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Energy Price Reform: A Guide for Policymakers

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Abstract

This essay reviews the conceptual and quantitative literature on the efficient system of fossil fuel energy prices in different countries for reflecting supply and environmental costs, as well as the environmental, fiscal, and economic benefits from energy price reform. Drawing on recent experiences in numerous countries, the ingredients for successful reform are then discussed (e.g., the need for a comprehensive reform strategy and for compensating vulnerable groups). Low energy prices, fiscal pressures, and momentum for climate action provide an especially conducive environment for price reform and much is happening rapidly on the ground, however there is a long way to go to reap the enormous benefits at stake (e.g., at the global level, over a 20 percent reduction in carbon emissions and revenues gains of 4 percent of GDP).

JEL-Codes: Q310, Q350, Q380.

Keywords: energy price reform, efficient taxation, environmental externalities, reform experiences.

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1. Introduction

Low international energy prices, momentum for reducing carbon dioxide (CO_2) emissions from the 2015 Paris Agreement, concerns about local environmental impacts of fossil fuels, mounting fiscal pressures (set to worsen with aging populations), and numerous recent efforts to reform energy prices on the ground, have heightened widespread attention to the appropriate level of fossil fuel prices and how to implement them.

This paper seeks to provide a practical guide for doing just that by pulling together the quantitative literature on efficient energy prices with case studies of recent reform episodes. The first issue is to define, conceptually, what an efficient energy price is, and how it can be measured. The next issue is to understand the level of energy prices to aim for and the size of the environmental, fiscal, and economic benefits from reform—information that is needed to craft legislative specifics (including, for example, how much other taxes can be reduced with revenues from higher energy taxes) and to communicate the case for reform to policymakers and stakeholders. The third issue is the political economy of getting it done, that is, the ingredients for successful reform that can be distilled from recent experiences. The three main sections of this essay take up these issues in turn and a final section offers brief concluding remarks.

2. Conceptual and Measurement Issues

The most important point here is that the environmental costs of fossil fuel use are potentially large and (even if more uncertain) are just as real as the supply costs and therefore should be take into account in determining efficient energy prices. A possible counter argument is that policymakers might prefer reducing environmental damages with regulatory measures (e.g., because they are perceived as politically more acceptable). Economic analysis and evidence demonstrates, however, that pricing policies are substantially more effective and cost effective than regulatory approaches[1] and even the presence of regulations (which are implicit, for example, in observed emission rates) reduces—but does not eliminate—efficient charges on energy use to reflect unpriced environmental damages.[2] Although fossil fuel use causes a diversity of environmental impacts, three are generally the most important to reflect

[1] That is, targeted pricing policies exploit a wider range of behavioral responses to mitigate environmental damages (e.g., Krupnick et al. 2010) and efficient use of their revenues (which are not raised under regulations) substantially lowers their overall costs.

[2] See, for example, Parry, Evans, and Oates (2014). Put another way, even if, for example, regulations were to achieve the efficient abatement of air pollution emissions per unit of fuel combustion, the *level* of fuel consumption is still excessive because the remaining emissions are not priced.

in energy prices: CO_2 emissions, premature deaths from local air pollution, and broader externalities (e.g., congestion) associated with the use of road fuels.[3]

We first discuss the charges needed to reflect environmental impacts and the overall efficient energy prices, followed by procedures for measuring them.

A. Defining Efficient Energy Prices…

Conceptually, the charge needed to reflect global warming in fossil fuel prices is the fuel's CO_2 emissions factor times the damage per ton of CO_2 emissions—this charge can be combined with crediting for downstream capture and storage of CO_2 emissions (if and when these technologies become viable). Imposing carbon charges upstream on fuel supply comprehensively covers emissions and is a highly practical extension of existing tax administration (e.g., for fuel excises and royalties on extractive industries) which is well established in most countries.[4] Alternatively, charges can be imposed downstream at the point of combustion (as is typical in emissions trading systems) though for administrative reasons small emissions sources (from buildings, vehicles, and small firms), which generally account for roughly half of a country's energy-related CO_2 emissions, are not covered.

The efficient fuel charge for local air pollutants—most importantly, direct fine particulates ($PM_{2.5}$) which are small enough to penetrate the lungs and bloodstream and can be produced directly from fuel combustion and formed indirectly from sulfur dioxide (SO_2) and nitrogen oxide (NO_x) emissions—is in principle analogous to that for carbon. It equals the fuel's emissions factor, times environmental damages per ton of emissions, summed over direct $PM_{2.5}$, SO_2 and NO_x—again these charges can be combined with crediting for downstream entities demonstrating abatement (e.g., through SO_2 scrubbers) at the point of fuel combustion. Alternatively, charges can be directly levied on smokestack emissions for large sources, though again coverage is incomplete and some countries may lack the institutional capacity to comprehensively monitor and enforce these charges.

The more controversial charge is the one for road fuels to reflect broader externalities—traffic congestion, accidents, and (less importantly) road damage—because these

[3] Other impacts include, for example, morbidity, impaired visibility, crop damage, and building corrosion from local air pollution; spoiling of the environment at fuel extraction sites; and fugitive emissions during fuel extraction, processing, transport, and distribution. Estimates of these damages tend to be moderate relative to the mortality impact of local air pollution, at least for advanced countries (NCR 2009, Ch. 2).

[4] See, for example, Calder (2015) and Metcalf and Weisbach (2009). In principle, charges should be levied at the point where the number of taxpayers is minimized and emissions factors are easiest to measure, which usually means, for example, outputs from refineries and coal processing plants rather than from oil wells and coal mines.

externalities are much more efficiently addressed through taxing vehicle mileage (e.g., congestion fees rising and falling during the rush hour on busy roads). At present, however, it is difficult to imagine these externalities being comprehensively internalized on a nationwide basis through finely-tuned mileage taxes in any country. For the interim, it is therefore entirely appropriate to reflect unpriced externality benefits when assessing efficient road fuel taxes—not doing so violates long-established principles of welfare measurement[5] and has perverse policy implications (e.g., European countries should cut their road fuel taxes to US levels—see below).

Beyond environmental and supply costs, efficient fuel prices also include a fiscal component reflecting the rate of value added tax (VAT) or general taxes applied to consumer goods. These taxes should be applied to both supply and environmental costs (i.e., the full social cost of production) but only to fuels consumed at the household level to avoid distorting firm's input choices[6] (rebates for intermediate fuels like those used in power generation and trucking are automatic under normal VAT procedures). The 'double dividend' literature suggests additional taxation might be warranted on fiscal grounds, though for practical purposes this is ignored here.[7]

B. …and Measuring Them

Clearly, there are substantial uncertainties and controversies in quantifying environmental damages from fossil fuel use, most importantly the value of carbon damages, the link between air pollution and mortality, and the value of a statistical life (VSL) for monetizing air pollution deaths. The approach described here is nonetheless useful in providing a broad sense of the direction and extent of needed pricing reforms, as for the most part efficient taxes are not excessively sensitive to alternative parameter values.

Carbon damages. CO_2 emissions factors (per unit of energy for coal and natural gas and per unit of volume for refined petroleum products) are well established and vary very little across countries. As regards valuing carbon damages, the standard approach in the economics

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[5] See, for example, Harberger (1964).

[6] Diamond and Mirrlees (1971).

