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Evidence.
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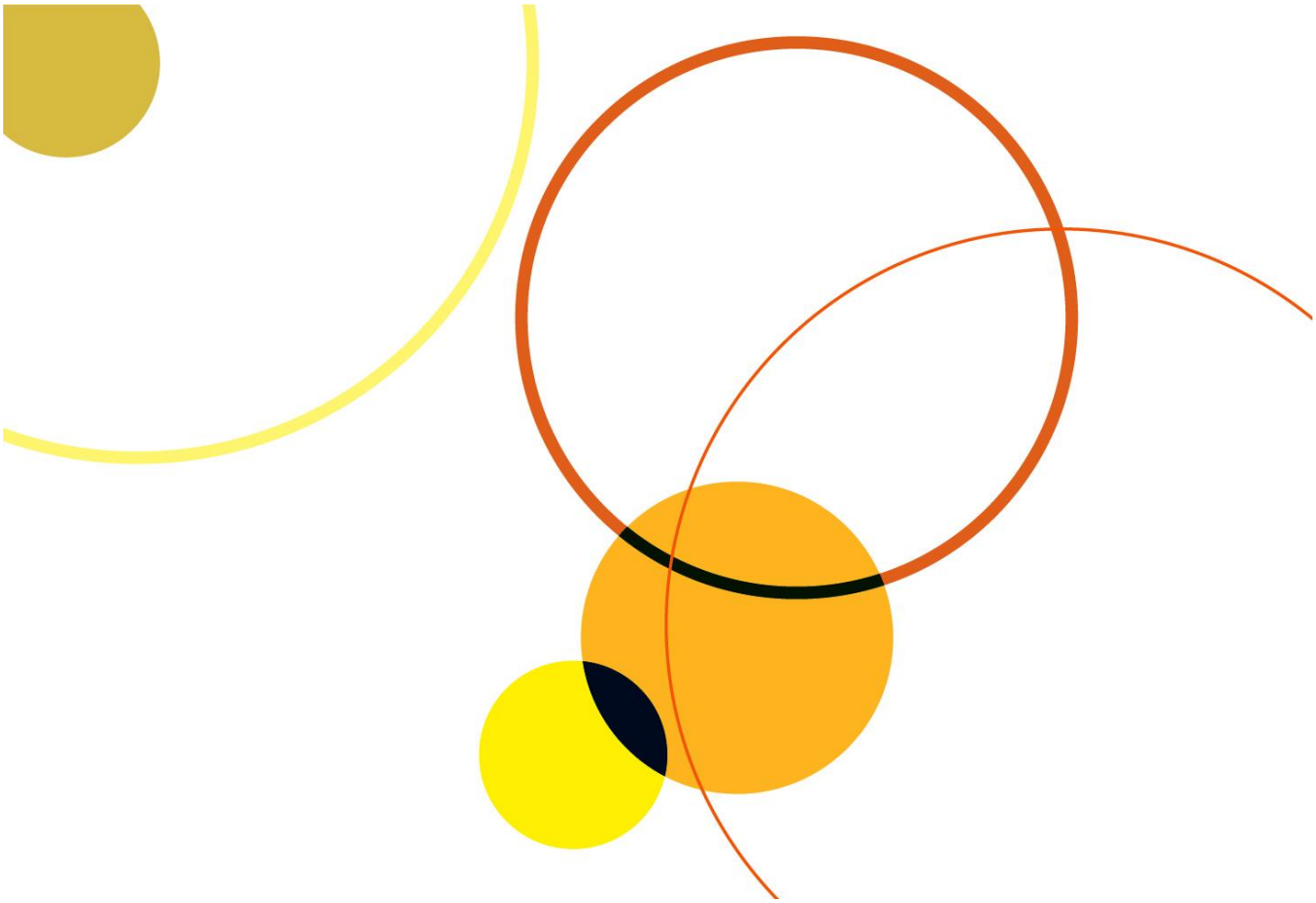
Estimating Effective Carbon Prices: Accounting for Fossil Fuel Subsidies

Vivid Economics and the Overseas Development Institute report for the Carbon Pricing Leadership Coalition

January 2019



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1 Introduction

Fossil fuel subsidies create a negative carbon price. The recent report of the High-Level Commission on Carbon Prices emphasises that "*reducing fossil fuel subsidies is another essential step toward carbon pricing—in effect, these subsidies are similar to a negative emissions price.*"[1] Without fossil fuel subsidy reform, carbon pricing is significantly undermined, and low-carbon technologies are made inefficiently more expensive. Consistent with this, a key recommendation of the 2018 report of the Global Commission on the Economy and Climate was that all developed and emerging economies, and others where possible, commit to introducing or strengthening carbon pricing by 2020, and phase out fossil fuel subsidies.[2] The report found that subsidy reform and carbon pricing alone could generate an estimated US$2.8 trillion in government revenues per year in 2030 – resources that can be used to invest in public priorities.

As such, there is a need to provide clear metrics that link the phasing out of fossil fuel subsidies with carbon pricing to strengthen policy action and accountability. Although there have been calls to incorporate subsidies into the analysis of effective carbon prices, to date, this analysis has been limited.

These linkages have been echoed by key investor and business groups. The 'Investor Agenda' representing almost 400 investors with over $32 trillion in assets under management has called for governments to "*put a meaningful price on carbon, and phase-out fossil fuel subsidies by set deadlines*".[3] The 'We Mean Business' coalition, representing over 800 companies, developed definitions for five carbon pricing bands to provide a common language to talk about pricing levels. This includes negative carbon prices/fossil fuel subsidies (see Figure 1 over page). They highlighted that this negative price on carbon is one way that governments boost fossil fuel consumption and render low-carbon alternatives economically less viable.[4]

The aim of this analysis is to develop two complementary approaches for determining and reporting on both carbon prices and fossil fuel subsidies in conjunction with each other. We label these the 'revenue' and 'price' approach and apply each to the United Kingdom (UK) as a first case study, to test how this analysis might be replicated for all the G7 countries. If taken up by key governments and international institutions, these metrics would significantly increase transparency around fossil fuel subsidies and support fiscal policy coherence through more robust carbon pricing combined with wider fiscal tools to implement climate policy. This, in turn, would create far stronger signals for the private sector to shift funding away from high-carbon activities, especially fossil fuel production and consumption.

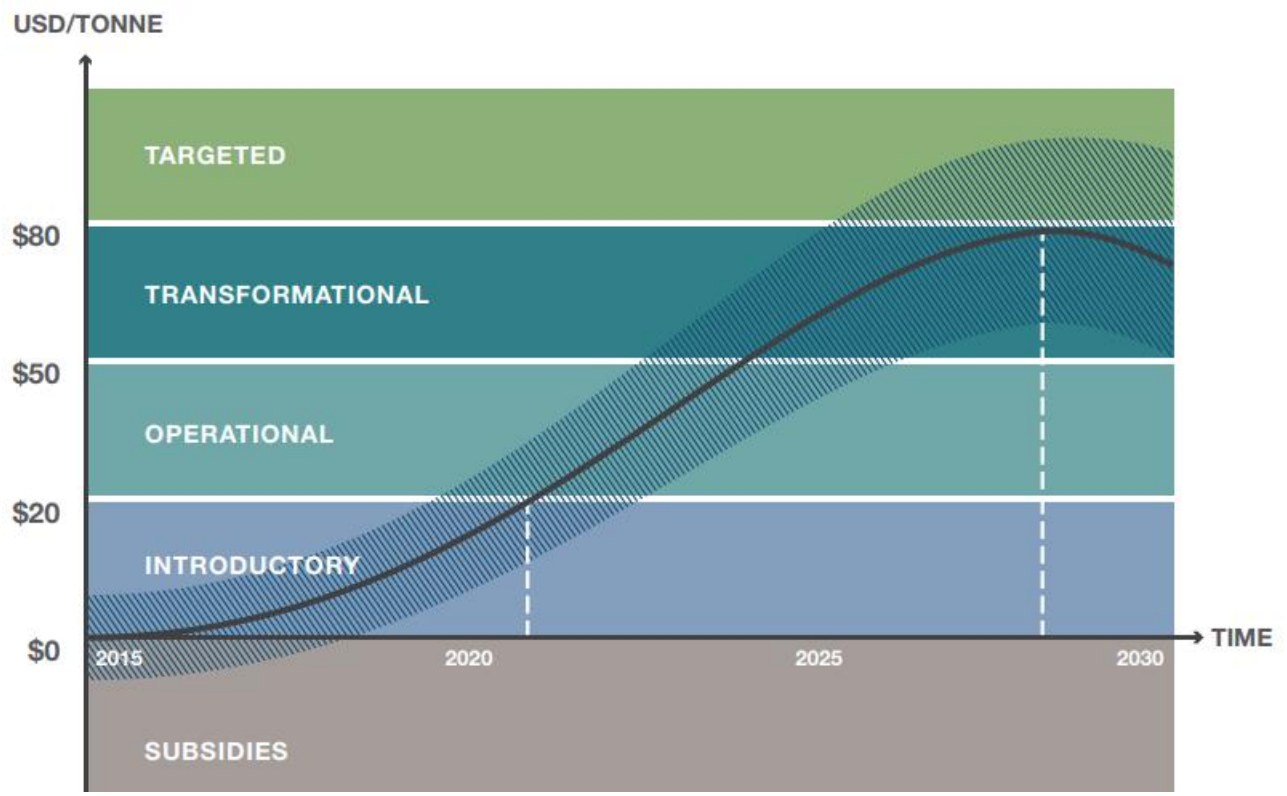
[1] Carbon Pricing Leadership Coalition (2017). Report of the High-Level Commission on Carbon Prices

