlike the EMTR, the EATR is concerned with discrete investment decision of whether to begin well development and extraction. It uses cash flow analysis to inform on whether the tax system encourages new investment to take place in the first place, i.e. the extensive margin. More specifically, the EATR relies on a project-level internal rate of return, which ensures zero net present value of cash flows over the lifetime of the investment, and is expressed as a share of the project's economic profits and gives the percentage of economic profit that is taxed away (Dressler, Hanappi and van Dender, 2018[18]).

The EATR indicates how a fiscal regime can facilitate investment in new fossil-fuel projects, but it requires assumptions on expected revenues and costs that are best representative of the industry. Since such assumptions can be drastically different from one oil field to another or coal mining project to another, the EMTR, which only requires measuring the user cost of capital, might be less sensitive to such specifications. The EATR, on the other hand, could better reflect investment decisions in the resource sector since it accounts for investment decisions for large scale projects with location-specific supernormal returns.

The OECD uses fiscal models to deliver economic indicators such as EATR and EMTR. Building on OECD efforts in documenting and modelling economy-wide corporate effective tax rates, in the electricity sector and for R&D tax subsidies, there is scope to expand these models to account for specificities of fossil fuel extractive industries.[17] Also, the IMF provides an open-source tool, the Fiscal Analysis of Resource Industries (FARI) model, to generate EATR and EMTR as well as other outcomes such as government revenue raised under different fiscal regimes. These OECD and IMF tools remain partial as they take production and investment paths as exogenous parameters. Modelling production of oil and gas, using an optimal extraction model such the one developed by (Anderson, Kellogg and Salant, 2018[19]), can be highly complementary.

2.2.4. Other tools available to evaluate distortiveness in the upstream sector

The use of optimal extraction models can provide a more comprehensive evaluation of the distortiveness of different fossil fuel fiscal regimes as they can quantify production volumes. For example, (Daubanes and Andrade de Sá, 2014[14]) and (Gaudet and Lasserre, 2015[15]) study the impact of different tax provisions on exploration and extraction outcomes, though not quantitatively. (Anderson, Kellogg and Salant, 2018[19]) model the drilling decision of the firm and under simplifying assumptions, as in (Metcalf, 2018[20]), it is possible to analytically derive the additional drilling and production induced by preferential tax treatment.[18]

The impact of fiscal regimes on trade can be inferred. For instance (Metcalf, 2018[20]), constructs a simple model of an oil and of a gas market and calibrates them to reproduce a future global oil price provided by different forecast scenarios. In doing this exercise, he draws on the literature of supply and demand elasticities, and provides a back-of-the-envelope calculation of the impact of tax preferences on macroeconomic outcomes such as global prices, domestic and international supply, and domestic demand. As for the environmental implications of such incentives, the resulting excess production can be converted in CO_2 equivalent quantities and the associated welfare loss can be derived using the social cost of these emissions.

2.2.5. Evaluating distortions from fossil fuel support for industrial end-user sectors

A focus on firm decisions in response to government support programmes allows to study one of the more relevant concerns for OECD and G20 countries about reform of support for fossil fuels reform, i.e. their potentially deleterious consequences on domestic energy-

[17] (Hanappi, 2018[23]), (Dressler, Hanappi and van Dender, 2018[18]), (Cinta Gonzalez Cabral and Appelt, 2018[64]).

[18]The model proposed by (Anderson, Kellogg and Salant, 2018[19]) includes both economic and geophysical factors influencing extraction observed empirically, i.e. that production does not respond to changes in oil prices but drilling activity does. This feature is due to the fact that conventional oil and gas production is constrained by physical conditions, such as pressure, and cannot be adjusted easily to the price conditions. Therefore, the decision to drill an oil well is irreversible.

using industries. Those fossil-fuel support measures that encourage carbon-intensive capital lock-in are inconsistent with climate policy ambitions and hamper the transition to a low-emissions economy. Tax expenditures on energy used by industries are the main support instrument that directly impact their use of fossil fuels. Therefore, deriving some guidance from economic theory will help inform the discussion on how support for fossil fuels causes distortions in the investment, production, and consumption decisions of firms.