[7] When account is taken of the full range of distortions created by broader taxes on labor and capital (not only to factor markets but also excessive informality, compensation in the form of untaxed fringe benefits, spending on tax-preferred goods like housing, and so on), replacing these taxes with energy taxes can, up to a point, lower the overall efficiency cost of the fiscal system, prior to counting environmental benefits (e.g., Parry and Bento 2000, Bento et al. 2012). However, for most countries information on the fiscal parameters needed to accurately pin down this extra tax is lacking and in any case the tax mark-up is inversely related to the corrective tax component.

literature would be use the social cost of carbon which US IAWG (2013) put at $40 per ton in 2015 (in $2015)—though not without controversy[8]—and this value is used here. In light of the 2015 Paris Agreement, countries may instead prefer to use CO_2 values in line with their mitigation pledges.[9]

Air pollution damages. Health damages from local air pollution by fuel product and country (for over 150 countries) have been estimated by Parry et al. (2014) as follows. For coal plant emissions, intake fractions (the fraction of emissions inhaled as $PM_{2.5}$ by exposed populations) for direct $PM_{2.5}$, SO_2, and NO_x were extrapolated to other countries from a widely cited study for China by Zhou et al. (2006). This is done by adjusting for differences in average population exposure using coefficients in the intake fraction regression equations, and estimates (obtained by mapping geographical data on the location of power plants in each country to granular population density data) of the average number of people living at different distance classifications from coal plants in other countries relative to the average for China. Intake fractions are converted into deaths per ton of emissions for the three pollutants using current mortality rates by country for pollution-related illnesses (ischemic heart disease, lung cancer, pulmonary disease, and strokes) and evidence on the sensitivity of these mortality rates to pollution exposure from 'concentration-response' functions.[10] Health impacts are monetized by extrapolating VSLs from OECD (2012)'s estimate (from a meta-analysis of several hundred stated preference studies) equivalent to of $3.7 million in 2010 for the average OECD economy and using their estimate for the income elasticity of the VSL of 0.8. Health damages are then expressed per unit of coal use using country-level estimates (compiled by the International Institute of Applied Systems Analysis) of emissions factors for coal for the three air pollutants, averaging over representative plants with and without control technologies (like SO_2 scrubbers). Health damages for natural gas plants are estimated using the same procedures.

One caveat is that this approach ignores, because country-level data is not yet available, differences in local meteorological factors (e.g., wind speed and direction) affecting intake fractions. However, some cross checks against a regional air quality model suggest the resulting bias is not systematic across countries and not that substantial (Parry et al. 2014, pp. 83-87). Another caveat is that the concentration response function might eventually flatten

[8] Alternative assumptions for discounting and modelling extreme climate risks can lead to much higher values (e.g., Weitzman 2009).

[9] See Aldy et al. (2016) for some discussion of these prices.

[10] Both pieces of information are inferred from the World Health Organization's Global Burden of Disease project (see Burnett et al. 2014). Baseline mortality rates, and hence the susceptibility of the local population to pollution exposure, vary substantially by country, being relatively high in former Soviet Union countries (due to high prevalence of smoking and alcohol abuse) and relatively low in many African countries (where people are less likely to live long enough to die from pollution-related illnesses).

out as people's channels for absorbing air pollution become saturated implying, paradoxically, that (given other factors) incremental pollution reductions have smaller health benefits in countries with especially severe air pollution. Evidence on this is mixed however (e.g., Goodkind et al. 2012), and moreover if Pigouvian emissions charges were comprehensively imposed, they are likely large enough to lower pollution concentrations into the more linear portion of the concentration response function (Parry et al. 2014, pp. 76).

Vehicle externalities. Intake fractions are more reliably estimated for ground level emissions sources like vehicles—unlike for tall smokestacks, the pollution is not transported large distances—and Parry et al. (2014) extrapolate them to the national level from a data base of estimates[11] for about 3,600 urban centers across the world to obtain (along with the other information mentioned above) air pollution damages for gasoline and road diesel.[12] Parry et al. (2014) also extrapolate traffic congestion externalities to the nationwide average level using relationships between travel speeds and transportation indicators (estimated from a database of cities in different countries), relationships between average travel delays (which motorists consider) and delays they impose on others (which they do not), and evidence that the value of travel time is about 60 percent of the local wage.[13] Traffic accident externalities are obtained from country-level data on traffic fatalities, assumptions about which risks are internal (e.g., in single vehicle collisions) versus external (e.g., to pedestrians or other vehicle occupants in multi-vehicle collisions), and extrapolations of other costs (e.g., third party property and medical costs, nonfatal injuries) from country case studies. And road damage externalities are obtained from country data on road maintenance expenditure and the fraction of it caused by (essentially heavy) vehicles.[14]

Supply costs, current energy prices, and taxes/subsidies. IMF (2015) measure supply costs for (tradable) fossil fuel products by their opportunity costs, or prices these products could have sold for in regional international markets, plus (for fuel importers) a standard mark up for transportation and distribution costs. Current retail prices for fossil fuels are compiled in IMF (2015) based on publicly available data and other sources. The gap between retail prices and supply costs provides a measure of existing fuel taxes or (if the gap is negative) subsidies

[11] From Apte et al. (2012) and Humbert et al. (2011).

[12] Some emissions from natural gas (e.g. from buildings) are also released at ground level but the absolute differences in the resulting health costs compared with those from gas combusted in tall smokestacks are small given the very limited emissions from natural gas (see below).

[13] More sophisticated (though broadly similar) estimates of congestion for EU countries have been compiled, for example, by Van Essen et al. (2011).

[14] Distance-related externalities need to be scaled back by around 50 percent in computing second best road fuel taxes given evidence that only about half of the tax-induced fuel reduction comes from reduced distance driven (the other half coming from fuel economy improvements which do not affect congestion, etc.).

(e.g., Clements et al. 2013, Coady et al. 2015, Kaplow 2009). The advantage of this approach is that it estimates the combined effect of sometimes opaque and difficult to measure tax and regulatory provisions (e.g., VAT reliefs, pricing rules by state owned enterprises).

3. Findings on Energy Price Distortions and the Gains from Reform

This section presents country and global statistics to provide some quantitative sense of the extent of energy mispricing and the potential reform benefits.[15]

A. The Extent of Energy Mispricing

Figure 1 illustrates efficient prices (shown by the bars) and current prices (shown by the diamonds) for fuel products in the 19 G20 countries updated to 2013 (or a more recent year if available).

For coal (panel a), supply costs vary between $2.5 and $7.0 per Gigajoule (GJ) and carbon damages (i.e., $40 per ton of CO_2) amount to $3.7 per GJ (uniform across countries).[16] Air pollution damages are also substantial, more than the carbon damages in 10 cases, and more than double the carbon damages in 6 cases. Not surprisingly, however, the damages differ considerably across countries with differences in population exposure, baseline mortality rates, VSLs, and air emission rates. For example, damages are high ($15.0 per GJ) in (densely populated) China and relatively modest ($0.9 per GJ) in Australia (where population density is low and a high portion of emissions from coastally-located plans disperse over the oceans). Although deaths per GJ of coal in the United States are about one ninth of those for China, air pollution damages still $6 per GJ in the former as the VSL is about 3.5 times as high as China's. India's deaths per GJ are almost as large as in China, though the pollution damage is about the same as the United States due to the lower assumed VSL. Given that coal is essentially untaxed, current prices are equal to the supply prices, leaving pervasive and substantial undercharging for coal use,[17] though reform is less pressing where coal is a small share of primary energy (e.g., Argentina, Brazil, Canada, France).