[2] New Climate Economy (2018) Unlocking the Inclusive Growth Story of the 21st Century

[3] Investor Agenda (2018). 2018 Global Investor Statement to Governments on Climate Change

[4] CDP and the We Mean Business Coalition (2015) Carbon Pricing Pathways

Figure 1. **Carbon pricing bands and trajectories**



Source: *Carbon Disclosure Project and We Mean Business, 2016*

2 Fiscal policy tools shaping the transition to a low-carbon economy

Fossil fuel subsidy measurement seeks to assess the extent of preferential treatment for fossil fuel production and use; effective carbon prices, seek to calculate the explicit costs of carbon and energy taxation; while implicit carbon prices seek to extend consideration of these costs to measures outside of the tax-and-transfer system that influence the relative competitiveness of high- and low-carbon activities. The following section highlights the different fiscal tools that governments are currently deploying that influence the relative competitiveness of high- and low-carbon activities, and the approaches currently used to quantify 1) fossil fuel subsidies and 2) effective and implicit carbon prices.

2.1 Quantifying fossil fuel subsidies

In recent years there has been increased pressure for the reduction or removal of fossil fuel subsidies as part of an integrated policy response to climate change. Reflecting this, there have been several efforts to define, identify and quantify the level of fossil fuel subsidies.

In its Agreement on Subsidies and Countervailing Measures, the World Trade Organization (WTO) defines a subsidy to include financials contribution by a government, or agent of a government, that is recipient-specific and confers a benefit on its recipients in comparison to other market participants.[5]

This definition has been accepted by the 164 WTO Member States, including all G7 countries, and includes the following subsidy categories:

1. **direct transfer of funds** (e.g. budgetary transfers, grants, loans and equity infusion), and potential direct transfers of funds or liabilities (e.g. loan guarantees), below market value
2. **government revenue that is otherwise due, foregone or not collected** (e.g. fiscal incentives such as tax expenditures)
3. **government provision of goods or services other than general infrastructure**, or purchase of goods, below market value
4. **income or price support**.

The WTO does not, however, quantify energy subsidies. Rather, the three most prominent approaches adopted by international organisations are:

1. **The OECD's inventory approach** which quantifies the value of the policies and measures introduced by governments that support the production or consumption of fossil fuels.
2. **The IEA's price-gap approach** which identifies the impact of policies supporting fossil fuels by measuring the difference between final consumer prices and a representative non-subsidised price (adjusted for transport and distribution costs).

[5] WTO (1994) Agreement on Subsidies and Countervailing Measures

3. **The IMF's efficient-tax approach** identifies the price-gap between the actual cost of consuming a fossil fuel and the efficient price, that would prevail if the externalities associated with that consumption were efficiently priced.

These measures have different attributes that make them appropriate for different uses. The OECD's inventory approach provides a clear definition of the specific policies that support fossil fuel consumption, and draws links between fiscal and energy policy, but does not capture the impact of policies, such as renewable energy mandates, that impact prices and consumption but do not directly affect a government's fiscal balance.[6] The IEA's price-gap approach identifies the net impacts of policies on prices, however the value of producer support estimates must be calculated separately (using the inventory approach). In this approach, the effects of specific consumption subsidies are also unclear and the impact of policies that have a countervailing impact on prices may be missed. Although focussed on consumption subsidies the IMF's efficient tax approach provides the broadest measure. It references the data of the OECD and IEA to establish a price-gap measure of consumption subsidies, and then calculates the difference between actual tax treatment and the efficient tax level for a fuel and/or sector to estimate 'pre-tax subsidies'. It then calculates the additional VAT revenue that is foregone by not pricing the energy sector at efficient prices, so-called 'post-tax subsidies'. Externalities considered by the IMF include climate change, local air pollution, congestion and road accidents and damage. However, identifying and quantifying these externalities is often deeply uncertain.[7]

The approaches above are methodologically distinct, but complementary. For instance, in 2018, an OECD and IEA review combined estimates from the inventory and price-gap approaches to estimate fossil fuel subsidies in 76 countries[8] (responsible for 94 per cent of global CO_2 emissions). This analysis includes country by country estimates of budget transfers and tax expenditures for the production and consumption of oil, gas and coal but does not include subsidies provided through public finance (government grants, concessional loans, equity, guarantees and insurance), nor direct government provision of goods and services (such as investments in state-owned enterprise) or income and price support (such as through capacity mechanisms). The studies found that support to fossil fuels reached US$373 billion in 2015.[9] While significant, these subsidies are small when compared to the post-tax subsidies provided by not pricing the externalities, such as unpriced pollution or traffic congestion, associated with fossil fuel consumption. The IMF's estimates suggest that in 2015, this broader set of subsidies were likely to be more than US$5 trillion.[10]

[6] This includes accounting for transfers to producers that compensate them for selling fossil fuel products for below-market prices. An explicit measures approach is also used by the Global Subsidies Initiative, which uses the World Trade Organisation's definition of a subsidy as its basis for definition and quantification.

[7] The IMF's measure of post-tax subsidies accounts for the social cost of carbon (SCC), which links this estimate of subsidies with the discussion on carbon pricing below. For estimates of the SCC see: US IAWG (2013) Technical Update of the Social Cost of Carbon

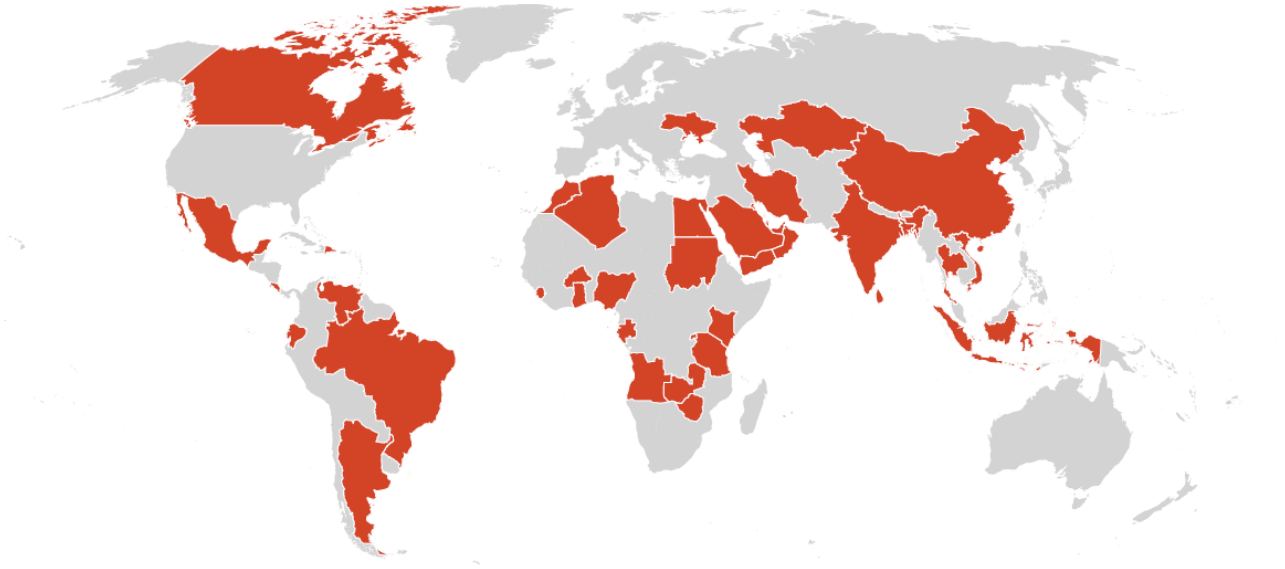
[8] OECD (2018) Companion to the Inventory of Support Measures to Fossil Fuels

