WPS7220

Policy Research Working Paper 7220

Fossil Fuel Subsidies

Approaches and Valuation

Masami Kojima
Doug Koplow

WORLD BANK GROUP
Energy and Extractives Global Practice Group
March 2015

Policy Research Working Paper 7220

Abstract

Numbers ranging from half a trillion to two trillion dollars have been cited in recent years for global subsidies for fossil fuels. How are these figures calculated and why are they so different? The most commonly used methods for measuring subsidies are the price-gap approach—quantifying the gap between free-market reference prices and the prices charged to consumers—and the inventory approach, which constructs an inventory of government actions benefiting production and consumption of fossil fuels. Practitioners are not faced with two choices. The two methods are complementary and should be used together—price gaps cause distortions throughout the economy and quantification is needed for improving pricing policies; an inventory is useful for examining budgetary allocation. An inventory based on a full accounting framework for producer and consumer support estimates in fact captures price gaps as market transfers to producers or consumers. Differences in subsidy valuation arise from assumptions made to compensate for missing data and the scope of subsidy measurement. Having a common understanding of terms and standardizing calculation methods would go a long way in enabling comparison of subsidies across countries and sectors, benchmarking pricing, and assessing subsidy policies. Subsidy measurement should not be viewed as a one-off exercise to inform subsidy reform strategies. Just as subsidy reform in many countries does not have a clear end but is a continuous process of adjustment, so too is subsidy tracking. Devoting resources to data collection and analysis to track subsidies on a continuous basis can bring rich dividends by increasing transparency and enabling informed decisions.

This paper is a product of the Energy and Extractives Global Practice Group. It is part of a larger effort by the World Bank to provide open access to its research and make a contribution to development policy discussions around the world. Policy Research Working Papers are also posted on the Web at http://econ.worldbank.org. The authors may be contacted at mkojima@worldbank.org.

Fossil Fuel Subsidies: Approaches and Valuation

Masami Kojima[1]

Doug Koplow

Key words: fossil fuels, oil, gas, coal, subsidies, price gap, inventory, producer support estimate, consumer support estimate, total support estimate, OECD, International Energy Agency, International Monetary Fund

JEL codes: H20, Q48

[1] Masami Kojima is at the World Bank and Doug Koplow of Earth Track is a consultant. The authors are grateful for the comments provided by the following reviewers: Shanta Devarajan, Marianne Fay, Sameer Shukla, Ashley Taylor, Michael Toman, and Ruslan Yemtsov, all of the World Bank Group; and Jehan Sauvage and Ronald Steenblik of the Organisation for Economic Co-operation and Development. The authors also thank Amos Bromhead, Nora Selmet, and Georgios Zazias of the International Energy Agency and Louis Sears of the International Monetary Fund for checking the sections on the methods used by their respective organizations. The financial support provided by the Energy Subsidy Reform and Delivery Technical Assistance Facility of the World Bank's Energy Sector Management Assistance Program (ESMAP) is gratefully acknowledged.

Abbreviations

CNG	compressed natural gas
CO_2	carbon dioxide
CSE	consumer support estimate
EIA	(U.S.) Energy Information Administration
EITI	Extractive Industries Transparency Initiative
FOB	free on board
G20	Group of Twenty
GDP	gross domestic product
GIZ	Deutsche Gesellschaft für Internationale Zusammenarbeit (German Federal Enterprise for International Cooperation)
GSSE	general services support estimate
GST	general sales tax
HSE	health, safety, and environment
IEA	International Energy Agency
IMF	International Monetary Fund
kWh	kilowatt-hour
LNG	liquefied natural gas
LPG	liquefied petroleum gas
MENA	Middle East and North Africa
MPS	market price support
OECD	Organisation for Economic Co-operation and Development
OLADE	Organización Latinoamericana de Energía (Latin American Energy Organization)
OPEC	Organization of Petroleum Exporting Countries
PSE	producer support estimate
R&D	research and development
SOE	state-owned enterprise
TSE	total support estimate
VAT	value added tax
WTO	World Trade Organization

Introduction

Measurement of energy subsidies generates data on the scale and opportunity costs of subsidy patterns. The information can help build an economic and political case for mapping and addressing subsidies. As with any political reform, enduring implementation of subsidy reform will take much more than transparency, but a good understanding of the subsidy landscape can improve policy choices at the margin, help consider policy trade-offs, and garner political support for alternative energy pathways and reform strategies.

The objectives for defining, identifying, and quantifying subsidies vary by country and stakeholder. Some are concerned about the costs, allocative efficiency, execution efficiency, and transparency of government spending programs. Among the objectives may be to compare subsidies in the energy sector with those in other parts of the economy, or across different options for meeting the country's energy needs. Where subsidies have led to acute and frequent energy shortages, those adversely affected want to know the scale and incidence of subsidies in order to address the problem. The resulting economic harm has been alarming in some countries: for example, the Planning Commission of Pakistan (2013) notes that power outages affecting industry alone have slowed down economic growth by 2 percent a year. Where budgetary transfers to support subsidies have grown unsustainably large—exacerbated by low fuel prices encouraging over-consumption and smuggling—governments would naturally be concerned. Subsidy reporting may be required to check compliance with international commitments, such as those for the World Trade Organization (WTO). At the regional and global level, there is growing interest in quantifying subsidies for the purpose of making cross-country comparisons. Underpricing of fossil fuels has also been widely acknowledged to work against global efforts to increase energy efficiency and to shift from fossil fuels toward renewable energy, as captured in the two of the three goals of the *Sustainable Energy for All* initiative (www.se4all.org).

The tracking of energy subsidies has moved from an area of sporadic attention a few decades ago to a central tenet of policy reform today. In addition to efforts by governments focusing on their own country's situation, substantial investments of time and resources by international organizations and non-governmental organizations have enabled cross-country comparisons, and the information so collected and analyzed is being released with increasingly regularity. There is also a growing recognition that the scale of support has been substantial and far from optimal. In its *World Energy Outlook 2014*, the International Energy Agency (IEA) estimates that global subsidies that artificially lowered end-user prices of fossil fuels and electricity amounted to US$548 billion in 2013. A variety of subsidies for renewable energy totaled another US$121 billion (IEA 2014b, 313 and 275). These figures do not count subsidies for civilian nuclear power, which have not been tabulated globally. Further, subsidies in many countries are not calculated for lack of data, although the IEA covers all countries with significant subsidies to fossil fuel consumers.

Significantly, in September 2009, the leaders of the Group of Twenty (G20) pledged to "phase out and rationalize over the medium term inefficient fossil fuel subsidies while providing targeted support for the poorest" (G20 2009, paragraph 24), although reporting as well as progress on reform has been slow (Koplow 2012). Subsequently, the G20 finance ministers in February 2013 committed to a voluntary peer

review process for fossil fuel subsidies with the objective of "reducing wasteful consumption, enhancing the efficient functioning of markets, increasing energy security, taking into consideration reform impact on the poor and helping in the fight against climate change" (G20 2013). Governments of China and the United States are currently undertaking this process.

Departures from prices that would have prevailed in a deregulated, competitive market—known as price gaps in the subsidy literature—create distortions with ripple effects throughout the economy. In this context, subsidies and taxes would ideally be considered together, because distortions caused by a tax are largely symmetric to those caused by a subsidy. For example, a cross-subsidy taxes one group of consumers to subsidize another. A high export duty taxes producers and subsidizes consumers, and conversely a high import duty taxes consumers and subsidizes domestic producers. Two policy actions can have essentially the same effects on fuel prices but with the opposite effects on economic distortions. As an example, reducing the import duty on a fuel has the same effect as providing a price subsidy: both lower end-user prices. However, import duty reduction decreases, while a price subsidy (a negative fuel-specific consumption tax) increases, economic distortions. As such, a full examination of fossil-fuel subsidies would cover both fuel taxes and subsidies.

Fuel taxation across the supply chain is a vast and complex topic, starting with upstream fiscal regimes. The large resource rent, especially with oil; the exhaustible nature of fossil fuel resources and extraction; very high upfront costs spent on intangibles combined with relatively low operating costs; the desirability of transparent bidding parameters for licensing; and other issues have led to divergent views on how best to structure upstream fiscal regimes. Issues to consider for midstream and downstream taxation are arguably more standard but nevertheless numerous.

While recognizing the importance of considering taxes and subsidies together, this paper has a more modest objective. It considers optimal taxation beyond its scope and sets out instead to be a practical guide for governments and practitioners who wish to quantify fossil fuel subsidies. In particular, the paper presents issues that would be of interest to a broad spectrum of developing countries in subsidy measurement. Detailed treatment of estimation of subsidies across the economy exists in the literature (for example, see Jones and Steenblik 2010 for a detailed examination of definitions, a wide spectrum of types of subsidies, and methods for measuring each). This paper focuses primarily on fossil fuels and adds details specific to the fuels. It begins by outlining basic approaches to evaluating subsidies. It next describes the two most commonly used methods—price gap and inventory—in some detail, assessing their strengths and limitations. It then reviews the work undertaken in recent years by the IEA, OECD, and the International Monetary Fund (IMF) as illustrative examples. It ends with concluding remarks.

Approaches to Evaluating Subsidies

This paper defines a subsidy for fossil fuels as a deliberate policy action by the government that specifically targets fossil fuels, or electricity or heat generated from fossil fuels, and has one or more of the following effects:

A. Reducing the net cost of energy purchased
B. Reducing the cost of production or delivery of fuels, electricity, or heat
C. Increasing revenues retained by resource owners, or suppliers of fuel, electricity, or heat

The definition excludes policy actions that achieve these effects through promotion of efficiency improvement along the supply chain, greater competition in the market, or other improvements in market conditions.

As the exclusion implies, not all policy actions with one or more of the above effects would be classified as subsidies. Allowable rates of return in a regulated electricity sector offer an example. If the allowed rate of return on the regulatory asset base is reduced from 15 percent to 12 percent as the electricity market matures and investor risk declines, resulting in falling end-user prices, such actions are not generally viewed as an introduction of a subsidy for consumers. By contrast, if political factors result in regulated returns being either artificially high or low for particular risk conditions, classifying the intervention as a producer or consumer subsidy could be justified.

The definition concerns government action, not inaction. Because subsidies are confined to government actions, financial incentives offered by businesses as marketing decisions—such as selling cylinders for liquefied petroleum gas (LPG) at a loss as a means of attracting new customers—would not be considered subsidies, except in cases where the private decisions ultimately trigger large financial losses to energy suppliers that the government steps in to staunch. Not attributing subsidies to government inaction would exclude from the definition budgetary transfers and other compensation measures that are induced by commercial malpractice or weak administrative capacity—such as theft of energy, reduced or non-payment by consumers bribing energy company staff, illegal diversion of subsidized fuels for fuel adulteration or smuggling, and low bill collection rates—because it is highly unlikely that any of these results would be a direct result of a deliberate government policy action. The definition also speaks to specificity. A policy that affects the economy as a whole would not be considered a fossil-fuel subsidy.

Effects A, B, and C imply that cross-subsidies and assistance programs tied to the purchase of fuel or energy derived from fossil fuel are subsidies. Cross-subsidies reduce the cost of energy purchased by the cross-subsidized consumers, even if the cross-subsidies are financially neutral. Assistance programs tied to energy consumption—voucher schemes, cash transfers to consumers' natural gas accounts, allocation of free gas or heat for the first so many units consumed a month—reduce the cost of the energy purchased. A recent example of a new conditional cash transfer scheme is Pratyaksh Hanstantrit Labh, the world's largest direct benefit transfer program recently launched by the government of India that includes cash for LPG purchase (India 2014). By contrast, unconditional cash transfers—such as those in Indonesia in 2005 and 2008 (World Bank 2012)—are not subsidies because they raise income but do not reduce the cost of energy consumed. Fuel-specific border restrictions can also give rise to subsidies, in the form of transfers to or from consumers.

The definition raises the question of how to define the reference case (the counterfactual) against which the increase (or decrease) is measured. The reference cases for some types of subsidies (such as tax expenditures and non-tax fiscal concessions) can vary significantly from country to country and are therefore difficult to compare internationally (OECD 2013a, 36). Identification and quantification of subsidies inevitably entails varying degrees of analyst judgment. Anderson (1990) illustrated this point by examining a major greenfield coal project in Canada to establish whether there were large subsidies.