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[15] Results for over 150 countries are available from IMF (2014, 2015) spreadsheets.

[16] Charges for VAT applied to other goods contributes modestly at most to the efficient coal price where coal is used at the household level.

[17] India has recently introduced a coal tax, but at a modest level (about $0.3 per GJ). Figure 1 does not account for the implicit coal charge from the European Union's emissions trading system (though this is modest—about $0.5 per GJ) or royalties on extractive industries (though at the country level these largely lower domestic producer prices rather than raise consumer prices).

For natural gas (panel b), supply costs are around $5-20 per GJ and carbon damages $2.2 per GJ, about 60 percent of the rate per GJ for coal. However, air pollution damages are very small, typically about $0.1 per GJ, as natural gas does not produce direct $PM_{2.5}$ or SO_2, and NO_x emission rates per GJ are a fraction of those for coal. Again, taxes on natural gas are rare and some countries (e.g., Argentina, India, Russia) modestly subsidized it in 2013, though overall the differentials between current and efficient prices for natural gas are far less striking than for coal.

As regards gasoline (panel c), global warming damages (8 cents per liter) are fairly modest relative to supply costs (40 to 70 cents per liter), and this is even more applicable to local pollution (with the exception of Russia which has unusually high vehicle emission rates). Nonetheless, the overall (second-best) efficient charges on gasoline are still substantial—typically between 40 and 80 cents per liter—due to the large contributions from traffic congestion and traffic accidents. For most G20 countries, current fuel prices fall well short of efficient prices, and even for the three exceptions (Argentina, Italy, UK) cutting fuel taxes may not be appropriate, given the imprecision of the efficient price estimates. Undercharging for road diesel tends to be a more pronounced than for gasoline (panel d), as the fuel is often taxed at a lower rate than gasoline and the environmental costs (e.g., local air pollution) can be larger.[18]

Energy subsidies. Energy subsidy estimates provide another way to look at the extent of energy mispricing, so long as they are defined broadly to include undercharging for supply costs, environmental costs, and general consumption taxes. This broad notion has been termed 'post-tax' subsidies, in contrast to a narrower measure, which captures undercharging for supply costs alone, termed 'pre-tax' subsidies, (Coady et al. 2015).

As indicated in Figure 2, post-tax subsidies at the global level—that is, the gap between efficient and current fuel prices times fuel use and aggregated over fossil fuel products and countries[19]—amounted to a staggering $5.3 trillion in 2015 or 6.5 percent of world GDP.[20]

Pre-tax subsidies ($333 billion) account for only 6 percent of this subsidy[21] and forgone revenue from undercharging for general consumer taxes another 6 percent. The biggest

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[18] An offsetting factor is that most diesel is used in heavy vehicles with substantially lower fuel economy than cars, implying smaller mileage-related externalities per unit of fuel use.

[19] In cases where fuel prices exceed efficient levels subsidies are counted as zero (rather than negative).

[20] Renewables are also subsidized, but to a much smaller degree (deployment subsidies were $135 billion worldwide in 2014 according to IEA 2015, pp. 382).

[21] This includes both consumer-side (e.g., state owned enterprises undercharging for supply costs) and producer-side (e.g., tax preferences for fuel extraction) subsidies though the latter are small (about $18 billion). Petroleum accounts for 41 percent of the pre-tax subsidy, electricity 30 percent, natural gas 28 percent, and coal 1 percent.

component by far is undercharging for local air pollution (52 percent), followed by global warming (24 percent), and undercharging for broader vehicle externalities (12 percent).[22]

Decomposed by fuel product (Figure 2), coal accounts for 59 percent of the subsidy given it's disproportionate contribution to global warming and air pollution, followed by petroleum (28 percent), natural gas (10 percent) and electricity[23] (3 percent). Subsidies are large and pervasive for both advanced and developing countries and among oil-producing and non-oil-producing countries alike. For example, advanced countries accounted for 25 percent of the global subsidy; Emerging and Developing Asia and the Commonwealth of Independent States (where there is high coal use and high population exposure to its air emissions) 51 and 9 percent respectively; and the Middle East/North Africa region (where there is substantial undercharging for petroleum's supply and environmental costs) 7 percent.

B. …and the Benefits from Reform Are Large

Figure 3 indicates the large environmental, fiscal, and economic welfare gains from energy price reform based on a simple (static) comparison of outcomes that would have happened under a counterfactual with fully efficient energy prices, compared with outcomes under actual prices. These estimates are from Coady et al. (2015), which are computed at the country level, then aggregated into regions, using uniform fuel price elasticities based on empirical evidence.

The global CO_2 reduction is substantial at 21 percent. The biggest proportionate CO_2 reductions (35 percent) are actually in the Middle East/North Africa region (despite the lack of coal use there), due to the large increases in petroleum product prices implied by getting energy prices right.

The reduction in premature fossil fuel air pollution deaths is even more striking at 55 percent, with coal accounting for 93 percent of the reduction as energy price reform (assumed to be coupled with crediting for control technologies) reduces both coal usage and air emission rates. In Latin America and advanced countries, the reduction in deaths is more moderate at around 25 percent, reflecting the limited use of coal in the former and relatively low air emission rates in the latter. In contrast, reductions in air pollution deaths are more than 60

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[22] Going forward we might expect the contribution from local air pollution to shrink as older and dirtier coal plants are retired, existing plants are subject to increasingly stringent regulation, and new plants are located away from densely populated areas. Counteracting trends include rising VSL with income, rising urban populations in emerging market economies, and a possible shifting back to coal in light of lower prices (see below).

[23] The environmental costs of power generation are attributed to fuel inputs.

percent in Central and Eastern Europe and Emerging and Developing Asia, given high coal usage there and the extensive population exposure to emissions due to high population density.

Global revenue gains from getting energy prices right are estimated at about $3.0 trillion or 4 percent of global GDP (lower than the energy subsidy due to the price-induced reduction in energy use).[24] Revenue gains vary substantially across regions with large potential revenue gains—about 9 percent of regional GDP or more—in Emerging and Developing Asia, Commonwealth of Independent States, and Middle East/North Africa. These are also regions where the revenue potential from broader tax instruments is often severely constrained by extensive informal activity, making revenue from (easier to tax) fuels especially appealing on fiscal grounds.

Global welfare gains amount to more than $1.4 trillion, or a very substantial 2.0 percent of global GDP,[25] with the bulk of the gains again coming from coal. The relatively small welfare gain in advanced economies mainly reflects their high deployment of emissions control technologies by coal users and the small gap (at least in Europe) between consumer prices and efficient prices for petroleum products.

Reaping these benefits would however imply substantial disruptions to current energy systems. For example, at the global level, the price of coal, petroleum products, natural gas, and electricity would increase by around 200 percent, 50 percent, 45 percent, and 70 percent respectively.

4. Lessons from Recent Reform Experiences

Experience has shown that successful and durable energy price reform is hard to achieve. Many countries have started on the path of subsidy reform only to abandon these efforts, often in the context of sharply increasing international energy prices or social unrest. There are, however, some grounds for cautious optimism.

For one thing, there is growing appreciation of the large (and primarily domestic) benefits at stake. For another, there is peer pressure on countries to demonstrate progress on mitigation pledges made for the Paris Agreement and the superior effectiveness of carbon pricing is

[24] This is still more than 10 percent of (global) government revenue or more than the entire revenue most governments collect from corporate income taxes (Coady et al. 2015).

