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Underpriced and Overused:

Fossil Fuel Subsidies Data 2025 Update

Simon Black, Weronika Celniak, Alberto Garcia-Huitron, Ian Parry, Paulina Schulz-Antipa, and Nate Vernon-Lin

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ABSTRACT: This paper provides a bi-annual assessment of efficient fossil fuel prices and subsidies for 170 countries, based on a comprehensive analysis of environmental and other externalities from fuel consumption. Globally, explicit (or fiscal) subsidies were $725 billion (0.6 percent of GDP) in 2024. Implicit subsidies, primarily underpricing of environmental costs, were $6.7 trillion (5.8 percent of GDP), with three quarters from underpriced air pollution and climate change.* Relative to GDP, explicit subsidies have stablized at pre-COVID levels while implicit subidies have increased somewhat and are expected to rise gradually until 2035. Explicit subsidy removal would reduce CO_2 emissions by six percent below baseline levels in 2035, avoid 70,000 premature air pollution deaths annually, raise 0.6 percent of GDP in government revenue, and generate net economic benefits worth 0.5 percent of GDP. Removal of both explicit and implicit subsidies (through corrective taxes) generates substantially larger benefits, such as 1.1 million fewer premature air pollution deaths and a 46 percent reduction in CO_2 emissions, but would be politically difficult. Subsidizing fuels is an inefficient way to support low-income households: for every dollar spent on explicit fuel subsidies, the poorest 20 percent of households receive just 8 cents.

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* A spreadsheet with results and data for all countries and fuels can be found at: www.imf.org/-/media/files/topics/energy-subsidies/imffossilfuelsubsidiesdata.xlsb.

WORKING PAPERS

Underpriced and Overused: Fossil Fuel Subsidies Data 2025 Update

Prepared by Simon Black, Weronika Celniak, Alberto Garcia-Huitron, Ian Parry, Paulina Schulz Antipa, and Nate Vernon-Lin[1]

[1] “The authors are grateful to Dora Benedek, Ruud de Mooij, participants in an IMF seminar, and numerous other IMF colleagues for helpful comments and suggestions on an earlier draft.

Contents

Executive Summary

Globally, fossil fuel prices in most countries are inefficient as they fail to adequately charge for both the supply and environmental costs of fuel use. Consequently, countries' scarce resources are misallocated between fossil fuels and other sectors, promoting greenhouse gas emissions, local air pollution deaths and other environmental damage, causing other taxes to be higher or public spending lower than otherwise, and undermining distributional objectives since wealthier households benefit most from artificially low energy prices.

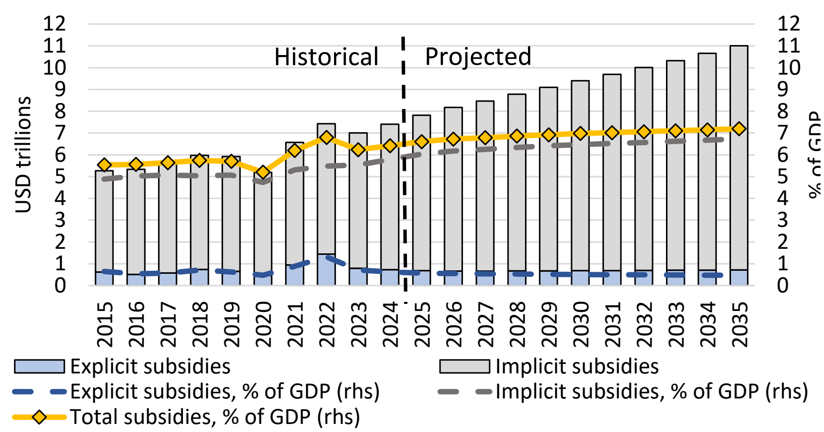
This paper presents a biannual assessment of the efficient set of prices on fossil fuel products, by sector, and subsidies implied by undercharging relative to efficient prices, for 170 countries. Results are available online[2] and based on an extensive compilation and update of energy and environmental data using the IMF-World Bank Climate Policy Assessment Tool (CPAT). In addition, the paper presents the environmental, fiscal, and economic benefits from price reform, as well as the distributional impacts across household income groups.

As in previous IMF reports, this paper distinguishes between explicit and implicit fossil fuel subsidies. Explicit subsidies are defined as the extent of undercharging for supply costs, such as labor, capital and raw materials to produce fossil fuels. These explicit subsidies come with explicit government outlays in the budget. However, from an economic perspective, the private supply costs fail to recognize the environmental (or external) costs of fossil fuel use, such as the social cost of local air pollution and greenhouse gas emissions. These environmental costs should also be reflected for prices to be efficient. A key contribution of the IMF fossil fuel subsidies database is that these environmental externalities are measured for all 170 countries. The estimated underpriced environmental costs are called implicit subsidies as they reflect the extent of undercharging for the environmental costs of fuel consumption. The sum of the explicit and implicit subsidy (or total subsidy) per unit of fuel use measures the difference between the current price and the socially efficient price.

Main findings include:

- Fossil fuels are pervasively and substantially underpriced globally. Prices do not reflect the full costs, including both supply and environmental costs, especially coal and road fuels, where for many countries prices are less than half of their efficient levels.
- Globally, explicit fossil fuel subsidies, that result in direct fiscal costs, totaled $725 billion in 2024 (0.6 percent of GDP), with petroleum, natural gas, and electricity each accounting for about a third of the subsidy. Middle East and North Africa and Europe and Central Asia

Figure ES1. Estimated and Projected Explicit and Implicit Global Fossil Fuel Subsidies, Baseline



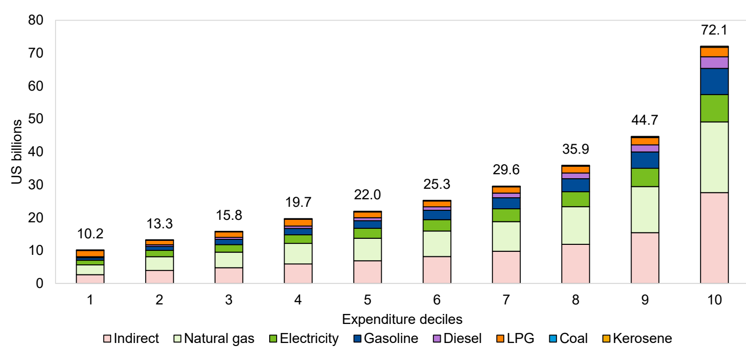
Source: Authors.

[2] For data refer to: www.imf.org/-/media/files/topics/energy-subsidies/imffossilfuelsubsidiesdata.xlsb.

account for three-quarters of global subsidy. Explicit subsidies have fallen from a peak of $1.4 trillion in 2022 but are projected to remain at current levels (as a share of GDP) to 2035 (Figure ES1).

- Implicit fossil fuel subsidies, that is undercharging for environmental externalities, were $6.7 trillion (5.8 percent of GDP) in 2024. These are increasing over time (from 4.9 percent of GDP in 2015 to 6.7 percent on 2035) with rising costs of climate change and local air pollution and greater concentration of fossil fuel consumption in emerging markets where underpricing is more severe (Figure ES1).
- By fuel products, petroleum accounted for about half of total (explicit and implicit) subsidies in 2024 and coal nearly two-fifths. By components, underpricing for local air pollution and climate damage accounted for 70 percent of total (explicit and implicit) subsidies in 2024, and other environmental costs of transport like congestion nearly one-fifth. And by regions, total subsidies relative to GDP are largest for Middle East and North Africa (16 percent), followed by East Asia and Pacific and South Asia (9.5 percent each), while in other regions subsidies range from about 3.5 to 4.5 percent of GDP.
- Removing explicit subsidies would reduce global CO_2 emissions 6 percent below baseline levels (with no further mitigation measures) in 2035, air pollution deaths by 70,000, raise revenue of 0.5 percent of global GDP, and generate environmental benefits net of economic costs of 0.5 percent of GDP.
- Full energy price reform (raising fuel prices to their efficient levels) and partial reform (removing explicit subsidies and closing half the gap to efficient prices) would cut global CO_2 emissions from fossil fuels 46 and 35 percent below baseline levels in 2035, which is consistent with a target of limiting peak global warming to 1.7°C and 1.85°C above preindustrial levels, respectively.
- Partial price reform would avoid about one million local air pollution deaths in 2035 (compared to 1.1 million under full reform), raise extra tax revenues of 2.3 percent of global GDP (3.3 percent of GDP for full reform), and generate environmental benefits net of economic costs of 2.2 percent of GDP (3.4 percent of GDP for full reform). Partial and full price reform are, however, difficult politically.
- The subsidy estimates have changed very little from the previous update (Black and others 2023a) where explicit and implicit subsidies for 2024 were projected at 0.7 and 5.7 percent of global GDP respectively.
- Subsidizing fuels is a remarkably inefficient to support low-income households. Globally in 2024, for every dollar spent by governments on explicit fossil fuel subsidies, the poorest 20 percent of households received just 8 cents. The richest 50 percent of households capture almost three quarters of the benefits of artificially low fuel prices (both in terms of lower costs and indirect through lower prices of non-energy goods; Figure ES2). As a result, countries can achieve substantial fiscal savings from reforming subsidies while also shielding low-income households from higher energy prices, with compensation requiring only a small portion of revenues saved. However, given large differences in fuel consumption between individual households, impacts of reform can vary significantly within deciles, underpinning the importance of effective targeting of cash transfers or other compensation mechanisms.

Figure ES2. Global Explicit Fossil Fuel Subsidy Distribution by Fuel 2024



Source: Authors. Note: shows the total explicit subsidy by income decile across 87 countries who collectively account for 40 percent of total explicit subsidies and about 80 percent of global GDP, population, and CO_2 emissions. Indirect subsidies include subsidies for coal and natural gas used in the power sector, subsidies to industrial electricity tariffs, and consumer- and producer-side oil subsidies.

1. Introduction

Using the IMF-World Bank Climate Policy Assessment Tool (CPAT), this paper provides the 2025 biannual fossil fuel subsidies update. It provides a comprehensive assessment of current prices for different fossil fuel products in different sectors for 170 countries, as well as the economically efficient prices based on a quantitative analysis of the external costs of fuel use. The difference between the current and the efficient price reflect subsidies implied by undercharging for fuel use. We then use the model to explore the environmental, fiscal, economic and social benefits from energy price reform.[3] A new contribution compared to previous editions is an assessment of the distributional incidence of fuel subsidies and the costs that households across countries would face if subsidies were phased out. Currently, fossil fuels are underpriced in most sectors and countries, which compounds environmental problems, distorts the allocation of countries' scarce resources across production sectors, forgoes substantial government revenues (implying government deficits and other taxes are higher than needed, and/or public investment is underfunded), and undermines distributional objectives (because wealthier households consume more energy and benefit more in absolute terms from low energy prices).

As in previous IMF reports on the fossil fuel subsidies database, we distinguish between two different notions of fossil fuel subsidies. The first are explicit (or fiscal) subsidies, reflecting undercharging for supply costs. These are commonly known as simply 'subsidies' and are reflected in government spending budgets. However, from an economic perspective, private costs of supply do not reflect efficient prices, which include supply costs (for example, labor, capital, raw materials), environmental costs, and (less importantly) general consumption taxes applied to household fuels. Environmental costs include climate damage caused by emissions of carbon dioxide (CO_2), deaths from local air pollution, and (for road fuels) congestion, accidents, and road damage (the last three costs are often just called 'externalities' rather than environmental costs). Environmental damage from CO_2 emissions is uniform across the globe, while other environmental damage depends on country-specific factors. The IMF's fossil fuel subsidies database defines as implicit subsidies the difference between the supply costs and the efficient price—thus reflecting the environmental cost of fuel use. Indeed, a major contribution of this paper is to quantify these external costs for 170 countries across the world. We use the term 'implicit subsidy' for convenience as it measures undercharging for the environmental costs relative to an economically efficient price—which is reminiscent to the explicit subsidy measuring the undercharging of the supply costs of fuel. However, readers who prefer different terminology could refer to the implicit subsidy as the underpriced environmental (or external) costs of fuel use.[4]

Table 1 provides a summary contrasting explicit and implicit subsidies as defined in this paper. Explicit subsidies are useful for indicating the current fiscal costs of holding down fuel prices below production costs. Removing them has relatively limited environmental benefits however as they have minimal relevance for coal (the most polluting fuel). Quantifying implicit subsidies helps to pinpoint where reforms are most pressing to address environmental externalities (get energy prices right) so that households and firms consider the full cost of fossil fuel consumption. Reforming them can have large climate and local air pollution benefits, not least as

[3] Previous reports in this series include Black and others (2023a), Coady and others (2017, 2019), and Parry and others (2014, 2021).

[4] In some countries, governments use a different definition of implicit subsidies based on tax expenditure estimations. However, by assessing the revenue foregone from tax concessions relative to some benchmark price of fossil fuels, these estimates are highly sensitive to the assumed benchmark price. By estimating the environmental cost of fuel use, the methodology here is less prone to such assumptions.

implicit subsidies for coal are substantial (though rebates are needed to promote adoption of local pollution 'scrubbing' technologies at power and industrial plants). Raising road fuel prices also has significant congestion, accidents, and other environmental benefits, though other policies (like congestion fees and pay-as-you-drive car insurance) would be more efficient. The fiscal benefits from reforming implicit subsidies are smaller than the implicit subsidy, as higher fuel prices would erode the base of fuel taxes.

To maintain anti-poverty objectives while implementing fuel price reform, low-income households might be compensated through strengthening income support, usually requiring a small fraction of revenues saved or raised from the reform. Objectives like social protection are more efficiently addressed with other instruments beyond fuel prices, like targeted compensation schemes which impose much smaller fiscal costs on the government than untargeted fuel subsidies. For countries with limited ability to target support at the household level, spending on developmental priorities can (more than) offset impacts. Where higher fuel prices are unacceptable politically, environmental concerns can be addressed using instruments like feebates, tradable performance standards, and clean technology subsidies. These policies are less efficient and forgo revenue but avoid significant increases in fuel prices. While information about efficient fuel prices indicates how countries can price for supply and environmental costs it also: (i) provides a benchmark against which alternative policy reforms can be evaluated which, along with distributional analysis, informs about the trade-offs in policy choices; and (ii) indicates price signals that ideally would be implicit in alternative policies.

Table 1. Contrasting Explicit and Implicit Subsidies

		Explicit Subsidies	Implicit subsidies
Definition		Underpricing for supply costs	Underpricing for environmental costs/general consumption taxes
Rationale for removing subsidy		Ensure supply costs recovered in prices	Ensure prices reflect production and environmental costs
Benefit from removing subsidy	Fiscal	= subsidy	< subsidy (due to base erosion)
	Environmental: climate	Limited because subsidies: (i) not for coal; (ii) moderate size at global level	Large benefit due to coal reduction
	Environmental: air pollution		Large benefit (especially if rebates for scrubbing technologies)
	Environmental: road congestion/accidents	Limited because subsidies moderate size at global level	Significant but other policies (e.g., congestion fees) more effective

Source: Authors.

Estimates of efficient fuel prices and subsidies in this paper are based on an exhaustive data compilation of diverse sources using standard approaches (with some new refinements) for measuring supply and environmental costs from the economics literature. Parametrization in the analysis can be debated but results are based on central case parameter assumptions, while the implications of other assumptions (for example over carbon damages) are largely transparent from the results. The full set of results, including fuel subsidies and efficient prices for 170 individual countries and explicit subsidies for an additional 20, is available online. [5]

The rest of the paper is organized as follows. Section 2 discusses some conceptual, measurement, and data issues. Section 3 presents the main results on efficient fuel prices, trends in, and composition of energy subsidies, and the benefits from policy reform. Section 4 presents the household distributional analysis, and Section 5 concludes.[6]

[5] For data refer to: www.imf.org/-/media/files/topics/energy-subsidies/imffossilfuelsubsidiesdata.xlsb.

[6] All policy discussions in this paper are in line with previous IMF recommendations in Parry and others (2014).

2. Conceptual, Measurement, and Data Issues

This section discusses conceptual issues in defining efficient fuel prices and fossil fuel subsidies and how the main energy data is compiled. Annex 1 discusses measurement of environmental costs and procedures for calculating the emissions, health, fiscal, and economic benefits/costs of subsidy reform.