The study found that the results were highly sensitive to the assumptions made about such standard parameters as costs, selling price, capacity utilization, the project life, discount rate, and inflation, and different but plausible assumptions had led to the opposite conclusions about the presence of subsidies. Specificity could be particularly problematic. It immediately raises the question of how specific—if a tax policy affects only three sectors, including energy, and fossil fuel prices fall as a result, is that a fossil fuel subsidy? More importantly, a policy may not specifically target fossil fuels on paper but may be designed to benefit the fossil fuel industry disproportionately. If fossil fuel suppliers capture the bulk of the benefits of a tax break, not including that tax break in the subsidy calculations—on the grounds that the tax relief did not "specifically" target fossil fuels—would under-estimate support to producers (effect C above).

A commonly employed method for estimating subsidies falling under effect A (reduced spending by consumers) is the "price-gap" approach. The method calculates the difference between the reference price for energy in an actual or imputed market-based transaction and the price actually paid by, or officially charged to, an end user for that same energy delivered to the same location at the same time. The IEA follows this approach in its estimations of global subsidies for fossil fuels. The use of price gap measurements for fossil fuel subsidies usually focuses on positive gaps on the assumption that if energy is sold at a price below what it would have been in a competitive, deregulated market, the main reason for the lower price is some government intervention—a subsidy, a cross-subsidy, or some form of price regulation (including an export tax or restriction). This is in contrast with agriculture, where the focus has historically been more on domestic prices being higher than reference prices, especially in OECD countries, and which has been the subject of international trade negotiations. Because prices can be high or low for reasons other than subsidies, it remains important to confirm that there is a plausible policy mechanism that would result in lower prices. Price gaps do not capture all energy subsidies. Some policies affect market participants (most often producers, including resource owners) in ways that do not result in lower end-user prices. Also, some consumers are subsidized through vouchers or similar programs that are tied to their purchase of fuels but do not affect the domestic prices of those fuels.

One way of arriving at a more comprehensive understanding of subsidies is to list policies using different subsidy-delivery mechanisms in an inventory. Some of these policies may have no measurable effects on prices and some may increase prices charged to consumers. Many alter the mix of energy resources deployed in an economy and the timing of their availability. An overview of different subsidy delivery mechanisms applicable to a wide range of sectors can be found in a primer by Steenblik (2007). Using the WTO's definition of a subsidy (WTO undated) as the starting point—summarized as "a financial contribution by a government, or agent of a government, that confers a benefit on its recipients"— the primer describes what kind of benefits may be provided and how. The OECD (2010a) provides a detailed overview of subsidy definitions and approaches to calculating indicators of support to arrive at the total support estimate (TSE).

Much of the methodological development has been led by agriculture, where producer subsidies have historically been high in OECD countries, aided by border restrictions. Over the past several decades, practitioners in agriculture have come to a common understanding of terms and acceptance of standardized approaches, enabling comparison of subsidies across countries (Steenblik 2002). The OECD

has been applying this approach to agricultural support for almost 30 years. The coverage has been extensive, with detailed estimation of market price support (MPS) for producers (which can be positive or negative but has historically been highly positive), and price transfers to consumers, which have the same unit value as MPS but with the opposite sign. The OECD has more recently expanded its work to include support provided to fossil fuels in its member countries. The coverage of fossil fuels is more limited than in agriculture due to lack of data, and the OECD to date has focused on direct transfers of government funds and tax and other revenue forgone. Because of extensive data and calculation requirements, numerous other forms of support (see table 1.1 in OECD 2013a)—such as risk transfers, concessional credit, and MPS—have not yet been quantified, although the OECD Secretariat intends to include them in the future. As the OECD points out, not all interventions are necessarily subsidies; its inventory seeks to tabulate all interventions, recognizing that further evaluation is often needed to gauge whether a particular intervention results in subsidies to fossil fuels and whether or not the policy achieves its aims. The OECD also notes that some types of subsidies are not additive across countries (OECD 2013a, 20). The IMF uses a mix of approaches, including price-gap estimations as well as producer support calculated by the OECD, depending on the country and the type of energy.

Table 1 lists representative categories of subsidies for fossil fuels. More details with examples are provided in Table A.1 of the appendix, which also identifies effects A, B, and C above in the third column. The categories in Table 1 are not necessarily mutually exclusive. As an example, budgetary transfers to energy service providers are often caused by government control of prices below market levels, as are domestic supply obligations, which are set most typically for natural gas. Where a state-owned enterprise (SOE) has a low credit rating and the government intervenes with loan guarantees, the guarantees provide a subsidized input (cheaper loans than otherwise) and a tax break (in the form of exempting interest payments to investors from taxation), and transfer default risk to the government.

Table 1 Subsidy categories and descriptions

Intervention category and description	OECD coverage of TSE for fossil fuels	Gap between reference and local prices?
Direct transfer of government funds		
Budget and off-budget transfers. Direct transfers of funds to producers (for example, to compensate producers for price controls or fund applied research and development, demonstration projects in commercial development of an energy technology involving fossil fuels, and other types of support for a fossil fuel or firms engaged in fossil fuel trade and transformation). Cash transfers to consumers, where transfers are directly linked to consumption of fuel, electricity, or heat.	As reported	Yes, if end-user prices are affected

Intervention category and description	OECD coverage of TSE for fossil fuels	Gap between reference and local prices?
Government-induced transfers between producers and consumers		
Government control of energy prices		
• **Prices or price ceilings set by government**. Direct regulation of prices at any level along the supply chain to reduce costs to producers or consumers, or to increase prices paid to producers.	Yes, if budgetary transfers are used to compensate producers; MPS not yet captured	Yes, if end-user prices are affected
• **The domestic price effects of import or export measures**. Import tariffs or quantitative restrictions that raise the domestic price received by producers and paid by consumers; export tariffs or quantitative restrictions that reduce the domestic price received by producers and paid by consumers.	MPS created by import tariffs to be measured by the OECD in future Inventories.	Yes, if end-user prices are affected
• **Special case of cross-subsidy**. Policies that reduce costs to particular types of customers or regions by increasing charges to other customers or regions, or by requiring firms to use profits in one segment of the supply chain (usually upstream oil and gas) to reduce prices charged to consumers in another segment of the supply chain.	Yes, if budgetary transfers are used to compensate producers	Yes, if price information is sufficiently disaggregated (by consumer category, location, or fuel type or grade) and there are clear price effects out of line with reference prices.
Purchase or supply mandate		
• **Purchase requirements.** Required purchase of particular energy commodities, such as domestic refined products or priority access to the grid, typically when other choices are more financially attractive	No	Likely to increase end-user prices
• **Domestic supply obligation.** Required sale of energy—typically oil or gas—on the domestic market, usually when domestic prices are kept artificially low	No	Local prices likely to be lower than reference
Fiscal revenue forgone		
Tax expenditure. Corporate tax, petroleum profit tax, value added tax, excise tax, and other taxes reduced or waived. Acceleration of allowable deductions. Special tax-favored corporate structures primarily accessible by fossil fuel industries.	As reported	Possibly
Other fiscal revenues. Bonuses for oil blocks, royalties, production share, and other non-tax payments reduced or waived in upstream oil and gas	As reported	Possibly
Underpricing of other goods and services, including risk		
Subsidized inputs. Subsidies to large-volume inputs to energy suppliers, including water and rail or water freight	Data not yet reported	Possibly
Lending and Credit. Below-market provision of loans, loan guarantees, or grants for energy-related activities	Data not yet reported consistently across member countries	Unlikely

Intervention category and description	OECD coverage of TSE for fossil fuels	Gap between reference and local prices?
Goods and services provided by government. Underpricing of access to land and other goods and services	Not yet reported	Unlikely
Permits. Underpricing of permits and licenses	No	Unlikely
Shifting of risk burdens. Government assumption of price, safety, and other risks; consumer or resident assumption of risks through limits on commercial liability	No	Not for fuel priced at trade parity
Special treatment of SOEs. Undue risk-taking, soft budget constraints leading to contingent liabilities, debt cancellations, tax-exempt operating status	As reported	Unlikely

Source: Authors.

The second column in Table 1 indicates which items the OECD's analysis of budgetary support and tax expenditures for fossil fuels has quantified to date (www.oecd.org/site/tadffss/). The last column indicates which of the individual categories may be captured in the price-gap approach, as used by the IEA and IMF. More specifically, to be captured by the price-gap approach, a specific measure would need to affect the end-user price (usually downward). With most measures in the table, there are potential scenarios wherein the price is decreased (or increased), although the degree of capture will depend on the scope and quality of input data. The ability of price-gap calculations to pick up subsidies is not consistent across energy sources. For example, globally traded commodities such as refined petroleum products may have clearing prices at global levels (the fuel is sold at trade parity), regardless of the cost of production. To the extent that producer subsidies lead to over-supply by a major producer, even in the case of oil, the world oil price could, at least in theory, fall slightly. However, this effect will be more likely with other fossil fuels.

Table 2 below and Table A.2 in the appendix present additional issues that can have the same effects as A, B, and C above but are not included in Table 1 for a variety of reasons:

- *The main policy objective is not the provision of energy subsidies.* Examples include unconditional cash transfers as social safety nets (last item in Table 2), even if one of the reasons for the introduction of cash transfers is higher energy prices, and generation of fundamental knowledge such as basic research and development, as opposed to support for commercially developing specific technologies. Social protection merits an explanation.
- *The distortions in energy markets are the result of administrative or managerial deficiencies rather than targeted strategies to promote fossil fuels.* Examples include weak capacity (such as lack of enforcement of regulations against short-weighting or weak tax administration), crime (electricity theft), operational inefficiencies (billing and collection inefficiency), or political difficulties in implementing disciplinary procedures (a classic example being the inability to disconnect government ministries or the military for nonpayment of energy bills).
- *They have to do with uninternalized costs of externalities*, which are discussed in more detail below.

Table 2 Other interventions and issues for consideration

Intervention category and description	OECD coverage of TSE for fossil fuels	Gap between reference and local prices?
Regulatory oversight		
Weak regulations. Absence of basic HSE regulations, weak standards because of domestic producers' inability to compete with imports meeting higher standards	No	Unlikely
Weak enforcement. Lack of monitoring, failure to fine and punish violators, lack of enforcement leading to rampant commercial malpractice defrauding consumers	No	No
Underpayment		
Under-collection of taxes and non-tax fiscal revenue. Lack of administrative capacity to properly assess taxes and other payments due, manipulation of transfer pricing, administrative errors	No	Unlikely
Under-collection of payments from consumers due to administrative inefficiency. Failure to impose payment discipline, lack of disaggregated metering, inaccurate metering, under-billing due to administrative errors	No	Prices could be higher if losses lead suppliers to raise prices
Malpractice. Loss of revenue due to non-technical losses, such as theft, meter tampering, and collusion between consumers and utility staff with the objective of under-reporting consumption	No	Prices could be higher if losses lead suppliers to raise prices
Research and development (R&D)		
Government financing of R&D. Support for basic research useful for a wide range of sectors	Yes, as reported	Unlikely
Costs of externalities		
Costs of negative externalities that are not accounted for. Examples include greenhouse gas emissions and pollutant and heat discharges to water systems	No	No as long as reference prices exclude uninternalized externalities
Social protection		
Support for the vulnerable. Compensation to enable the vulnerable to meet their basic needs, including those for energy, but not directly linked to consumption of a specific energy item (unconditional cash transfer being one example)	Yes, as reported.	No

Source: Authors.
HSE = health, safety, and environment.

For some items, varying degrees of judgment may be involved in deciding whether to place them in Table 1 or Table 2. For example, if the government finances R&D clearly intended to benefit specific SOEs and not other firms in the same industry, or worse, if the government finances R&D expenditures on commercial-scale application of an already established technology, such support would be considered a subsidy because it would be difficult to categorize it under the rubric of general knowledge generation. Similarly, if there is a uniform import duty of 10 percent on all goods, and the government

reduces the duty to 5 percent only for petroleum products in times of soaring world oil prices, it would be difficult to argue that this tax reduction represents trade liberalization. Analysts should carefully consider if any items mentioned in Table 2 might appropriately be regarded as support in their individual country circumstances.

Many items in Table 2, particularly in terms of managerial and administrative improvements, receive as much or more attention than policies identified in Table 1, although not necessarily under the heading of subsidy reform. Placing an item in Table 2 does not in any way diminish its policy importance, nor dilute the needed attention to it. For example, transfer pricing has been identified as a key revenue concern in both developed and developing countries. One study calculated that approximately US$100 billion had been lost between 2002 and 2006 in developing countries due to misuse of transfer pricing (Hollingshead 2010). However, strengthening of tax provisions and administrative capacity to address this and other issues related to tax collection is not normally considered "subsidy" reform.