[25] For comparison, Robert Lucas once estimated that replacing capital taxes with (less distortionary) labor taxes in the United States would generate an annual welfare gain approaching one percent of GDP which he called "the largest genuinely free lunch I have seen in 25 years" (Lucas 1990, pp 314).

increasingly accepted.[26] And currently low energy prices may dampen opposition from affected groups, while also creating urgent pressures for new revenues (e.g., from higher domestic energy prices) where fiscal budgets have been highly dependent on energy exports—though prices may start to rise soon, even sharply for some energy products over the next decades (Figure 4).[27]

Indeed, we are now seeing reforms in many countries (see Table 1) that, not long ago, might have seemed unimaginable. In many cases, however, these reforms have been moving in the direction of shrinking pre-tax subsidies. Far more important (from a global perspective) is to introduce and ramp up charges for environmental costs, and here progress has been more stunted, for example, while a plethora of carbon pricing schemes have emerged (see Table 2), at present legislated schemes cover only 12 percent of global greenhouse gases and typically with prices below \$10 per ton of CO_2.[28]

Reviews of recent reform efforts identify how energy subsidy reform strategies can be designed to enhance the likelihood of successful and durable subsidy reform.[29] While these lessons are largely drawn from country reform experiences of pre-tax subsidies, they could be potentially also useful for countries to further raise energy prices to efficient levels. The six key ingredients identified in Clements and others (2013) include:

Develop a comprehensive reform plan. A key barrier to reforms is the lack of public confidence that the resulting fiscal space will be used for the benefit of the broader population. This can be addressed by embedding energy price reform within a more comprehensive reform plan that clearly identifies the wider benefits from reform. For example, the broader reform plan should identify how the resulting fiscal space will be reallocated, which could include decreases in other distortionary or inequitable taxes or financing planned expansion of infrastructure, education, health and social protection programs. It should also include a clear plan for reforming the energy sector to address any operational inefficiencies or governance problems. Setting out these broader reform objectives in detail together with a clear reform timeline can also help to enhance the credibility of the reform plan. Seeking input from a broad range of stakeholders (including

[26] See, for example, www.carbonpricingleadership.org/carbon-pricing-panel.

[27] Current low energy prices also mean that the gap to efficient energy pricing has decreased (with the size of the decline depending on the extent to which drops in international prices are passed through to domestic prices) and the price increases needed to reach efficient pricing is therefore lower.

[28] WBG (2015).

[29] See Clements and others (2013), Global Subsidies Initiative (2010), UNEP (2002, 2008), World Bank (2010), Vagliasindi (2013).

different ministries, the private sector, trade unions, and the public) can help create a broader support base for reforms (Graham, 1998).

The absence of a credible reform plan was seen as an important factor behind the less successful fuel subsidy reforms in Indonesia (in the late 1990s and early 2000s) and Nigeria (in 2011), including the absence of credible plans to reallocate savings efficiently and equitably. In Indonesia, the lack of effective planning contributed to unsuccessful reform efforts in 1998 and consultation with stakeholders had been inadequate in the run-up to the failed 2003 fuel subsidy reform. The widespread and sometimes violent opposition to that reform was partly motivated by the belief that the reform favored powerful interest groups (Beaton and Lontoh 2010). In Nigeria, the National Assembly refused to support the removal of gasoline subsidies due to lack of clear evidence on their size and on who benefits from them (Okigbo and Enekebe 2011).

On the other hand, the existence of comprehensive reform plans played a key role in the successful subsidy reforms in Iran (in 2010) and Namibia (over the late 1990s and early 2000s), Philippines (in the late 1990s), Turkey (over the late 1980s and early 1990s and subsequent administrations). In Iran, the plan incorporated clear objectives and timetable for reform, as well as credible compensating measures with bank accounts opened for most citizens prior to the reform and compensating cash transfers deposited into them preceding the implementation of price increases. In Namibia, the authorities undertook comprehensive planning, including broad consultation with civil society and a well-crafted plan that involved the introduction of a fuel price adjustment mechanism and a targeted subsidy for those living in remote areas. A clear medium-term reform strategy backed by careful planning was also a major factor behind the successful electricity price liberalization reforms in the Philippines and Turkey.

Develop a comprehensive communications strategy. This communication strategy should highlight clearly the shortcomings of energy subsidies, including the crowding out of more efficient and equitable public spending. Since lack of knowledge of the magnitude of subsidies and their shortcomings is often a key barrier to reform, it is important to publicize their magnitude, including by recording subsidies explicitly in the budget, and the fact that most of these subsidies are captured by higher income groups. For a group of 32 developing countries, the top income quintile, on average, receives more than six times more in total subsidies than the bottom quintile (Figure 5; Coady, Flamini and Sears, 2015). The concentration of subsidy benefits is even more pronounced for gasoline and LPG, where the top income quintile receives 27 and 12 times that of the bottom quintile, respectively. Although the poorest households receive a much higher share of kerosene subsidies, there is still substantial leakage of kerosene subsidies to higher-income groups. The details of the component parts of a comprehensive reform package should be identified and discussed stakeholders along with specific timelines for achieving these so that the government can be held accountable. Setting up a reform taskforce to develop and communicate the reform strategy and monitor and publicly report on its implementation can also help.

The absence of an effective communications strategy is seen as a major factor behind failed attempts at energy subsidy reforms in many countries, including early attempts at reform in Ghana, Indonesia, Mexico, Nigeria, the Philippines, Uganda and Yemen. In contrast, many of the countries that implemented successful energy subsidy reforms designed and implemented very effective communication campaigns that highlighted the large magnitude of subsidies and their shortcomings, including in Armenia, Iran, Namibia, Niger, the Philippines, and Uganda. The successful fuel subsidy reforms in the Philippines in the 1990s was in part attributable to a very effective communication strategy focused on consensus building (Bernardo and Tang 2008). While initially energy subsidy reform proposals lacked support from the majority party in both legislative chambers, the administration quickly launched a nationwide road-show to inform the public of the problems of oil price subsidies, and also set up a coordination body between the executive and congress to forge a political consensus. The successful subsidy reform in Iran in 2010 was preceded by an extensive public relations campaign emphasizing that the main objective of the reform was to replace price subsidies with cash transfers to reduce incentives for excessive energy consumption and smuggling. In Namibia, the authorities set up a national task force to examine fuel price deregulation, and a comprehensive reform plan was developed involving broad consultation with civil society, enhanced transparency in the use of fuel tax revenues, and a well-crafted plan that included the introduction of a fuel price adjustment mechanism and a targeted subsidy for those living in remote areas. Similarly, in Niger in 2011, the authorities established a committee tasked with identifying the best way to approach the fuel subsidy reforms in consultation with all relevant stakeholders.

Undertake a gradual and sequenced reform. A gradual approach to energy subsidy reform is desirable when large price increases are needed since the public often react very negatively to large price increases (as in Indonesia in the late 1990s, Mauritania in 2008, and Nigeria in 2012). This allows consumers time to improve their energy efficiency and thus mitigate the adverse impact of further price increases, and also reduce the annual inflationary impact of energy price increases. Energy price increases can also be sequenced across energy products to reduce the impact on lower-income groups while the safety net is being strengthened, e.g. starting with increases in gasoline prices but delaying the increase in kerosene prices. Having a strong safety net in place before increasing the prices of energy products that are more important for the poor can help to build public support for the reform.