[9] Parallel research by the IEA found that subsidies for renewables in power generation amounted to $140 billion in 2016 (IEA, 2017).

[10] IMF (2015) How Large are Global Energy Subsidies?

With the work of these organisations, alongside research organisations and civil society groups, there has been significant improvement in our understanding of the magnitude and distribution of fossil fuel subsidies. Further, several countries have taken up fossil fuel subsidy reforms in the past few years, as shown in Figure 2. Nonetheless, substantial gaps remain due to limited transparency at the national level, and a full accounting of global energy subsidies (to fossil fuels and renewables) has never been completed. As a result, it is likely that global estimates are well below current levels of support.

Figure 2. **Countries implementing some level of fossil fuel subsidy reform in 2015-17**



Source: *New Climate Economy, 2018, Unlocking the Inclusive Growth Story of the 21st Century: Accelerating Climate Action in Urgent Times, drawing on International Institute for Sustainable Development, 2017; and IEA, 2016*

2.2 Quantifying effective and implicit carbon prices

Effective carbon prices look at the other side of the fiscal ledger, seeking to identify incentives to reduce fossil fuel consumption and related emissions. Governments currently use a range of instruments with the goal (either explicit or implicit) of steering their economies towards low-carbon activities. The 2018 OECD report on "Effective Carbon Rates" (ECR)[11] calculates effective carbon prices in 42 OECD and G20 countries (representing 80 per cent of world emissions), and six sectors: road transport, off-road transport, industry, agriculture and fisheries, residential and commercial electricity.

Under the OECD approach, the ECR is the total carbon price that applies to CO_2 emissions from energy use because of market-based policy instruments. The effective carbon rate adds up taxes and tradable emission permit prices, and has three components:

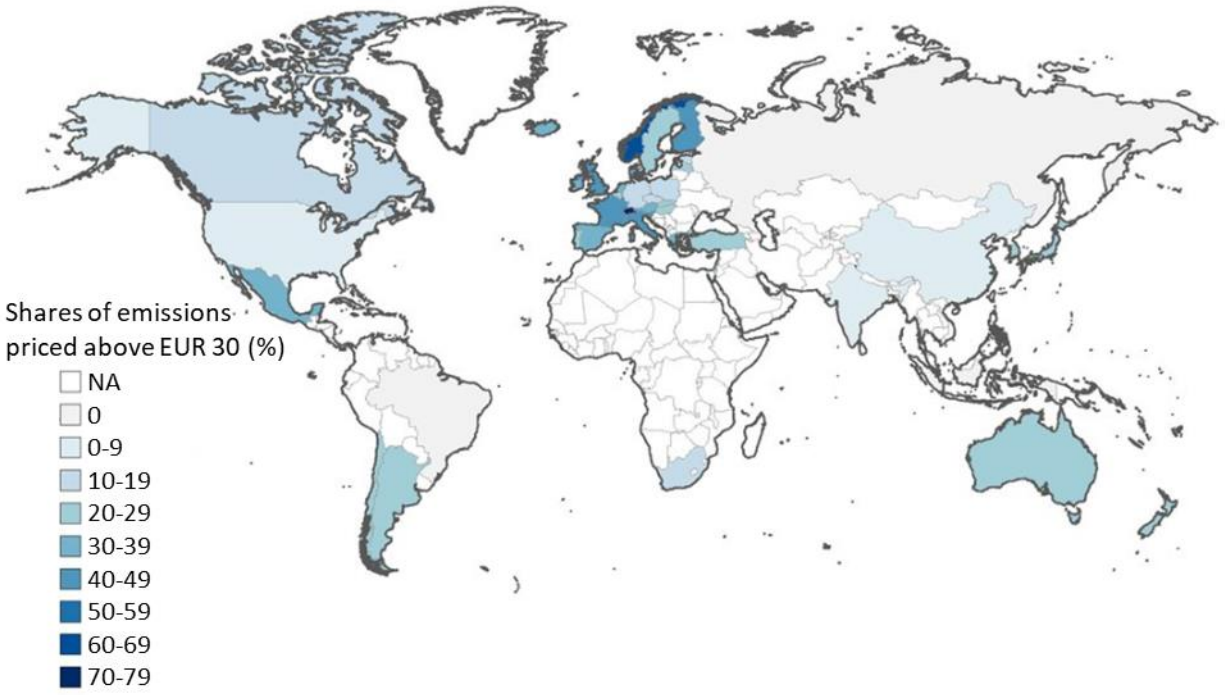
1. **carbon taxes**, which set a tax rate on the carbon content of each form of energy;

[11] OECD (2018) Effective Carbon Rates

2. **other specific taxes** (primarily excise taxes) on energy use, which are typically set per physical unit or unit of energy, but which can be translated into effective tax rates on the carbon content of that form of energy; and
3. **the price of tradable emission permits** that must be surrendered per unit of CO_2 regardless of how it was acquired, representing the opportunity cost of emitting an extra unit of CO_2.

Figure 3 illustrates some of the key results from this work, reporting the share of emissions from energy use that are priced in excess of €30/tCO_2 (tCO_2).

Figure 3. **Share of emissions from energy use priced above €30/tCO_2**



Note: *Legend text replicated from original for clarity*

Source: *OECD, 2018, Effective Carbon Rates*

The ECR approach utilises an inventory approach, and in aggregating explicit carbon prices and energy specific taxes, compares incentives stemming from government taxation policy. In doing so, however it overlooks the potential countervailing forces stemming from fossil fuel subsidies.

Implicit carbon prices provide the final piece of the puzzle, as they consider not just policies that result in direct prices or have explicit fiscal consequences, but also those that set rules that introduce further costs. Implicit carbon prices have been used widely, most often to assess individual policies or in a subset of sector's, most often the electricity sector. For instance, one study found that, in 2010, the implicit carbon price associated with the renewable energy surcharge to fund feed-in-tariffs in Germany reached

€63/tCO_2.[12] Another study, by the Institute for Fiscal Studies, calculated the implicit carbon price for electricity and gas consumers in the UK, and found that while most business faced an implicit carbon price on electricity of close to £40/tCO_2 or more, consumption of gas faced a very low carbon price with household consumers even receiving an effective subsidy for gas consumption.[13] An earlier study by Vivid Economics estimated the implicit price on carbon in the electricity sector in six major economies, finding that the implicit carbon price ranged from just US$0.50/$tCO_2$ in South Korea, to up to US$28/$tCO_2$ in the UK.[14] While these studies provide a useful starting point, implicit carbon prices have generally been calculated for specific policies or sectors, with less of a focus on how they contribute to the overall impact of the government in supporting low-carbon energy.

[12] Claudio Marcantonini, A. Denny Ellerman, 2015. The Implicit Carbon Price of Renewable Energy Incentives in Germany, The Energy Journal, 0(4).