There are divergent views on how to deal with uninternalized externalities, ranging from not counting them as subsidies to classifying all uninternalized externalities that are in any way associated with fuel production or consumption as fuel subsidies. Inclusion or exclusion of subsidies is what accounts for the difference of half a trillion versus 2 trillion dollars of global fossil fuel subsidies, as shown later. Because many such externalities relate to environmental damage, with large associated health costs, environmental economists have long argued for charging corrective taxes as a means of internalizing externalities. While appealing from one point of view, inclusion of uninternalized externalities in subsidies poses difficulties, including reconciliation with how practitioners in other sectors understand the concept of subsidy. For example, in agriculture, which is more advanced than energy in measuring subsidies in a consistent way across countries, uninternalized externalities are not included in the definition of subsidies. The IEA and the OECD consider such externalities to be outside the scope of subsidy measurement, and this report also follows that approach.

The IMF includes costs of consumption-related externalities in its "post-tax" subsidy estimations, counting as subsidies failure to charge for the economic damage caused. The underlying assumption is that the damage cost should have been captured in the price of the fuel. In such an approach, an important question is the extent to which the externality can be directly attributed to the production or use of a particular fuel. Some externalities, such as the emissions of carbon dioxide (CO_2) from fossil-fuel combustion, are directly linked to fuel use, unless CO_2 is captured and permanently sequestered. But fine particulate emissions in vehicle exhaust, responsible for many premature deaths and illnesses and resulting in high economic costs, depend more on engine design and maintenance than on the fuel, suggesting that an externality charge scheme would want to rely on technological characteristics rather than fuel. The relationship between fuel consumption and other externalities, such as traffic congestion and road damage, is even less straightforward.

Characteristics of sound subsidy tracking

A process for estimating subsidies should not a one-off exercise but a continuous process in which subsidy calculations are regularly updated and the scope is expanded over time to capture a growing share of all mechanisms of government support. The broad scope of interventions in energy markets

warrants an iterative process of subsidy disclosure and quantification, allowing for improvements over time. Tailoring outputs to support the data needs of all key stakeholders is also important. Focusing on the most significant subsidy impacts first can leverage the limited resources available for subsidy tracking: subsidies with serious adverse effects on the budget, energy suppliers, consumers, or any combination of them. For example, subsidies triggering acute shortages of modern energy extend to the entire economy and are an important area in which to prioritize review. In the face of severe energy shortages, even direct beneficiaries of energy subsidies have been known to call for subsidy elimination (Kojima 2011, 60). In practice, data availability and political support also affect which policy areas are evaluated first. Following the concept of materiality from accounting, subsidies that are very small or spread broadly across the economy and have smaller differential distortions in the energy sector can be ignored. As policy and market environments change over time, periodic rechecks on materiality are warranted to ensure previously small supports remain so.

To the extent possible, data and analysis should be transparent, complete, and comparable, and calculations both relatively easy to carry out and replicable. The estimation and aggregation methods used would ideally have the following characteristics: they are consistent and allow meaningful comparison of subsidies within a given sub-sector over time and across different sectors; they disclose data sources, assumptions, and relationships to those used in other studies; they ensure reasonable accuracy while minimizing uncertainties as far as practicable; and they avoid overburdening estimators by selecting, to the extent possible, the least data- and calculation-intensive means, without compromising the integrity of the calculations and without systematic over- or underestimation. Some of the features are described below.

- **Consistency across estimators**. Both within a country and internationally, subsidy measurement results would reflect the policies in place, regardless of who is doing the estimation.
- **Consistency across sectors**. One policy question is how subsidies compare across different sectors. For example, policy makers may want to compare subsidies given to the energy sector with those for agriculture or infant industries in manufacturing. Cross-sectoral comparison in particular requires meticulous attention to detail to ensure that the same methods are applied despite substantially and even qualitatively different market conditions, sector structure, and key policy questions.
- **Transparency about assumptions, baselines, and boundaries**. Part of ensuring this consistency is for assumptions on key inputs and boundaries to be clearly stated. Including specific information about the data sources, timing, and required adjustments for reference price calculations is important. This transparency enables users to adjust existing work for alternative assumptions or to integrate it with other studies more accurately.
- **Able to be aggregated**. Being able to combine data elements in a consistent manner, even if different components are estimated by different parties, in a way that enables broader patterns to be seen would be helpful. Combining subnational data and national estimates is one such example—subsidies for district heating in particular are largely subnational (see figure 2.5 in World Bank 2014 for an example from Belarus). Combining subsidies for different energy

sources or across sectors is another. This requires applying consistent methods and using data from a comparable time period for all calculations.

- **Data availability at different levels**. There are many analytical and political challenges that are best addressed by examining data on a more granular level—be it by geographic region, beneficiaries (by fuel type, industry, consumer or producer), type of support mechanism, or some other attribute.
- **Consistency and availability over time**. Subsidy estimates change from year to year as the economic and policy environment shifts. World energy prices, government policy, energy extraction or consumption rates, and a variety of other factors all affect the magnitude of subsidies. A tracking system needs to provide consistent data over a sufficient period of time in order to provide the necessary base for subsidy analysis and reform, and highlight the main drivers behind shifts in subsidy values over time.
- **Provision of estimation range**. While budgetary transfers can usually be measured precisely, many other types of subsidies cannot be. Estimate variance can sometimes be quite wide, and it is useful to be able to see the estimate range in the reported calculations. Such disclosure can also help prioritize the areas in which analytical work can improve the estimation accuracy over time.

It is also informative to be able to compare subsidies across countries or regions, and even to aggregate subsidies to arrive at regional or global figures. Attempts at producing such aggregated numbers face several challenges, the most significant of which is lack of key data in many countries. Another methodological difficulty is the presence of different tax systems that preclude cross-country comparisons for many tax expenditures. While some subsidy types are technically difficult to aggregate, analytical work should be able to narrow the areas facing such difficulties over time.

If the calculations are to form the basis for checking compliance with international commitments, the subsidy data and calculation assumptions need to be transparent, easy to understand, and broadly follow the same method from country to country. Further, since many subsidy types are measured against particular assumptions and baseline scenarios, presenting the calculations on a platform that allows users to modify the assumptions would be useful. For example, a country's default reporting may evaluate credit subsidies in reference only to its treasury borrowing rate, but other users may wish instead to run scenarios using the market cost of credit to enterprises of a similar risk profile.

There may be lessons from corporate financial reporting. Financial reporting is critical to the efficient functioning of capital markets, just as accurate subsidy tracking is helpful to the efficient functioning of the energy sector. Both financial and subsidy reporting need to address complex measurement challenges in a transparent and standardized way, and to integrate information from a wide variety of actors operating under many different sets of regulatory and statutory systems. Issues that have had to be addressed in financial reporting include how to value long-term contingent liabilities—which the OECD defines as "liabilities whose budgetary impact is dependent on future events which may or may not occur" (OECD 2013b)—or credit guarantees, and how to report tax benefits. These largely overlap

with issues that need to be addressed in subsidy calculations. Relevant institutions and professional bodies from the corporate financial reporting sector may be able to support subsidy tracking as well.

Review of Methods

Arguably the two most common approaches to estimating fossil fuel subsidies that have been used to date have been to (i) focus only on price subsidies for consumers (price gap), and (ii) identify different subsidy delivery mechanisms and quantify each (referred to as the inventory approach hereafter). The OECD uses the latter to list and quantify a wide variety of interventions, including some on which there is not yet a consensus regarding its status as a subsidy. The hidden-cost approach (Ebinger 2006) is also discussed; not all of the shortfalls identified in the hidden-cost calculations would be considered subsidies in this paper. Hidden costs are alternatively referred to as quasi-fiscal deficits where SOEs are concerned, capturing "the value of implicit subsidy computed as the difference between the actual revenue charged and collected at regulated prices and the revenue required to fully cover the operating costs of production and capital depreciation" (Saavalainen and ten Berge 2006).

The different approaches complement each other and capture different parts of a unified framework—a comprehensive accounting of TSE. In fact, the inventory approach itself could be set up to capture all forms of subsidies, although at the moment no institution has applied the inventory approach in a comprehensive TSE framework to fossil fuel subsidies. Until a full TSE framework is adopted, the combined use of different methods helps develop a better understanding of the working of a given sector and areas for reform or improvement.

Price gap

A price gap quantifies the difference (gap) between what a particular form of energy is likely to sell for in a deregulated competitive market (reference price, adjusted for local costs and quality) and what it actually sells for (the local price). In agriculture, the price gap is referred to as the market price differential (OECD 2010b), but because domestic agricultural prices in OECD countries tend to be higher than reference prices, reference prices are subtracted from domestic prices. For fossil fuels, the calculation is usually reversed, subtracting local prices from adjusted reference prices. Many studies focus only on positive price gaps, that is, cases in which the reference price is higher than the local price. The price gap is multiplied by the total units consumed to arrive at a total value:

$$\text{Subsidy} = (\text{Adjusted reference unit price} - \text{local unit price}) \times \text{units consumed}$$

$$= \text{Price gap} \times \text{units consumed}$$

A price gap on the consumer side can also be negative, usually representing subsidies to producers. The subsidy calculated is equivalent to the inverse of MPS, which is the monetary value of gross transfers from consumers and taxpayers to producers, usually calculated on an average annual basis.

Calling any deviation from the reference price a subsidy imposes exacting data collection and calculation requirements on the estimators, because it assumes that an accurate reference price can be calculated and only subsidies can lead to departures from the reference price. In practice, price gaps are

informative if the gap is consistently and measurably positive or negative, and can be linked to specific policy interventions.

The data requirements for both local and reference prices can be demanding:

- Calculating adjusted reference prices may require dedicated studies. Even with petroleum products—the only energy sources for which international benchmark prices applicable to all countries are available—situation-specific costs of transportation (both international and domestic), storage, distribution, and retailing need to be added. Coal and natural gas are traded much less frequently across national borders, and electricity and district heating seldom so, making identification of reference prices even more challenging.
- As for local prices, where there is pan-territorial pricing—whether the territory is the country or a province or a city—official prices can be used, although if different prices apply to different territories, consumption in each territory may be difficult to obtain. If price competition exists, a price survey is needed, and the prices so collected would ideally be volume-averaged to arrive at weighted average prices paid by consumers. Further, frequent price surveys may be needed, and are in fact essential in times of rapidly changing world energy prices. If, for example, only the prices collected in the global price survey conducted by Deutsche Gesellschaft für Internationale Zusammenarbeit (GIZ) over a few days in mid-November every other year (GIZ 2014) were used to compute unit subsidies and annualized for 2008, the subsidies for that year would be grossly under-estimated.

Price gaps do not capture many forms of subsidies (Koplow 2009):

- If there are gross inefficiencies somewhere along the supply chain—such as large technical and non-technical losses in energy delivery (see World Bank 2011 for a detailed discussion on such losses)—local prices may not be lower than reference prices and there could be subsidies to energy suppliers.
- By definition, any subsidy that does not result in net changes in end-user prices is not captured. Because oil is a global commodity usually unaffected by production costs in a single country, subsidies provided to oil producers are typically not accounted for. Policies that boost domestic prices, such as market price support and priority purchase of more expensive forms of energy, may not be captured if price-gap calculations focus only on underpricing, as is often the case with conventional energy. Conditional cash transfers to consumers that leave prices untouched, such as India's direct benefit transfer program for LPG purchase (India 2014) or the Low-Income Heating Assistance Program in the United States, are also not captured.
- Many other forms of subsidies may not lower prices measurably enough to be captured by a price gap. Examples include corporate tax concessions, statutory limits on commercial liabilities, and underpricing of government assets during privatization.

Reference prices

Calculating reference prices can be data-intensive. Depending on the conditions of the energy market in the country and data availability, a number of simplifying assumptions may have to be made. Common issues across fuels are presented below, followed by more fuel-specific adjustments.

Common issues

Some issues common to all forms of energy include economies of scale and setting benchmarks for efficiency. There are economies of scale in most parts of the fossil-fuel supply chain, and cost penalties for under-scale operations can be large. For example, importing liquid fuels—crude oil, petroleum products, and especially LPG—in large quantities is much less costly than doing so in small shipments. This is one reason fuel prices are higher in small markets. Relying on standardized shipping cost data from international trade journals could grossly under-estimate costs for small markets. Similarly, supplying electricity to sparsely populated areas is much more expensive than in densely populated urban centers, so using a national or global point estimate for power transmission and distribution can result in systematic inaccuracies in reference prices for power.

Another element that significantly affects costs, especially in large-scale projects, is the rate of utilization. Large economies of scale are often associated with equally large upfront infrastructure investments—pipelines, electricity generation plants, district heating distribution networks, and refineries are all examples. Fixed costs per unit of production are sensitive to throughput, and low utilization rates can increase unit costs by hundreds of percent. As a result, a sudden loss of a very large consumer (or of supplier, in the case of pipelines) could push up costs for the remaining consumers.