In both Brazil (over the 1990s) and Namibia, subsidies were gradually reduced over a number of years to help diffuse public and political opposition. Countries in the Middle East with large price subsidies (such as Bahrain, Egypt, Kuwait, Iran, Oman, Qatar, Saudi Arabia, United Arab Emirates) have also started to decrease subsidies as part of a gradual (e.g., five year) plan to eliminate subsidies. India, Indonesia and Malaysia successfully adopted a gradual and sequenced approach to price reform. India's energy subsidy reform strategy started by eliminating gasoline subsidies in 2010 and subsequently very gradually reducing diesel subsidies through monthly small increases in prices until subsidies were completely eliminated by November 2014. Indonesia started to reduce subsidies from mid 2013, first eliminating gasoline subsidies and then gradually reducing diesel subsidies by 2015. Malaysia started price reforms in 2010, first completely eliminating subsidies on premium gasoline and gradually reducing subsidies on regular gasoline and diesel until they were eliminated by the end of 2014. Similarly, Peru started by eliminating subsidies on high-octane gas used primarily for luxury cars in 2011 followed by elimination of subsidies for regular gasoline in 2012. Some countries, such as Brazil and India, have also started by eliminating subsidies and liberalizing energy prices for large industrial users. In Brazil this was followed by liberalization of gasoline prices in 1996 followed by liberalization of diesel prices in 2001. However, there are limits to sequencing since large price differentials between products over a prolonged period can result in inefficient substitution between fuels (e.g., diesel for petrol cars) and adulteration of fuels (mixing diesel and kerosene), as well as fraudulent redirection of fuels between different users. For example, Turkey had to reduce liquefied petroleum gas (LPG) subsidies more rapidly than planned because of a sharp increase in LPG consumption as a result of conversion of vehicles to LPG. Similarly, the liberalization of gasoline prices in India resulted in a large price differential with diesel and a substantial increase in diesel car sales (Rahul and others 2013).

Implement targeted measures to protect lower-income groups. Ideally countries should use targeted cash transfer programs or near-cash transfers (vouchers) to mitigate the adverse impact of higher energy prices on the poor. Cash transfers give beneficiaries the flexibility to purchase the level and type of energy that best suits their needs and also remove the need for governments to be directly involved in the distribution of subsidized energy to households, which is often extremely costly and prone to abuse (Grosh and others, 2008). When cash transfers are not feasible, other programs can be expanded while administrative capacity is developed. The focus should be on existing programs that can be expanded quickly, possibly with some improvements in targeting effectiveness.

The successful 2005 subsidy reform in Indonesia has been credited by some to the government's decision to compensate poor households for price increases by establishing specific welfare programs. The highest profile program is the Bantuan Langsung Tunai—an unconditional cash transfer scheme targeted at poor households which not only helped the poor but also prevented near-poor households from falling into poverty (Beaton and Lontoh 2010). The success of early reform efforts in Iran was also in a large part due to the near-universal electronic cash transfer program put in place just prior to the increase in fuel prices. The expansion and eventual strengthening of a cash transfer safety net played an important role in Jordan's success in eliminating fuel subsidies since 2005 and eventual linking of domestic to international prices.

Other countries with weaker safety nets (such as Gabon, Ghana, Kenya, Niger, Nigeria, and Mozambique) have had to rely on a combination of programs such as school meals, public works, reduction in education and health user fees, subsidized mass urban transport, and subsidies for consumption of water and electricity below a "lifeline" threshold, to mitigate the impact on lower-income households. The Philippines maintained college scholarships for low-income students and subsidized loans to enable engines used in public transportation to be converted to less costly LPG; it also maintained electricity subsidies for indigent families (World Bank 2008).

Implement measures to reform the energy sector—State Owned Enterprises (SOEs) in particular—and support energy-intensive sectors. Where energy sector suppliers are inefficient it is important to include in the reform package measures to improve their efficiency to avoid giving the impression that the fiscal space from energy price increases will be simply used to allow these suppliers to remain inefficient. This is particularly important where there is a public perception that corruption and inefficiencies are rampant in the sector. Improving operational efficiencies will also reduce supply costs and reduce the needed energy price increases to eliminate energy subsidies. In addition, temporary support could be provided to energy-intensive sectors such as ceramics, electricity, fertilizers, and water, to facilitate investments in improving energy efficiency (e.g., access to credit or a more gradual subsidy removal) but these should be made conditional on the sector being viable over the medium term.

In Nigeria, public concern that the benefits from subsidy reform would be used to continue to prop up an inefficient refinery sector was a key factor behind the public backlash against the reform. As part of its reform strategy, the Iranian government undertook extensive consultation with enterprises to understand the challenges they faced if energy prices increased substantially. This led to a program targeted to agriculture and energy-intensive sectors hard hit by price increases, which included direct assistance and access to subsidized fuel.

Improving the efficiency of energy sector often appears challenging and country experiences suggest the importance of strengthening SOE governance, improving demand management and revenue collection, and better exploiting economies of scale. Governance of SOEs can be strengthened by improving the reporting of information on operations and costs and countries that have adopted information systems include Kenya, Uganda, and Zambia. Improved demand management (e.g., by charging higher prices during peak periods) has proven effective in shifting demand to periods where marginal costs of provision are lower (Antmann, 2009). Utilities in sub- Saharan Africa have had programs to provide free compact fluorescent bulbs, which have helped reduce demand and costs in Cape Verde, Ethiopia, Malawi, Uganda, and Rwanda. Efficiency can be improved by exploiting regional trade in electricity (Foster and Briceño- Garmendia, 2010). For instance, Mali and Burkina

Faso have been able to expand domestic supply and household access through integration into the regional market.

Depoliticize energy pricing. A reform strategy also needs to address the issue of the overall approach to energy pricing. Countries that directly regulate energy prices in an ad hoc manner are prone to recurring energy subsidies, especially when international prices increase sharply. The adoption of an automatic pricing mechanism, which fully passes on international energy price changes (increases and decreases) to the domestic market, can help to distance governments from energy pricing policy and help the public understand that international price changes determine domestic price changes. However, they are not a silver bullet since countries often abandon these mechanisms when international prices increase sharply, as was the case in Gabon, Ghana, The Gambia, Sierra Leone and Togo in the mid 2000s. The resilience of such an mechanism can be enhanced by transferring its implementation to an independent pricing body that reports directly to the public and the government in a transparent and regular manner (e.g., via publication of pricing details on a website and national media as in Ghana, the Philippines, South Africa, Turkey). Fuel subsidy reforms in South Africa and Turkey shifted responsibility for pricing to independent bodies, as did Armenia, Kenya, the Philippines and Turkey in the context of electricity pricing. Where pass-through of sharp increases in international prices remains a concern, countries can consider building in a formal price smoothing rule into the mechanism that limits the magnitude of price changes over the short term but ensures full pass-through over the medium term (Coady and others, 2012). Adoption of such mechanisms can facilitate the transition to a fully liberalized pricing system.