[13] Institute for Fiscal Studies, 2013, Energy use policies and carbon pricing in the UK

[14] Vivid Economics, 2010, The implicit price of carbon in the electricity sector of six major economies

3 Accounting for energy and carbon policies

Building on the discussion in section 2, this section draws together strands of existing literature on effective carbon prices, implicit carbon prices, energy taxes and fossil fuel subsidies to provide two alternative approaches to developing an international-comparable snapshot of policies encouraging or constraining fossil fuel consumption within an economy. They each represent a comparable metric that can be tracked across jurisdictions to complement existing metrics. The two approaches are:

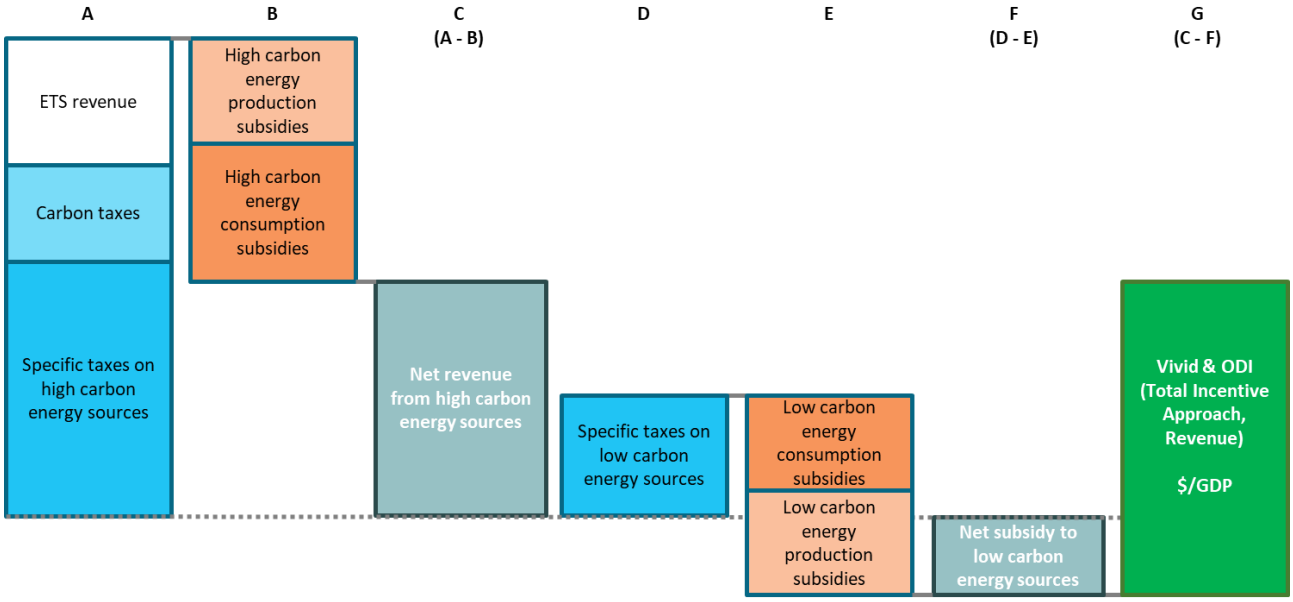
— **The revenue approach** which estimates the net fiscal stance of a government towards high-carbon compared to low-carbon technologies and how they help or hinder the low-carbon energy transition.
— **The price approach** which seeks to identify the total set of incentives provided by policies that alter energy prices, per tonne of CO_2 associated with the combustion of that energy, within a jurisdiction. This includes policies that introduce an explicit price and those that might undercut that price, capturing both those with explicit budgetary impacts, as well as off-budget measures such as minimum obligations for renewable generation.

These approaches can be mapped against those used in the fossil fuel subsidy literature, with the revenue approach broadly aligning with the inventory approach, and the price approach aligning conceptually with the price-gap approach or an implicit carbon price approach.

The revenue approach compares the deviation from standard tax and transfer treatment for both high-carbon and low-carbon energy sources, to approximate the net fiscal stance of the government to low-carbon energy, as shown in Figure 4 (over page). This can be normalised by GDP to provide a comparable metric across countries. By contrast, the price approach identifies the overall incentive created by government for all energy consumers to reduce emissions, relative to standard tax treatment. It includes explicit carbon prices, specific taxes on energy, subsidies that impact consumer prices and other policies that seek to alter the implicit price of carbon. This builds on much of the existing effective carbon price literature. As such, Figure 5 (over page) shows the calculation of the price approach and its relationship with the OECD's ECR approach.

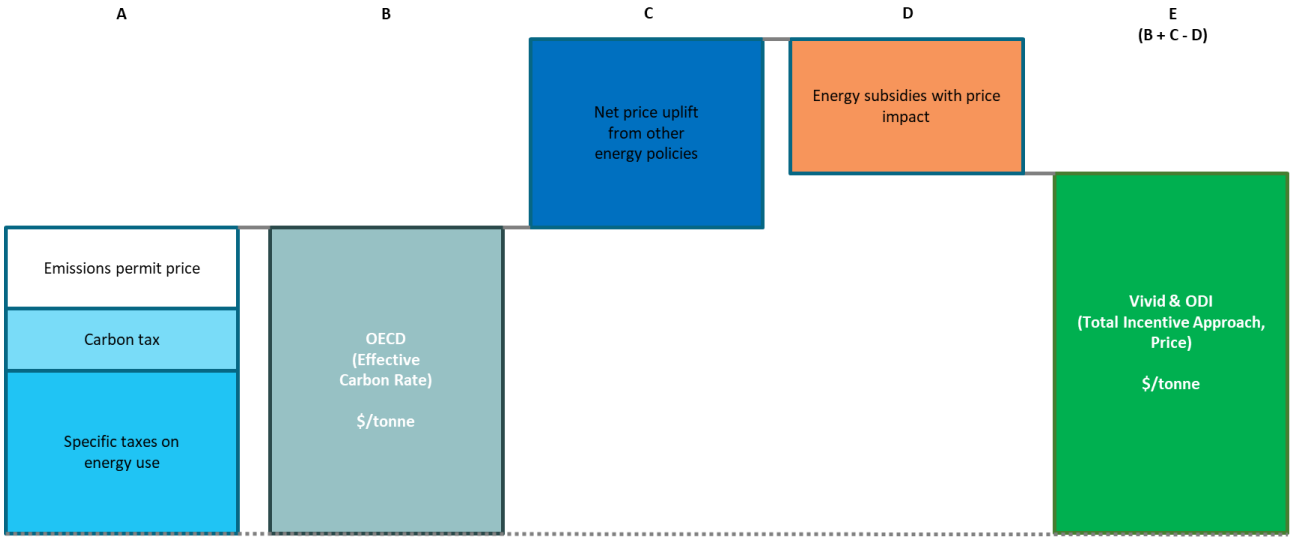
Both approaches require an understanding of what might be a 'deviation from standard tax and transfer treatment'. In the broadest case, the analysis includes all taxes and transfers applying specifically to energy, including excise taxes, even though these are common to almost all systems, and were in most cases introduced before climate change was an active policy concern. For the revenue approach, we also present results of a narrow approach that excludes some taxes such as fossil fuel excise and taxes on resource rents. This choice of baseline can have a major impact as discussed in the results in Section 5.

Figure 4. **The revenue approach shows the net fiscal stance of a government to high-carbon energy**



Source: *Vivid Economics and the Overseas Development Institute*

Figure 5. **The price approach calculates the effective carbon price considering overall incentives**



Source: *Vivid Economics and the Overseas Development Institute*

These approaches have different advantages and disadvantages. The revenue approach, in principle, allows the user to capture many of the ways in which the government is providing resources to high- and low-carbon energy, along with the fiscal cost of those measures. This includes elements that may not flow through to consumer prices, or that flow through only indirectly, such as production subsidies. On the other hand, it does not capture induced transfers from policies that operate outside of the tax and transfer system. For instance, the revenue approach would not account for the impact of mandatory renewable energy targets, that provide transfers from consumers (through higher prices) to renewable energy generators. The revenue approach also requires a definition of what constitutes high- and low-carbon energy that, in cases such as gas generation, may be debatable. In contrast, the price approach has the advantage of capturing the effect of policies on prices, including those that place an implicit price on carbon, such as renewables mandates. The price approach however, fails to capture the impact of subsidies that only affect prices indirectly or not at all, such as fossil fuel production subsidies, or free allowances/rebates provided under a carbon price that may not be directly reflected in marginal incentives.