Some types of infrastructure have such large economies of scale that they become natural monopolies. Examples include oil and gas pipelines, district heating distribution systems, and electricity transmission. The presence of a natural monopoly calls for economic regulation. In such cases, reference prices are usually set based on costs incurred under efficient procurement, project execution, and operations. What is considered efficient varies from market to market. A total of 15 percent for aggregate technical and nontechnical losses in electricity might be considered efficient in markets that until recently were experiencing losses in excess of 25 percent, but 15 percent would be considered inefficient in a mature power market. Uncompetitive procurement and project delays could push up costs far above notional benchmarks, but what is efficient procurement and project execution varies from market to market.

Ultimately these reference prices are intended to approximate the price levels in a market with healthy competition combined with enforcement of sound regulations. Competition would drive down prices and pass efficiency gains to consumers in the form of lower prices, while effective regulation would minimize the chances of widespread commercial malpractice defrauding consumers, ensuring that consumers are paying for energy of the stated quality and quantity. To foster efficiency improvement, allowed profit margins can be set relatively small, but if set too low, the sector could struggle to attract the needed investment. Price regulators face the challenge of balancing efficiency and cost minimization on the one hand with provision of sufficient incentives to attract and retain responsible investors on the other, and similar considerations apply in calculating reference prices.

For internationally traded energy sources, the standard approach is to select import- or export-parity prices as the starting point for reference prices, because these sources constitute the alternative supply for the domestic market regardless of how efficient or inefficient domestic production of energy may be. A country's net trade status on a national basis, however, may not represent the trade status in some parts of the country. For example, if a country is separated into two coastal areas by a mountain range, one coastal area may be a net importer and the other a net exporter. In such cases, ideally the trade status applicable to each region should be used. For thinly traded or non-traded energy, cost-recovery levels or costs of competing energy sources have served as references; shadow pricing taking account of a depletion premium is another approach (Devarajan, Martin, and van Wijnbergen 1987).

Price-gap calculations compare adjusted reference and domestic prices at a specific point in time, so the timing of data matters. This includes not only the raw pricing data, but also the exchange rates used to convert import- or export-parity prices. If there are parallel foreign exchange markets due to restrictions on the official exchange, it may not be straightforward to determine the exchange rate at which energy, or goods and services necessary to supply energy, were traded.

There is general consensus that taxes applicable to all goods and services, such as general sales tax (GST) or value added tax (VAT), should be levied on energy. In calculating the price gap, if both domestic and alternative supplies are adjusted for baseline taxes, many of the effects from the tax system drop away because both prices would be affected almost equally. This would include situations in which GST rates on fossil fuels are lower than for other goods. However, two aspects of the tax system may affect price-gap calculations even with netting. First, where fuel taxes are ad valorem (a fixed percentage of the value of the energy being sold), the monetary amount will automatically be lower for the local price if the energy source is subsidized; adjustments may be required to ensure that reference and local prices be compared on the same tax basis. Second, the government may charge energy-specific user fees (such as for maintenance of strategic reserves or spill response capability), and they need to be taken into account in price-gap calculations. Where there are various end-consumer taxes at different levels of the government (central, provincial, municipal), data requirements to properly adjust for fuel taxes can become large.

Reference prices are discussed next by fuel and energy type. The challenges faced are similar to those faced by governments in setting an automatic pricing mechanism for fuels or cost-reflective tariffs for electricity and district heating.

Petroleum products

Crude oil and refined petroleum products are internationally traded global commodities. In 2013, two-thirds of oil consumed globally crossed national boundaries (BP 2014). Daily free-on-board (FOB) spot prices of different types of crude are available in trade publications. While daily prices of Brent and West Texas Intermediate, two benchmark crude oils, are publicly available, most others are proprietary and available only to subscribers. Similarly, daily spot prices of key petroleum products are available in major refining centers, notably western Europe, the Arab Gulf, Singapore, and several markets in the United States (New York, U.S. Gulf Coast, and West Coast), but again mostly to subscribers. For the same

refined product, prices in these markets are comparable. Because of ease of transport and the opportunity for arbitrage, there is little potential for marked price divergence across regions.

With the exception of a handful of countries in the Middle East that burn crude oil for power generation, crude oil is rarely used in final consumption. Virtually all crude oil is supplied to refineries, making refined product prices at international hubs the relevant reference prices. Provided sufficient information exists, these prices are adjusted for key fuel-quality parameters. For gasoline, the most important determinant of price is its octane number. For all oil-based liquid fuels, the sulfur content is an increasingly important determinant of price.

For each refined product, the first step is to see whether the country or a region in the country is a net importer or exporter. Assessing the trade status at the refined product level is important; approximations relying instead on a comparison of total fuel net imports (crude oil plus refined products) versus total exports can lead to large over- or under-estimations of reference prices. Several major crude-oil exporters are also net importers of certain refined products, including the Islamic Republic of Iran, Iraq, and Nigeria, making import- rather than export-parity prices relevant.

If the actual costs at the domestic port of entry or exit are known, they represent a natural starting point for calculating reference prices. Otherwise, a common practice is to add shipping costs to FOB prices at the nearest international hub for net importers and subtract transportation costs for net exporters. For a net exporter, shipping and associated costs to major markets to which the country sells the refined product in question are subtracted from the reference prices at those destinations. Because such an approach might entail calculating reference prices in foreign countries, a simplifying approach would be to subtract shipping and other associated costs from the closest export-oriented refining center providing the benchmark FOB price.

The formula used by the Department of Energy in South Africa, a net importer, illustrates many principles used to arrive at reference prices. It is intended to "represent the realistic, market-related costs of importing a substantial portion of South Africa's liquid fuels requirements … in terms of both product quality and sustained supply considerations" (www.energy.gov.za/files/petroleum_frame.html). The so-called basic fuels price is equal to

> FOB + freight + demurrage + insurance + ocean loss + cargo dues (wharfage) + costal storage + stock financing + inland transport costs + wholesale margin + retail profit margin + government taxes and charges,

where

> FOB = combination of FOB prices in the Mediterranean, Singapore, and the Arab Gulf, depending on the fuel; price adjusted for gasoline octane number using linear interpolation
>
> Freight = freight rates published by London Tanker Brokers Panel on January 1 each year, adjusted on a monthly basis in line with the Average Freight Rate Assessment, which is a function of risks and supply and demand of ships transporting refined petroleum products internationally
>
> Demurrage = rates published by the World Scale Association Limited, with the total demurrage time limited to 3 days

Insurance = 0.15 percent of the FOB value and freight

Ocean loss = 0.3 percent calculated on the sum of the FOB, freight, and insurance values

Wharfage = the tariff set by the National Ports Authority of South Africa

Coastal storage = cost of providing storage and handling facilities at coastal terminals

Stock financing = cost based on the landed cost of refined petroleum products, 25 days of stockholding, and the ruling prime interest rate less 2 percent.

One important question is how much time lag to allow between when FOB prices were observed and when domestic selling prices were in effect. Even in very large, completely deregulated markets close to refining centers, the price transmission is not instantaneous because it takes time to move products and for the inventory to turn over. A detailed study of price transmission in 12 European countries found that it took 5 weeks on average for retail prices to capture about 90 percent of the price change (Myler 2009). In more distant markets, the time lag could be longer, especially if they are remote and small. Therefore, selecting the same time period for reference and actual prices could lead to serious over- or under-estimation of the price gap in times of rapidly changing world oil prices or foreign exchange rates. Given the above findings in Europe, it would make sense to allow for a time lag of at least a month for many developing countries.

If detailed shipping rates are available, declining costs with increasing scale can be captured, but such information is not always available. Delays in customs clearance or port congestion, as in Kenya and Nigeria (Kojima 2013), could increase demurrage charges significantly, but keeping track could be resource-intensive unless the delays and additional costs are fairly consistent over time. Inland transportation costs similarly depend on economies of scale as well as road conditions and, where they are used, the state of the rail network and oil pipelines. Obtaining cost information at this level would require dedicated studies.

LPG—about 60 percent of which is derived from natural gas and 40 percent from refining oil—is more difficult to store and transport than other liquid fuels, and as a result there is not a single global market for it. LPG is a gas at room temperature unless pressurized, and is stored in pressurized containers with attendant economies of scale (Kojima 2011). The costs of bottling and storage are unique to LPG and location-specific.

Coal

Coal is the least internationally traded of the three fossil fuels. In 2013, only 17 percent of thermal coal consumed was traded (IEA 2014a). A substantial portion of the market, both within and between countries, operates under long-term contracts, and these prices are usually not published. Spot or short-term prices may diverge considerably from long-term contract prices (OECD 2010a: 23), making establishment of reference prices difficult. As with petroleum products, it is important to adjust reference prices for coal quality, such as its caloric value and sulfur content. Of the three fossil fuels, coal is least likely to have inherent natural monopolies along the supply chain.

Natural gas

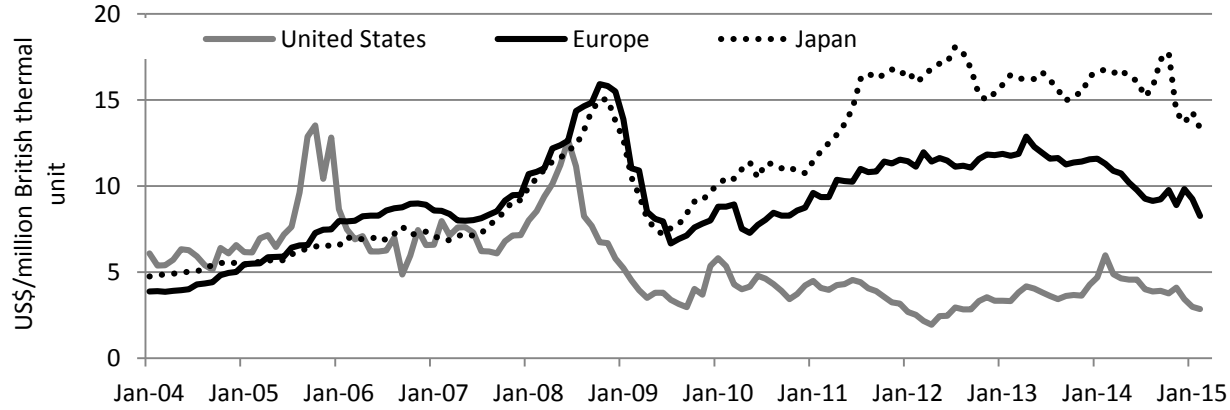
Unlike oil and even more so than LPG, natural gas is difficult to store and transport, making it more difficult to trade than oil. In 2013, less than one third of natural gas consumed globally crossed national borders, about two thirds by pipeline and one third as liquefied natural gas (LNG) (BP 2014). Although spot prices are the most readily available data on natural gas prices, only a fraction of the internationally-traded gas is sold on the spot market. The considerable upfront costs associated with setting up LNG terminals have meant that LNG projects are seldom, if ever, undertaken without long-term contracts in place.

As a result, there are three major and distinct natural gas markets: North America, Europe, and Asia. The degree of divergence in the prices in the three markets (Figure 1) signals the impact of high transportation costs on the global gas market. Oil, too, used to have distinct regional markets, each with its own prices, but the commercialization of very large crude carriers beginning in the late 1960s reduced transport costs. After 1973 the share of transport in the landed cost of imported oil declined precipitously (even across long distances, such as from Saudi Arabia to New York), helping to further equalize prices across different regional markets. Such a dramatic cost reduction is unlikely for natural gas in the foreseeable future.

If it is not economic to export domestic natural gas—for example, if the amount of economically recoverable natural gas reserves is too small or the reserves are too distant from major foreign consumption centers—export-parity equivalent prices cannot be used as the reference price. In such cases, market prices will be above the cost-recovery level at a minimum, and, at the high end of the price spectrum, at parity with petroleum products for which that natural gas might substitute.

Natural gas is valued for its energy content. In markets where unit prices are based on volume, the energy content of different gas streams needs to be examined to assess if the price level is appropriate. If pipeline operators set strict limits on the gas composition, such specifications can be used to estimate the energy content. Calculating the reference price for compressed natural gas (CNG) for automotive use involves estimating the cost of establishing and operating a CNG distribution network.

Figure 1: Natural gas prices in three markets



Source: World Bank data.

United States = Henry Hub spot prices; Europe = average import border price and a spot price component; Japan = landed LNG price

Natural gas is virtually always distributed through a network of pipelines, which are natural monopolies. Economic regulation is therefore necessary. Estimating costs of connecting new customers may be challenging because they depend on the distance to the closest pipeline, the number of others consumers being connected, and several other factors.