Fuel Prices, Subsidies, and Reform Benefits

(i) Efficient Fuel Prices
For fuels consumed at household level, the economically efficient fuel price is given by:

[supply cost + environmental cost] * [1 + general rate of consumption tax]

For fuels used as intermediate inputs, the efficient price is just the supply cost plus the environmental cost.[7]

Supply costs reflect whichever is the larger of the cost incurred by a domestic supplier to produce (or import, if import infrastructure is available) and deliver fuels or (if export infrastructure is available) the revenue forgone (that is, the opportunity cost) by not selling the fuel on international markets. Environmental costs for all fossil fuels include carbon damage and local air pollution, while use of road fuels is associated with broader environmental costs like traffic congestion and accidents.

Carbon damage. Expressed per unit of fuel combustion, carbon damages are the CO_2 emissions factor (tonnes of CO_2 per unit of energy or volume) times the environmental damage per tonne of CO_2. For a given fuel product, there is little variation in CO_2 emissions factors across countries, but there is significant variation across fuel products—about 25 and 45 percent lower per unit of energy for oil and gas respectively than for coal, and about 16 percent higher per liter for diesel than gasoline.[8] Reflecting carbon damages in fuel prices is straightforward, for example applying taxes midstream as fuels enter the economy after processing.

Local air pollution. The main component of local air pollution damage is mortality impacts,[9] principally caused by fine particulates with diameter less than 2.5 micrometers ($PM_{2.5}$). These particles are small enough to enter the lungs and bloodstream and elevate risks of heart disease, stroke, diabetes, lung cancer, and chronic obstructive pulmonary disease, including for children under five. Fine particulates can be emitted directly (primary $PM_{2.5}$) during fuel combustion or formed in atmospheric reactions (secondary $PM_{2.5}$) involving sulfur dioxide (SO_2), nitrogen oxide (NO_x), and other local pollutants. Emissions factors for $PM_{2.5}$, SO_2, and NO_x, vary substantially across countries (depending, for example, on emission rate regulations) and fuels, though are generally a lot lower for gas than coal, and for gasoline than diesel.[10]

[7] According to standard economic theory, pricing policies are the most efficient instrument for mitigating externalities. The previous fuel subsidy update (Black and others 2023a) provided comparisons of pricing policies with non-pricing approaches.

[8] EIA (2021).

[9] Indeed, air pollution (primarily from fossil fuels) was the second leading risk factor for death globally in 2021. Other environmental impacts include morbidity, impaired visibility, and building, crop, and ecosystem damage, but studies suggest their combined damages are on a much smaller scale to those from mortality reflecting the relatively high values attached to mortality risks (for example, NRC 2010, Ch. 2).

[10] Fuel combustion also causes of low-lying ozone which has mortality effects which are included in the results below but are relatively modest.

For local pollutants from power and industrial plants, the most efficient policy would be a fee on smokestack emissions to encourage fuel switching away from coal and use of emissions capture technologies in smokestacks. For countries lacking government capacity to monitor smokestack emissions, an alternative is to tax coal use based on default emissions factors but allow firms to petition for rebates if they demonstrate (through their own monitoring) their emission rates are below the default.

Local air pollutants from vehicles have been reduced through tighter regulations on vehicles and fuel quality. Nonetheless, reflecting damages from remaining emissions through fuel taxation remains appropriate to reinforce mitigation incentives and promote shifting from diesel and gasoline to electric vehicles.

For all sectors, the environmental damage per unit of fuel use included in the efficient fuel price calculations below depends on country-specific evidence on emission rates per unit of fuel use, increased rates of fatal illnesses due to the exposure of local populations to the pollution, and mortality risk valuations (see Annex I).

Other environmental costs. For road fuels in vehicles, environmental costs also include traffic congestion, accidents, and (for vehicles with heavy axle weights), wear and tear on the road network. These broader effects are efficiently addressed through instruments like congestion pricing, pay-as-you-drive car insurance, and truck tolls per km scaled by axle weight[11], but to the extent these costs remain unpriced, it is efficient to reflect them in fuel prices. The appropriate corrective tax equals the externality, that is, the cost imposed on others that is not factored into individuals' driving decisions, averaged at the nationwide level (see below), scaled by the portion of the price-induced fuel reduction that comes from reduced driving (which reduces these externalities) as opposed to the reduction from higher fuel economy or shifting to electric vehicles (which does not).[12] For other petroleum products, environmental costs are limited to CO_2 and local air emissions, while environmental costs from electricity are zero as CO_2 and local pollution are attributed to fuel inputs.[13]

General consumption taxes. In principle, all products consumed at the household level should be subject to same general consumption tax applied on top of the full social (supply and environmental) cost of products so revenue from the tax is raised without distorting the choice among goods (accounting for their full social cost).

(ii) Fossil Fuel Subsidies

Total fossil fuel subsidies are a combination of explicit and implicit subsidies. Explicit subsidies equal any positive gap between supply costs and fuel prices, times fuel consumption (orange rectangle of Figure 1A).[14] Where the gap between supply costs and fuel prices is negative the difference taken to be a tax. These are

[11] See Black and others (2023a), Parry and others (2014).

[12] According to CPAT, the long-run elasticity of reduced driving from all vehicles (including switching to electric vehicles) and improvements in the fuel economy for internal combustion engine vehicles is -0.18 and -0.4, resulting in a scaling factor of 32 percent on average for gasoline (down from 43 percent when ignoring electric vehicles). The scaling factor falls relatively more for diesel (37 to 21 percent) since heavy goods vehicles drive more miles and, thus, are more sensitive to changes in fuel prices.

[13] Electric vehicles contribute to road congestion and accidents, but the share of these vehicles in total electricity consumption was 0.5 percent in 2023 and is estimated to be 10 percent under current policies by 2035.

[14] Explicit subsidies are measured using the price-gap approach where retail prices are compared to the economically efficient price. Under this methodology, tax expenditures (such as reduced VAT rates on fossil fuels) only result in an explicit subsidy when they cause retail prices to fall below supply costs, which is rare. Similarly, price controls that lead to retail prices above supply costs are not explicit subsidies and, instead, function as a tax. The other common method, called the inventory approach, is called the inventory approach and compares retail prices to what the retail price would be if there were no tax expenditures (e.g., reduced VAT rates) or if all fossil fuel were taxed at the highest domestic rate for a given fossil fuel (e.g., gasoline). An unintuitive implication of the inventory approach is that subsidies can decline if other tax rates are reduced (e.g., the standard VAT rate or excises on gasoline). See Annex C of Parry and others 2021 for more.

usually consumer subsidies in that they affect the prices paid by fuel users (households and firms) rather than prices received by producers (fuel extractors and refiners). Producer subsidies (for example, accelerated depreciation and other favorable tax treatment for fossil fuel extraction) are included in explicit subsidies but are not that large at the global level (around 10 percent of explicit subsidies in 2024).

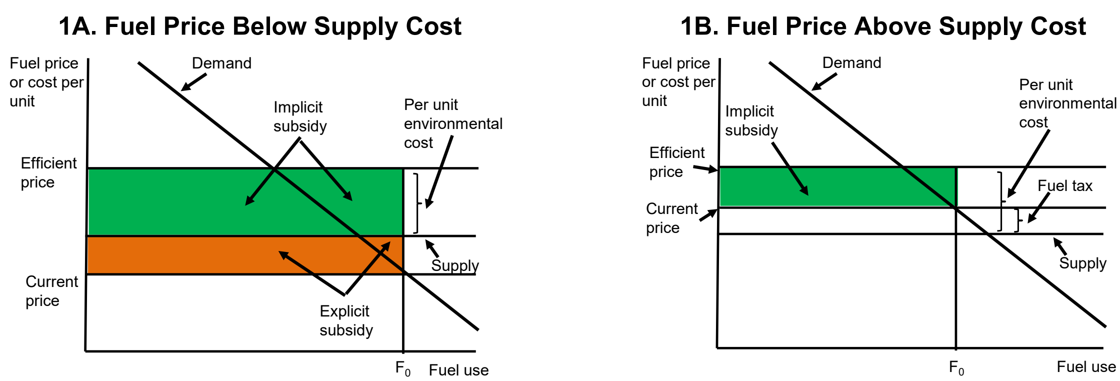
When fuel user prices are below supply costs, implicit subsidies are the gap between efficient fuel prices and supply costs, that is, for intermediate fuels, environmental costs times fuel consumption (green rectangle in Figure 1A). For household fuels, implicit subsidies are:

[environmental cost] * [1 + general rate of consumption tax] * [fuel consumption]

When prices exceed supply costs, implicit subsidies for intermediate fuels are the gap between efficient and current fuel price, or the gap between environmental costs and fuel taxes, times fuel consumption (green rectangle of 1B). For household fuels, implicit subsidies in this case are:

[environmental cost – fuel tax] * [1 + general rate of consumption tax] * [fuel consumption]

Figure 1. Conceptual Distinction Between Explicit and Implicit Fuel Subsidies



Source: Authors.
Note: General consumption taxes should be added to the environmental cost for fuels consumed at household level. Green reflects implicit subsidies and orange explicit subsidies. F_0 is fuel consumption at the current price. Implicit subsidies are zero if environmental costs are overtaxed.

Explicit subsidies are commonly discussed among policymakers as they reflect fiscal costs in the government budget (such as rebates to households for energy purchases), or losses/reduced profits at state-owned enterprises (due to price controls and other off-budget mechanisms). But the total fossil fuel subsidy (explicit plus implicit) is what matters from the perspective of getting fossil fuel prices right—environmental costs are just as real as supply costs (though more uncertain) but, without government policy, they are not captured in market prices due to a lack of property rights.

Energy Data

(i) Fuel Use

The primary source for fuel use by product and sector is the International Energy Agency (IEA)'s World Energy Balances, which compiles this data for 156 countries submitted annually by national authorities. Fuel use data is available up to 2023 for most countries (2022 for others), and beyond that is projected using CPAT.[15],[16] Electricity consumption is scaled down to exclude electricity produced by zero-carbon sources.

(ii) Prices, Taxes, and Supply Costs

For this update, a comprehensive database on retail and wholesale prices for households and industry/power generators by fuel product, sector, and country was compiled from questionnaires completed by IMF and World Bank country economists, supplemented by sources such as Eurostat, Global Petrol Prices, the IEA, and Enerdata. Prices reflect supply costs plus the combined effect of any fuel excises/subsidies, carbon pricing, and (for household fuels) general consumption taxes. Fuel taxes/subsidies are estimated to be the difference between fuel prices and supply costs. Future fuel prices are projected using current prices plus the product of changes in future international prices and (historically estimated) passthrough rates (typically 60 to 100 percent). International energy price projections average over IMF and World Bank sources, differentiated by region for natural gas.

For oil, which is traded in well-integrated international markets, the supply cost is the import/export price (for fuel importing/exporting countries, respectively) plus transportation, processing, and distribution costs. For coal and natural gas (where global markets are partially integrated) and electricity (largely a non-traded product), supply costs vary with country characteristics and available data. If a well-functioning market is present (for example, United States and Western Europe), supply costs are market prices, while if there is no market but tax/subsidy data is available, then supply costs are retail prices excluding taxes/subsidies. Otherwise, supply costs are the average (weighted by supply shares) of domestic and international (margin-inclusive) prices for coal and natural gas and cost recovery levels for electricity.[17]

3. Quantitative Results for Fossil Fuel Subsidies and Efficient Fuel Prices

This section presents results on efficient prices by fuel product and country, global fossil fuel (explicit and implicit) subsidies and their breakdown by fuel, component, sector, and region. It then discusses the climate, other environmental, fiscal, and economic benefits of reform. Annex 2 discusses additional implicit subsidies from other sectors (international transport, extractives) and environmental costs (traffic noise).

Efficient Fossil Fuel Prices

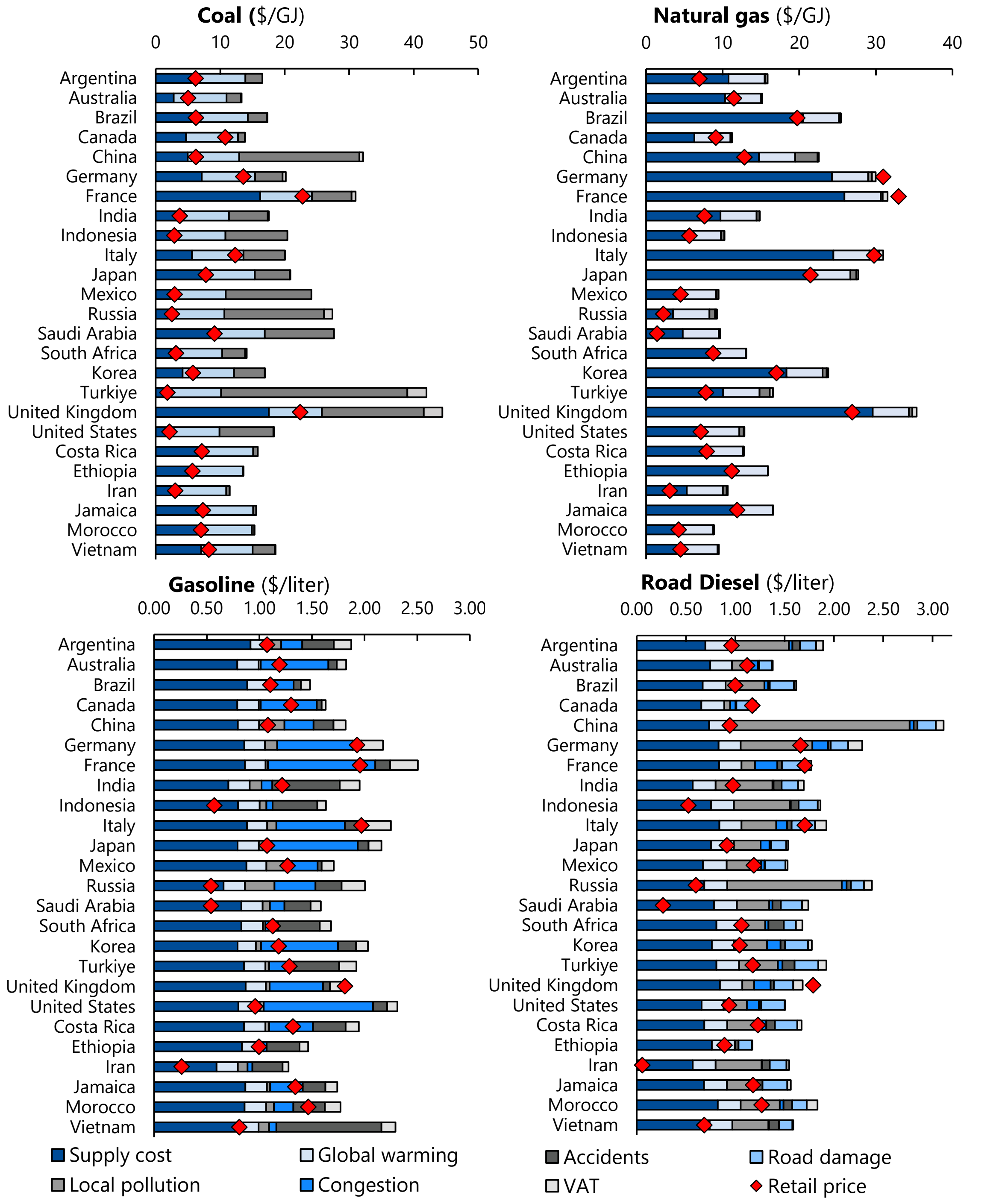
Figure 2 shows estimates of efficient prices for fossil fuel products in 2024, broken down by supply costs, various environmental costs, and VAT (or general consumption taxes), along with current prices, for G20 countries and selected other countries.

[15] IEA (2025). For other countries Enerdata 2025 is used (33 countries) and US EIA (2025) and UNSD (2025) is used for less than 10 small economies.

[16] See Black and others (2023a).

[17] For further details on the compilation of price and supply cost data, along with data sources, see Black and others (2023b), Annex 1. Estimates of producer subsidies for fossil fuels by country are from the OECD and major energy producers (OECD 2024). Supply costs for electricity are estimated using CPAT.

Figure 2. Comparing Current and Efficient Fuel Prices, G20 and Select Other Countries, 2024



Source: Authors.
Note: prices for coal and natural gas are averaged over fuel consumption in the power generation, industrial, and building sectors and weighted by consumption, while prices for gasoline and diesel are for road fuel consumption only. Congestion, accident, and road-damage externalities are scaled by the fraction of fuel price elasticities reflecting changes in driving distances, rather than improvements in fuel efficiency.