Similarly to the method proposed for the upstream sector, distortions generated by support measures for fossil fuels can be captured through an evaluation of how fiscal regimes might reduce the user cost of capital in a given sector. An ETR for end-user industries indicates the extent to which support creates incentives for investment in fossil-fuel consuming industries through preferential tax treatment of their energy inputs. Industry-country specific ETRs can also point to industries that benefit the most from government support and thus inform on the potential impacts of reform across sectors. OECD's *Taxing Energy Use* (TEU) and *Effective Carbon Rates (ECR)* databases provides effective tax rates for energy use, including for industrial users (OECD, 2019[21]; OECD, 2018[22]). Already, data therein shows that 76.5% of emissions are priced below EUR 30/tCO_2, with more than two-thirds of industrial and residential emissions completely unpriced (OECD, 2018[22]).[19]The integration of information on tax benefits for energy inputs could strengthen the capacity of the TEU and ECR databases to inform on capital-related distortions created by the fiscal regime (Hanappi, 2018[23]).

Another approach to measuring the direct impact of fossil-fuel support on resource allocation for end-users is through modelling behavioural responses of end-user industries to government support measures. Given the prevalence of tax expenditures for energy-intensive industries among OECD, a modelling framework similar to that used in (Fullerton and Heutel, 2007[24])and (Heutel and Kelly, 2016[25]) would be suitable to derive and analyse the effect of different types of support measures commonly used to benefit downstream industries. This type of framework provides analytical expressions for the impact of distortionary support measures on output and the allocation of factors of production across two-sectors: an energy-intensive sector and a non-energy-intensive one.

The model is in a closed-economy setting, but can be extended to take into account trade effects. In the model, the energy-intensive sector is one that uses energy as a factor of production in addition to labour and capital; the second sector employs only non-energy factors of production. It is flexible enough to evaluate the role of different support mechanisms benefitting end-user industries, a fossil fuel excise tax reduction being one of them. Additionally, results from such model also allow estimating of the environmental implications of government support through a conversion of energy-use into burnable emissions.

Countries that provide tax expenditures on energy products for their industrial sectors often claim that these measures are necessary for maintaining their domestic industries' international competitiveness and preventing relocation of polluting industries to less environmentally-stringent countries. Several empirical studies on differential energy price impacts on firm performance find that this impact is small relative to other indicators.[20] The above-mentioned analytical framework can complement insights from these studies to

[19] The EUR 30/tCO_2 benchmark represents a conservative estimate of the social cost of carbon.

[20] (Flues and Lutz, 2015[67]), (Garsous and Kozluk, 2017[69]), (Dechezleprêtre, Nachtigall and Venmans, 2018[70]), and (Dechezleprêtre et al., 2019[68]) are among studies tackling the issue of competitiveness and carbon leakage.

further investigate the impact of tax expenditures and other transfers on end-user industries performance.

There are, however, limitations to the suggested modelling framework. Since its equilibrium outcomes are derived from a log-linear approximation of the underlying model, it is only considered robust enough for measuring small changes in tax rates, restricted to a maximum 10%.[21] While it is too simple to derive precise point estimates for effects (Fullerton and Heutel, 2007[24]), it can provide a robust indication of the direction of the impacts.

Another advantage to using such framework is that the functional form of supply and demand equations need not be specified, and the data needed to calculate the impact of a tax reductions on production decisions are available and documented in the literature. Energy, capital and labour use at the sector level are available for OECD and some partner economies. Factor shares, factor expenditure shares in total sector income can also be measured. Elasticities of substitution between inputs and also outputs can be informed on the vast literature dedicated to their estimation.