Electricity and district heating based on fossil fuel

There are two approaches to calculating subsidies for electricity and district heating produced from fossil fuel. The first considers fuel on the one hand and power or district heating on the other as being separate and focus only on subsidies provided to the fuels consumed in the generation of electricity or heat. The second considers subsidies for the entire supply chain and apportions the fossil-fuel component according to its share in the total amount of energy supplied or consumed, capturing any subsidies to conversion and the delivery system as well. In the latter approach, if district heating is subsidized and is entirely from natural gas, the subsidy for district heating would count as a natural gas subsidy, even if the natural gas itself is not subsidized.

The first approach is simpler than the second, both in terms of data collection and associated calculations. Where there are significant subsidies for electricity or district heating, irrespective of whether fuel inputs are subsidized, it is useful to calculate such subsidies with a view to putting the sector on a financially and fiscally sustainable path over the long run. Absent limits on resources and time availability, price gaps would be calculated by taking the long-run marginal cost of supply as the starting point for the reference price. Where there are increasing returns to scale, it may be necessary to address, through the use of two-part or other tariff structures, the revenue deficit arising from marginal costs being lower than average costs (Friedman 1991).

In a market with increasing demand, as in the power sector in all developing countries, such supply-cost calculations would ideally be based on long-term, system-wide optimization and integrated resource planning—which evaluates the full range of alternatives, including options for both supply and end-use, to provide adequate and reliable service to customers while minimizing long-term costs. This has important implications for subsidy reform. Suppose, for example, that a country is reliant on oil-based electricity generation and that its average tariff of US$0.35 per kilowatt-hour (kWh), while high, is still heavily subsidized. The long-term policy goal may not be to raise the tariff to US$0.50/kWh for full-cost recovery, but to shift power generation away from oil to cheaper resources available in that country, combined with aggressive steps to reduce technical and nontechnical losses. Both steps would enable reductions in unsubsidized tariffs. In many countries a comprehensive long-term plan does not yet exist, making it difficult to calculate reference prices according to the above criterion. Absent a long-term expansion plan, one simplifying approach is to estimate the cost of energy production and delivery without system expansion, benchmarked against some measure of efficient operation.

The so-called hidden-cost approach calculates the combined effects of electricity prices below levels needed to recover costs, losses, and under-collections. Implicit in the calculation of cost recovery is a

notion of costs of efficient operations; otherwise, all losses and under-collections would be captured inherently in cost recovery. For sector reform, hidden-cost calculations are important—reducing losses and improving collections are integral to sector reform—but they are not synonymous with subsidies. Because reducing these hidden costs is vital for long-term sustainability of the sector, many utilities and regulatory agencies routinely measure and monitor collection efficiency and combined technical and non-technical losses.

As with natural gas, calculating benchmark connection charges is not straightforward and many simplifying assumptions have to be made. They include average distance to the closest network and the number of other new consumers being connected.

Actual prices and quantities

It would be a rare country that has one price for each fuel throughout the country for all consumers and a straightforward tariff structure for electricity, natural gas, or district heating. If there are different prices for similar or even same grades of fuel, consumption of each is needed to calculate the total subsidy. Complications for liquid fuels include the following:

- Subsidizing one grade of a given fuel but not other grades of the same fuel (diesel in India and gasoline in Malaysia until recently, gasoline and diesel in Indonesia).
- Offering different amounts of subsidy for the same fuel depending on the grade (gasoline and diesel in Egypt, diesel in Tunisia).
- Having one or more prices for the same fuel grade by consumer category, sometimes with rationing of the lowest-priced fuel (gasoline and diesel in the Islamic Republic of Iran; diesel in Kazakhstan and Malaysia; kerosene in India; LPG in Argentina, India, Indonesia, Thailand, and Tunisia).

Pricing structures for network energy are usually far more complicated. Key elements include an initial cost of connecting new customers to the system, a recurring fee to remain connected, and a variety of pricing structures for the energy consumed. Connection charges may be a function of several factors, such as the distance from the network system or the installed capacity. While emerging economies may have a simple pricing schedule, most markets have multiple schedules even for residential consumers. The charge per unit may increase with consumption (an increasing block electricity tariff, used to encourage conservation or to facilitate lifeline services to the poor) or decrease with consumption (a decreasing block electricity tariff, often employed to provide bulk discounts to large industrial customers). Electricity tariffs in Burkina Faso, for example, have three increasing blocks each for 12 different residential consumer categories that vary with load and other supply characteristics (www.sonabel.bf/statist/tarif.htm). Tariffs for large industrial consumers are often consumer-specific and bilaterally negotiated. The wide variation in charge schedules makes analysis of tariff-revenue data intensive. If there is a single utility in the country, approaching that utility to provide the requisite data should be sufficient in principle. Where there are many utilities (such as Namibia), data requirements can multiply.

Cross-subsidies add to the complications. Simply because an energy supplier recovers sufficient revenue from its customer base to cover its costs does not mean that the prices charged accurately reflect the cost drivers in providing the energy services. Insufficient prices charged to one group of customers can be compensated for via higher-than appropriate charges on other groups of customers. These cross-subsidies represent a subsidy to the first group and a *de facto* tax on the second. Cross-subsidies are common especially for network energy.

Even if revenue neutrality is intended, cross-subsidies often result in net losses. For liquid fuels, some countries tax one fuel (almost always gasoline) heavily to cross-subsidize other fuels. Ghana and Nepal are two historical examples, having used gasoline to pay for subsidies on other fuels, although the tax on gasoline was often insufficient to cover the subsidies. Price-gap calculations carried out on a product-specific basis would capture cross-subsidies among fuels. By contrast, cross-subsidies within the same energy or fuel type, as is common for network energy, may be masked in the average values and therefore not be identified in price-gap estimates. Low tariffs for agricultural electricity use are often compensated by other customer classes, and industrial cross-subsidization of residential electricity or district heat is also common in developing countries. Attribution of cross-subsidies is further complicated by a lack of metering of certain customer classes. In India, for example, agricultural as well as residential consumption of electricity in rural areas is often unmetered.

Fuel subsidies linked to national trade or foreign policy deals can have material effects on energy pricing within a country. Examples include a large price discount historically offered to Jordan by the government of Iraq for crude oil and similar deals provided in the past to the Republic of Yemen by Saudi Arabia. If large enough, these subsidies would depress the end-user price nationally, and therefore be apparent in price-gap calculations. The recipient government is likely to have little interest in "reforming" such subsidies. Rather, tracking this class of subsidies is important in order to prepare for the day when the foreign support is reduced or withdrawn.

Where prices are controlled, fuel shortages may ensue, pushing up prices on black markets. Subsidies should, however, be calculated based on the official prices, or else subsidies may "disappear" altogether if black market prices rise high enough. Black-market pricing of price-controlled supplies normally shifts the recipient of the subsidies away from the fuel consumer and to the black market intermediary, but the subsidy remains all the same.

Illegal diversion affecting quantities consumed is another source of inaccuracy. For example, if subsidized kerosene is used to adulterate automotive diesel, diesel consumption may be artificially inflated while consumption of subsidized kerosene may not be captured fully. Depending on how final consumption is measured, out-smuggling (which by definition is not accurately measured) of subsidized fuels may result in understating the quantity of subsidized fuel actually supplied or overstating the quantity consumed domestically.

Inventory Approach

An inventory approach aims to identify, document, and quantify a wide range of government interventions in energy markets, utilizing a mix of support delivery mechanisms. The goal of an inventory

approach is twofold: to help government officials and citizens understand the overall scale of public spending and policies promoting particular energy pathways, and to help identify the most important leverage points for reform. An inventory would ideally cover all direct expenditures by the government, forgone revenues due to targeted tax and other fiscal concessions, and potentially many other forms of support, including below-market provision of credit and insurance, MPS to producers, and market transfers to or from consumers. A detailed exposition on the accounting framework for producer support estimate (PSE) and consumer support estimate (CSE), with illustrative calculations in agriculture, can be found in OECD (2010b). Examples of measures supporting fossil fuels include budgetary transfers to an oil price stabilization fund or to state-owned natural-gas utilities; sales of subsidized crude oil by a national oil company to a state-owned refinery; a tax holiday, credit guarantees, or a subsidized loan for a new natural gas pipeline project; and priority access to the grid for electricity generated by a utility in financial trouble. Particularly informative compared with the sole use of a price gap is the full quantification of producer subsidies, consumer subsidies, or both, that an inventory approach enables. Case studies for energy can be found in Koplow and Charles (2010) and Koplow and Lin (2012). For agriculture, *OECD Review of Agricultural Policies* has numerous examples, not only for the OECD countries but also for seven countries outside of the OECD (www.oecd.org/tad/agricultural-policies/producerandconsumersupportestimatesdatabase.htm#country).

Even qualitative listings of support measures add value, because market distortions can be seen more clearly and examined once interventions are identified. The qualitative information can be expanded and quantified over time. For this reason, starting with a comprehensive list, even if many entries are blank for lack of data, can be informative, in particular for policy makers seeking to reform fossil fuel subsidies.

The framework developed by the OECD to produce its inventories of transfer mechanisms provides a strong starting point. Policies of primary support to individual producers are grouped into the PSE and those to individual consumers into the CSE. Policies that benefit producers or consumers collectively, or that do not necessarily support current production or consumption, are grouped under the general services support estimate (GSSE). Examples of the GSSE include rehabilitation of lignite mining sites in Germany; government assumption of inherited environmental liabilities for coal mining in the Republic of Korea; and public funding for basic, fossil-fuel-related R&D. The OECD combines PSE, CSE, and GSSE to arrive at the TSE, with some adjustments to avoid double-counting.

This framework, if carried out comprehensively, may be considered a unified framework covering all measures of subsidies. All price gaps would be captured as transfers to consumers (from tax payers, producers, or both) or to producers (from tax payers, consumers, or both). Additional forms of subsidies, such as cash transfers to consumers to pay for fuel purchase or tax breaks for producers, would be captured as CSE or PSE. The OECD has been compiling these data for agriculture since the mid-1980s and for fisheries since the late 1990s. The coverage in agriculture is broad, covering virtually everything that this paper defines as a subsidy.

The OECD began tracking for fossil fuels in 2010. To date, the OECD has included in its *Inventory* mainly those measures that have been obtained from published government sources. Due to data limitations,

the OECD does not claim to have yet accounted for all transfers that could be incorporated into the existing framework related to fossil fuels in its member countries. The OECD's coverage of support for fossil fuels goes beyond the items discussed in Table 1 and includes some items in Table 2. The OECD calls its *Inventory* one of "budgetary support and tax expenditures," rather than an "inventory of subsidies."

Because of the difficulty of obtaining consistent data across countries, certain types of support measures are often missed in the accounting. They include off-budget spending or commitments, such as credit support or below-market insurance, and subsidies offered by foreign entities, such as concessional financing by donors (except where there are sovereign guarantees). Depending on the scope and definition, cross-subsidies that are revenue neutral may also not be captured.

Because price-gap measurements are an integral part of a full PSE-CSE set of accounts, the issues discussed in the section on the price-gap approach are also applicable here. Additional issues are covered below.

Direct expenditures

Although direct expenditures are more transparent than any other instrument, there are still several challenges in producing meaningful estimations:

- **Level of disaggregation**. Budget line items may commingle many activities. For example, if there is a single ministry of energy and industry, the budget may provide one aggregate figure for various transfers to SOEs under the ministry, making it difficult to disentangle what went to state-owned steel manufacturers and what went to state-owned refineries. Even for transfers to a petroleum ministry, disaggregating subsidies across different uses can be difficult. Funds for CNG filling stations and subsidies for unconventional natural gas may be a single number for natural gas, although the two types of subsidies serve very different purposes.
- **Different levels of government**. Where different levels of government are offering explicit subsidies, collecting information becomes challenging the lower the level of the government. Not only does the number of governmental units rise, data quality tends to be less robust for lower levels of government. This problem is particularly evident with district heating, where subsidies are often disbursed at the municipal level.
- **Off-budget spending**. Off-budget spending by definition is not presented in the budget, making it less transparent and more difficult to collect data for. Off-budget spending escapes the level of oversight and scrutiny applied to budgetary spending, and instead faces similar transparency and accountability problems for analysts as do tax expenditures and contingent liabilities. One historical example is special oil bonds issued by the government of India to state-owned oil companies to help offset financial losses caused by price subsidies (IEA 2009).
- **Transfers to SOEs not operating commercially**. Where SOEs are supposed to be operating commercially in principle, on- or off-budget spending is most likely to be subsidies. Where SOEs are not operating on a commercial basis, valuation of such transfers requires careful analysis against a commercially-based counterfactual. SOEs may not be allowed to retain earnings and

are instead financed by the government by design. Some national oil companies submit annual budgets to the parliament for approval, and may also be burdened with non-core projects, such as running local schools and hospitals and operating aircraft for politicians. This approach obscures expenditure as well as market governance and makes it difficult to separate subsidies—such as access to tax exempt debt, no required return on taxpayer capital, and a tax-exempt operating status—from justifiable business expenditures.