(i) Coal

Supply costs for coal vary significantly by country (with extraction, labor, transportation, coal quality, and other factors), for example, they are less than $3.5 per gigajoule (GJ) in Australia, India, Indonesia, Mexico, Russia, South Africa, Türkiye, and Iran, while they exceed $11.5 per GJ in France, Germany, and UK. Current prices generally reflect supply costs—as coal is rarely subject to significant excise or subsidies—or markedly exceed them in a few countries with carbon pricing, like France, Germany, Italy, Korea, and UK.

Global warming damages ($85 per tonne of CO_2 times coal's emission factor) vary only slightly across countries, between $7.9 and $8.3 per GJ, but are between 50 and 370 percent of supply costs.[18] In contrast, local air pollution damages vary dramatically from less than $3 per GJ in Argentina, Australia, Canada, and Morocco, to over $15 per GJ in China, Türkiye, and UK. Some countries, like India and Vietnam, have relatively high local air emissions rates and population exposure to the resulting pollution, but overall damages are relatively modest at $3 to 6 per GJ due to the assumed lower valuation of mortality risks in countries with lower per capita income. Conversely, while countries like Japan and US have made considerable progress in reducing emission rates, air pollution damages are still on the high side ($6-8 per GJ), due to relatively high assumed mortality values of $5.4 and $7.8 million, respectively. Overall however the picture is one of pervasive and large underpricing of coal use—coal prices are less than half their efficient levels in 21 out 25 cases shown in Figure 3, and around a third or less in fifteen cases.

(ii) Natural Gas

Supply costs for natural gas also vary considerably across countries (with fragmentation of international markets and significant costs to shipping and processing liquified natural gas) and are generally larger per unit of energy than for coal. They vary from less than $10 per GJ in 12 countries to about $20 per GJ or more in Brazil, France, Germany, Italy, Japan, and UK. Prices are below supply costs in 14 countries, but only moderately so (less than 10 percent) in seven of these cases—explicit per unit subsidies are largest (between about 20 and 40 percent of supply costs) in Argentina, India, Iran, Türkiye, and Russia, and 70 percent of supply costs in Saudi Arabia.

Global warming damages are $4.7 per GJ for natural gas (compared with $8.1 per GJ for coal), and generally much smaller relative to supply costs than for coal, between 10 and 100 percent, reflecting both lower emission rates per GJ and higher supply costs. Local pollution damage is modest (typically below $1 per GJ). The VAT component of efficient natural gas prices would contribute 5-20 percent of the efficient price for household consumption alone but is much smaller in Figure 2 given averaging over use in buildings, power generation, and industry. As for coal, natural gas is pervasively underpriced, but the severity is less pronounced: prices are about 50 percent or less of supply costs in only seven cases.

(iii) Gasoline

Supply costs for gasoline (used by light-duty vehicles) are very similar across countries given well integrated world markets, mostly about 80-90 cents per liter. Prices are below supply costs in four cases (Indonesia, Iran, Russia, and Saudi Arabia) but exceed them by about 50 percent or more (due to fuel excises) in 12 cases.

Global warming damages for gasoline are relatively modest, about 20 cents per liter. Local pollution costs are even smaller, about 10 cents per liter or less in 20 cases, reflecting strictly enforced emission rate standards for new and used vehicles in most cases, but exceeding 20 cents per liter in China, Russia, and Mexico.

[18] CO_2 emissions factors vary significantly across coal types (anthracite, bituminous, sub-bituminous, lignite) per tonne of production, but very little per unit of energy content.

Congestion adds substantially to efficient gasoline taxes, over 65 cents per liter, in Australia, Canada, France, Germany, Italy, Japan, Korea, UK, US but is less than global warming damages in India, Indonesia, South Africa, Ethiopia, Iran, and Vietnam—these cross country differences reflect, most importantly, differences in the value of travel time, and to a lesser extent in average nationwide travels delays per km. Accidents contribute significantly to efficient taxes, 50 cents or more per liter, in India, Indonesia, South Africa, Türkiye, and Vietnam (due, most importantly, to high pedestrian fatality rates) but are less than global warming damages in Australia, Brazil, Canada, France, Germany, Japan, Mexico, and US. VAT adds around 5 to 30 cents per liter to efficient gasoline taxes across different countries. Overall, gasoline is underpriced in all countries, and by about 50 percent or more in ten cases.

(iv) Diesel

Supply costs for diesel (used by heavy- and some light-duty vehicles) are typically about 5 percent smaller than for gasoline (though up to about 20 percent smaller in some cases). Diesel is subsidized in the same four countries that subsidize gasoline. Of the remaining countries that tax diesel, taxes are lower than gasoline taxes in 13 cases, and higher than them in seven cases.

Carbon damage per liter is mostly about 15 percent higher for diesel than gasoline (due to its higher emissions factor from higher fuel density). Local pollution is, however, much higher on average at about 90 cents per liter, reflecting the higher on-road emission rates for diesel vehicles. Conversely, the contribution of congestion and accidents to efficient fuel taxes is much smaller, as km driven for heavy trucks per liter of fuel consumption is only around one third of that for light-duty vehicles (implying smaller costs for km-related externalities when converted to costs per liter of fuel use). The VAT component of efficient taxes is also smaller for diesel, given much of the fuel (unlike for gasoline) is consumed as an intermediate input. Road damages costs are very small per liter of fuel use. Overall, diesel is underpriced by about 50 percent in 13 countries.

Fossil Fuel Subsidies

(i) The Global Picture

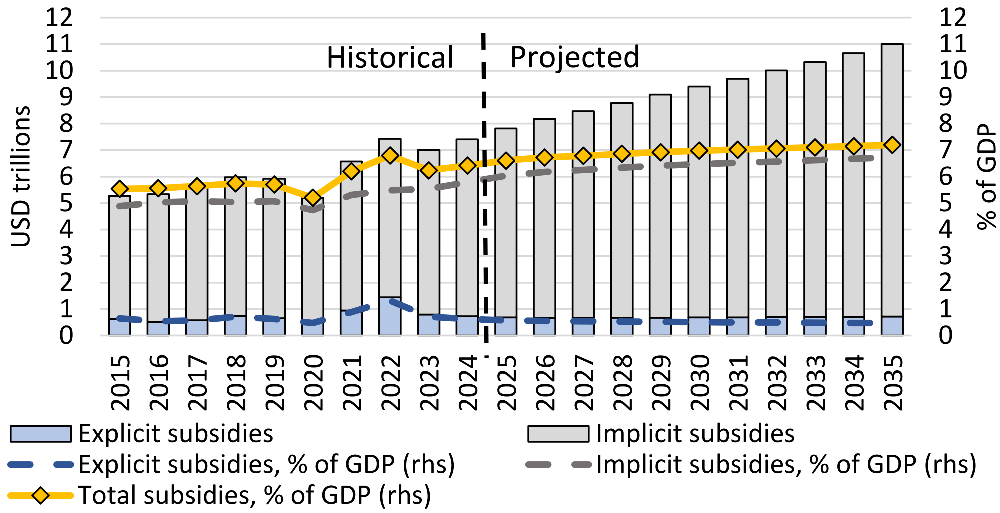
Figure 3 shows explicit and implicit fossil fuel subsidies at the global level using actual data, from 2015-2024, and projected data, from 2025 to 2035, in a baseline scenario with future fuel taxes, explicit subsidies per unit, and carbon pricing fixed in real terms at 2024 levels.

In 2024, explicit subsidies were $0.73 trillion, or 0.6 percent of global GDP, with consumer and producer subsidies accounting for 85 and 15 percent of the total, respectively. Relative to GDP, explicit subsidies tend to vary with international energy prices, with a large drop to 0.5 percent of GDP in 2020 and then rising to 1.3 percent in 2022 as many governments used temporary measures to contain retail price increases during the surge in international energy prices. Fixed pricing regimes result in higher subsidies as international prices rise and vice versa. Under current policies, explicit subsidies are projected to slightly decline relative to GDP through 2035 as international energy prices are projected to gradually fall and baseline demand for fuels to rise by slightly less than in proportion to GDP growth.[19]

[19] IEA (2024), which covers a subset of countries and also uses the price-gap approach find explicit subsidies in 2023 to be $0.62 trillion, while OECD (2024) report subsidies of $1.1 trillion, using the inventory approach.

Implicit fossil fuel subsidies are estimated at $6.7 trillion, or 5.8 percent of global GDP in 2024. In contrast to explicit subsidies, implicit subsidies are increasing over the period relative to GDP from 4.9 percent of GDP in 2015 to 6.7 percent in 2035 (this trend is explained below).

Figure 3. Estimated and Projected Explicit and Implicit Global Fossil Fuel Subsidies over Time, Baseline Scenario



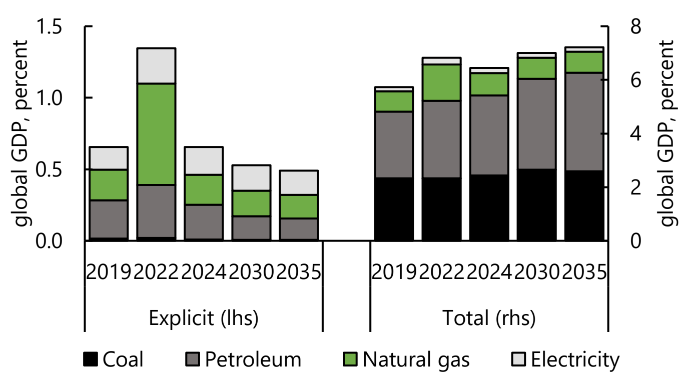
Source. Authors.

Note. Figures after 2023 and 2024 onwards use projections for fuel use and fuel prices, respectively.

Total (explicit plus implicit) fossil fuel subsidies are $7.4 trillion in 2024, or 6.4 percent of GDP, with explicit and implicit subsidies accounting for 10 and 90 percent of the total, respectively. Total subsidies were 5.5 percent of GDP in 2015 and are projected to reach 7.2 percent in 2035 in the baseline scenario.[20]

The subsidy estimates have changed very little from the previous update (Black and others 2023a) where explicit and implicit subsidies for 2024 were projected at 0.7 and 5.7 percent of global GDP respectively.

Figure 4. Decomposition of Explicit and Total Global Subsidies by Fuel Product



Source: Authors.

(ii) Breakdown by Fuel Product

Figure 4 shows the breakdown of global explicit and total subsidies by fuel product and for selected years. For 2024, electricity, petroleum, and natural gas each account for 30 to 37 percent of explicit subsidies.

The picture looks entirely different for total (explicit and implicit) fuel subsidies, with petroleum accounting for the largest share (46 percent) of the total in 2024, followed by coal (38 percent), gas (13 percent), and

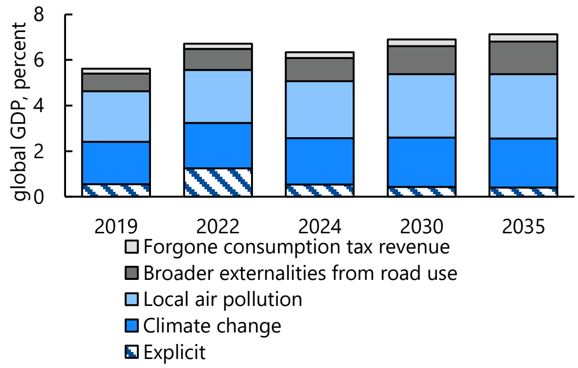
[20] For comparison, subsidies for clean technology deployment were around $70 billion in 2023 according to UN (2025).

electricity (3 percent). The higher shares for coal and petroleum in the total subsidy reflect (underpricing for) their much larger environmental costs compared with natural gas, while there are no environmental costs attributed to electricity consumption. Going forward, total subsidies for petroleum and coal rise gradually relative to GDP reflecting several factors: increasing concentration of global fossil fuel consumption in emerging market economies where the underpricing of fossil fuels tends to be more severe (see above); the rising value of carbon damages relative to GDP; and a widening gap between road fuel taxes and efficient pricing (the former is fixed in real terms while the latter is rising, for example, with values of travel time).

(iii) Breakdown by Component

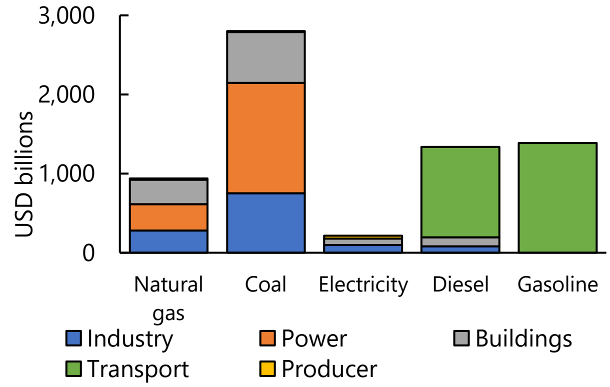
Figure 5 shows the breakdown of total (explicit and implicit) global fossil fuel subsidies by component. In 2024, local air pollution was the largest component (accounting for 39 percent of the total global subsidy), followed climate change (32 percent), underpricing for broader externalities from road use (16 percent), explicit subsidies (9 percent), and forgone consumption tax revenue (4 percent). Within implicit subsidies, climate change and local pollution account for three quarters of the global total. The relative contribution of different components to the total global subsidy remains similar in the baseline out to 2035, aside from a gradual decline in the share of the explicit subsidy as the implicit subsidy rises.

Figure 5. Decomposition of Total Global Fossil Fuel Subsidies by Component



Source: Authors.

Figure 6. Decomposition of Total Global Fossil Fuel Subsidies by Fuel and Sector



Source: Authors.

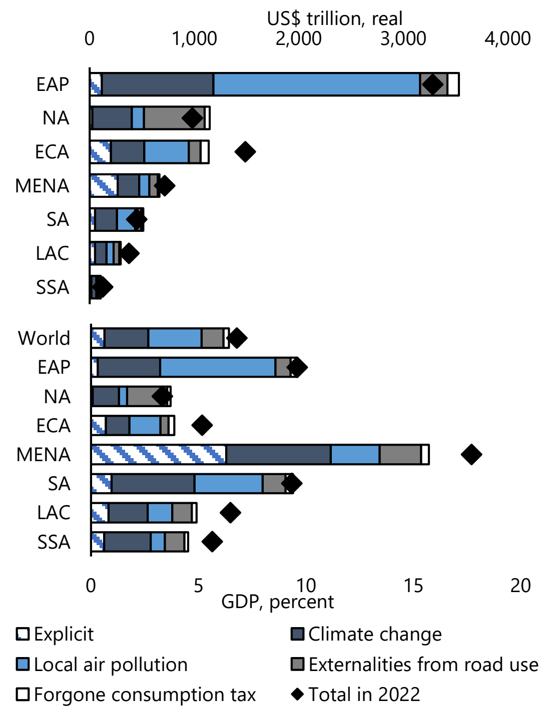
(iv) Sectoral Breakdown

Figure 6 indicates the breakdown of (explicit plus implicit) global fossil fuel subsidies for each product by energy-consuming sectors in 2024. Industry, power, and buildings each contribute about one third to the total natural gas subsidy. For the coal subsidy, power, buildings, and industry contributed 50, 27, and 23 percent respectively. The total subsidy for electricity is primarily from industry (45 percent) and buildings (37 percent), with the remainder for producers. For gasoline, all of the subsidy is from transport, and for diesel 74 percent (with the remainder from industry and buildings). Overall, transport and power are subsidized most at around 30 percent, followed by buildings and industry at nearly 20 percent each. For explicit subsidies only (not shown in the figure), the main difference is natural gas where buildings, industry, and power contribute 54, 22, and 15 percent of the subsidy respectively (there are no explicit subsidies for coal).

(v) Geographical Breakdown

Figure 7 indicates the breakdown of global fossil fuel subsidies by region in 2024.[21] The Middle East and North Africa (MENA) and Europe and Central Asian (ECA) regions account for the majority of explicit subsidies at 37 and 28 percent, respectively, followed by East Asia and Pacific (EAP), 16 percent, South Asia (SA) and Latin America and Caribbean (LAC), 7 percent each, North America (NA), 3 percent, and Sub-Saharan Africa (SSA), 2 percent. Again, the breakdown is very different for total subsidies. In this case, EAP is by far the largest portion of the subsidy (47 percent), followed by NA and ECA (15 percent each), MENA (9 percent), SA (7 percent), LAC (4 percent), and SSA (1 percent).

Figure 7. Decomposition of Total Global Fossil Fuel Subsidies by Region, 2024



Source: Authors.