This framework is similar to the Policy Evaluation Model (PEM) used for evaluating producer support policies in the agricultural and fisheries sector at the OECD. However, it extends the analysis to a two-sector model to address the allocation of factors of production and the share of producer surplus between sectors that are eligible for energy support and those that do not meet the requisite criteria. In this sense, it can shed light on the benefits conferred to the use of fossil fuel energy and emissions-intensive capital lock-in and can point to the impact of government support on wage income.[22]

2.2.6. Evaluating distortions of fossil fuel support to consumption

Under-pricing fossil fuel products relative to the market prices or cost recovery, through regulating domestic price or reducing tax rates, and hence the end-user price, results in increased consumption of fuels relative to an efficient pricing counterpart. (Coady et al., 2017[26]) provide analysis on the fiscal, welfare and environmental distortions caused by the under-pricing of fossil fuels. Their analysis uses a stylised long-run comparative static framework to provide insights on the potential gains from correcting the under-pricing of fossil fuels.[23] Similarly, (Davis, 2014[27]) and (Davis, 2017[28]), measure effect of under-pricing road fuels on consumption and the resulting deadweight loss. The authors use the following data: the private cost of fossil fuels (as set by international markets or cost recovery), the cost of externalities, end-user prices, and demand and supply elasticities. (Jacobsen et al., 2016[29]) offer an alternative way to measure the deadweight loss of second-best energy policies for internalising the external costs. Their proposed method demonstrates that regression results of the externality on the policy instrument can have welfare interpretations provided that certain conditions are met. This method does not rely on demand or supply elasticity estimates. It requires data on the distribution of the externality (e.g. carbon emissions) and the policy instrument used (e.g. effective energy prices).

[21] This restriction is also applied for the OECD PEM model.

[22] To gain insight on the distribution consequences, labour as a factor of production would have to be split into different skill levels, such that the impact of support policies on wages of different skill-levels can be measured.

[23] For the IMF, under-pricing of fossil fuels is measured relative to an efficient price level that comprises environmental and health externalities.

2.2.7. Evaluating the incidence of fossil fuel support

It is not always straightforward to ascertain the incidence of a government support programmes because those who are directly targeted or eligible for a support programme do not necessarily coincide with those that benefit from it; the statutory incidence and the economic incidence of support are not always the same. Fossil fuel taxes are important fiscal instruments deployed to raise revenues and to internalise negative externalities associated with the use of fossil fuels. The price pass-through of such instruments is highly dependent on the market structure and its price-setting behaviour. When the market is competitive, firms shift the burden of energy taxes completely onto consumers, whereas in imperfectly competitive settings, the price changes to consumers pass-through can be more or less than proportional to the changes in tax rates (Fullerton and Metcalf, 2002[30]) and (Flues and Thomas, 2015[31]).[24]

At the same time, tax expenditures that reduce the prevailing statutory tax rate on energy products for some consumer classes, such as agricultural and manufacturing sectors, are pervasive among OECD and G20 countries. The implications of these tax expenditures on household income and consumption are therefore important for understanding the extent to which the benefits are passed on to consumers, including across income-levels, and inform on the potential equity issues that can arise. Micro-simulation models that use household surveys with data on income and expenditures are specifically designed to study such questions.

In emerging and less developed countries, consumer price support is a policy tool that has been used, among other objectives, to extend energy access and affordability as well as alleviate poverty, particularly in fossil-fuel-resource-rich countries. Several country studies have shown that the under-pricing of energy products benefits richer households more than proportionally (Arze del Granado, Coady and Gillingham, 2012[32])and (Lustig et al., 2013[33]). Tools to analyse the distribution of such support across income groups are widely available within the OECD and externally; Commitment to Equity (CEQ) Institute and the IMF, among other, have built publically accessible toolkits to this end.

2.2.8. Prioritising fossil-fuel support measures for reform

This last step towards assessing the relative distortiveness of support measures for fossil fuels is to develop indicators on different outcomes – ETRs, production, investment, consumption, environmental, and welfare – that capture the relative impact of one measure versus another. From the analytical tools discussed above, a parsimonious way to ascertain relative distortions, is to take the outcomes of the reference fiscal regime as numeraires against which to measure the relative distortiveness of support measures. The ratios between the reference case and the case with a given support policy can be used to rank support measures along different dimensions.