Philippines and Turkey successfully implemented automatic pricing mechanisms for fuel products during their transitions to liberalized fuel pricing. Many other countries have adopted automatic energy pricing mechanisms to prevent the return of energy subsidies. China continued its move towards deregulated fuel product pricing in March 2013 by increasing the price readjustment frequency in its automatic pricing mechanism to every 10 days (from 22 days). Jordan has also implemented an automatic pricing mechanism since 2005; although it abandoned it briefly due to social unrest, it was reinstated in January 2013. Tunisia reduced energy subsidies over 2012-3 and reintroduced an automatic pricing formula for gasoline in January 2014, and Mauritania adopted an automatic mechanism for diesel in May 2012. Morocco adopted an automatic mechanism in September 2013 (for some products) and liberalized gasoline prices in January 2014. Nepal adopted an automatic mechanism in September 2014, and UAE adopted an automatic mechanism for gasoline and diesel in August 2015. In sub-Saharan Africa, Cote d'Ivoire adopted an automatic pricing mechanism with smoothing in 2013. Chile, Colombia, Peru, Malawi, Mauritius, Namibia, Thailand and Vietnam have also used smoothing as part of their automatic pricing mechanisms. After gradually eliminating gasoline and diesel subsidies from 2010, both India and Malaysia had fully liberalized these prices by 2014.

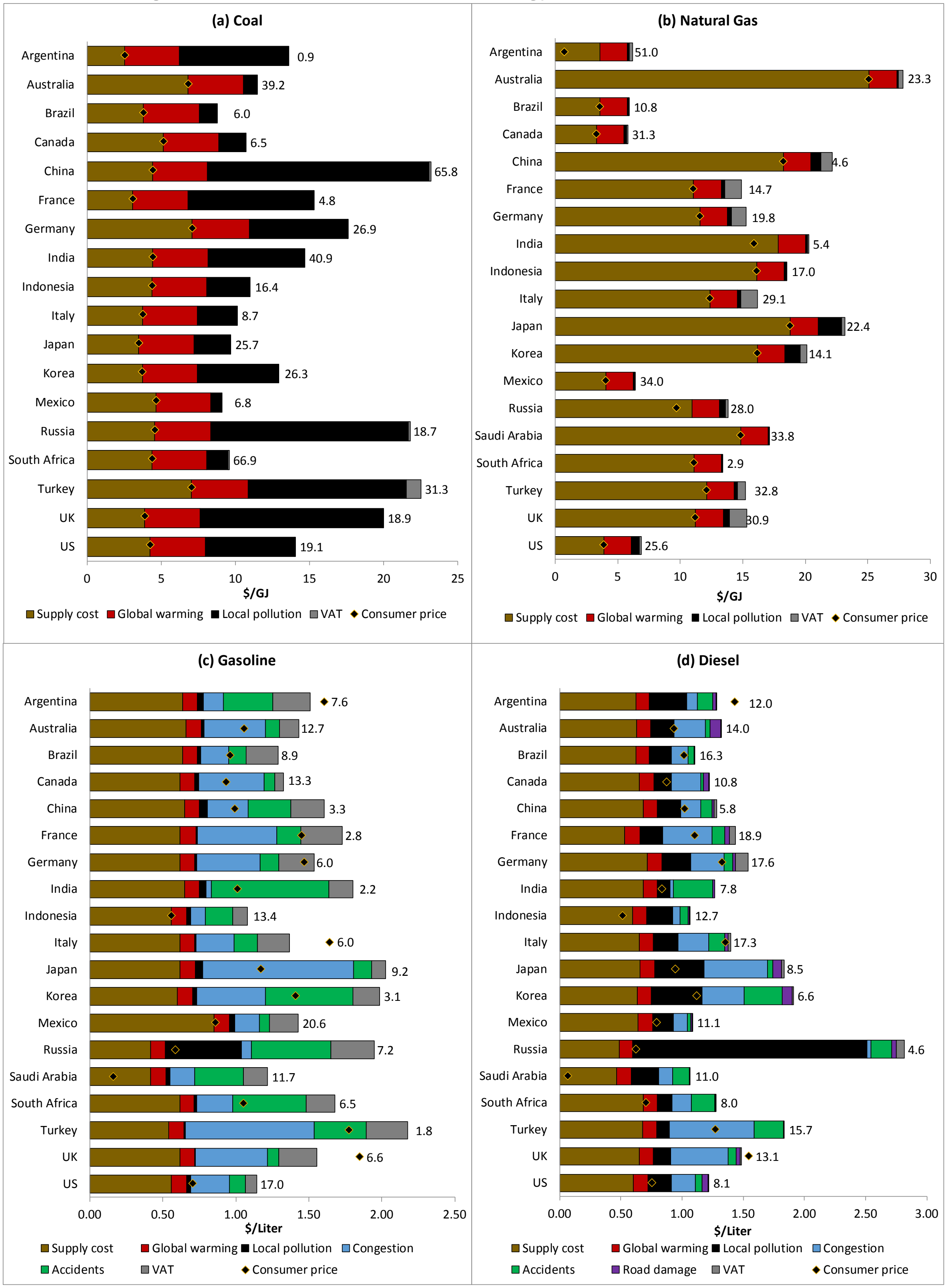
5. Conclusion

It is rare to find unanimous support among economists for a major policy action, but reforming fossil fuel prices is an exception to this—the conceptual case for pricing externalities is clear and country-level assessments suggest mispricing of energy is substantial and pervasive. To help move the process forward policymakers in essentially all countries need:

- Flexible tools to help them better understand the specific price trajectories needed to meet their Paris emissions commitments and reflect other externalities, as well as the impacts of price reform on the energy system, emissions, fiscal balances, and the broader economy;
- Quantitative assessments of the trade-offs between alternative mitigation instruments (e.g., pricing versus regulation, taxes versus trading) to help policymakers communicate their preference for pricing measures;
- Assessments of design specifics for other components of the reform strategy like cuts in other taxes enabled by the new revenues and the form and amount of measures to relieve households and firms especially vulnerable to higher energy prices; and
- Lessons from reform experiences in other countries that policymakers can incorporate into their own policy packages and communication strategies.