Consistent with these differing advantages and disadvantages, the approaches may be relevant for different audiences. For those focused on fiscal policy, the revenue approach provides a better indication of the fiscal opportunity costs associated with net subsidising fossil fuels and it can allow one to identify where contradictory incentives exist in the tax and transfer system due to countervailing policies supporting high- and low-carbon energy. In contrast, the price approach is more relevant for those with a focus on the incentives created by energy fiscal policy, as it shows where incentives for decarbonisation are the strongest and where incentives may be inadequate to support the energy transition.

4 Methodology and assumptions

To demonstrate proof of concept, we have applied both the price approach and the revenue approach to the UK and tested the potential for replicating this analysis for all G7 countries in the future. Below we outline our methodology in applying the conceptual approach outlined above, to demonstrate that these approaches can provide a tractable tool for policy makers seeking to understand the channels through which the tax and transfer system effect policy, and one that could be rolled out to other jurisdictions to better understand effective carbon prices in operation in an economy.

4.1 Revenue approach

The revenue approach focuses on quantifying, at the aggregate level, how the fiscal system supports or constrains the production and use of fossil fuel and low-carbon energy sources. By comparing the treatment of fossil fuels and their low-carbon alternatives, we identify the government's net fiscal stance towards these energy options. In applying the revenue approach, we seek to identify where the treatment of fossil fuels and low-carbon energy is different from the treatment of other economic activities under the fiscal system.[15] As such a key challenge for this approach, is the method of categorising policies supporting or constraining fossil fuel or low-carbon energy.

We present two variants on the treatment of government revenues in this approach, to account for the multiple objectives that a fiscal system may attempt to achieve:

— **The broad approach** includes a wide set of taxes as potentially targeting fossil fuels, this includes the Climate Change Levy (CCL) and Carbon Price Support (CPS); EU ETS auctions; environmental levies; petroleum resource taxes; and revenues from fuel duties.
— **The narrow approach** includes a narrower set of taxes, which are focussed on carbon emissions or environmental outcomes more specifically, and therefore excluding revenues from fuel duties and petroleum resource taxes.

The exclusion of revenues from fuel duties and petroleum resource taxes under the narrow approach, reflects the fact that these taxes were established for purposes wholly separate from addressing carbon emissions from fossil fuels. For instance, fuel duties have been charged for decades well before addressing climate change was considered a serious policy objective. The popularity of fuel duties reflects both their stability (in the near term) as a revenue source and their role in internalising – to an extent – a range of externalities associated with fuel consumption, such as local air pollution and congestion. As such this taxation treatment is somewhat or wholly divorced from the carbon emissions associated with the fuel use. Similarly, the purpose of the petroleum resource tax (up to now) has been as a mechanism to achieve a return to the state for the value of the extraction of a scarce resource, rather than as a tax treatment applied to a carbon intensive fuel.

[15] That is, where a fiscal measure specifically targets energy, for instance a specific fuel tax would be counted whereas a broad-based value added tax would not.

In calculating the revenue approach (both broad and narrow), we have used public data that is easily accessible. The data on revenues have been collected from the OBR's March 2018 Economic and Fiscal Outlook – supplementary fiscal tables on receipts[16]. The data on expenditure measures have been sourced from the OBR's March 2018 Economic and Fiscal Outlook – supplementary fiscal tables on expenditure.[17]

We have categorised the following expenditure as support for low-carbon energy: energy efficiency measures and incentives in the households and public sector; warm homes discount; feed-in-tariffs; renewables obligation; contracts for difference; capacity market; expenditure on renewable heat incentive.[18]

UK governments' support for fossil fuels include VAT exemptions for electricity and natural gas use in the residential sector and an additional winter fuel and cold weather payments made to the households. The data for these is taken from the review of the OECD's 2018 inventory of subsidies and the OBR's March 2018 Economic and fiscal outlook.

4.2 Price approach

The price approach requires the mapping of emissions and energy use against energy taxation and subsidies to calculate the net tax burden for each activity (e.g. use of electricity in the residential sector) for which final energy use and emissions are available.

Given data availability across multiple sources, we calculate the effective carbon price (£/tCO_2) for the year 2016. Energy use and emissions data are gathered from the IEA's Extended World Energy Balances 2018[19] and the IEA's CO_2 Emissions from Fuel Combustion 2018[20].

Effective carbon prices are calculated for the sectors corresponding to the following IEA sectors: Iron and steel; Chemical and Petrochemicals; Non-ferrous metals; Non-metallic minerals; Transport equipment; Machinery; Mining and quarrying; Food and tobacco; Paper, pulp and printing; Wood and wood products; Construction; Textile and leather; Non-specified industry; Transport; Domestic aviation; Residential; Commercial and public services; Agriculture/forestry; Fishing. We provide estimates of effective carbon prices for each of the sectors noted above for the following fuels (corresponding to the sum of IEA fuels): Coal (coking coal, other bituminous coal, patent fuel, coke oven coke, coke oven gas and blast furnace gas), Natural gas, Oil (crude/NLG/feedstocks, refinery gas, kerosene type jet fuels, other kerosene, fuel oil, naphtha and petroleum coke), LPG, Motor gasoline, and Gas/diesel oil.

[16] OBR 2018 March 2018 Economic and Fiscal Outlook – supplementary fiscal tables: receipts and other

[17] OBR 2018 March 2018 Economic and Fiscal Outlook – supplementary fiscal tables: expenditure

[18] Some of these policies, for instance the renewables obligation and feed-in-tariffs are revenue neutral, as the tax collected is equal to expenditure provided under the measure. These are nonetheless included given their inclusion in national accounts.

[19] IEA (2018) World Energy Balances 2018

[20] IEA (2018) CO_2 Emissions from Fuel Combustion 2018

To calculate each aspect of the price approach the following data sources were used:

— **Specific taxes on energy use;** For the UK, this category comprises the excise that is levied on energy use, predominantly on the use of liquid fuels in transport. Data on excise rates was compiled from the European Commission's Excise Duty Tables[21].

— **Carbon taxes;** The UK has carbon taxes that partially overlap with the covered sectors of an emissions trading system. These include the Climate Change Levy (CCL) charged on energy use in non-domestic sectors and the Carbon Price Support that levies an additional charge on electricity generators. For these policies, tax rates were drawn from the HM Revenues & Customs Guidance[22].

— **Emissions Permit Price;** The European Union Emissions Trading Scheme (EU ETS) has been treated as equivalent in its incentive effects to a marginal tax on emissions, based on data sourced from the Intercontinental Exchange.[23]

— **Price uplift from other energy policies;** The price uplift from energy policies is only identified to have a material impact in the electricity sector. The data for electricity price components from energy policies was gathered from the Committee on Climate Change's Energy Prices and Bills 2017.[24]

— **Energy subsidies with a price impact;** Energy subsidy data is drawn from various sources including UK government publications and the OECD's Inventory of Support Measures for Fossil Fuels (2018).[25]

Further detailed description of assumptions for each element is provided in the Annex.

4.3 Replicability of approaches

Both the revenue approach and price approach applied in this paper are replicable across the G7 countries.

The data for fossil fuel tax revenues and fossil fuel and low-carbon subsidies used in the revenue approach is derived from government reported figures on annual receipts and expenditures. We expect this data to also be publicly reported by the other G7 countries.

For the price approach most of the energy consumption, emissions and taxes data are available from global sources. As shown in Table 1, energy consumption and emissions data are gathered from the IEA databases, which reports these for all countries. Similarly, data on excise rates and EU ETS prices is compiled from the EU databases, which covers all the EU countries. For non-EU countries in the G7 - Canada, Japan and the US - excise and ETS data (where applicable) will be easily available from government sources. In addition, the ODI maintains a database on fossil fuel subsidies for all major economies.