In the case of effective tax analysis, the difference between the ETRs delivered through a chosen reference fiscal regime can be used as the baseline against which to gauge the effects of different tax provisions on the allocation of capital across sectors. The EMTR differential between the oil and gas sector and the reference fiscal system, for example, informs on the relative treatment of the concerned industries and thus the relative incentives offered at the

[24] Such models may not capture all features that impact the cost pass-through of energy prices. Other factors can also include whether the cost change is firm specific or industry wide, the sensitivity to demand and supply and associated elasticities in addition to the degree of nonlinearity of these curves. Also the cost pass-through can be affected by the income distribution of households, by whether the general price level rises or remains unchanged, regional variations and whether the models used account for overlapping generations (RBB Economies, 2014[71]; Ganapati, Shapiro and Walker, 2020[73]).

intensive margin. Differences in EATRs between the reference case and the tax regime that includes a support measure would indicate the relative incentives delivered to new investments, thus at the extensive margin. Investment distortions can be analysed along several dimensions: intertemporal, inter-asset types, inter-jurisdictions, and inter-sectoral (Mckenzie, 2016[34]). The effective tax analysis, while comprehensive in terms of the tax provisions it can assess, stops short of delivering insights on the relative impact of different support measures on other behavioural outcomes of interest.

Partial-equilibrium and general equilibrium models by (Anderson, Kellogg and Salant, 2018[19]) and (Heutel and Kelly, 2016[25]), respectively, are examples of analytical frameworks that can shed light on how different support policies deliver different production, investment and consumption outcomes and environmental and welfare implications compared with a reference fiscal regime. Eventually, the different policies can be *ranked* according to their impact along these different dimensions. Those policies that create the largest deviations from a reference fiscal regime could be put forward for reform.

2.3. Identifying and quantifying adverse effects that might hinder reform

The analytical frameworks described above are useful for identifying the most distortive measures that can be considered good candidates for reform. However, they provide a limited assessment of the reform consequences of fossil-fuel support. By not taking into account the forward and backward linkages between upstream fossil fuel producers and downstream industrial consumers and other end-users (e.g. transport and residential users), they are silent on the implications of reforms.

The phasing-out of fossil-fuel support may have some unwanted economic and social effects that could hamper its political acceptance and jeopardise the reform process. These possible effects should be anticipated by assessing the distributional consequences and their implications for firm and industrial performance of increasing energy and capital costs. The analytical tools discussed in this section can inform on the transmission mechanisms of reforms and identify the potential winner and losers.

Adverse effects of a reform of a support programme for fossil fuels can be direct or indirect. Direct effects emanate from behavioural responses of individuals and firms targeted by the specific government support. Indirect effects result from price changes for inputs and outputs throughout the fossil-fuel value chain that shift consumption and production patterns along that chain, and can induce macroeconomic and trade effects. There are two widely-used approaches to evaluate the impacts of reforms: empirical and modelling-based methods.

2.3.1. Econometric studies using micro-data

Econometric studies that examine distributions consequences of policies, often rely on surveys with high granularity, at the firm or at the household level, on expenditures and incomes. They provide precise information on the effect of reform on consumption demand or more generally their welfare implications by studying the erosion of household income or firm competitiveness.

Empirical analysis using household or firm surveys can provide important information on the groups affected by the phasing-out of fossil-fuel support and the magnitude of this impact. The micro-data available with the survey allows for a precise assessment of distributional effects of reforms, including effects on poverty or inequality. The OECD has done work using household budget surveys to investigate heterogeneous effects of energy tax reform on households across different income and demographic groups (Flues and Thomas, 2015[31]).

Other institutions have also developed open-source modules to help policy makers understand the distributional impacts of reforms based on household surveys. The IMF developed a tool for analysing the distributional impacts of fuel subsidy reforms emanating from both direct and indirect effects of price changes on household income (Fabrizio, Goumilevski and Kpodar, 2016[35]). The Commitment to Equity (CQE) Institute developed a framework to analyse the incidence of taxes and benefits and applied it to a gamut of low to medium-income countries (e.g. (Enami and Lustig, 2018[36])).[25] Survey-based tools may also prove to be useful simulating alternative compensation measures accompanying the reform (an increase of means-tested benefits, for instance).