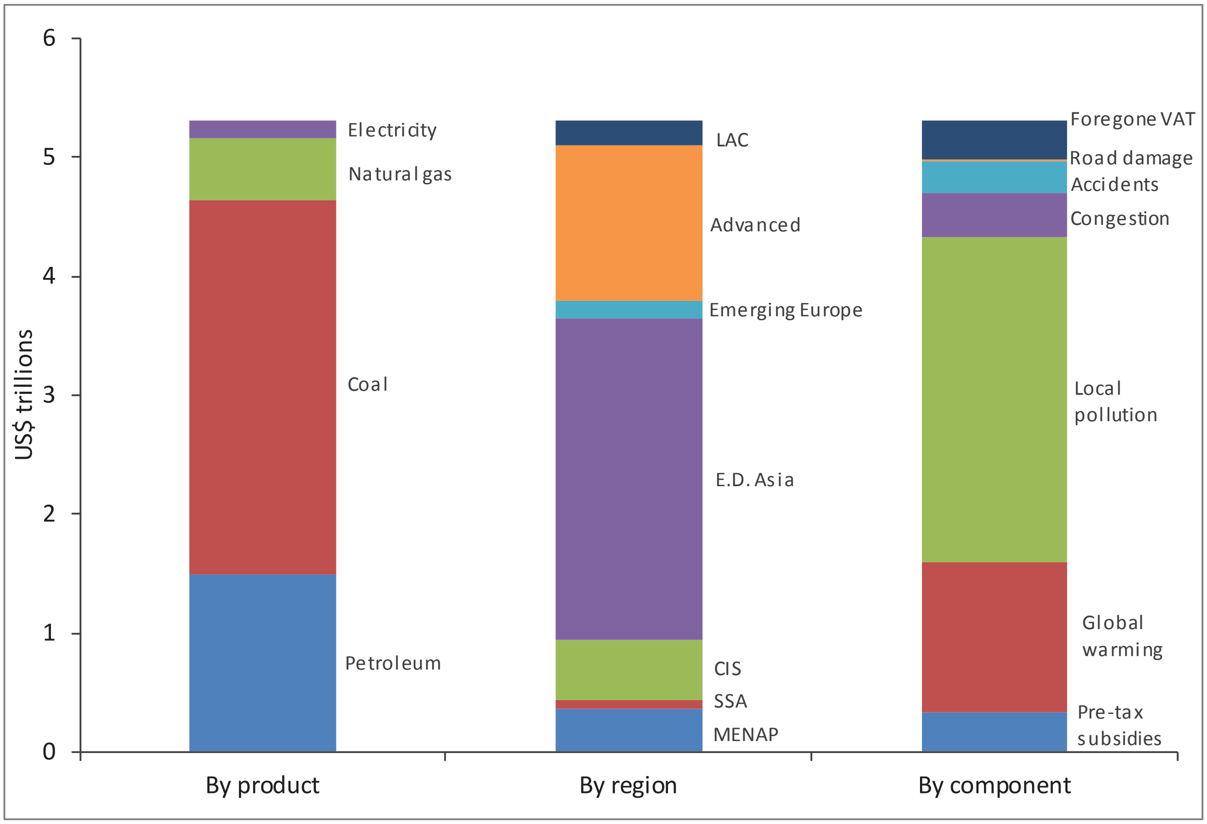
It is truly an exciting time for economists working on the practicalities of energy and environmental policy, given the unprecedented interest in these issues and need for analysis—a need which is unlikely to diminish any time soon.

Figure 1. Current and Efficient Energy Prices in G20 Countries



Source. IMF (2015). Note. Figures to the right of the bars are the share of fuels in primary energy.

Figure 2. Energy Subsidies by Fuel Product, Region and Component, 2015

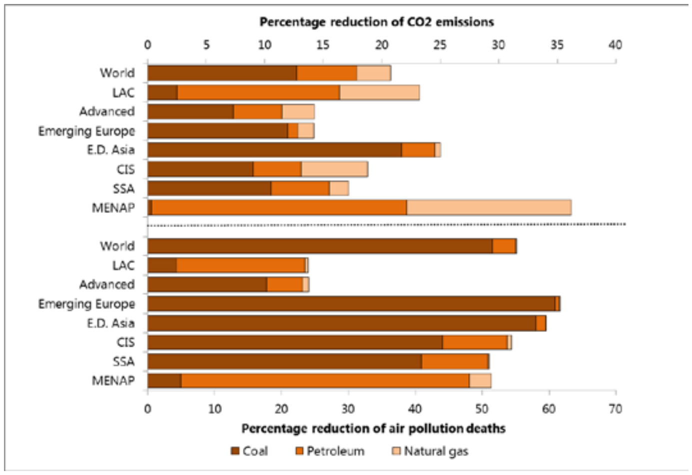


Source. IMF (2015).

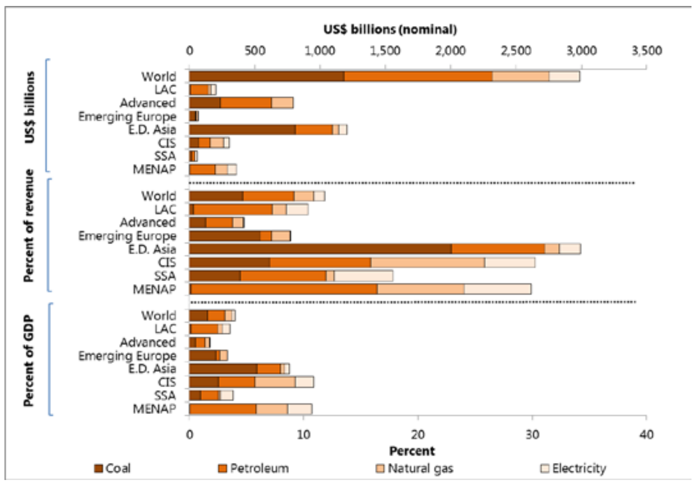
Note: CIS = Commonwealth of Independent States; E.D. Asia = Emerging and Developing Asia; LAC = Latin America and the Caribbean; MENAP = Middle East, North Africa, Afghanistan, and Pakistan.