[21] European Commission (2016) EXCISE DUTY TABLES Part II – Energy and Electricity

[22] HM Revenues & Custom Guidance (2018) Climate Change Levy Rates

[23] Intercontinental Exchange (via Quandl), 2016, EUA futures (December delivery)

[24] Committee on Climate Change (2017) Energy Prices and Bills – impacts of meeting carbon budgets

[25] Further details provided in the Annex, see OECD (2018); Ofgem (2016); HMRC (2017b); HM Treasury (2014); HMRC (2016); HMRC (2015); HMRC (2014)

The UK specific data utilized in this approach is expected to be replicable using administrative data in other G7 countries. The carbon taxes (apart from the ETS), breakdown of price components from different policies and some energy subsidies data are available from government sources. As the G7 make up the seven largest advanced economies of the world, similar data will be collected and reported by respective national regulators and should be accessible from their government data agencies and data portals.

Table 1. **Both approaches are likely to be replicable across the G7**

Variable	Unit	Year	Source
Revenue Approach			
Fossil fuel tax revenues	£	2016	OBR's March 2018 Economic and fiscal outlook – supplementary fiscal tables on receipts and other
Subsidies for low carbon	£	2016	OBR's March 2018 Economic and fiscal outlook – supplementary fiscal tables on expenditure
Fossil fuel subsidies	£	2016	Various UK government sources and the OECD's Inventory of Support Measures for Fossil Fuels
Price Approach			
Energy consumption	TJ	2016	IEA Extended World Energy Balances 2018
Emissions	tCO_2	2016	IEA CO_2 Emissions from fuel combustion 2018
Excise taxes	€ per energy consumption	2016	European Commission's Excise Duty Tables, Part II Energy Products and Electricity (July 2016)
Carbon taxes (CCL/CPS)	£ per energy consumption	2016	UK HM Revenues & Customs Guidance on Climate Change Levy rates
EU ETS price	€/tCO_2	2016	The Intercontinental Exchange
Price uplift from other energy policies	£/kWh	2016	UK Committee on Climate Change's Energy Prices and Bills 2017
Energy subsidies	£/kWh	2016	Various UK government sources and the OECD's Inventory of Support Measures for Fossil Fuels

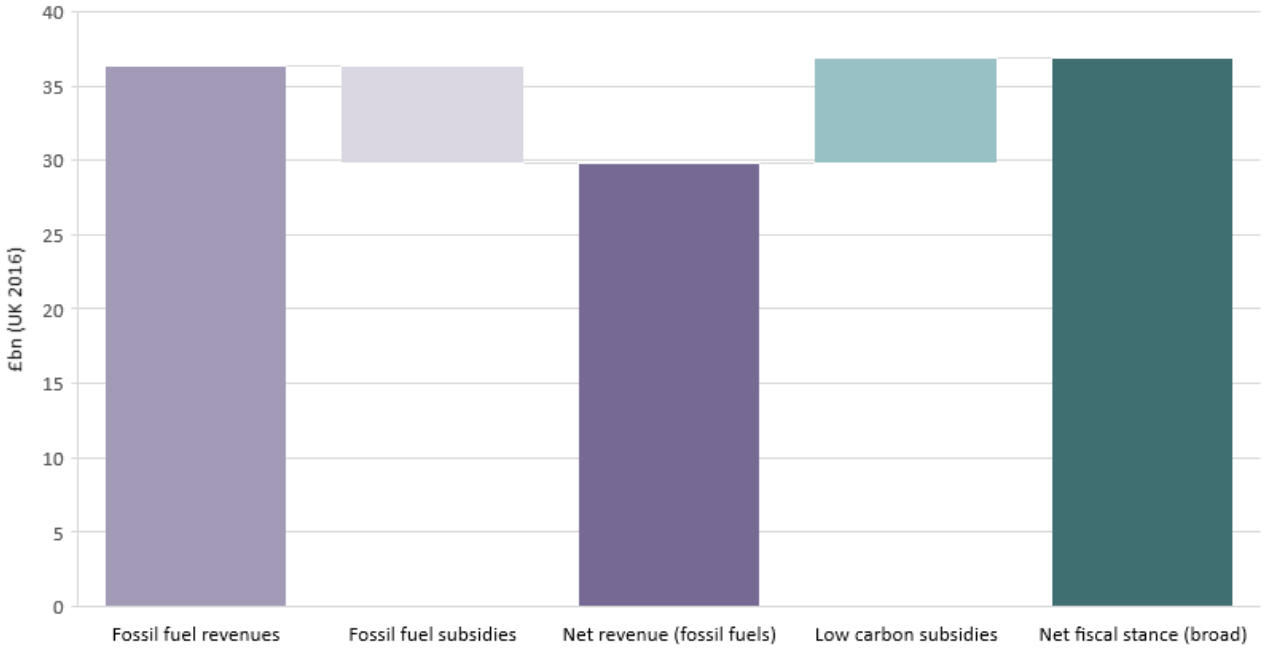
Source: *Vivid Economics and the Overseas Development Institute*

5 Results and discussion

5.1 Revenue Approach

The results from the broad approach on the net fiscal stance of the UK government on low-carbon energy is shown in Figure 6. Revenues from tax on fossil fuels amounted to around £36 billion in the UK in 2016, whereas fossil fuel subsidies were provided at around £7 billion. UK subsidies for low-carbon sources stood at similar levels. This means that in 2016 the net fiscal stance of the UK government provided relative support for low-carbon sources of around £37 billion, or about 2 per cent of UK's GDP.

Figure 6. **Net fiscal stance of the UK government on low-carbon energy stood at about 2 per cent of GDP in 2016 (broad approach)**

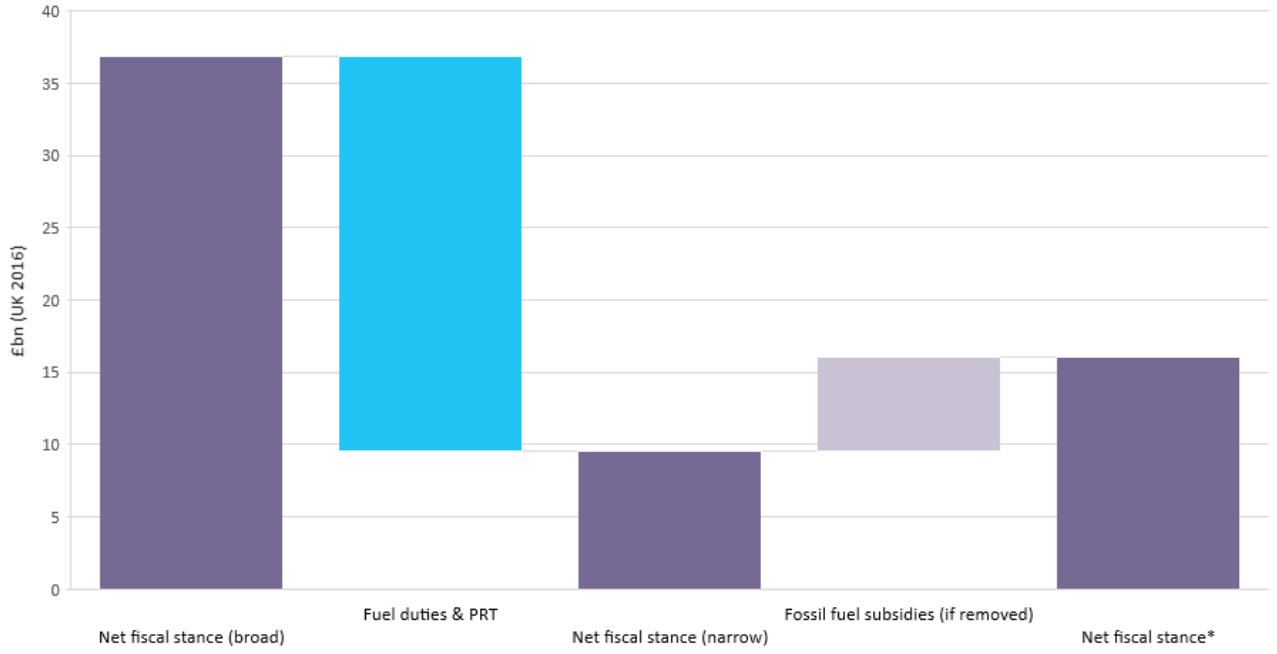


Note: *There were no specific revenues from the low carbon sector*

Source: *Vivid Economics and the Overseas Development Institute*

In comparison, using the narrow approach significantly reduced estimates of net fiscal support, from £37 billion to £10 billion in 2016, as shown in Figure 7 over page. The exclusion of fuel duties in this approach makes a significant different, as they represent the dominant source of fossil fuel revenue. These results also suggest that it would be possible to provide an even more favourable fiscal stance towards low-carbon industries by removing fossil fuel subsidies. These subsidies represent lost revenue of over £6 billion in 2016, and their removal would improve the relative fiscal stance toward low-carbon energy by an additional 0.3 per cent of GDP.