- **Reimbursement of previous budgetary transfers**. Where budgetary transfers were made to help companies in financial trouble, one method that is commonly used to capture such public infusions is to amortize the support over the period of troubled operations, rather than assigning the entire bailout to a single year. Similarly, repayment of infusions, if required, needs to adjust for the time value of the funding. The initial subsidies are usually recorded, but reimbursements may not be, or are not adjusted for imputed interest and loan administration.
- **Accounting for offsetting revenues**. Many government programs, including direct expenditures, consist of a mix of government support and offsetting revenue collections. It is important that subsidy inventories match both streams and present a net value in final calculations. Budget line items for related offsetting collections are not always co-located with the spending, particularly at the subnational level, making the matching challenging.

While the size of public spending on programs to reduce or support market prices is generally known, the amount does not necessarily match what would be computed using a price-gap measurement. Self-reported costs may be used in the place of benchmark prices, and the quantities claimed may be inflated—sometimes dramatically so. An example is Nigeria in 2011, where a series of government investigations found that fuel marketers with no infrastructure for importing or distributing products had claimed to have sold subsidized gasoline and received payments from the government (Kojima 2013, 61–62).

Large losses due to theft, inaccurate metering, collusion, and billing inaccuracy and collection inefficiencies—none of which are deemed to be subsidies in this paper—will be included in direct expenditures if they fully or largely cover the losses suffered by energy suppliers. Splitting the budgetary transfers into two categories appearing in Table 1 and Table 2 hardly seems an efficient use of limited resources for tracking subsidies. The usual approach is therefore to present the entire transferred amounts as subsidies. In such cases, it would be good to recognize this point of departure.

Tax expenditures

Tax expenditures take a variety of forms, including tax-rate reductions, allowances, credits, and deferrals (through accelerated depreciation and other means). Special tax-favored organizational structures may also exist, some of which are accessible primarily to firms in the fossil fuel sector. As with so many forms of government support, tax expenditures support targeted sectors, firms, or individuals, and are prone to capture by interest groups. Direct spending can achieve the same outcome as tax expenditures, but unlike direct spending, tax expenditures are almost always deliberated outside of the budgetary framework. The assessment of tax expenditures is hampered by inadequate reporting and accounting practices, particularly in developing countries, but also at the subnational level in developed countries.

In contrast to the scrutiny that government spending is usually subjected to, tax expenditures do not have to be approved by the legislature year after year, and many have no expiration dates. While there are ceilings on direct expenditures, tax expenditures often escape such spending discipline. Kraan (2006) proposes ways of ensuring that off-budget and tax expenditures do not impair the proper functioning of the budget.

Some countries have been compiling tax expenditure reports for years. These include OECD countries that require tax expenditure reports by law, typically annually. Some subnational entities also report tax expenditures on a regular basis. The reports are often annexed to the budget, rather than presented in the budget alongside direct spending programs so that trade-offs can be considered. Of the 10 OECD countries reviewed recently, only Germany was found to present tax expenditures together with outlay subsidies every other year in a subsidy report, attached to the draft budget. The 20 largest tax expenditures of the German central government are presented in the draft budget every year, but these estimations are not integrated with information on spending programs (OECD 2010c).

Tax expenditures are more difficult to estimate than direct expenditures. Because tax expenditures are concessions that fall outside a tax norm, the benchmark rate structure, accounting conventions, and eligible deductions need to be established. Tax expenditure valuation measures the difference in revenue due to deviations from the tax norm. Ex post assessments evaluate forgone revenue and do not consider taxpayers' behavioral responses to eliminating a particular tax break (such as by reducing activity levels or shifting activities to capture other tax breaks). Ex ante assessments more dynamically consider the additional revenue that would accrue from repealing tax expenditures, considering taxpayers' behavioral responses and hence requiring estimation of critical elasticities. Forgone revenue (ex post) calculations are simpler to carry out, and therefore are more common. The OECD (2013a, 33–36) provides an overview of different approaches to defining a tax norm and calculating tax expenditures. A far more detailed treatment—including legal, conceptual, procedural, and measurement issues—is available in OECD (2010c).

In upstream oil and gas, there are significant payments that are technically not taxes. They include royalties, bonuses (of which signature and production bonuses are most common), and production share in countries with production sharing contracts. Fiscal concessions given on these terms should be treated similarly to tax expenditures.

Shifting of risks to government

Market returns depend heavily on how market risks and rewards are allocated among parties in an industry or transaction. Government interventions that shift risks normally absorbed by the private sector on to other parties implicitly boost expected returns from that activity and alter market choices among different options for providing energy services. Various forms of government assumption of risks are detailed in Table A.1.

Among them, contingent liabilities have many similarities to tax expenditures: they are outside the budgetary framework in many developing countries because they require little or no spending at the time of issuance, and are far less scrutinized than direct expenditures. Government credit guarantees,

loan guarantees, government contingent support programs to rescue troubled energy suppliers, and excessive risks taken by SOEs due to soft budget constraints would all fall into this category of intervention. Contingent liabilities generate subsidies in a number of ways. Most visible is when claims are made on the government budget when loans default or insurance claims arise. But even earlier, if contingent liabilities become alarmingly large, the government's sovereign credit rating may fall and its cost of borrowing may increase, with adverse fiscal and financial implications. OECD (2013b) examines various types of contingent liabilities, discusses their potential causes and effects, and outlines some suggested policies to mitigate fiscal risks. Quantification of credit subsidies can be complicated, and is often not performed in the same way across programs or government entities. To establish more rigorous and consistent valuation methods, the Massachusetts Institute of Technology launched the Center for Finance and Policy in October 2014. The Center focuses on governments' role as financial institutions and financial system regulators. Building on work by Lucas (2014), the center will work to improve valuation of sovereign credit support. The OECD plans to include credit subsidies eventually in its inventories; doing so across the 34 OECD countries is expected to increase the resource requirements considerably.

Financial risk transfers through credit markets commonly include government loans, lower interest rates offered by state-owned banks than what the beneficiary firms could obtain in the market, and government purchase or provision of insurance at below-market rates. Often insurance programs hedge against accidents, attacks, natural disasters, and other external events. For example, the government of Chile in 2005 purchased insurance to hedge against diesel price increases on the world market (Bacon and Kojima 2006, 142). Subsidy baselines for loans should be based on market terms and rates for an enterprise of similar risk. It would not be appropriate to look only at loan defaults; there are subsidies even with full repayment because of concessional terms. Similarly, benchmarks based on treasury interest rates tend to reflect much lower default risks than what most energy enterprises receiving sovereign loans or guarantees face, and therefore understate actual credit subsidies. Administrative costs to oversee the credit program also need to be accounted for.

Some forms of government assumption of risks appear under direct expenditures. Examples include government support for orderly closure of mining operations through separation payments and retraining, decommissioning of extractive industry operations in the absence of industry-financed abandonment funds, and emergency cleanup of a major oil spill. Arguably among the least monitored is government assumption of other types of risks that do not incur immediate spending, such as limits on commercial liabilities.

Underpricing of government-owned assets

If government-owned assets are sold or auctioned in a transparent, open, and competitive tender process, even if the payments received appear much lower than initially expected, they are deemed to represent the market's valuation of the assets. Where the process is not transparent, open, or competitive, such conclusions cannot be drawn. This is particularly true where the payments received by the government seem out of line with the value of the asset, if the new asset owner is linked to high-ranking government officials, or both. The loans-for-share scheme in the Russian Federation in 1995–96,

for example, is viewed by many to have lacked competition and effectively resulted in the sales of shares in oil companies at very low prices (Goldman 1999).

These concerns are longstanding, particularly in the upstream oil, gas, and mining sectors where billions of dollars of wealth can transfer hands. It is notable that the Extractive Industries Transparency Initiative (EITI) requires disclosure of information related to the award or transfer of licenses for exploration, development, and production, including a description of the process for transferring or awarding the license; the technical and financial criteria used; information about the recipient(s) of the license that has been transferred or awarded, including consortium members where applicable; and any non-trivial deviations from the applicable legal and regulatory framework governing license transfers and awards. Where licenses are awarded through a bidding process, the government is required to disclose the list of applicants and the bid criteria (EITI 2013). Such disclosure represents international good practice and should be adopted by all governments.

Multi-Country Estimations by International Organizations

The IEA (2014b), IMF (Clements et al. 2013), and OECD (2013a) have carried out some of the most extensive multi-country estimates of government support to fossil fuels in recent years. Depending on the organization, energy source, and the country, various approaches are used—price gap, hidden cost, and inventory. The three organizations cover oil, natural gas, and coal, and the IEA and IMF also cover electricity. The IEA estimates for fossil fuels cover only subsidies at the level of final consumption and measure them through the price-gap approach. Therefore, the IEA's estimation represents very much a lower bound.

The IMF produces two sets of "subsidy" estimations, which it refers to as "pre-tax" and "post-tax." The reference point for the IMF's pre-tax subsidies excludes taxes on consumers, such as fuel excise tax, VAT, and GST. In tabulating its pre-tax subsidies, the IMF combines estimates obtained by price-gap measurements; budgetary and tax expenditure support for producers in OECD countries for petroleum products and coal (mostly using the OECD's data); and hidden costs in the power sector in 40 countries, inclusive of hydropower and nuclear power where they exist (based on a mix of IMF and World Bank sources). As such, the IMF's pre-tax subsidy calculations are not strictly comparable across countries, nor are they confined solely to fossil fuels, although the contribution of energy sources not derived from fossil fuels should be small.

In terms of country coverage, the IMF reports petroleum product subsidies for 176 countries, some of which have been found not to have pre-tax subsidies. The most recent IEA analysis identified 40 countries that subsidized fossil fuel consumption in 2013 based on the IEA's longstanding program of work that monitors energy pricing across the world. The IEA estimates cover subsidies to fossil fuels consumed by end-users (households and businesses) and subsidies to fossil-fuel inputs to electric power generation. The IEA notes that it believes that more than 40 countries had fossil fuel subsidies in 2013, but there was insufficient information available to perform the necessary calculations to confirm their existence with sufficient confidence for inclusion in its publication. The two numbers—176 versus 40—are not directly comparable, in part because types of subsidies covered are different. The numbers of countries covered by the IMF for other types of energy are smaller than 176, and as few as 39 for coal.

The OECD covers its member countries, numbering 34. Of the 40 countries the IEA considers to have subsidized fossil fuels in 2013, the only OECD members were Mexico and the Republic of Korea.

The IEA calculations are based entirely on the price-gap approach, making its subsidy estimations comparable across countries. The IMF, in contrast, uses different methods depending on the country (IMF 2013). For petroleum products, it uses mainly price gap but for OECD countries it also includes the PSE as calculated by the OECD. For electricity in 40 countries, the IMF uses the hidden-cost approach for the entire power sector, inclusive of power not generated from fossil fuels. In addition, the IMF takes the IEA's power subsidy estimations for another 37 countries. As such, the IMF's subsidy estimations are not comparable across countries for oil or electricity, nor are they comparable across different fuels and electricity. In addition, the hidden-cost approach and the PSE include costs or forms of support not considered subsidies in this paper. The OECD states that not everything in its *Inventory* might be considered a subsidy, refrains from identifying subsidies, and generally refrains from aggregating estimations across countries, in part because tax expenditures cannot be directly compared from country to country. The coverage of energy and countries by the three organizations is shown in Table 3.

Table 3 Coverage of energy and countries

Item	IEA	IMF	OECD
Method	Price gap	Price gap and PSE for oil Price gap for natural gas Price gap and budgetary producer support for coal Price gap and hidden cost for electricity	Inventory using PSE-CSE-GSSE framework
Types of energy covered	Oil, gas, coal, electricity	Oil, gas, coal, electricity	Oil, gas, coal
Incidence	Consumer	Consumer for price gap, producer with PSE and hidden costs	Consumer and producer
Countries, number			
Oil	40[a]	176	34
Gas	40 [a]	41	34
Coal	40 [a]	55	34
Electricity	40 [a]	77[b]	NA
Last year for which estimations available	2013	2011	2011
Sub-national subsidies	Limited	Limited	Many
Reporting frequency	Annual	Not fixed[c]	Biennial

Sources: IEA 2014b; Clements et al. 2013; OECD 2013a.
a. Each year the IEA undertakes a global survey to identify countries that subsidize fossil-fuel consumption through reduced end-user prices. The most recent survey identified 40 such countries.
b. Electricity includes electricity not generated from fossil fuels, such as hydropower in several countries and nuclear power in South Africa, among the 40 countries with hidden-cost calculations.
c. Calculations were carried out for 2000–2011 for petroleum products and for 2007–2011 for natural gas and coal. The results are presented by country for 2011.