Note: NA = North America; EAP = East Asia and Pacific; LAC = Latin America and Caribbean; SSA = Sub-Saharan Africa; MENA = Middle East and North Africa; ECA = Europe and Central Asian; SA = South Asia.

Relative to GDP, however, total subsidies are largest for MENA (16 percent), followed by EAP and SA (9 percent each), and around 4 percent for all other regions. In MENA, subsidies largely reflect undercharging for supply and environmental costs of petroleum, in SA low taxes and high environmental costs for coal, and in EAP underpricing for climate and local air pollution. Annex III provides information on explicit and implicit subsidies for selected countries.

Benefits from Fuel Price Reform

This sub-section discusses the global CO_2, health, fiscal, and economic benefits of fuel price reform scenarios including when all 170 countries progressively reach their efficient fuel price levels by 2035 (full reform) or close half the gap between pre-reform and efficient price levels (partial reform)—the scenarios are illustrative, as in practice political, social, or economic constraints preclude immediate and uniform implementation. Under the baseline scenario, current fuel taxes/subsidies, including any carbon pricing, are fixed at 2024 levels in real terms.

The previous assessment[22] also reported results on: (i) the benefits from a combination of non-pricing reforms (like feebates and tradable emission rate standards), expressed relative to those from full price reform; (ii) the proportionate CO_2 reductions that maximize domestic environmental benefits; and (iii) efficient local air emissions fees. Updated graphics are not provided below, however, due to little change in the results and (ii) and (iii) are shown in the online spreadsheet. For similar reasons, an updated sensitivity analysis is not provided here.

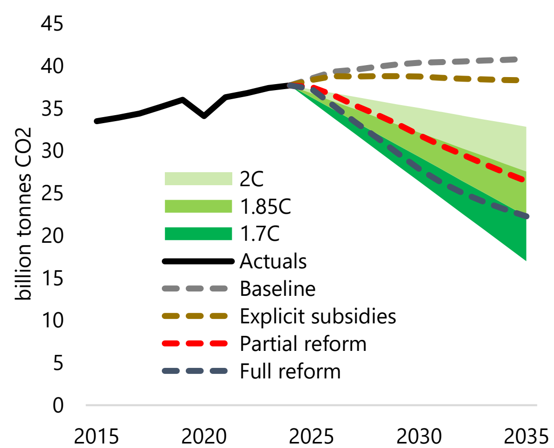
(i) Climate and Health Benefits

[21] See Black and others (2023b), Annex II, for the classification of countries by region.
[22] Parry and others (2023).

Figure 8 shows global CO_2 emissions from fossil fuels over time under alternative policy scenarios and compares them with emissions pathways consistent with alternative targets for stabilizing future global temperature increases.

In the baseline scenario with no changes in fuel taxes/subsidies, global CO_2 emissions increase from 37 billion tonnes in 2024 to 41 billion tonnes in 2035. Getting global emissions on track with limiting peak warming to 2°C, 1.85°C, and 1.7°C, requires cutting global emissions 19, 28, and 46 percent below baseline levels respectively (the bands indicate uncertainty ranges over the needed reductions).[23] However, current national targets in nationally-determined contributions (NDCs)—if achieved—would cut global emissions by just 7 percent (see Black and others 2025).

Figure 8. Global Fossil Fuel CO_2 Emissions Under Alternative Scenarios for Future Fuel Prices



Source: Authors.

Under the partial and full reform scenarios, CO_2 emissions are reduced by 35 and 46 percent respectively below baseline levels in 2035, implying consistency with a 1.85°C and 1.7°C peak temperature level, respectively. Emissions reductions rise by less than in proportion to higher fuel prices as the lower cost options for cutting emissions are progressively used up—technically speaking, this is because fossil fuel demand curves are convex rather than linear (or marginal cost schedules for cutting emissions are convex). Removing explicit subsidies only would cut global CO_2 emissions by just 6 percent below baseline levels in 2035.

Globally, around 60 percent of the CO_2 reduction under full price reform comes from reduced use of coal, 25 percent from petroleum, and 15 percent from natural gas. The relative contributions from different fuels reflect: (i) the much larger proportionate increase in coal prices from fuel price reform compared with petroleum and natural gas (as can be seen from Figure 2); and (ii) the larger shares of coal and petroleum in baseline global CO_2 emissions (about 40 and 35 percent, respectively) compared with gas (about 25 percent). By sector, power generation contributes 40 percent to emissions reductions, followed by 30 and 20 percent in the industrial and transportation sectors. The regional CO_2 reductions in the full reform scenario vary from 55 percent below 2035 baseline levels in South Asia (SA) and Middle East, and North Africa (MENA) to 50 percent in East Asia and the Pacific to around 40 percent in other regions, with most of the differences in proportionate CO_2 reductions across regions due to different shares of coal in regional CO_2 baseline emissions and in gaps between efficient and current fuel prices.

Full fuel price reform also reduces global air pollution deaths from fossil fuel combustion by 40 percent below baseline levels in 2035, or 1.1 million a year, while partial reform saves 0.9 million. In either case, coal accounts for about 90 percent of the avoided fatalities. Besides the disproportionately large reduction in coal consumption, local air emissions rates for coal-using power and industrial plants are assumed to decline (due to implicit rebates for downstream mitigation technologies), implying a disproportionately larger reduction in

[23] This corresponds to a 19, 28 and 46 percent cut vs. 2019 levels.

local air emissions than CO_2 (whereas CO_2 emissions factors are fixed).[24] The reduction in mortality rates from fossil fuels ranges from 5 to 15 percent in SSA, LAC, and NA to 40 percent in ECA, reflecting in part differences in the baseline share of coal in fossil fuel use and differences between baseline and efficient fuel prices. Removing explicit subsidies only would save 70,000 premature deaths in 2035.

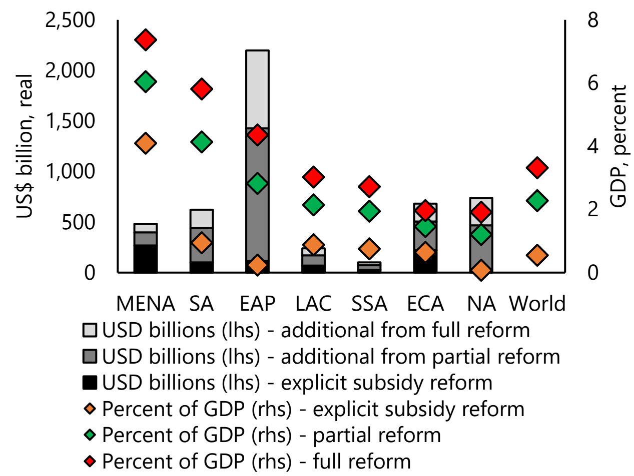
(ii) Fiscal and Economic Benefits

Figure 9 indicates net revenue gains from fuel price reform by region. Full price reform raises extra revenues of $5 trillion, or 3.3 percent of global GDP, in 2035 (relative to baseline revenues and accounting for revenue losses due to erosion of pre-existing fuel tax bases). There is considerable divergence in revenue gains across regions, largely mirroring the distribution of subsidies across regions. Partial reform raises about $3.5 trillion in revenues globally in 2035, or about two-thirds of that from full price reform. Explicit subsidy removal generates 0.6 percent of GDP) in fiscal space, which is equal to the size of subsidies since explicit subsidies reflect direct government support where increasing energy taxes erode the tax base for both existing and new taxes.

At the global level, full price reform would generate net economic welfare benefits of 3.2 percent of global GDP, equal to environmental benefits of 5 percent of GDP, less economic welfare costs of 1.8 percent of GDP (see Figure 10). Again, the pattern of welfare gains by region and by fuel products is similar to that for total subsidies and fiscal gains.

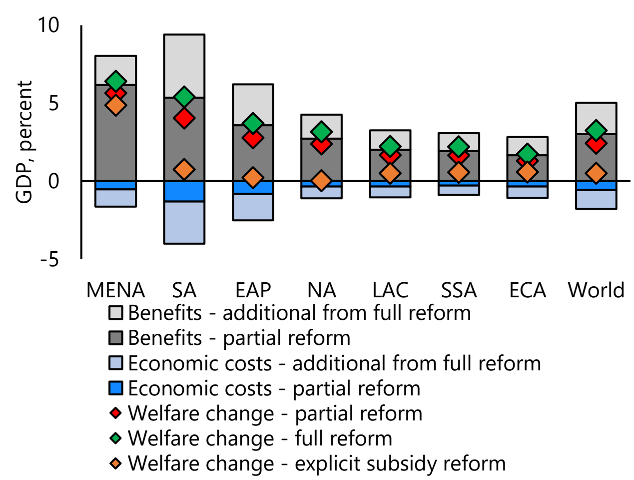
Figure 10 also underscores that the environmental benefits are approximately proportional to the extent of price reform, while economic costs increase disproportionately (refer back to Figure 3), consequently partial reforms can generate a disproportionately large share of the welfare gains from full price reform. For explicit subsidies, economic costs are less pronounced and their removal actually results in negative costs (or benefits) due to improved resource allocation. Overall, partial reform and explicit subsidy removal result in welfare gains of 2.4 and 0.5 percent of GDP, respectively.

Figure 9. Revenue Gains from Fuel Price Reform by Region, 2035



Source. Authors. Note: For an explanation of abbreviations see note to Figure 7. Absolute revenue from full reform is the sum of columns.

Figure 10. Environmental Benefits and Economic Costs of Fuel Price Reform by Region, 2035



Source. Authors. Note: For an explanation of abbreviations see note to Figure 7. Benefits and costs from full reform are the sum of gray and blue columns respectively.

[24] Local air emission rates (averaged over all firms) fall to those of the cleanest firms in response to energy price reform and tax increases are adjusted downward to reflect these falling emissions rates.

4. Distributional Impacts on Households of Fossil Fuel Subsidies and Their Reform

Fuel subsidy reform can reduce household purchasing power by raising energy prices. A central policy concern is the risk of raising poverty. Raising energy prices impacts all households, but although the poorest tend to consume far less fuels than wealthier households, they may be vulnerable if subsidies are withdrawn without compensation. Additionally, effects may be regressive, with low-income households bearing a larger relative burden than wealthier households, though this varies across countries. Lastly, there are heterogenous effects across regions within a country, notably effects may disproportionately affect households in rural areas, which tend to be poorer and consume a higher relative share of fuels than households in urban areas.

This section examines which households benefit from existing explicit subsidies and how they would be affected by removing explicit subsidies only or full price reform to reach efficient prices. Using a large dataset of household energy consumption covering 87 countries across all regions, effects are examined and generalized, including identifying beneficiaries of existing subsidies and which households would be affected by explicit fuel subsidy removal or full fuel price reform (including corrective taxes to address externalities).[25]

Methodology

Changes in fossil fuel prices impact households both directly—through the amount they spend on fuel consumption—and indirectly—by changing prices and expenditures of goods and services whose production uses fuel as an input. The effects on household income groups are estimated by combining microdata from household budget surveys (see Annex 5 for details) and input-output tables (using GTAP 14), where data is available. The dataset covers 87 countries accounting for 40 percent of total global explicit subsidies in 2024. The countries are broadly representative of the global economy,[26] though the absence of certain countries means that coal, gasoline, diesel, and oil are under-represented in the sample, while electricity and natural gas are over-represented.[27]

To generalize across countries, the analysis separates households within a given country into consumption deciles. The global analysis then takes medians across each decile for each country. The subsidy received by each decile is estimated based on its consumption of the subsidized fuel. Direct effects—impacts via prices of energy consumed by households—are estimated by grouping households into consumption deciles and calculating their budget shares for each fuel using national accounts adjusted consumption.[28] For each fuel, we estimate the share of total consumption attributable to each decile, including both direct purchases and indirect

[25] Annex 6 provides a methodology for assessing a key country-level distributional impact: the affect on fossil fuel producers.

[26] In 2024, countries included accounted for about 80 percent of global GDP, population and CO2 emissions. Of the 87 countries, 33 are classified as high income, 20 as upper middle income, 24 as lower middle income and 10 as low income. Some countries that provide large explicit subsidies for petroleum, notably Russia, Iran, Saudi Arabia, Algeria, and Iraq, are excluded due to lack of data.

[27] Broken down by fuel, the data covers: coal (38 percent of the global explicit coal subsidy), electricity (48 percent), natural gas (55 percent), gasoline (43 percent), diesel (19 percent), kerosene (50 percent) and LPG (52 percent).

[28] Consumption or expenditure is commonly viewed as a more reliable measure of well-being than income. For example, reported income can be a small share of total resources for both low-income households (receiving significant transfers and in-kind assistance), or wealthy households (receiving significant capital and property income), and it can also be subject to transitory shocks at the time of the survey. Moreover, expenditure data is more widely available and internally consistent across countries. Incidence analyses based on expenditure generally appear more distributionally neutral than those based on income.

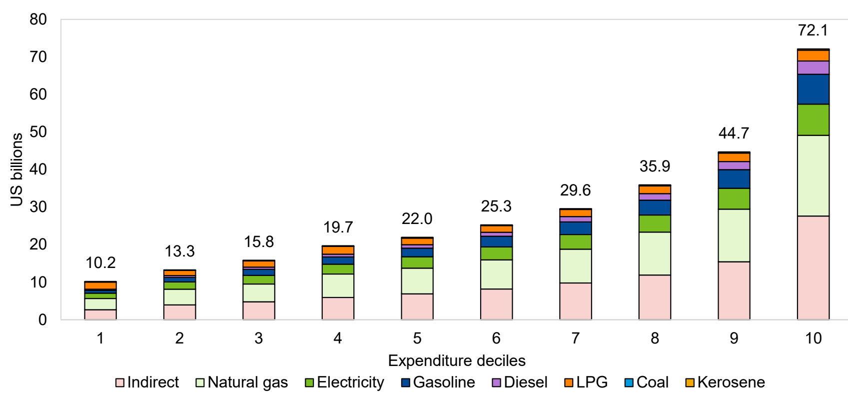
use embedded in other goods and services.[29] The total value of the subsidy for each fuel is then allocated across deciles in proportion to those shares. To assess the burden of subsidy reform on households, we estimate the additional spending each household would require to maintain its pre-reform consumption bundle after prices increase. To avoid overstating the burden on households, the calculation is adjusted for changes in household consumption using own price elasticities of demand.[30] To quantify distributional effects of reform across households, we use CPAT (refer to Black and others 2023b for full methodology).

The net distributional impact of energy price reform depends critically on how revenues saved or raised—from phasing out explicit subsidies or raising fuel taxes, respectively—are used. The appropriate recycling strategy—such as targeted cash transfers to low-income households, reductions in labor or other taxes, clean infrastructure or other increased public investments, reduced fiscal deficits, and so on—depends on country-specific capacity and policy priorities. We report the required share of revenues needed to compensate lower income households, though full net distributional effects of reform depend on how all revenues are used.

Results: Current Beneficiaries of Explicit Fossil Fuel Subsidies

Policymakers and commentators often suggest that fuel subsidies should be retained as they support low-income households who rely on fuels. However, the results suggest that subsidizing fuels is a remarkably inefficient way to support low-income households, with more wealthy households capturing most fuel subsidies. In 2024, of the $289 billion in global explicit fossil fuel subsidies included in the analysis, the top 50 percent wealthiest households captured about three quarters of the fuel subsidies. The lowest and highest deciles received $10 and $72 billion, respectively. That is, for every dollar in subsidy received by the poorest 10 percent of households, the wealthiest 10 percent received about seven dollars (see Figure 11). The poorest 10 percent of households received just 3.5 percent of total subsidies, while the richest 10 received 25 percent. The poorest

Figure 11. Global Subsidy Distribution by Fuel, 2024



Source: Authors. Note: shows the total explicit subsidy by income decile across 87 countries who collectively account for 40 percent of total explicit subsidies and about 80 percent of global GDP, population, and CO_2 emissions. Indirect subsidies include subsidies to coal and natural gas used in the power sector, industrial electricity tariffs, and consumer- and producer-side oil subsidies.

[29] Indirect effects—impacts via prices of non-energy goods, which still require energy to produce—are estimated by aggregating non-energy items in household budget surveys into broader consumption categories and mapping these categories to sectors in input-output tables, allowing estimation of the energy intensity of the bundle of goods and services consumed by each decile.

[30] For further details about the methodology in the distributional section, see The IMF-World Bank Climate Policy Assessment Tool (CPAT): A Model to Help Countries Mitigate Climate Change.