Figure 7. **The exclusion of fuel duties in the narrow approach lead to significant decline in the net fiscal stance on low-carbon energy**



Note: *Net fiscal stance* provides a counterfactual scenario without expenditure on fossil fuel subsidies.*

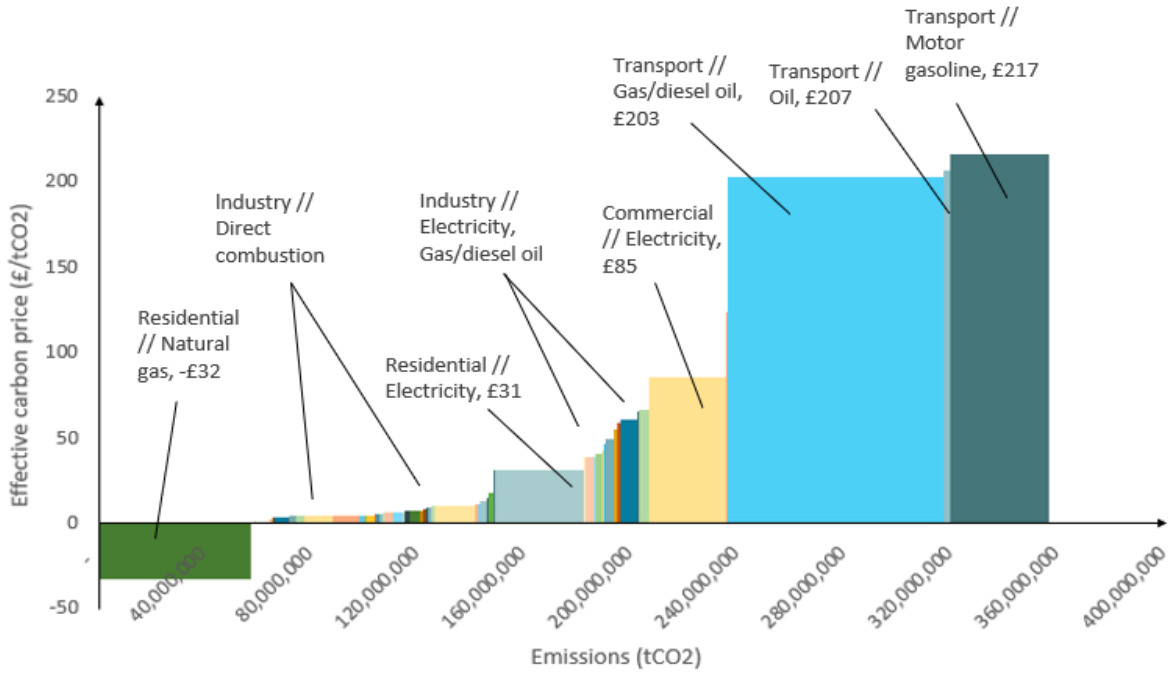
Source: *Vivid Economics and the Overseas Development Institute*

5.2 Price Approach

A key advantage of the price approach is that it details how effective carbon prices vary across the economy by fuel and sector. Across the UK we see an average effective price in the energy sector of £80/tCO_2. However, this economy wide estimate masks significant variance by fuel and sector, with some, such as oil used in transport facing very high effective carbon price, and others, like residential gas use, having a negative effective carbon due to large fossil fuel subsidies.

Figure 8 over page, maps effective carbon prices for the sectors and fuels in the UK against emissions. On the Y-axis, the total effective carbon price is shown for each sector and fuel (£/tCO_2). On the X-axis, emissions are shown. Each fuel/sector is represented as a rectangle, with the effective carbon price represented by its height, and the associated emissions with its width.

Figure 8. **There is significant variance in effective carbon prices across energy end-use in the UK**



Source: *Vivid Economics and the Overseas Development Institute*

Transport sector has the highest effective carbon prices: The effective carbon price for use of motor gasoline in transport in the UK is the highest, at £217/tCO_2. This is followed by oil in transport, at £207/tCO_2 and gas/diesel oil, at £203/tCO_2. The high prices are driven by the high rates of excise, which may also be considered as (roughly) accounting for externalities such as congestion and air pollution from transport. It is therefore appropriate for the transport sector to be facing a higher price. This pattern may not be repeated in other G7 countries such as Germany and Italy which have comparatively higher subsidies to fossil fuel use in transport.[26]

Electricity consumption in the commercial sector face high effective carbon price relative to the industries: The commercial sector's electricity consumption in the UK is subject to a relatively high price of £85/tCO_2. The commercial sector does not benefit from the reduced rates of CCL arising from the Climate Change Agreements that apply to much of industry, nor from further low-carbon support compensation that many industries receive due to the concerns regarding carbon leakage and industry competitiveness.[27]

[26] ODI (2017) Phase-out 2020: Monitoring Europe's fossil fuel subsidies

[27] Such exemptions are labelled as subsidies in the relevant OECD database. There is an important policy question to assess whether these subsidies are justified by the risks of carbon leakage and competitiveness concerns and, in that sense, an example of an 'efficient' fossil fuel subsidy. This assessment is beyond the scope of this paper. However, analysis comparing firms that benefited from the exemption subsidies provided by the Climate Change Agreements with firms in the same industry that did not, found that those not receiving the subsidy saw no impacts from the tax on employment, gross output or total factor productivity (TFP). Centre for Climate

Most direct combustion in industries face a low effective carbon price which would increase if fossil fuel subsidies were eliminated: Energy consumption including coal, natural gas and oil products in the industrial sector pay a small positive effective carbon price, ranging from £2/tCO_2 to £14/tCO_2. As noted above, industries are lightly taxed and benefit from subsidies in the form of carbon tax exemptions and rate reductions.

Natural gas consumption in the residential sector faces a negative effective carbon price, however energy policies drive up the price faced by electricity consumption: VAT subsidies on natural gas use in households give an effective carbon price of -£32/tCO_2. Electricity consumption is subjected to the same VAT subsidy, however energy policies such as support for low-carbon and energy efficiency schemes bring the effective carbon price on electricity use to a positive figure of £31/tCO_2.

Change Economics and Policy, Grantham Research Institute on Climate Change and the Environment (2009) The impacts of the Climate Change Levy on business: evidence from microdata

6 Conclusions

To demonstrate proof of concept, this study builds on existing literature on effective carbon prices, implicit carbon prices, energy taxes and fossil fuel subsidies to provide two alternative approaches to developing an international-comparable snapshot of the total set of incentives encouraging or constraining fossil fuel consumption within an economy. By applying both the revenue and price approaches developed in this study to the UK, and testing their replicability across the G7, we find each approach represents a comparable metric that can be tracked across jurisdictions and complement existing metrics.

Applying the revenue approach to the UK shows that in 2016 the net fiscal stance of the UK government to low-carbon energy provided net support of around £37 billion, or about 2 per cent of UK's GDP. However, this figure drops significantly, to £10 billion, when fossil fuel duties and resource rents are excluded from this calculation. The removal of the approximately £6 billion of fossil fuel subsidies presents an opportunity to further enhance the government's positive fiscal stance to low-carbon energy.