Assumptions and data sources

Multi-country estimations necessarily require simplification of assumptions that may not be considered in country-specific studies, but they illustrate what approaches and assumptions can be used where data are scarce, which is the situation in some developing countries. For this reason, the assumptions and data sources used by the IEA and IMF, both of which cover many developing countries, are reviewed in some detail.

The IEA's estimations are confined to fossil fuels and are based on observed price gaps. Data collection is extensive. To calculate reference prices, various internal IEA and propriety databases are used for five petroleum products, tanker rates for major international shipping routes and by scale, landed LNG spot prices in different parts of the world, pipeline gas prices, and spot prices of coal of varying quality by location. For example, there are five distinct reference prices for coal in China. Trade-parity prices are used throughout for every fuel. Fuel use in district heating is excluded, because reliable end-user prices are rarely available. Fossil fuels used in power generation are captured under electricity. To ensure that reference electricity prices do not become unrealistically high, costs are capped at those of a new combined-cycle gas turbine plant. To the extent that some isolated or small economies do not have financially viable access to natural gas, this assumption could under-estimate subsidies. All prices are annualized, and price-gap calculations are based on annual averages. Averaging over 12 months reduces potential under- or over-estimations arising from lags in price transmission as identified by the European Central Bank (Meyler 2009). Consumption focuses only on subsidized fuels, which requires disaggregation of consumption by fuel grade and consumer category. Where such information is not available, it is estimated based on available sources such as government or industry reports.

The IMF uses a variety of methods, depending on data availability. Coverage of 176 countries for petroleum products means that some markets have very limited local price data. In some cases, only one local price is available for the entire year. In such cases, that price is taken to be representative of the monthly average price and a price gap is computed by taking the difference with the reference price in that month. However, as mentioned in the discussion of price gap in the methodology section, empirical analysis of the time lag in passing through world price changes in countries with complete price deregulation and vigorous price competition suggests that it is probably more appropriate to introduce a time lag of at least a month (Myler 2009), if not longer. For simplicity, the IMF uses a universal cost of US$0.10/liter for international shipping of petroleum products to a non-OECD importing country. Another US$0.10/liter is added for domestic distribution. For a net importer, a total of US$0.20/liter is therefore added to the FOB price of gasoline, diesel, and kerosene to arrive at their respective reference prices. For a net exporter, the domestic distribution cost of US$0.10/liter is canceled by the assumed savings of US$0.10/liter from not having to take the fuel from consumption centers to exporting ports. As a result, no additional costs are added to the FOB price to arrive at the reference price.

The IMF bases a country's trade status on the sum of crude oil and petroleum products. This means that a major net importer of a specific fuel may be treated as a net exporter, resulting in the reference price being US$0.20/liter lower than it should be. For example, Brunei Darussalam is a net exporter of

petroleum overall, but what it exports is crude oil; because it has no refineries, it imports 100 percent of its petroleum product consumption. The IMF's treatment of petroleum products in OECD countries is entirely different. If an OECD country levies taxes on petroleum products as reported in the IEA's publication series *Energy Prices and Taxes*, it is assumed to have no subsidies, and reference prices are taken as actual end-user prices net of taxes. Subsidies to producers are then taken from producer-support estimations calculated by the OECD. This approach misses the significant consumer price subsidies for petroleum products in Mexico, an OECD country.

Natural gas is the only fuel for which the IMF's method is based only on price-gap measurements. For 37 countries, the results are taken from the IEA. There are four additional countries in the Middle East and North Africa (MENA), for which the IMF calculates subsidies. For these countries, average U.S. export prices published by the U.S. Energy Information Administration (EIA) are taken. For coal, the IMF takes subsidy estimations from the IEA for 39 non-OECD countries, and producer-support estimations from the OECD for another 16 countries. For electricity, the IMF takes the IEA's calculations for 37 countries. For another 40 countries in Sub-Saharan Africa, MENA, and emerging Europe, hidden costs are used, which cover the entire electricity sector and not just electricity generated from fossil fuels. These include countries with hydropower as well as South Africa, which has nuclear power. Diesel consumption appears twice, first under the fuel category and second under electricity subsidies. The effect of this double-counting of diesel fuel subsidies where they exist is assumed to be small on account of the relatively small share of diesel used in power generation in most countries. For 31 out of the 40, the most recent year for which data were available was 2009. They were adjusted to 2011 by assuming that the same percentage of gross domestic product (GDP) had been spent on electricity subsidies in 2011 as in the year of calculation. Because hidden costs in the power sector can change markedly from year to year (Briceño-Garmendia and Shkaratan 2010:15 documents such variation in Kenya), this simplifying assumption could introduce large errors. The assumptions and data sources for the IEA and IMF are summarized in Table 4.

Table 4 Assumptions and data sources for estimations by IEA and IMF

Item	IEA	IMF pre-tax
Exchange rates	Rates as reported by the IMF	Rates as reported by the IMF
Petroleum products		
Type	Gasoline, kerosene, diesel, fuel oil, LPG	Gasoline, kerosene, diesel
Method	Price gap	Price gap for consumers in non-OECD countries, producer support estimates taken from the OECD for its member countries
End-user prices	Data provided by large network of country partners, regional organizations such as OLADE, international organizations such as GIZ and OPEC, and commercial databases	For OECD countries, net-of-tax prices as reported by the IEA, which also serve as reference prices. For other countries, IEA, IMF staff reporting, GIZ's biennial Nov price surveys.
End-user price by location	Regional prices in some countries, such as India; otherwise country average prices	Single price for the entire country except where IEA prices are used

Item	IEA	IMF pre-tax
End-user price data frequency	Monthly in most cases but less frequent in some cases	Varying from monthly to quarterly in MENA and to once a year (typically Dec) in some countries
FOB hub locations	Rotterdam, Singapore, U.S. Gulf, IEA data	U.S. Gulf prices from U.S. EIA for non-OECD countries
Quality adjustment	Adjustment made	No adjustments made (IEA adjustments flow through where IEA values are used)
International shipping	Shipping costs are from Argus, which covers major routes, such as from the Middle East to East Africa and Caribbean to the United States, and takes into account different vessel classes and sizes. For large economies, country-specific costs are available.	US$0.10/liter for non-OECD net-importing countries
Domestic transportation	Assumed to be USUS$0.08/liter for gasoline, diesel, and kerosene in all countries based on data from the U.S. Department of Energy	US$0.10/liter for non-OECD countries. Canceled by US$0.10/liter that would have paid to transport from consumption center to exporting port for net exporters.
LPG bottling	Costs differ by end-use sector. A study was conducted taking data from the United States	Not applicable (LPG not estimated)
Consumption quantities	Consumption by end-users using specific subsidized fuels. Fuels used in power generation are captured under the electricity end-use subsidy calculation.	Economy-wide consumption Diesel fuel used in power generation captured here also
Treatment of tax	Country-specific VAT by fuel and consumer category included in the reference price.	Exclusion of end-user taxes
Net trade status	Country-wide net imports calculated for each fuel	Country-wide net imports calculated for the sum of crude oil and all petroleum products
Time lag for pass through	None. Comparison of annual averages of reference and actual prices	None. Dec reference prices are compared to Dec end user prices in countries where only one set of prices are obtained per year.
Natural gas		
Method	Price gap	Price gap. For 37 countries, IEA subsidy estimates are used after subtracting VAT
End-user prices	Data provided by IEA's network of country partners and commercial databases	IEA data where IEA calculations are used, prices obtained by IMF staff otherwise
End-user price data frequency	Monthly or yearly	Same as IEA where IEA calculations are used, quarterly or yearly otherwise
Reference price data source	Prices from a wide range of commercial sources	Where IEA calculations are not used, U.S. EIA
Hub locations	All key locations. For example, for LNG in Asia, prices for Asia average, China, India, and Rep. of Korea are available.	For 4 countries in MENA not captured by IEA, average U.S. export prices
International shipping costs	Landed costs obtained for many markets, otherwise adjust for distance.	Same as IEA where IEA calculations are used, not considered otherwise

Item	IEA	IMF pre-tax
Pipeline transport costs	Country-specific estimates for some countries, adjusted for distance	Same as IEA where IEA calculations are used, not considered otherwise
Consumption	Natural gas used as feedstock for manufacturing, power generation, or district heating excluded; subsidies for gas used in power generation captured under electricity end-use subsidy calculations	Same as IEA where IEA calculations are used, all domestic consumption with the exception of electricity otherwise
Coal		
Method	Price gap	For all 39 non-OECD countries, price-gap estimations are taken from the IEA after subtracting VAT; PSE for 16 countries taken from OECD
End-user prices	Data provided by IEA's network of country partners and commercial databases	
End-user price data frequency	Monthly where available	
Reference price data source	Spot prices from IEA data and commercial databases	
Hub locations	Large number of locations. For example, there are five prices in China.	
Quality adjustment	Prices already capture quality differences.	
International shipping	Costs for major routes obtained, and then adjusted for distance.	
Domestic transportation	Match costs in individual countries with costs in major markets (Indonesia, Colombia, China, South Africa) and adjust for distances.	
Consumption quantities	Thermal and coking coal; coal used for district heating excluded. Subsidies for coal used in power generation captured under the electricity end-use subsidy calculations	
Electricity		
Method	Price gap	IEA subsidies in 37 countries, hidden cost in 40 countries in SSA, MENA, and a few European countries. For these 40, 2009 was the last year when data were available.
Generation sources	Fossil fuels only	For countries using hidden cost, all sources of electricity included
Local tariffs	Data provided by IEA's network of country partners and commercial databases	For hidden-cost calculations, tariffs from utilities or country authorities
Reference tariffs	Only fuel costs and T&D costs. T&D costs are taken from OECD, US$0.015/kWh for industrial consumers and US$0.04/kWh for residential consumers. To avoid unrealistically high reference prices, costs are capped at those of a new combined cycle gas turbine plant.	For hidden costs, country-specific costs of generation, T&D, under-collections, and losses
Consumption quantities	Consumption by end-user sectors	Consumption of all electricity for hidden cost calculations.

Sources: IEA 2014b; Clements et al. 2013; OECD 2013a; IEA staff; IMF staff.
Note: For more information on the IEA's methodology, see the IEA's website at www.iea.org/publications/worldenergyoutlook/resources/energysubsidies/methodologyforcalculatingsubsidies/;

OLADE = Organización Latinoamericana de Energía (Latin American Energy Organization); OPEC = Organization of Petroleum Exporting Countries.

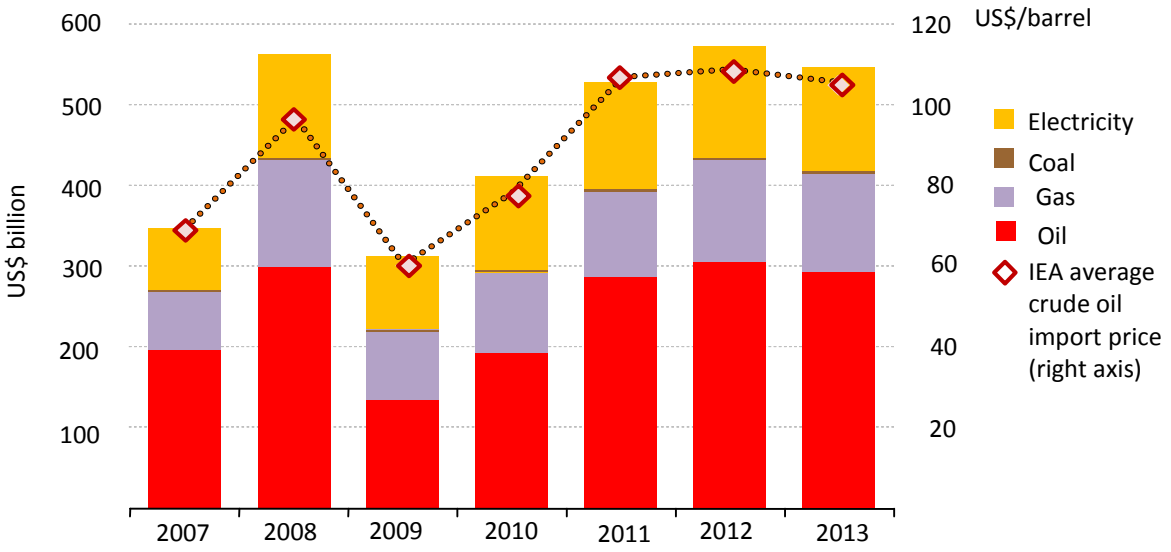
Magnitude of Subsidies

The IEA has been calculating fossil-fuel consumption subsidies annually since 2008 (for 2007). In recent years, the total varied from US$312 billion in 2009 to US$573 billion in 2012, before falling by US$25 billion to US$548 billion in 2013 (Figure 2). Except in 2008 and 2009, more than half of subsidies were for petroleum products. Some fuel subsidies are captured under electricity; this is particularly true for coal, as the power sector is the main outlet market for thermal coal. These estimates represent a lower bound on global subsidies to fossil fuels for two reasons. First, the reliance on the price-gap approach misses a variety of subsidies that flow to producers even if they do not lower the market price of the commodity. Second, for lack of reliable data, the IEA does not evaluate all countries. The total will be higher after the addition of producer subsidies and inclusion of more countries, although the likely scale of increase is not known.