20 percent of households received only 8.1 percent of total subsidies, while the richest 20 percent received 41 percent.[31]

Most of the subsidies are on electricity and natural gas, with gasoline, diesel, coal and LPG representing a smaller share. For most energy sources, high-income households capture a large share of explicit subsidies. For example, the top 20 percent of households captured 37, 40, and 42 percent of electricity, natural gas and gasoline subsidies, respectively. These patterns highlight that although low-income households benefit somewhat from fuel subsidies, the fiscal cost of delivering that support is extremely high. Redirecting even part of these resources—while providing targeted compensation to low-income households—could create substantial fiscal space for development priorities, such as expanding energy access and financing social protection and would mostly (in absolute terms) affect wealthier households.[32]

Results: Effects of Reforming Fossil Fuel Subsidies

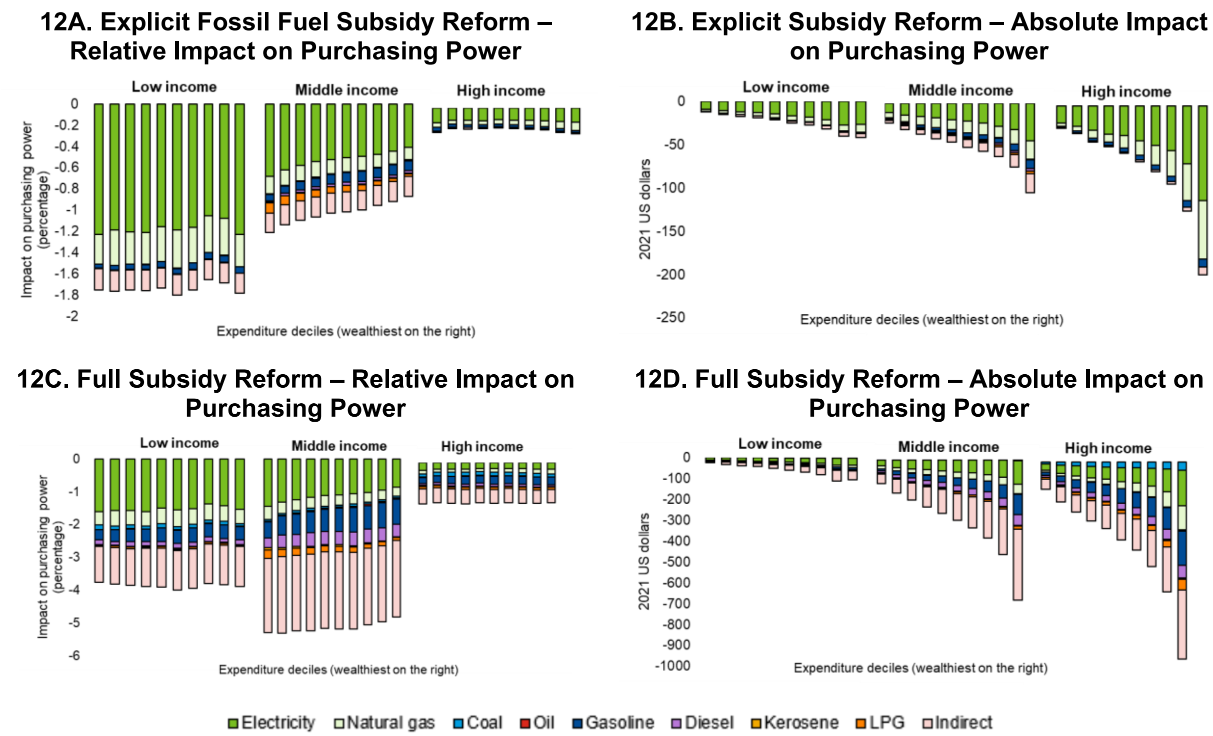
Figure 12 reports the estimated cost to households in 2035 of removing explicit fuel subsidies. As a share of total expenditure, the impact on purchasing power (before considering any potential fiscal transfers – see below) varies across countries (Figure 12A). Negative impacts on purchasing power would be larger for low-income countries via higher electricity prices, although the overall pattern is neutral. Middle income countries face regressivity, while high income countries would experience a slight U-shaped pattern, although fairly neutral. Low levels of aggregate consumption in lower income countries drive the large effects on purchasing power despite energy access gaps.

Globally, when taking medians across deciles for each country, the pattern is slightly regressive. A median household in the lowest decile would experience a reduction in real purchasing power of about 0.46 percent; households in the middle of the distribution would experience a median impact of up to 0.43 percent, compared to 0.38 percent for households in the top decile.

[31] These results are broadly consistent with prior studies. For example, Del Granado and others (2012) find that, on average across 20 countries, the richest 20 percent of households capture about 42.8 percent of explicit fuel subsidy benefits, while the poorest 20 percent receive only 7.2 percent. Sladrevich and others (2014) show evidence for the Middle East and North Africa: only 1 to 7 percent of diesel subsidy spending accrues to the poorest quintile, compared with 42 to 77 percent accruing to the richest quintile. In Sub-Saharan Africa, the African Development Bank (2012) estimated that 44 percent of fossil fuel subsidies go to the richest quintile, while the poorest quintile receives 8 percent.

[32] Estimating who is affected by implicit subsidies would be quite challenging. For example, it would require matching data on income deciles to spatial data on air pollution exposure, accounting for possible differences in access to medical care across income groups.

Figure 12. Impact of Explicit Fossil Fuel Subsidy Phaseout on Purchasing Power, 2035

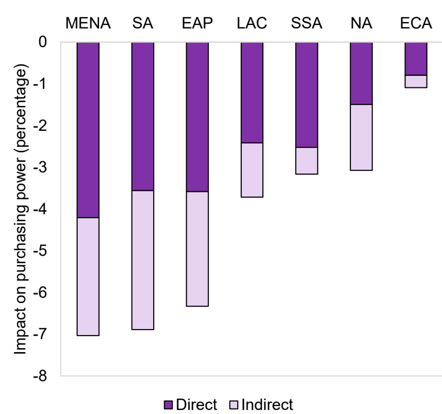


Source: Authors. Note: absolute impacts are expressed as monthly US $ equivalent loss in purchasing power.

For total (explicit and implicit) subsidy removal, the indirect channel becomes more relevant in all cases, driven by the taxation used in production processes like diesel and electricity. In absolute terms, impacts on wealthy households increase up to $1,000 per year in high income countries. Overall, the reform remains neutral for low-, middle- and high-income countries.

Full energy price reform has substantive impacts on households, generating larger losses for households before accounting for any compensating measures or the use of revenue. Globally, the reform is regressive with lowest income households experiencing a median impact of -2.8 percent of real purchasing power, as opposed to -2.4 for high income households. Figure 13 shows significant regional heterogeneity, broadly following the size of subsidies by region. For countries included in the sample, countries in Middle East and North Africa, East Asia and the Pacific and South Asia experience the largest impacts, where the reduction in purchasing power could reach 7 percent. The estimated burden is about half of that in Latin America, Sub-Saharan Africa and North America at around 3 percent.

Figure 13. Impact of Full Energy Reform on Purchasing Power by Region, 2035



Source: Authors. Note: shows median effect across deciles. For an explanation of abbreviations see note to Figure 7.

Results: The Urban and Rural Divide

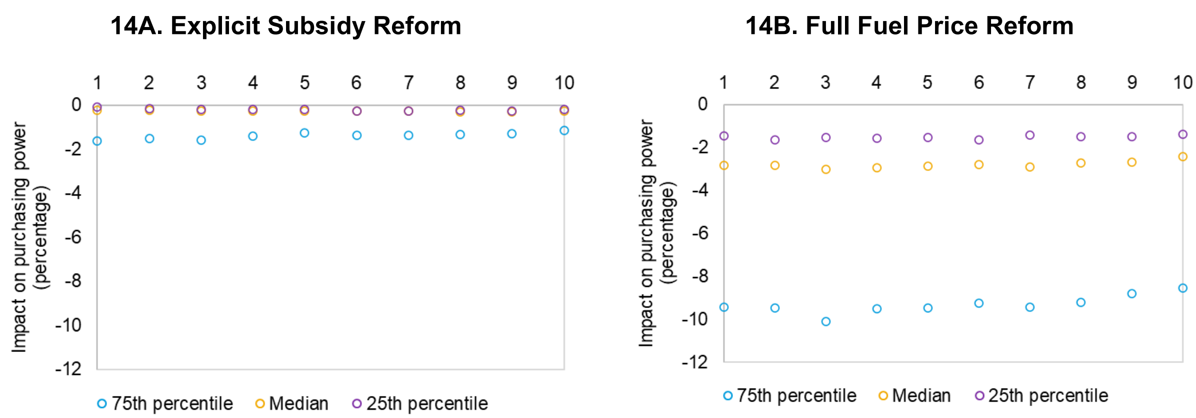
Lastly, policymakers might have equity considerations beyond income levels. For example, rural areas tend to be poorer and rural households may be more affected by fossil fuel subsidy reform than their equivalents in urban areas. However, effects may be heterogenous and difficult to predict due to differing consumption baskets (urban households consume more electricity, natural gas and LPG, rural households rely relatively more heavily on kerosene and gasoline) and infrastructure disparities (rural households have fewer local transport options, for example). By further disaggregating deciles into rural and urban households, we can examine the urban vs. rural divide (refer to Annex VII for details). Globally, it does not appear that rural households are systematically affected more than urban households by fossil fuel subsidy reform, though differences can emerge at the country level. In addition, in general, reforming subsidies remains distributionally neutral for both urban and rural households, with poorer and wealthier households being affected equally as a share of income.

Within-Decile Variation

Vertical equity (relative impacts between consumption deciles) does not fully capture the distributional consequences of energy price reform. Vertical equity (relative impacts between consumption deciles) does not fully capture the distributional consequences of energy price reform. The literature suggests that horizontal equity (differences between households within the same income group) is at least as important for measuring net welfare impacts. Household expenditure-based models that report only average or median effects by decile risk obscuring this variation and could underplay household vulnerability.

The incidence of explicit and total subsidy reform is highly context specific. It depends on country characteristics, such as energy access, reliance on specific fuels, transport patterns, and on policy design. As a result, the burden on any given household is difficult to predict solely from its position within the income distribution. Figure 14 illustrates the dispersion of impact within each decile. Within-decile variance is large but broadly similar across the distribution. In the case of an explicit fuel subsidy phase-out, some households within a given decile, especially among lower income households, could experience an effect up from four to seven times larger than that decile's median impact depending on the scenario. Under full energy price reform, the

Figure 14. Within-Decile Variation for Explicit Subsidy Reform and Full Price Reform



Source: Authors.

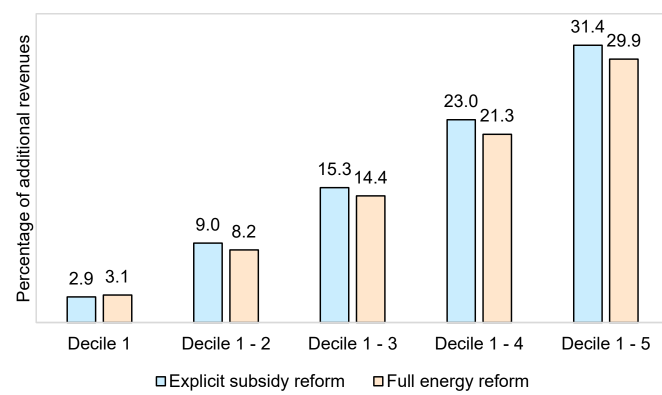
potential loss in purchasing power can reach as high as 10 percent for the most exposed lower income households, and up to 9.5 percent for the most exposed wealthier households.

These results have two implications. First, compensation schemes that are calibrated only to the average or median household in each decile may leave a substantial share of low income households unprotected. Second, successful reform requires administrative capacity to target support within deciles, not only across them. Incorporating horizontal heterogeneity into the design of compensatory transfers can improve the political viability of reform and reduce the risk of reversal.

Compensating Low-Income Households.
Figure 15 shows the share of revenues from removing explicit subsidies, or explicit and implicit subsidies, needed to compensate income deciles as a group, where the compensation applies to alternative coverage of low-income households. The revenue shares are very similar for full subsidy removal.[33] In both cases, only about 3 percent of revenues would be needed to compensate the bottom 10 percent of households, about 9 percent to compensate the bottom 20 percent of households, and 30 percent to cover the bottom 50 percent of households (which might be a reasonable policy goal in low-income countries). In short, governments can both safeguard equity while generating substantial fiscal space.

If the amount of compensation is set at a level at the upper end of the distribution, e.g. 75th percentile of most affected households, . this would significantly increase the share of revenues required to compensate households. In this case, it would require about four times more to compensate the poorest 10 percent of households, and 28 percent to protect the poorest 20 percent. If compensation was perfectly targeted, however, the share of revenues required for compensation would fall significantly. This illustrates the trade-off between broader and more generous coverage that protects the most exposed households within deciles but raises budgetary needs. In addition, it underscores the importance of robust social registries and effective targeting systems.

Figure 15. Share of Revenues from Subsidy Reform Needed for Compensating Low-Income Households by Income Group (Cumulative Deciles)



Source: Authors.

Future areas of research are twofold. First, increasing country coverage, particularly for countries that provide large subsidies, low-income countries and countries in Sub-Saharan African and the Middle East and North Africa, will allow for a more accurate estimate of current subsidy beneficiaries. Second, developing a methodology to better understand who is affected by implicit subsidies (e.g. whether poorer households

33 Under full energy price reform, the required share of revenues for compensation is slightly lower than in the subsidy phase-out scenario. This is because the corrective (Pigouvian) taxes raise additional revenue. The additional revenue more than offsets the higher initial burden on household’s purchasing power. In an extreme case, if all revenues were used for targeted transfers for the bottom half of the 85 countries considered, welfare would rise among the poorest 20 percent of households by x percent.

experience more welfare losses from local air pollution) and who would gain from their removal would give a fuller picture of the impacts of mispriced fuels.

5. Conclusion

This paper provides a comprehensive assessment of fossil fuel subsidies across 170 countries, highlighting the pervasive underpricing of fossil fuels and the substantial fiscal, environmental, and welfare costs that result. Explicit fossil fuel subsidies (undercharging for supply costs) are large at $725 billion (0.6 percent of GDP) in 2024. But implicit subsidies, primarily underpricing of environmental costs, are much larger at $6.7 trillion (5.8 percent of GDP). Indeed, fossil fuels remain pervasively and substantially underpriced globally, especially for coal and road fuels, where for many countries prices are less than half of their efficient levels. The findings underscore that most countries continue to misallocate scarce fiscal resources, exacerbating greenhouse gas emissions, air pollution mortality and undermining distributional objectives, as wealthier households disproportionately benefit from energy prices well below efficient levels.

Removing explicit subsides would have significant benefits, for example, reducing global CO_2 emissions by six percent below baseline levels in 2035, avoiding 70,000 premature air pollution deaths annually, raising 0.6 percent of GDP in government revenue, and generating net economic benefits worth of 0.5 percent of GDP. Comprehensive energy price reform, raising fossil fuel prices to their economically efficient levels, would however generate far larger benefits. These include a 46 percent reduction in CO_2 emissions below baseline by 2035 (consistent with peaking warming at 1.7°C), the avoidance of over one million premature air pollution deaths annually, as well as fiscal and net economic benefits each exceeding 3 percent of global GDP. Importantly, the distributional analysis shows that while subsidy removal and corrective taxation impact household purchasing power, targeted compensation mechanisms can fully offset adverse effects for lower income groups using only a modest share of the fiscal space created. This highlights the potential for governments to safeguard equity while freeing resources for other priorities such as reducing broader taxes, fiscal deficits, and poverty, or increasing public investment in infrastructure.[34]

Looking ahead, the evidence presented in this paper suggests that countries would benefit significantly by accelerating fossil fuel subsidy reform as part of their broader climate and fiscal strategies. Pursuing efficient pricing while strengthening social protection systems to support low-income households and investing in clean energy alternatives would require a comprehensive policy package. By doing so, countries can achieve substantial environmental and health gains, improve fiscal sustainability, and promote a fairer distribution of benefits. In short, the transition to efficient energy pricing can help countries achieve inclusive and sustainable growth.

[34] All policy discussions in this paper are in line with previous IMF recommendations in Parry and others (2014).

Annex I. Further Details on Methodology

This annex provides details on calculating the benefits from subsidy reform and the measurement of environmental costs.