However, survey-based studies suffer from important limitations. Their coverage is restricted to a country (or region), or a sector, which weakens the general validity of their conclusions. Also, this approach cannot account for spill-over effects that do not fall within the scope of the analysis and it might not allow for dynamic responses to an initial policy change as it often provides only short-term information on the consequences of reforms and does not capture behavioural responses.

2.3.2. Structural and computable general-equilibrium models

Structural models provide additional insight on the possible impacts of reforms since the outputs are more complete and they may allow for dynamic and long-term predictions of responses to an initial policy shock. These models, which posit a partial (sectoral) or general equilibrium (at the country or global level), simulate the reform considering a set of equations defining the relationships between economic agents, and compare the results thus obtained to a business-as-usual scenario. Sectoral models are useful to precisely assess impacts for the energy sector or other specific industries, though computable general-equilibrium models (CGE), are usually favoured at the country or global level, as they provide more complete information on macroeconomic variables and GHG emissions. CGE models may be dynamic and introduce markets' responses to a policy reform and transition and structural changes for the medium and long term. They are also modular in nature and can be extended to account for more indirect and feedback effects of households on upstream sectors.

Such models provide much information but still have their shortcomings. They are data and resource-intensive and often rely on fixed parameters (for instance, the proportion of income saved by households), which may change over time. These parameters are often determined by empirical studies, the results of which may be hard to extrapolate. Computing capabilities also limit the extent to which particular industries and countries (or regions) can be singled out, thus narrowing the range of questions that models can address. As a consequence, structural models should not be considered as precisely predictive, but as a tool to anticipate likely effects. They can also be complemented with insights from survey-based analysis.

The OECD is endowed with CGE models that are tailored to address specific policy areas and that can be used to study the questions at hand. ENV-Linkages is used to study climate change mitigation policy and the METRO model is developed to explore the economic impact of changes in policy, technology and other factors. The ENV-Linkages model was used to examine the macroeconomic, environmental and distribution consequences of energy subsidy reforms applied to Indonesia (Durand-Lasserve et al., 2015[37]). The model was extended to account for households' income distribution since its generic form limits the analysis to a single representative household type. By accommodating for household

[25] These tools have been mostly used to study the impacts of fuel price reforms on household incomes in developing countries.

heterogeneity, the CGE model delivered insights on how the effects are felt by different groups in the population. In the same vein, the OECD Trade model METRO (ModElling TRade at the OECD) is undergoing an extension to accommodate for distributional effects by mapping the information from household budget surveys to the model's structure.[26]

Several universities and research institutions have energy-specific models, such as the University College London Energy Institute's suite of energy models, ranging from a bottom-up model, BUEGO, which captures project-level oil and gas extraction information to an integrated assessment model, TIAM-UCL-IAM, which aims to captures the complexity of the climate system.[27] Table 2 summarises the main modelling tools to evaluate the effects of reform of fossil fuel support.

Table 2. Modelling tools for studying the impact of reform of fossil fuel support

Scope	Indicators	Tools
Macroeconomy	GDP Inflation Public debt Employment	CGE model
Firms	Competitiveness Redistribution between firms or sectors	Micro-simulations based on firm survey Empirical model Sectoral model CGE mode (with specific adds-on)
Households	Inequality Poverty Redistribution across income groups	Micro-simulations based on household surveys CGE model (with social add-on)
Environment	GHG emissions	CGE model Micro-simulation models based on household and firm surveys

2.4. Finding alternatives to subsidised activities

Since fossil-fuel support programmes is diffused throughout the economy, affecting economic, social, and environmental outcomes, their reform is to be accompanied by alternative measures that not only alleviate the negative effects of reforms, but also contribute to channelling the resulting fiscal savings to more productive uses. In that sense, an inclusive fossil-fuel support reform necessitate a whole-economy approach and fit in the context of energy transitions that protect vulnerable populations from potential harm.