Figure 3. Benefits from Getting Energy Prices Right, 2013

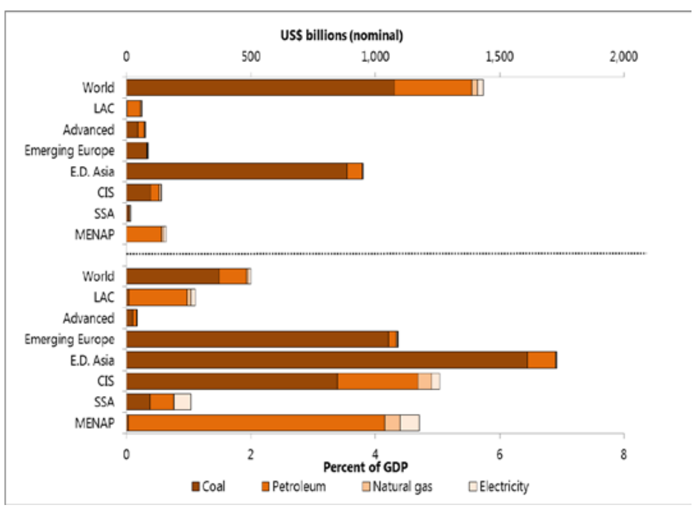
a. Environmental Gains



b. Revenue Gains

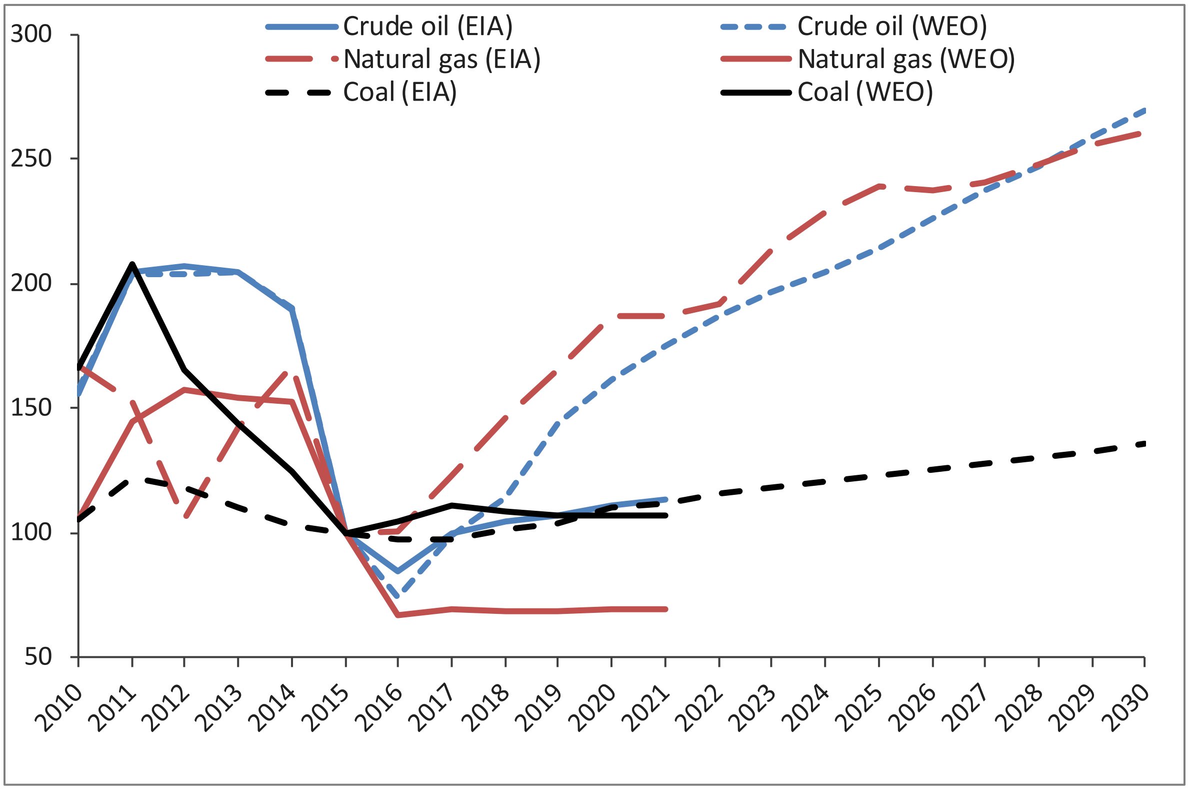


c. Welfare Gains



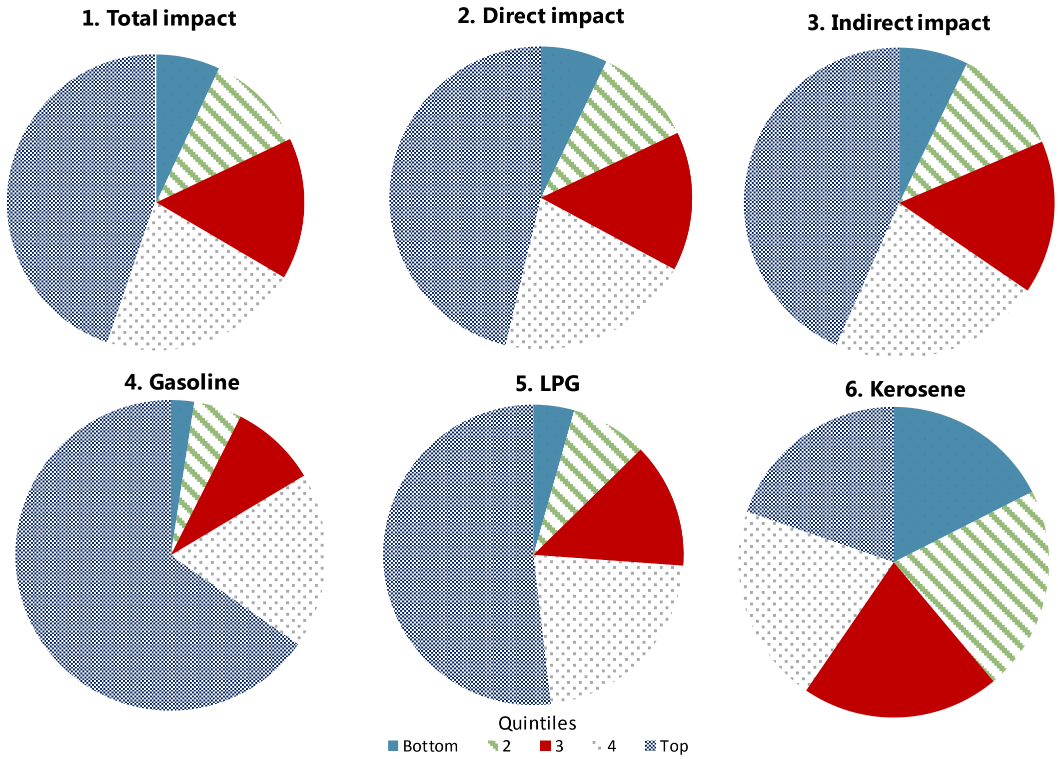
Source. Coady et al. (2015).

Figure 4. International Prices of Oil, Coal and Natural Gas, 2010-2030
(Current prices; indexed 2015 = 100)



Source: IMF, World Economic Outlook (WEO); and U.S. Energy Information Administration (EIA).
Note: EIA crude oil spot prices are the average of Brent and West Texas Intermediate prices and WEO crude oil prices are the average of Brent, Dubai, and West Texas Intermediate prices; EIA natural gas prices are the spot prices at the Henry Hub terminal in Louisiana and WEO natural gas prices are the average of Russian natural gas border prices in Germany, Indonesian liquified natural gas prices in Japan, and natural gas spot price at the Henry Hub terminal in Louisiana; and EIA coal prices are the average minemouth prices in United States and WEO coal prices are the average of Australia and South Africa export prices.

Figure 5. Distribution of Subsidy Benefits by Income Group
(Percent of total subsidy benefits)



Source: Coady, Flamini and Sears (2015).

Table 1. Recent Energy Price Reforms: Selected Countries

Country	Reform
Angola	Liberalize domestic fuel prices by 2020
Egypt	Fuel and gas prices increased 40-78%, electricity prices 20-50% in 2014
Ghana	Petroleum prices liberalized 2015
Haiti	Gasoline, diesel, kerosene prices increased 6-8% in 2014, 9-11% in 2015
India	Gasoline prices liberalized in 2010 and diesel prices in 2014
Indonesia	Abolished gasoline subsidies and capped diesel subsidies in 2015
Jordan	Automatic pricing mechanism in 2012, fuel subsidies zero in 2014
Kuwait	Raised diesel and kerosene prices 210% in 2015 (partially reversed)
Madagascar	Eliminating fuel subsidies and implementing automatic pricing in 2016
Malaysia	Prices for gasoline and diesel set monthly to reflect international prices
Mexico	Domestic fuel prices to be liberalized in 2018
Morocco	Gasoline, diesel, industrial fuel oil and LPG subsidies eliminated
Saudi Arabia	Gasoline price increased 50% in 2015, planned increases for diesel, gas, electricity
Sudan	Plan to eliminate fuel subsidies by 2019 (but fuel price riots in 2013)
UAE	Fuel price mechanism in 2015 and gasoline/diesel prices increased 25-30%
Yemen	Gasoline, diesel, kerosene prices increased 20, 50, 100% respectively in 2014

Source. IMF (2016).

Table 2. Carbon Pricing Schemes: Selected Examples

Government	Price 2015, US$/ton CO2	Coverage, % of GHGs	Government	Price 2015, US$/ton CO2	Coverage, % of GHGs
CARBON TAXES			Sweden	168	25
Br. Columbia	25	70	Switzerland	62	30
Chile	5	55	UK	16	25
Denmark	31	45	TRADING SYSTEMS		
Finland	40	15	Alberta	12	43
France	16	35	California	13	85
Iceland	10	50	EU	9	45
Ireland	23	40	Kazakhstan	2	55
Japan	2	70	Korea	9	66
Mexico	1-4	40	N. Zealand	5	54
Norway	50	50	Quebec	13	85
Portugal	5	25	RGGI	7	21
South Africa	10	80			

Source. WBG (2015).

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