Computing the Benefits from Subsidy Reform

The CO_2 emission reductions from policy-induced reductions in use of a particular fuel is simply given by:

$$(1)\quad CO2\ emissions\ factor \cdot \{initial\ fuel\ use - new\ fuel\ use\}$$

where the CO_2 emissions factor is fixed across sectors for a given fuel.

Reductions in mortality from a policy-induced reduction in the use of a particular fuel, in a particular sector, is given by:

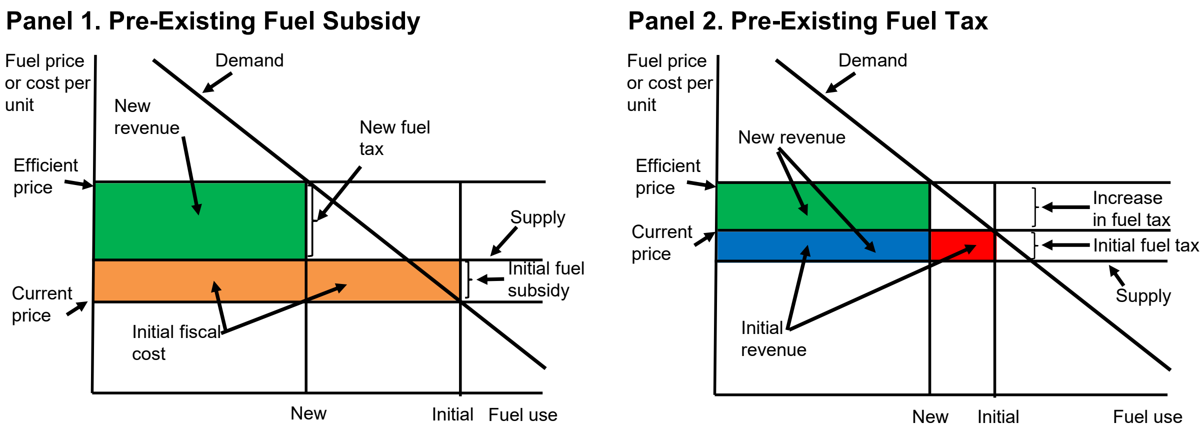
$$(2)\quad \{inital\ mortality\ rate\ \cdot\ initial\ fuel\ use\} - \{new\ mortality\ rate\ \cdot new\ fuel\ use\}$$

In this case, the mortality rate attributed to air pollution will vary by sector and fuel, since emissions and their impact on air quality are different in each sector. For example, if power generation is subject to stricter emission rate standards than industry, power emissions can be lower for the same amount of fuel use. Similarly, if power plants are far away from population centers, for the same amount of emissions, their impacts on air quality will be less compared to other sectors. And, the mortality rate may decline in response to policy, for example, if an emissions fee is introduced or, under a fuel tax, if firms adopting technologies to cut their out-of-smokestack emission rates can petition for rebates.

The fiscal benefits from fuel price reform are illustrated in Figure AI1. In panel 1, there is a pre-existing subsidy which entails a fiscal cost to the government equal to the subsidy rate times fuel consumption, or the red rectangular area. Removing the subsidy and imposing the efficient fuel tax increases revenues by the initial fiscal cost and new revenue raised from the tax, which is the tax rate times new fuel use (shown as the green rectangle). Where there is a pre-existing fuel tax, the case in panel 2, revenue benefits are the difference between the new and initial tax rate times new fuel consumption (the green rectangle) less revenue losses from the erosion of the tax base, which is the initial fuel tax times the fuel reduction (the red rectangle).[35]

[35] In principle, revenues could on net decline in response to higher fuel taxes (for example, if there is an especially large reduction in fuel use) but this does not occur under standard parameterizations in CPAT.

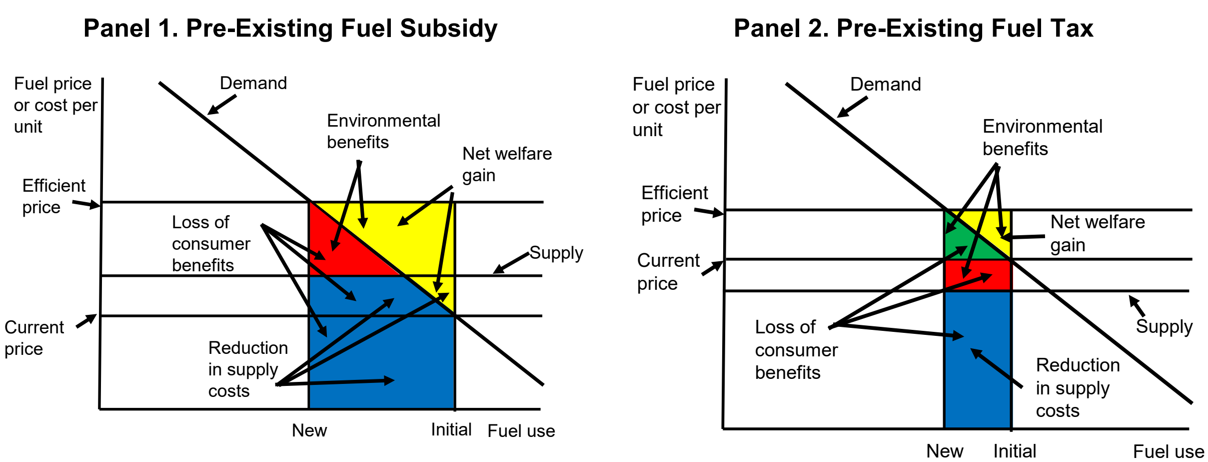
Annex Figure AI.1. Fiscal Benefits from Fuel Price Reform



Source: Authors.
Notes: green reflects revenue collected by new taxes, orange reflects the explicit subsidies initial fiscal cost, and red the loss in revenue from an initial tax due to base erosion.

Policy-induced fuel reductions have two sources of benefit and one source of cost. The first benefit is the environmental gains, which are simply the environmental costs per unit of fuel use times the fuel reduction. The second benefit is economic and reflects the savings in supply costs is simply the unit supply cost multiplied by the fuel reduction. The cost of reform is the loss of benefits to consumers from consuming less fuel than they would otherwise prefer—it is given by the area under the fuel demand curve integrated over the fuel reduction.[36] Figure AI2. illustrates these three effects as well as the overall economic welfare gains, indicated by the yellow triangles, for cases when initial fuel prices are below and above supply costs.

Annex Figure AI.2. Economic Benefits and Costs from Policy-Induced Fuel Reductions



Source: Authors.

[36] This follows because the height of the demand curve at any point reflects the benefit to consumers from an extra unit of fuel use (or price they are willing to pay for that extra unit).

Measurement of Environmental Costs

(i) Carbon Damages
We use an illustrative value of $77 per tonne of CO_2 in 2020, rising by $1.9 per tonne annually to reach $96 per tonne in 2030, and $106 per tonne in 2035 for carbon damages for each country.[37] These prices are based on mid-range assessments from modelling literature of the least-cost global carbon price trajectory consistent with limiting global warming to 2°C.[38] This is a conservative price trajectory, given the 2015 Paris Agreement seeks to limit warming to “well below” 2°C, ideally 1.5°C.

Alternatively illustrative values might draw from literature on the ‘social cost of carbon’, which measures the discounted value of global damage (for example, to agriculture, coastal activities, ecosystems, human health) from future climate change associated with an extra tonne of current CO_2 emissions—one recent study suggests a current social cost of carbon of around $185 per tonne in constant 2020$.[39] These estimates are, however, contentious given their sensitivity to different assumptions about intergenerational discounting and treatment of (poorly understood) tipping points in the global climate system.

Another approach would be to use estimates of the carbon prices implicit in countries’ own mitigation pledges. Alternatively, a 2°C consistent price could be used that is differentiated by country development level.[40] Both of these approaches are consistent with the Paris Agreement principle of common but differentiated responsibilities among developed and developing countries. For the first case, however, current mitigation pledges, globally, fall well short of those consistent with warming targets, while in the second case prices are somewhat arbitrary.

Nonetheless, CO_2 emissions from all countries contribute the same to global warming, and from this perspective it makes sense to use a common value for carbon damage across all countries for the purposes of the exercise here (the implications of other damage assumptions are transparent from the accompanying spreadsheet tool). Moreover, the general finding that fuels are underpriced would still be broadly apply, though less definitively, even if carbon damages were excluded from the analysis.

(ii) Air Pollution Damage
Air pollution damage is obtained from averaging over results from two different modelling approaches to relate emissions to ambient concentrations, each with its strengths and weaknesses. The first approach is based on ‘intake fractions’ which, for power and industrial plants (where emissions from tall smokestacks are transported long distances), use very granular population data to estimate how much pollution from different plants is inhaled by populations living at different distances from the plant. For building and vehicle emissions (which stay close to the ground rather than being transported through the atmosphere) intake fractions are extrapolated nationwide from an international database covering over 3,000 cities. The second approach is based on TM5-FASST tool, a reduced-form, global source–receptor model built from the TM5 chemical transport model. This model is adjusted using source apportionment studies to achieve sector-level differentiation on air pollution impacts from emissions. The air quality modelling (unlike intake fractions)

[37] Prices are in constant 2024$.

[38] See Black and others (2025), which in turn is consistent, after updating, with (mid-range) estimates from the broader energy modelling literature (see Stern and Stiglitz 2017).

[39] Rennert and others (2022).

[40] Black and others (2025).

captures differences in meteorological and topographical factors influencing pollution concentrations in different regions.

The ambient pollution that each sector contributes is calculated as the average across the two approaches. The estimates for total pollution are mapped to 'relative risk' curves from the epidemiological literature[41] indicating how country-specific baseline mortality rates for various heart, lung, and neurological conditions can be attributed to air pollution.[42] Deaths per micrograms per cubic meter of fine particulate matter are converted into deaths per unit of fuel use using country-sector-specific emissions factors for $PM_{2.5}$, SO_2, NO_x, and other local air pollutants, together with the sectoral contributions to ambient pollution. Emission factors are based on the Current Legislation Scenario in the GAINS model, which includes projections until 2050.[43] These factors are based on averaging over emissions rates for newer and older capital and account for complementary policies like emission rate standards (indeed, they are often based on emission rate standards applicable to capital of different vintages). Emission rates generally decline over time as capital stocks turn over. For SO_2 from power plants, emission rates are adjusted downward to account for firms installing abatement technology (scrubbers) in responses to a subsidy removal.

Finally, deaths per unit of fuel use are monetized using assumptions about the willingness of people in different countries to pay for mortality risk reductions. These valuations build off a meta-analysis of nearly 300 studies[44] which (after updating for inflation and income growth) implies a value of $6 million per death avoided in 2024 for the average advanced country. This is extrapolated to other countries based on relative per capita income (converted at purchasing power parity exchange rates) and an assumption that the elasticity for mortality value with respect to per capita income declines gradually from 1.2 to 0.8 as per capita income increases.[45]

(iii) Additional externalities from use of road fuels

Regarding road congestion, according to economic theory, the typical motorist should account for the cost of average travel delays when deciding where and when to drive, but not the marginal cost, that is, the costs from their impact on adding to congestion and slowing travels speeds for other road users.

Assessing how much fuel taxation might be warranted by (unpriced) traffic congestion requires an economywide measure of marginal congestion cost, which is built up here from estimated of average travel delays. These are obtained for different urban centers by comparing free flow travel speeds with observed speeds on road segments and weighting them by segment shares in total vehicle km driven to obtain urban averages. National average delay is obtained from averaging across urban/rural areas and peak/off-peak periods.[46] Marginal delay is then inferred from average delay by multiplying the latter by four, a standard assumption based on empirically estimated relations between marginal and average delay for urban centers. Adjustments are then made for average vehicle occupancies (accounting for the mix between cars and buses

[41] Based on GBD 2021 Risk Factors Collaborators (2024).

[42] Baseline mortality rates are from the Global Burden of Disease 2021 (IHME 2023).

[43] Updated, by personal communication by Fabian Wagner, from Wagner and others (2020).

[44] See OECD (2012). The studies rely on stated preference techniques (that is, survey questionnaires).

[45] From Robinson and others (2019). There is a lack of consensus on whether, and how, to adjust mortality valuations for other factors like life expectancy and health.

[46] Data is for 400 cities across 54 countries from www.tomtom.com/products/traffic-stats. Average delays were extrapolated to countries not in the database accounting for various country-level characteristics. Urban congestion is converted into a nationwide level using data from EC and CE Delft 2019 and manual sources for large countries and extrapolation based on country-level characteristics for others.

on the road) and the weaker responsiveness of driving on congested roads (which is dominated by commuting) to fuel prices compared with driving on free-flowing roads. Delays to others are then monetized assuming (based on empirical studies) that travel time is valued at the post-tax market wage and expressed (using fuel economy) per vehicle km.[47] Congestion costs are then scaled by the share of the price-induced fuel reduction from reduced driving, as opposed to the fraction coming from improvements in fuel economy and shifting to electric vehicles.[48]

Regarding traffic accidents, again according to economic theory the average motorist should internalize risk borne by themselves (like own-driver injury risks in single vehicle collisions) but not external risk borne by others (like injury risks to pedestrians, increased injury risks to other vehicle occupants in multi-vehicle collisions, and property and medical costs borne by third parties). Externalities per vehicle km are measured by apportioning country-level data on traffic fatalities[49] into external versus internal risks, monetizing them using the above approach to mortality valuation, and obtaining non-fatality external costs (from non-fatal injuries, third-party costs) by extrapolation from several country case studies.[50] Again, estimates are expressed per vehicle km and scaled by the portion of fuel price responsiveness due to reduced driving.

Externalities from wear and tear on the road network imposed by high axle-weight vehicles are averaged across countries, resulting in an average cost of around $0.12 per kilometer, since variation in country-level estimates cannot be easily explained. Country-specific estimates are based on highway maintenance expenditures by country[51] per unit of road diesel fuel use, an assumption that half of the expenditures are attributed to vehicle use as opposed to other factors (weather and natural deterioration) and scaled by the driving portion of the fuel price elasticity.

[47] Country-level data on taxes (FAD's tax rate dataset) and informality (ILO) is used to determine the wedge created by PIT, payroll, and consumption taxes.

[48] See Parry and others (2014), Ch. 5 and Black and others (2023b) for more detail on all the above adjustments.

[49] From IRF (2025), OECD (2025), and WHO (2024).

[50] See Parry and others (2014), Ch 5, for details.

[51] From IRF (2022) and OECD (2023).

Annex II. Subsidies from Other Sectors and Externalities

Additional sources of externalities and subsidies are not captured in the above analysis but add to global estimates. Three important sources, international aviation and maritime, methane from fossil fuel extraction, and noise, are described below.

International aviation and maritime, which have specialist UN agencies responsible for emissions targets and strategies, contribute around 3.5 percent to global energy-related CO_2 emissions. These fuels are generally subject to reduced or no fuel excises and exempt from VAT. Using emissions projections from Black and others (2024), explicit subsidies due to VAT exemptions are about $400 million (concentrated in aviation as its primarily a consumer goods industry) and implicit subsidies from climate damages are $200 billion in 2024, increasing to $320 billion and 0.2 percent of GDP by 2035, and roughly 40 percent aviation and 60 percent maritime. These estimates do not capture the significant local air pollution externalities from international maritime. For example, Zhang and others 2021 estimate premature deaths from local air pollution caused by international maritime to be around 60,000 after limits to the sulfur content of fuel were introduced in 2020 and 94,000 deaths before. Aviation generates noise externalities, airport congestion, and significant global warming unrelated to CO_2 through contrails, which are of similar magnitude to aviation's CO_2 emissions (Zhang and others 2025).

Methane emissions from fossil fuel extraction contribute nearly 10 percent to global warming and represent some of the lowest cost emissions reduction opportunities. They are generally underpriced with Australia and Norway being the only countries to implement a comprehensive pricing scheme.[52] The associated implicit subsidies from climate damages $0.7 trillion (0.6 percent of GDP) in 2024.

Noise from road vehicles using fossil fuels is an additional source of externalities that are not captured in these estimates. Recent estimates find that externalities are significant, for example, at $110 billion in the US (Moretti and Wheeler, 2025) and 1.3 million healthy life years lost in the EU (EEA 2025). One study (EC and CE Delft 2019) found noise externalities to be around three times more costly than that of road damage but significantly less costly than other driving related externalities, such as accidents and congestion. EVs are much quieter than fossil-fuel powered vehicles due to a lack of combustion, gear switching, and idle noise so switching to EVs lowers noise-related costs.