Given the diversity of countries providing support for fossil fuels, country-specific reform packages, including alternative policy measures, should be designed to deliver a low-emissions energy-transition that enables economic growth and social inclusion. If the carbon budget become binding, fossil-fuel capital assets and reserves run the highest risk of becoming stranded. Transition programmes for concerned sectors, as in the case of coal, should be anticipated, especially as pressure mounts for countries to phase-out their coal-fired power plants.

An organising concept used in economics to evaluate alternative policy options is the criterion of Pareto or near-Pareto improvements, whereby policy reform increases welfare compared to a situation without reform. Although, there is some scope for reducing distortions from fossil-fuel support, there can be trade-offs between the objective of having economically efficient policies, "equitable" income distribution, and better environmental

[26] See: ECO/CPE/WP1(2019)16.

[27] See: https://www.ucl.ac.uk/energy-models/.

outcomes. When existing policies are poorly designed and inefficient, their reform can result in deterioration of both efficiency and distribution outcomes. In other cases, the prospect of reform can pose difficult political choices. Therefore, designing alternative policies require a balancing act among these different goals. Clearly stated policy objectives, that harness synergies among seemingly disparate policy areas, can facilitate designing a Pareto improved reform agenda.

In order to build a policy reform package that includes compensation measures, insights from empirical and simulation work on the distributional effects of reforms across households and firms will allow to identify the groups that would be most affected by the reform and eventually develop alternative strategies to alleviate the adverse effects. OECD work and the broader literature have pointed to economic and distributional improvements, as well as emissions reductions due to better-targeted fuel subsidies or means-tested cash transfers relative to consumer price support, i.e. government regulation that lowers domestic prices relative to market prices.[28] The OECD work on structural reform undertaken through the *Going for Growth* work stream, identifies reform priorities for each country. It does so in an integrated way as to provide reform packages that account for the synergies and trade-offs among policies to mitigate adverse effects (OECD, 2019[38]). For example, in the case of reforms of fossil-fuel support, a combination of increasing energy taxes on firms and lowering labour costs has been identified as an alternative measure to reduce the "deadweight loss" from subsidies, while mitigating the impact of higher energy-input costs.[29] For fossil-fuel resource revenue dependent countries and regions, opportunities for economic development outside the sector should be part and parcel of a reform programme, particularly as unsubsidised coal becomes an unviable source of energy (Morris, Kaufman and Doshi, 2019[39]).

[28] (Rentschler, 2015[57]), (Yusuf and Resosudarmo, 2008[58]), and (Forward, Bhattacharya and Batra, 2008[59]).

[29] Some references on the design and implementation of energy or carbon tax and the accompanying fiscal adjustments are: (Welsch, 1996[60]), (Metcalf, 2014[61]), and (Metcalf, 2017[62]).

Conclusion

The proposed sequential approach demands the use of various analytical tools to measure the budgetary cost of support, quantify its effects on economic and environmental outcomes, and eventually investigate viable alternatives to address the distributional and competitiveness impacts that may emerge with reform. Countries can scale at their own pace the breadth and depth of their analysis along the different steps of this approach. Enhancing transparency on the ways a government deliver support to fossil fuel user and producers remains an essential first step towards reform.

The effective tax rate analysis, which is particularly relevant for OECD countries and G20, that provide most of their support for fossil fuels through tax expenditure, is useful in providing a stocktake of how tax regimes impact the allocation of fossil-fuel intensive capital in the economy. The risk of carbon-lock and stranded assets is becoming ever more pertinent with important implications for the long-term competiveness of fossil-fuel and energy-intensive industries. Indicators like the EMTR and EATR for these sectors inform on the distortions caused by tax expenditure measures on capital investments, and therefore represent a reasonable second step following the inventory building stage in the sequential approach.

The ranking of the different support measures according to their level of distortiveness, allows for an evidence-based prioritisation scheme for a reform process of fossil-fuel support. However, it does not address some important concerns that render reform difficult to implement and politically sensitive. To mitigate the potential adverse effects that ensue, particularly those affecting vulnerable populations and sectors, analytical tools are recommended and the last two steps in the sequential approach hone in on empirical work that can be used to tackle these issues.