Applying the price approach to the UK reveals high effective carbon prices for electricity consumption in the commercial sector and for fuel use in transport (£85/tCO_2 and £207/tCO_2 respectively), the impact of fossil fuel subsidies results in negligible effective carbon prices for industry (£2/tCO_2 to £14/tCO_2). In the case of gas use in households, significant subsidies through VAT tax breaks results in a negative effective carbon price (-£32/tCO_2).

Applying these approaches to a broader set of countries (including the G7 in the first instance) would provide additional evidence to support far more joined up efforts at the international and national level initiatives to tackle fossil fuel subsidies and implement carbon pricing. The G7 (including the EU) is a key group for engagement as they have committed to ending fossil fuel subsidies by 2025 (2020 for the EU) and already have a range of carbon pricing instruments in place. There are also wider opportunities to support these activities under the Sustainable Development Goals (SDGs) and the UNFCCC Paris Agreement, including within nationally determined contributions (NDCs). A 2015 study of iNDCs found 67 countries had included references to fiscal instruments (carbon pricing, subsidy reform etc.).[28]

Analysis by the Carbon Pricing Leadership Coalition shows that effective energy fiscal reform packages include both a revenue component (lower subsidy costs or higher revenues through a taxes or carbon pricing) and a spending component (such as a reduction in other taxes; increased spending on social protection, cash transfers, or public services).[29] By linking revenue from subsidy reform and carbon pricing to spending on wider public priorities, fiscal reform has a higher probability of success. The approaches set out in this paper provide improved metrics regarding the nature and interactions of fossil fuel subsidies, carbon pricing and energy policies. This can help policy makers target energy policy reforms in a manner that results in better outcomes for the climate, the economy and society.

[28] IISD (2015) Fiscal Instruments in INDCs

[29] Carbon Pricing Leadership Coalition (2017). Report of the High-Level Commission on Carbon Prices

Annex: Assumptions in calculating the price approach

Specific taxes on energy use

For the UK, this category comprises the excise that is levied on energy use in the UK, predominantly on the use of liquid fuels in transport. Data on excise rates was compiled from the European Commission's Excise Duty Tables. To align this data with the energy and emissions data from the IEA, we assume:

— 'Business use' corresponds to the following IEA sectors: Iron and steel; Chemical and Petrochemicals; Non-ferrous metals; Non-metallic minerals; Transport equipment; Machinery; Food and tobacco; Paper, pulp and printing; Wood and wood products; Textile and leather; Non-specified industry; Commercial and public services (partly, see below).

— 'Non-business use' relates to the IEA sectors of Commercial & public services (in part, see below) and residential.

— Energy used in the Commercial and Public Services category was allocated to business and non-business use based on Eurostat input-output tables, where the allocation was 100 per cent and 0 per cent for coal, 21 per cent and 79 per cent for refined products and 38 per cent and 62 per cent for electricity and natural gas, for business and non-business use respectively.

— 'Industrial and Commercial Usage' corresponds to the IEA sector categories of Construction & Mining and Quarrying.

— 'Agriculture, horticulture, pisciculture, forestry' and 'Agriculture' correspond to the IEA sector of agriculture/forestry.

— 'Gas Oil', 'Heavy fuel oil', 'Kerosene', 'Petroleum' and 'Gasoline' are assumed to correspond to the IEA fuels gas/diesel oil, fuel oil, other kerosene and motor gasoline respectively.

Carbon taxes

The UK has carbon taxes that overlap with covered sector in an emissions trading system. This includes the Climate Change Levy (CCL) charged on energy use in non-domestic sectors and the Carbon Price Support (CPS) that levies an additional charge on electricity generators. For these policies, tax rates were drawn from HM Revenues & Customs Guidance, with the following specific assumptions:

— The CCL is assumed to be charged on energy use in the following IEA sectors: Iron & steel; Chemical & Petrochemicals; Non-ferrous metals; Non-metallic minerals; Transport equipment; Machinery; Mining & quarrying; Food & tobacco; Paper, pulp & printing; Wood & wood products; Construction; Textile & leather; Non-specified industry; Commercial & public services; Agriculture/forestry; Fishing.

— The CCL is charged on the following fuels: Natural gas; LPG; Coking coal; Other bituminous coal; Petroleum coke; Coke oven coke; Electricity; Coke oven gas; Blast furnace gas; Refinery gas.

— The proportion of energy use liable to pay the reduced rate of CCL is calculated as the proportion of emissions under the Climate Change Agreements (CCA)[30] in each sector.

[30] Environment Agency (2017) Climate Change Agreements – Target Unit Performance Data

— We assume that electricity generators fully pass through the costs of the CPS, hence all electricity use is assumed to be subject to an implicit carbon price equivalent to the average effective carbon price for electricity generation from the CPS, in proportion with each sector's electricity consumption.

Emissions Permit Price

The European Emissions Trading Scheme (EU ETS) has been treated as equivalent in its incentive effects to a marginal tax on emissions. The data is drawn from the Intercontinental Exchange, with the EU ETS allowance price calculated as the average spot price in July 2016, amounting to 4.04 £/tCO_2 (4.65 €/tCO_2 converted with an exchange rate of €1 = £0.87). Other assumptions include:

— All emissions from the following IEA sectors are covered: Iron & steel; Chemical & Petrochemicals; Non-ferrous metals; Non-metallic minerals; Paper, pulp & printing; Domestic aviation.
— 70 per cent of emissions in the IEA sector of Food & tobacco and 12 per cent of emissions in Commercial & public services are covered EU ETS. This is based on the comparison of emissions data for the sector, and historic data from the UK's National Allocation Plan, giving EU-ETS covered emissions.
— Electricity producers pass on 100 per cent of costs, so that usage of electricity is assumed to be subject to an implicit carbon tax equivalent to the average effective carbon price in electricity generation, in proportion with each sector's electricity consumption.

Price uplift from other energy policies

The price uplift from energy policies is only identified for the electricity usage in the UK. The data for electricity price components from energy policies was gathered from Committee on Climate Change's Energy Prices and Bills 2017. These price components were mapped to the electricity consumption in end-use sectors and attributed to their respective end-use electricity emissions, to arrive at £/tCO_2 figures. The following assumptions were made:

— For the 'residential' sector, the following policies are assumed applicable: Support for low-carbon; Energy efficiency (low-carbon); Capacity market; System integration costs (transmission and intermittency); Additional distribution costs; Merit order effect; Warm Homes Discount; Energy efficiency (other); Smart meters.
— For the 'commercial' and 'manufacturing' sectors, the policies identified include: Support for Low-carbon; CRC; Capacity market; System integration costs (transmission and intermittency); Additional distribution costs; Merit Order effect.
— 'Small commercial' and 'Medium commercial' correspond to the proportions of the IEA sector category of commercial and public services, in accordance with the electricity consumed that were liable to pay the CRC scheme, which amounted to be 71 per cent of the commercial and public services sector.
— 'Large manufacturing' is the following IEA sectors: Transport equipment; Mining & quarrying; Food & tobacco; Machinery; Wood & wood products; Construction; Textile & leather; Non-specified industry.
— 'Large manufacturing (low-carbon support compensation)' correspond to the following IEA sectors: Iron & steel; Chemical & petrochemicals; Non-ferrous metals; Non-metallic minerals; Paper, pulp & printing.
— 'Extra-large manufacturing (low-carbon support & carbon price compensation)' is excluded from the analysis to avoid double counting, as CPS is already considered under the carbon tax element.

Energy subsidies with a price impact

Energy subsidy data is drawn from Various UK government sources and the OECD's Inventory of Support Measures for Fossil Fuels, compiled by the Overseas Development Institute and Vivid Economics. In addition to the policy exemptions considered above, subsidies that are deemed to have a price impact include the reduced rate of VAT for electricity and natural gas consumed in the residential sector. This subsidy is calculated based on the average VAT rate per household from the Committee on Climate Change's Energy Prices and Bills 2017. Other subsidies, such as reduced rate of excise for red diesel and rural fuel duty relief were also identified, but not included due to a lack of data availability.

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Organisation Profiles

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