[52] Other countries indirectly price these emissions through inclusions in royalties (Brazil), flaring penalties (Guyana, Nigeria), and regulatory requirements (Canada, Colombia, Nigeria, United States).

Annex III. Explicit and Implicit Fossil Fuel Subsidies 2024, Selected Countries

	Explicit subsidies			Implicit subsidies			Total subsidies		
Country	*US$ billion*	*% GDP*	*per capita US$*	*US$ billion*	*% GDP*	*per capita US$*	*US$ billion*	*% GDP*	*per capita US$*
Argentina	14	2.7	302	26	5.1	566	40	7.8	868
Australia	2	0.1	77	38	2.0	1,405	40	2.2	1,482
Brazil	3	0.2	15	62	3.1	290	65	3.3	305
Canada	2	0.1	47	25	1.1	625	27	1.2	672
China	46	0.2	32	2,792	12.9	1,967	2,838	13.1	1,999
Germany	1	0.0	9	48	1.0	571	49	1.0	580
France	0	0.0	1	12	0.3	178	12	0.3	179
India	36	0.8	25	393	9.1	271	429	10.0	296
Indonesia	42	2.7	147	128	8.5	453	170	11.2	600
Italy	0	0.0	0	24	0.9	408	24	0.9	408
Japan	4	0.1	33	190	3.0	1,536	194	3.0	1,569
Mexico	11	0.7	85	65	4.2	495	76	4.9	580
Russia	81	4.1	560	420	21.2	2,897	501	25.3	3,458
Saudi Arabia	57	5.7	1,691	81	8.1	2,388	139	13.8	4,079
South Africa	0	0.0	0	52	11.9	809	52	11.9	809
Korea	5	0.3	106	93	4.3	1,802	99	4.5	1,908
Turkiye	7	0.7	84	123	11.3	1,401	130	12.0	1,485
United Kingdom	14	0.4	199	22	0.6	320	36	1.0	519
European Union	4	0.0	11	120	0.7	347	123	0.7	358
Jamaica	0	1.2	77	1	4.4	291	1	5.5	368
Costa Rica	0	0.2	35	1	1.6	280	2	1.8	314
Vietnam	3	0.6	29	36	7.1	354	39	7.6	384
Ethiopia	0	0.1	1	2	1.3	14	2	1.4	16
Iran	71	26.2	781	109	39.7	1,185	180	65.9	1,966
Morocco	3	1.8	79	8	4.8	209	11	6.5	288

Source: Authors. Note: Results for other countries are available here www.imf.org/-/media/files/topics/energy-subsidies/imffossilfuelsubsidiesdata.xlsb.

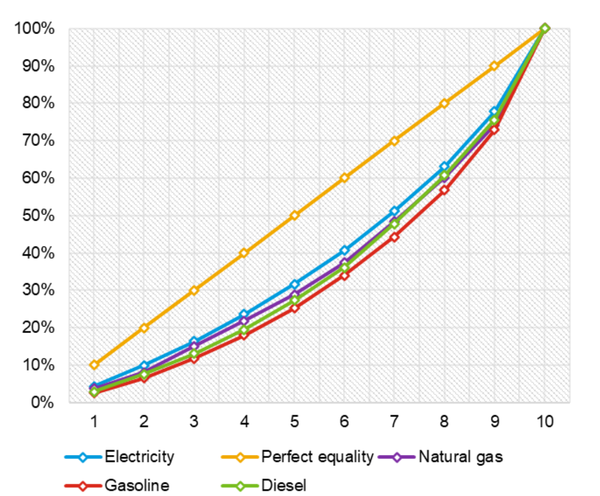
Annex IV. Global Fuel Consumption Patterns and Household Budget Shares

Energy consumption patterns. Energy consumption is heavily concentrated among higher income households. Although these households tend to use more energy-efficient appliances, lightning and vehicles, they also consume substantially more energy overall. As a result, they account for a disproportionately large share of total fuel use, even if energy represents a smaller share of their budgets. Figure AIV1. shows that the top decile alone consumes, on average, about 24 percent of the electricity, gasoline, natural gas and diesel purchased directly by households. The Lorenz curves confirm the high degree of concentration: the farther the curve lies below the 45-degree line of perfect equality, the more consumption is concentrated in wealthier deciles. Gasoline is the most unequal of the analyzed fuels, reflecting that car ownership is largely restricted to wealthier households.

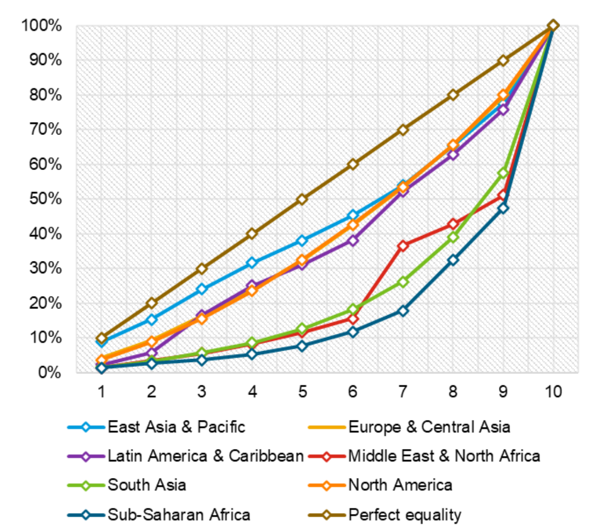
However, global averages mask important regional differences. Energy consumption is far more concentrated in Sub-Saharan Africa and less so in North America and Europe. For example, Figure AIV.1 shows that in Sub-Saharan Africa, the top decile accounts for 42 percent of electricity consumption, while the bottom 70 percent accounts for 28 percent of consumption. The pattern is more skewed for natural gas, with 52 percent of household natural gas use, while the bottom 70 percent of the population accounts for only 18 percent. Global and regional energy consumption patterns already provide an early indication that fuel subsidies largely benefit wealthier households, especially in regions where consumption is concentrated in the top deciles.

Annex Figure AIV.1. Global Distribution of Consumption by Fuel and Electricity Consumption by Region

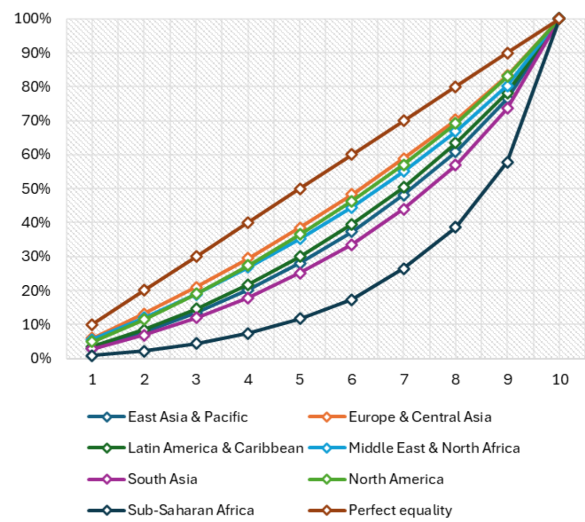
Panel 1. Global Distribution of Consumption by Fuel



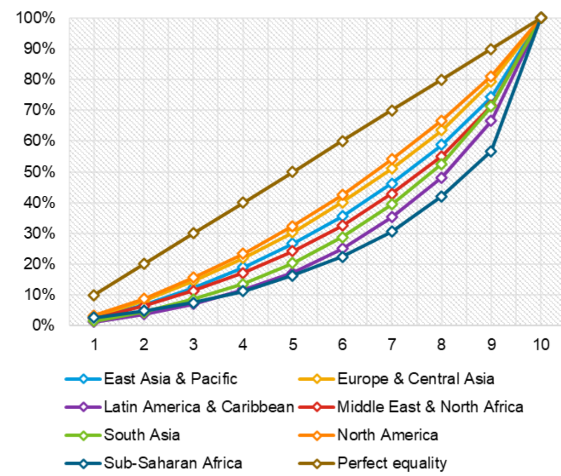
Panel 2. Natural Gas



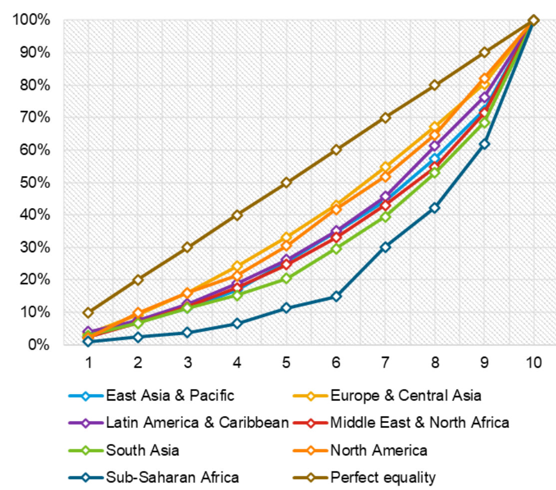
Panel 3. Electricity



Panel 4. Gasoline



Panel 5. Diesel



Source: Authors.

Household budget shares. The budget share that households use to consume energy tells a different story from absolute consumption. Although higher income households consume most of the energy, they devote a smaller share of their total spending to energy-related goods, with the notable exception of Sub-Saharan Africa. This pattern is especially pronounced for electricity. Table AIV1. shows that, on average, households in lower deciles spend about 4.6 percent of their budgets on electricity, compared with 2.8 percent for the top decile. By contrast, the budget share devoted to gasoline rises slightly with income, and the shares for natural gas and diesel are relatively flat across the distribution.

Regional patterns suggest that results vary importantly across regions. As shown in Figure AIV.1, low-income households in Europe and Central Asia, Latin America and the Caribbean and North America spend up to 6 percent of their budgets on electricity, pushing the global average for the bottom decile. In Sub-Saharan Africa, however, higher-income households append a larger share of their budgets on all fuels than lower-income households do, although the magnitude differs by fuel. This reflects large gaps in energy access.

Annex Table AIV.1. Household Budget Shares by Fuel and Region

Household budget shares										
Global averages by fuel	**1**	**2**	**3**	**4**	**5**	**6**	**7**	**8**	**9**	**10**
Electricity	4.65	4.05	3.80	3.65	3.46	3.39	3.30	3.16	3.07	2.84
Natural gas	1.15	1.06	1.04	1.03	1.01	1.02	1.01	1.01	1.02	1.00
Gasoline	1.48	1.68	1.81	1.81	1.88	1.93	1.98	1.97	1.99	1.98
Diesel	0.80	0.95	1.03	1.05	1.05	1.06	1.08	1.05	1.01	0.97
Regional averages										
Electricity	**1**	**2**	**3**	**4**	**5**	**6**	**7**	**8**	**9**	**10**
East Asia & Pacific	3.39	3.66	3.45	3.42	3.36	3.38	3.42	3.40	3.45	3.46
Europe & Central Asia	5.91	5.00	4.62	4.39	4.12	4.01	3.81	3.59	3.51	3.13
Latin America & Caribbean	5.49	4.61	4.29	4.04	3.72	3.53	3.30	3.06	2.67	2.28
Middle East & North Africa	4.39	3.58	3.27	3.21	2.98	2.94	2.92	2.79	2.65	2.56
South Asia	3.12	3.09	3.21	3.02	3.03	3.00	3.16	3.15	3.13	3.05
North America	5.14	4.41	3.98	3.75	3.51	3.21	3.00	2.86	2.56	2.05
Sub-Saharan Africa	1.59	1.46	1.53	1.62	1.66	1.74	1.93	2.00	2.05	2.22
Natural gas	**1**	**2**	**3**	**4**	**5**	**6**	**7**	**8**	**9**	**10**
East Asia & Pacific	0.23	0.33	0.28	0.27	0.25	0.23	0.24	0.24	0.22	0.19
Europe & Central Asia	1.85	1.76	1.78	1.76	1.76	1.78	1.77	1.77	1.80	1.76
Latin America & Caribbean	1.39	1.06	0.88	0.81	0.70	0.65	0.60	0.52	0.45	0.39
Middle East & North Africa	0.08	0.09	0.08	0.09	0.10	0.10	0.11	0.13	0.15	0.18
South Asia	0.12	0.11	0.12	0.13	0.15	0.19	0.23	0.31	0.37	0.51
North America	1.19	1.11	1.13	1.13	1.10	1.06	0.98	0.91	0.88	0.78
Sub-Saharan Africa	0.06	0.05	0.05	0.07	0.09	0.11	0.14	0.14	0.16	0.17
Gasoline	**1**	**2**	**3**	**4**	**5**	**6**	**7**	**8**	**9**	**10**
East Asia & Pacific	2.78	2.70	2.69	2.64	2.66	2.61	2.55	2.51	2.61	2.69
Europe & Central Asia	1.58	1.89	2.04	1.99	2.05	2.10	2.14	2.10	2.05	2.01
Latin America & Caribbean	1.17	1.54	1.75	1.96	2.04	2.37	2.54	2.64	2.88	2.83
Middle East & North Africa	1.28	1.56	1.49	1.45	1.54	1.61	1.62	1.64	1.78	1.82
South Asia	0.56	0.67	0.81	0.90	0.99	1.04	1.05	1.16	1.15	0.97
North America	5.00	5.00	5.13	4.86	4.80	4.59	4.50	4.09	3.70	3.16
Sub-Saharan Africa	0.66	0.62	0.68	0.70	0.82	0.77	0.81	0.81	0.89	1.03
Diesel	**1**	**2**	**3**	**4**	**5**	**6**	**7**	**8**	**9**	**10**
East Asia & Pacific	0.46	0.61	0.71	0.72	0.80	0.84	0.85	0.84	0.80	0.87
Europe & Central Asia	1.35	1.62	1.76	1.79	1.77	1.75	1.76	1.69	1.56	1.46
Latin America & Caribbean	0.16	0.15	0.15	0.19	0.16	0.20	0.20	0.22	0.22	0.24
Middle East & North Africa	1.05	1.18	1.14	1.00	1.04	1.07	1.00	0.96	0.92	0.78
South Asia	0.28	0.29	0.37	0.37	0.41	0.44	0.48	0.55	0.57	0.62
North America	0.52	0.67	0.65	0.61	0.67	0.65	0.63	0.56	0.55	0.46
Sub-Saharan Africa	0.12	0.13	0.14	0.15	0.20	0.22	0.31	0.32	0.44	0.50

Source: Authors based on national household budget surveys for covered countries.