The proposed sequential approach gives way to a framework that can be applied to inform reforms of fossil-fuel support measures. The OECD Secretariat stand ready to support countries that would volunteer to apply the sequential approach to obtain evidence-based recommendations for reform of government support for fossil fuels.

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Annex A. Definition of fossil-fuel subsidies

Different definitions are used by organisations that measure and evaluate fossil fuel or wider energy subsidies, particularly the World Trade Organization (WTO), the OECD, the IEA and the IMF. These definitions are based either on the form of policy intervention by governments (WTO, OECD), or the effect of some of these measures on cost and prices (IEA, IMF).

It remains, however, that a starting point for many initiatives working toward fossil-fuel subsidy reform is the subsidy definition in the Agreement on Subsidies and Countervailing Measures (ASCM) under the World Trade Organization (WTO). It is the most widely recognised definition of a subsidy and is the only definition that is legally binding for all WTO member countries; the ASCM currently has 164 WTO members as signatories. While the ASCM is not specific to fossil-fuel subsidies, it has been useful as an organising framework in the policy area.

More specifically, Article 1 of the ASCM ("Definition of a Subsidy") identifies broad forms of government support that it considers covered by the term "subsidy". It indicates that *a subsidy shall be deemed to exist if:*

i. *practice involves a direct transfer of funds (e.g. grants, loans, and equity infusion), potential direct transfers of funds or liabilities (e.g. loan guarantees);*

ii. *government revenue that is otherwise due is foregone or not collected (e.g. fiscal incentives such as tax credits);*

iii. *a government provides goods or services other than general infrastructure, or purchases goods;*

iv. *a government makes payments to a funding mechanism, or entrusts or directs a private body to carry out one or more of the type of functions illustrated in (i) to (iii) above which would normally be vested in the government and the practice, in no real sense, differs from practices normally followed by governments;*

or

b. *there is any form of income or price support in the sense of Article XVI of GATT 1994;*

and

c. *a benefit is thereby conferred.*

The OECD definition of "government support" used since 2011 to build its inventories follows the WTO-ASCM definition. The Global Subsidies Initiative (GSI) and several other NGOs also use the WTO-ASCM definition (Gerasimchuk et al., 2017[40]). A simplified version of the WTO-ASCM was used by the United States and China in the G20 Peer-reviews of Fossil Fuel Subsidies published in 2016, Mexico and Germany in 2017, and Indonesia. More recently, the broad ranging concept of "support" was also adopted to track and measure the Sustainable Development Goal Indicator 12.c.1 on fossil-fuel subsidies (UN Environment, OECD and IISD, 2019[8]).

The OECD definition of "support" for fossil fuel "includes both direct budgetary transfers and tax expenditures that in some way provide a benefit or preference for fossil-fuel production or consumption relative to alternatives. This broader definition therefore

encompasses policies that can induce changes in the relative prices of fossil fuels. However, although the present inventory covers measures that provide support (either absolute or relative) to fossil fuels, it does not attempt to assess the impact on prices or quantities of the measures considered, nor does it pass any judgment as to whether a given measure is justified or not."

The definition developed by the OECD serves as the basis for their inventory of support measures for fossil fuels in OECD countries and a selection of partner countries. The OECD describes what it finds as "support" measures rather than subsidies. In practice, there is generally a wide overlap between OECD "support" and WTO "subsidy", and the two would typically yield a similar set of measures if inventories were built from them.

While maintaining a broad definition of government "support" increases transparency on possible distortive measures, the inclusion of tax expenditures renders estimates of support difficult to compare across countries. The reported estimates of fiscal revenue that is foregone due is relative to a nationally determined benchmark tax rate. Therefore, tax expenditure estimates require caution when used for international comparisons of fossil fuel support.[30]

[30] For an in-depth discussion on the international comparability of tax expenditure estimates, consult the discussion note by the Secretariat: COM/ENV/EPOC/CTPA/CFA(2019)3.