Annex V. Country Coverage and Household Budget Surveys

Country	ISO-3 Country Code	Reference Year	Survey acronym	Survey name
Albania	ALB	2019	HBS	Household Budget Survey
Argentina	ARG	2018	ENGH	Encuesta Nacional de Gastos de los Hogares
Armenia	ARM	2019	ILCS	Integrated Living Conditions Survey
Austria	AUT	2015	EU HBS	European Union Household Budget Survey
Belgium	BEL	2015	EU HBS	European Union Household Budget Survey
Bangladesh	BGD	2016	HIES	Household Income and Expenditure Survey
Bulgaria	BGR	2015	EU HBS	European Union Household Budget Survey
Bosnia and Herzegovina	BIH	2015	HBS	Household Budget Survey
Bolivia	BOL	2015	EPF	Encuesta de Presupuestos Familiares
Brazil	BRA	2018	POF	Pesquisa de Orcamentos Familiares
Canada	CAN	2009	SHS	Survey of Household Spending
Chile	CHL	2017	EPF	Encuesta de Presupuestos Familiares
China	CHN	2016	CFPS	China Family Panel Studies
Côte d'Ivoire	CIV	2018	EHCVM	Enquête Harmonisée sur les Conditions de Vie des Ménages
Colombia	COL	2017	ENPH	Encuesta Nacional de Presupuestos de los Hogares
Cabo Verde	CPV	2001	IDRF	Inquerito às Despesas e Receitas Familiares
Costa Rica	CRI	2018	ENIGH	Encuesta Nacional de Ingresos y Gastos de los los Hogares
Cyprus	CYP	2015	EU HBS	European Union Household Budget Survey
Czechia	CZE	2015	EU HBS	European Union Household Budget Survey
Germany	DEU	2015	EU HBS	European Union Household Budget Survey
Denmark	DNK	2015	EU HBS	European Union Household Budget Survey
Dominican Republic	DOM	2018	ENGIH	Encuesta Nacional de Gastos e Ingresos de los Hogares
Ecuador	ECU	2014	ECV	Encuesta de Condiciones de Vida
Egypt	EGY	2017	HIECS	Household Income, Expenditure, and Consumption Survey
Spain	ESP	2015	EU HBS	European Union Household Budget Survey
Estonia	EST	2015	EU HBS	European Union Household Budget Survey
Finland	FIN	2015	EU HBS	European Union Household Budget Survey
France	FRA	2015	EU HBS	European Union Household Budget Survey
United Kingdom	GBR	2015	LCF	Living Costs and Food Survey
Georgia	GEO	2019	HIES	Household Income and Expenditure Survey
Ghana	GHA	2016	GLSS	Ghana Living Standard Survey
Gambia	GMB	2015	IHS	Integrated Household Survey

Greece	GRC	2019	HBS	Household Budget Survey
Honduras	HND	1999	ENIGH	Encuesta Nacional de Ingresos y Gastos de los Hogares
Croatia	HRV	2015	EU HBS	European Union Household Budget Survey
Hungary	HUN	2015	EU HBS	European Union Household Budget Survey
Indonesia	IDN	2019	SUSENAS	Survei Sosial Ekonomi Nasional
India	IND	2018	CMIE	Consumer Pyramids Household Survey
Ireland	IRL	2015	EU HBS	European Union Household Budget Survey
Italy	ITA	2015	EU HBS	European Union Household Budget Survey
Japan	JPN	2017	JHPS/KHPS	Japan Household Panel Survey
Kazakhstan	KAZ	2018	HBS	Household Budget Survey
Kenya	KEN	2015	KIHBS	Kenya Integrated Household Budget Survey
Cambodia	KHM	2017	CSES	Cambodia Socio-Economic Survey
Sri Lanka	LKA	2016	HIES	Household Income and Expenditure Survey
Lithuania	LTU	2015	EU HBS	European Union Household Budget Survey
Luxembourg	LUX	2015	EU HBS	European Union Household Budget Survey
Latvia	LVA	2015	EU HBS	European Union Household Budget Survey
Morocco	MAR	2014	ENCDM	Enquête Nationale sur la Consommation et les Dépenses des Ménages
Moldova	MDA	2018	HBS	Household Budget Survey
Madagascar	MDG	2010	EPM	L'Enquête Périodique auprès des Ménages
Mexico	MEX	2018	ENIGH	Encuesta Nacional de Ingresos y Gastos de los Hogares
North Macedonia	MKD	2019	HBS	Household Budget Survey
Mali	MLI	2018	EHCVM	Enquête Harmonisée sur le Conditions de Vie des Ménages
Malta	MLT	2010	EU HBS	European Union Household Budget Survey
Montenegro	MNE	2015	HBS	Household Budget Survey
Mauritania	MRT	2019	EPCV	Enquête Permanente sur les Conditions de Vie des Ménages
Malaysia	MYS	2019	HIES/BA	Household Income, Expenditure and Basic Amenities Survey
Netherlands	NLD	2015	EU HBS	European Union Household Budget Survey
Norway	NOR	2015	EU HBS	European Union Household Budget Survey
Nepal	NPL	2010	NLSS	Nepal Living Standards Survey
Pakistan	PAK	2018	HIES	Household Integrated Economic Survey
Peru	PER	2019	ENAHO	Encuesta Nacional de Hogares
Philippines	PHL	2018	FIES	Family Income and Expenditure Survey
Poland	POL	2019	HBS	Household Budget Survey
Portugal	PRT	2015	EU HBS	European Union Household Budget Survey
Romania	ROU	2018	HBS	Household Budget Survey
Rwanda	RWA	2013	EICV	Integrated Household Living Conditions Survey
Senegal	SEN	2018	EHCVM	Enquête Harmonisée sur le Conditions de Vie des Ménages
Serbia	SRB	2019	HBS	Household Budget Survey
Slovak Republic	SVK	2015	EU HBS	European Union Household Budget Survey

Slovenia	SVN	2010	EU HBS	European Union Household Budget Survey
Sweden	SWE	2015	EU HBS	European Union Household Budget Survey
Thailand	THA	2019	HSES	Household Socio-Economic Survey
Turkiye	TUR	2018	HBS	Household Budget Survey
Tanzania	TZA	2017	HBS	Household Budget Survey
Uganda	UGA	2019	NPS	National Panel Survey
Ukraine	UKR	2016	HLCS	Household Living Conditions Survey
Uruguay	URY	2016	ENGIH	Encuesta Nacional de Gastos e Ingresos de los Hogares
United States	USA	2015	CES	Consumer Expenditure Survey
Uzbekistan	UZB	2021	HBS	Household Budget Survey
Vietnam	VNM	2018	VHLSS	Vietnam Household Living Standard Survey
Kosovo	XKX	2016	HBS	Household Budget Survey
South Africa	ZAF	2014	LCS	Living Conditions Survey

Annex VI. Measuring the Impact of Fossil Fuel Subsidy Reform on Fuel Producers

This annex provides an methodology and high level results related to the impact that policies reducing demand for fossil fuels, such as subsidy reform, has on fossil fuel producing countries.

(i) Methodology. Oil, gas, and coal producers are impacted by fossil fuel subsidy reform through reduced production of fossil fuels and, depending on supply curve assumptions, lower prices. Impacts vary substantially across countries, primarily due to differences in the economic reliance on fossil fuel extraction and extraction costs. Country-specific impacts are estimated using project-level data from Rystad or oil and gas and a more simplified approach is taken for coal due to a lack of granular production data. This approach likely produces an upper bound for costs to energy producers since it omits benefits to clean energy producers and general equilibrium impacts, such as changes to monetary policy, that may partially blunt the impacts on fossil fuel producers.

Oil and gas – impact on prices. The relative elasticity of supply and demand curves influences how fossil fuel subsidy removal impacts producer (and consumer prices). The demand curve is an output of CPAT, with a global weighted demand elasticities of -0.55 (oil) and -0.65 (natural gas). The base case analysis in the paper assumes a flat long-term supply curve, resulting in taxes on fossil fuels that are fully passed through to fossil fuel users leaving producer prices unchanged. Here, scenarios assume an upward sloping supply curve, which is relevant for policies that substantially impact global demand, such as coordinated mitigation policies and those in very large consuming countries, since they substantially impact global fossil fuel demand and price marginal producers out of the market. Using project-level lifecycle breakeven costs in 2035 from Rystad, supply elasticities are estimated to be 1.5 for oil and 2.1 for natural gas. Since supply is elastic relative to demand, the bulk of the price impact is passed through to consumers (around 70 percent) with the remainder passed back to producer prices.

Oil and gas – impact on production. Using the universe of over 15,000 oil projects expected to be in production in 2035, projects are sorted based on their extraction costs per barrel of oil. Extraction costs are assumed to be unit operating costs for currently producing fields and lifecycle per-unit costs (inclusive of capital costs) for projects that have not yet started production. Under the baseline scenario, all projects continue production. Under reform scenarios, supply falls proportional to oil demand with the most expensive projects stopping production. In other words, the cheapest oil projects continue to produce while costlier projects are shelved.

A similar approach is taken for natural gas but with two important differences. First, a significant portion of natural gas production comes from projects that primarily produce oil (i.e., associated gas).[53] Since investment and production decisions for associated gas fields are mostly determined by the economics of oil production, associated gas production is conditional on oil prices rather than gas prices (EIA 2020). Because of this, associated gas is assumed to have an extraction cost of zero and whether the project continues to produce depends solely on oil extraction costs. Second, natural gas end-user prices vary considerably across countries,

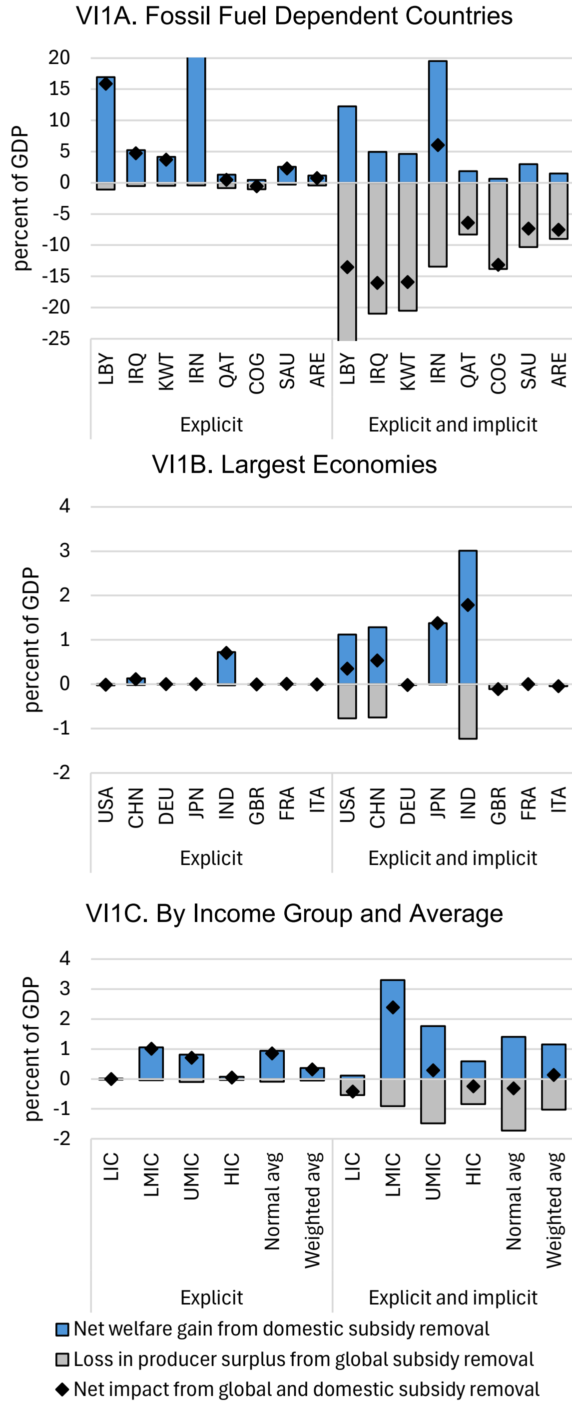
[53] According to Rystad, around 60 percent of natural gas is associated gas with associated gas defined as projects with a gas to oil ratio of up to 170 percent. Other data sources report lower associated gas shares (e.g., EIA 2024). This paper assumes that projects with oil revenue greater than gas revenue produce associated gas and vice versa, resulting in associated gas shares of around one-third.

while oil is traded internationally under a single price.[54] To determine whether non-associated gas projects produce under reform scenarios, they are ranked based on the ratio of natural gas end-user prices, weighted by the share of gas that is exported vs. consumed domestically, and extraction costs.

Coal. Under the baseline scenario, rents from coal extraction for the latest year of available data (2021 from the WB World Development Indicators) remain constant. The demand elasticity (-0.52) is similarly based on CPAT and supply elasticity (2.9) is estimated using data from [IEA 2020](). Coal consumption and production decline by around 60 percent with full energy price reform (reforming implicit and explicit subsidies) and remains at the baseline with explicit subsidy reform. The impact on coal extraction rents is assumed to be the product of the decline in production and prices.

(ii) Results. Removing explicit subsidies has limited impacts on prices and production, while full subsidy removal significantly reduces production in higher cost locations and lowers producer prices. Oil production in OPEC countries is similar across all scenarios, reflecting the resilience of production in lower cost projects, and their market share increases from around 35 to 40 percent with full subsidy removal. Oil production declines by 15 percent in OECD countries and more so in BRICS. Gas production follows similar trends except that OECD countries maintain production across scenarios and the global production decline is smaller. Global producer prices decline by one to two percent when explicit subsidies are removed and 50, 19, and 80 percent for oil, natural gas, and coal, respectively, for full subsidy removal.

Annex Figure AVI. 1. Net Impact of Subsidy Removal with Producer Impacts



Source: Authors.

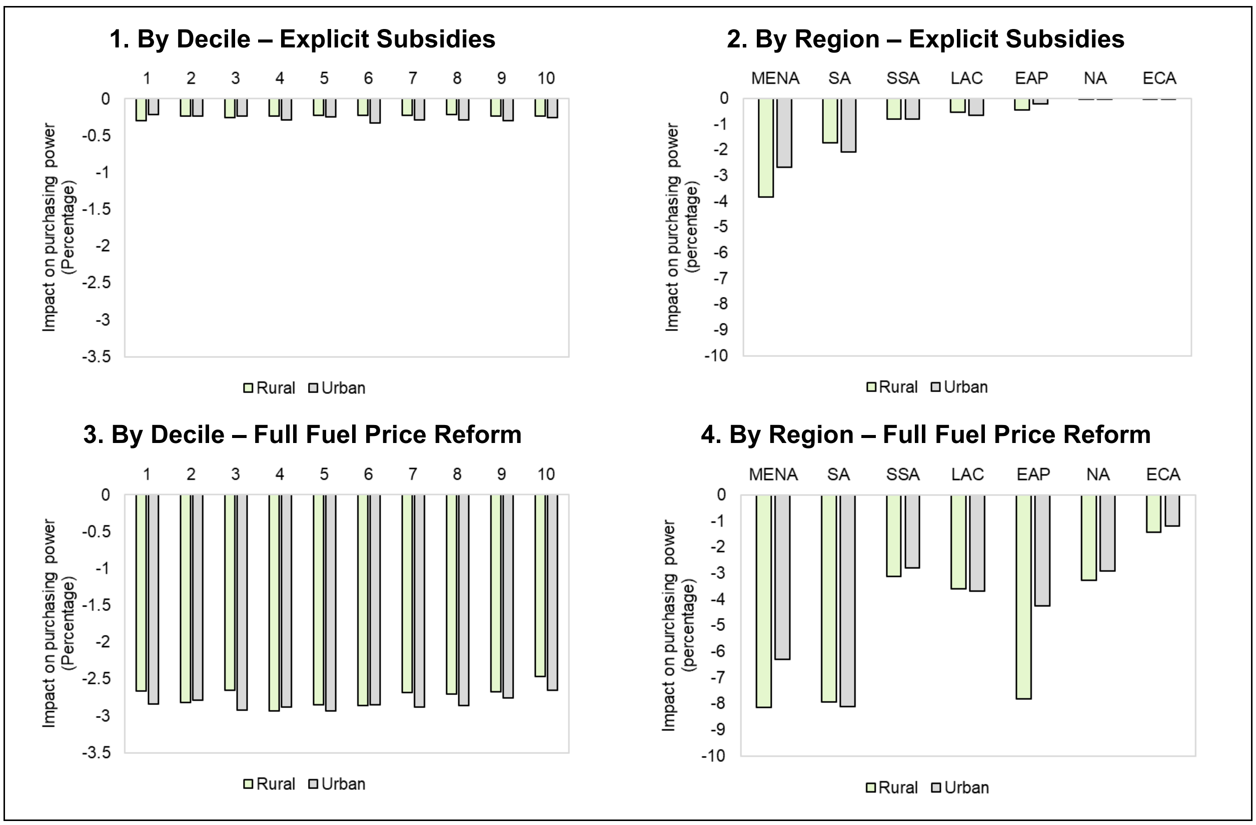
[54] For oil, there are differences due to crude oil quality and sanctions but these are ignored here.

Annex VII. Urban vs. Rural Divide

Figure AVII.14 illustrates the median welfare effects of subsidy phaseouts by area of residence, with further disaggregation by global region. Globally, urban households are usually more affected than rural households,[55] though differences are generally small (less than 1 percentage point difference in most cases), though there are some differences across regions. Rural households are more impacted by explicit subsidy reform in the Middle East and North Africa, while urban households are more impacted in South Asia.

For energy price reform, the largest differences appear in Middle East and Noth Africa and in East Asia and the Pacific, with the rest of regions experiencing heterogeneity in median impacts but small differences across the urban and rural divide. Globally, it does not appear that rural households are systematically affected more than urban households by fossil fuel subsidy reform, though differences emerge at the country level. Also, on average, reforming subsidies remains distributionally neutral for both urban and rural households, with poorer and wealthier households being affected equally as a share of income.

Figure AVII.14. Impacts of Full Fossil Fuel Subsidy Reform on Urban and Rural Households, 2035



Source: Authors. Note: NA = North America; EAP = East Asia and Pacific; LAC = Latin America and Caribbean; SSA = Sub-Saharan Africa; MENA = Middle East and North Africa; ECA = Europe and Central Asian; SA = South Asia.

55 The data covers 43 percent of global gasoline subsidies, 19 percent of diesel subsidies, and over half of electricity and natural gas subsidies.

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