The OECD does not yet capture all subsidy mechanisms, and does not report total OECD-wide support for each year for those that it does capture. Tax expenditures are not comparable and hence not strictly additive. The foreword to the 2013 inventory, which contains subsidy estimates for 2011, mentions that the aggregated value of the individual budgetary measures and tax expenditures provided in OECD countries amounted to between US$55 billion and US$90 billion a year between 2005 and 2011 (OECD 2013a). On average, support for oil and petroleum products far exceeded that for natural gas or coal.

The IMF reports subsidies by country as a percentage share of both government revenue and of GDP. These ratios are presented for each fuel and electricity in 2011, and then aggregated across all the

Figure 2 Fossil-fuel subsidies based on price gap calculated by the IEA



Source: IEA 2014b. Reproduced with permission.
Note: All dollars are nominal.

countries. Pre-tax and post-tax subsidies add up to 0.7 and 2.9 percent of GDP in 2011, or about US$490 billion and US$2 trillion, respectively. Dollar equivalent values are provided in Table 5. The wide range of the IMF estimates underscores the sensitivity to how externalities are quantified. Despite many differences in calculation methods and coverage, the IMF's total for pre-tax subsidies in 2011 is similar to that obtained by the IEA, both in the vicinity of US$500 billion, although there are some differences in the breakdown.

Table 5 IMF energy subsidy estimations for 2011 in nominal U.S. dollars

Type	Petroleum	Natural gas	Coal	Electricity	Total
Pre-tax	220	116	7	150	492
Post-tax	727	376	709	179	1,990

Source: Clements et al. 2013; IMF staff.

Once producer subsidies are included, global fossil fuel subsidies may have been about 1 percent of GPD in the past three years. If oil prices average US$55–75 a barrel in 2015, this figure could fall correspondingly, given the relative weight of oil in total subsidies.

Concluding Remarks

A confluence of factors in recent years has intensified policymakers' attention to measuring and assessing fossil fuel subsidies. Analysis of fuel subsidies can achieve several outcomes:

- **Policy assessment**. The *intended* economic and social outcomes associated with the subsidy policies can be evaluated against the *actual* outcomes. Such findings can help weigh economic effectiveness, efficiency, and equity of the existing subsidy policies against alternative options to achieve the same goals.
- **Decision-making relevance and policy alignment**. Timely availability of data on various forms of subsidies can better inform fiscal, sector, trade, environmental, and other policy making and debates.
- **Efficiency improvement in resource allocation and sector operations.** Redirecting existing subsidies and sending more appropriate price signals can improve resource allocation in the economy, efficiency in the energy sector, and the quality of government spending.

Such assessment begins with a good understanding of the scale of the subsidies, enabled by sustained and comprehensive subsidy tracking.

This paper suggests that the question facing governments with respect to evaluating energy subsidies is not a choice between different methods, but rather how to make the best use of available methodological approaches in order to leverage available data and provide timely and cogent insights on the policy question at hand. If the most pressing issue is how to reform prices, price-gap data are essential. Data needed for price-gap calculations are fairly well-known. It is important to pursue data collection, consolidation, and validation proactively. The price increases needed to eliminate subsidies estimated by the price-gap approach can be used as inputs in partial or general equilibrium models.

Such tools can assess the potential effects of subsidy elimination on economic, welfare, or environmental parameters of concern (OECD 2001; Burniaux and Chateau 2014; www.subsim.org).

Where utilities in power, natural gas, or district heating are financially strapped, it is likely that hidden costs and quasi-fiscal deficits also need to be understood. Some utilities do not have strong books of account, presenting data challenges. Poor record-keeping not only deters quantification of subsidies and hidden costs but, more fundamentally, harms operational efficiency.

At the same time, price gaps or hidden costs alone may miss some large subsidies, such as tax expenditures and off-budget transfers of risk. Unfortunately, systematic accounting for, and reporting of, tax expenditures is rare in developing countries and often sparse at the sub-national level worldwide. Even in OECD countries, integrating tax expenditures with outlay subsidies in the annual budget would be a significant step forward; only Germany seems to come close to achieving such transparency. A fuller picture of subsidies and other forms of government support requires an inventory, which is along the path toward an eventual TSE framework. How different approaches complement each other is described in Table 6.

Table 6 Complementarities and relative strengths of different measurement approaches

Approach	Use	Strengths	Challenges
Price gap	Benchmarking market prices and estimating price subsidies. Essential for pricing reform.	Could be less data-intensive than other methods. Good indicator of pricing distortions.	Ignores distortions that do not affect price levels. Does not capture gross inefficiencies resulting in high prices.
Hidden costs & quasi-fiscal deficits	Benchmarking sector performance, identifying contingent liabilities, identifying areas of operational inefficiencies and scope for cost reduction. Analysis integral to reform in network energy.	Captures areas of inefficiency and malpractice. Policymaking can focus on both subsidy reduction and cost reduction. Good for improving market and corporate governance. Useful even where there are no subsidies as defined in this paper.	Data tend to be less available than for price gap. Local government data, such as for district heating subsidies, are especially challenging to obtain.
Inventory approach	Mapping out all sources of subsidies, and often all measures of support beyond subsidies. Qualitative starting points can be iteratively improved over time.	Integrates transfers with market price support into holistic measurement of support. If a TSE framework is used, policy interactions between producers and consumers can be illustrated.	Most data intensive. Operational inefficiencies are not necessarily captured.

Source: Authors.

Examples of data disclosure for tracking

Tracking of end-user prices is an essential requirement. There are useful examples for liquid fuels in developing countries. Issuing time-series data in spreadsheet format is particularly helpful for analysts.

- The Government of Brazil posts monthly time-series data on retail prices and distribution margins for gasoline, diesel, LPG sold in 13-kilogram cylinders, and automotive CNG, as well as volumes consumed, in spreadsheet format at www.anp.gov.br.
- The Government of Chile has mandated public disclosure of retail prices on its regulator's Web site at www.cne.cl. Retailers are required to enter new prices no earlier than 15 minutes before price changes are implemented. Such price disclosure facilitates calculation of monthly average prices, the time series of which are published in spreadsheet format on the same Web site for different grades of gasoline, diesel, kerosene, and LPG sold in different-size cylinders. Time-series data on price structures are also posted, with negative margins and negative flows to the stabilization fund indicating price subsidies.
- The Government of Ghana posts time-series data on price structures for two types of gasoline, three types of diesel, kerosene, LPG, and residual fuel oil in a single spreadsheet file at www.npa.gov.gh/. Subsidies are immediately apparent from negative taxes. Historical monthly consumption data are also posted.
- The Government of Mexico publishes monthly time-series data and breaks down the price structure for the two grades of gasoline, diesel, heavy fuel oil, and jet fuel in spreadsheet format at http://sie.energia.gob.mx. The price structure shows negative taxes for gasoline and diesel, enabling easy calculation of price subsidies. LPG prices are shown by region but without a price breakdown. Time-series data on monthly consumption of all fuels are also posted.
- The Government of Peru publishes retail prices of different grades of gasoline and diesel, LPG sold in different-size cylinders, automotive CNG, and automotive LPG by retailor with its address at the regulator's Web site (www.osinerg.gob.pe). However, historical prices are not published, making it difficult to track historical trends.
- The Energy Policy and Planning Office in Thailand posts spreadsheet files containing time-series monthly data on ex-refinery prices as well as retail prices in Bangkok for different grades of gasoline and diesel, kerosene, heavy fuel oil, and LPG for different consumers (merged into a single price starting in February 2015) at www.eppo.go.th. Price breakdowns are issued on a daily basis in spreadsheet format, although there is one file per day, making data compilation time-consuming. Weekly and monthly levies for the Oil Fund, which show cross-subsidization, are also published as time-series data in spreadsheet format, as well as the net inflows to the Oil Fund and its balance, making it easy to spot subsidies. Time-series data on monthly consumption are also posted.

Many utilities post natural gas or electricity tariffs for residential consumers on their Web sites. Those for larger consumers are less available, in part because they may be bilaterally negotiated and in part because they depend on more parameters than those for residential consumers. Under these circumstances, robust financial statements by the utilities, important under all circumstances, become all the more important. Submissions for tariff revisions represent another important source of information, although they do not capture input subsidies or other forms of subsidies for costs not covered by the utilities.

Data on tax expenditures, off-budget spending, and shifting of risk burdens are difficult to obtain in many developing countries. In this regard, the OECD's *Inventory* publications contain many useful references for government sources that enable tracking in its member countries. While information on subsidies on fossil fuels or even energy generally is not consolidated in one place, a great deal of information is available in many OECD countries "if you know where to look." For example, the U.S. government's "Analytical Perspectives," which is a budget document, outlines various forms of tax expenditures for fossil fuels in some detail (U.S. Government Printing Office 2015). Some of the documents cited by the OECD can serve as useful guides for developing countries considering more robust subsidy tracking. The Open Budget Survey, coordinated by the International Budget Partnership (www.internationalbudget.org/), reviews budget transparency and accountability in 100 countries based on 125 factual questions answered by independent researchers. The results of the most recent survey in 2012 suggested considerable room for improvement, with only 23 countries deemed to have provided significant information (IBP undated).

In terms of prioritizing limited resources, the first area to focus may be those needed to estimate price gaps, given the repercussions in the rest of the economy from the distortions caused by underpricing energy. For liquid fuels, that means collecting data at each point in the supply chain, and preferably making them available as time-series data as spreadsheets. Showing all taxes and levies, positive or negative, would be especially useful, and such information is entirely under the control of the government. Consolidating such information may require coordination across two or more ministries and government entities—such as finance and petroleum ministries and the national oil company—where the challenge is often more political than funding. For the transmission and distribution of natural gas, electricity, and district heating, strengthening the information collected in revising tariffs may be one way of facilitating subsidy tracking.

Toward a common framework

An eventual goal in subsidy tracking is the application of a comprehensive TSE framework using a common definition of subsidies and standardized accounting methods. In the meantime, an inventory's coverage of subsidies in a given country depends both on its objectives and related activities in other policy areas. For example, a large tax administration program may be tackling transfer pricing (or, more accurately, mispricing), in which case transfer pricing in the energy sector may already be captured in that overall program, although disaggregation by sector may not be straightforward. Multi-country studies face limitations, both in terms of data availability and the need to ensure cross-country comparability. Single-country studies may be tempted to tailor definitions, scope, and approaches to the specific country circumstances and needs. Doing so, however, risks incompatible methodologies clouding the ability to generalize from the results. What is possible and helpful in single-country studies is collection of market-specific data, narrowing errors arising from assumptions made to compensate for missing data.

In agriculture, countries have largely adopted common approaches, making individual studies comparable. This is unfortunately not yet the case in the energy sector. Multi-country calculations on fossil-fuel subsidies carried out in recent years have helped illuminate the strengths and limitations of

different approaches and their usefulness. Efforts by various organizations to collect data and make them publicly available on a regular basis have facilitated subsidy measurement as well as benchmarking of pricing policies with one's peers. At the same time, the pursuit of different approaches has sown confusion among non-specialists.

As Jones and Steenblik (2010) point out, the absence of adoption of international standards for subsidy measurement in part reflects the diverse backgrounds and aims of subsidy-accounting practitioners. Working toward common standards requires a dialogue to reconcile the differences among the various methods used to quantify subsidies. Consensus building in conceptual areas also forces examination of an issue from various angles and can help deepen understanding.

There may be useful lessons from the evolution of corporate financial reporting—accounting is among the most advanced professions in setting international standards. Prompted by globalization, international accounting and auditing standards are now used extensively, including many developing countries. Financial reporting is critical to the efficient functioning of capital markets, just as accurate subsidy tracking is critical to the efficient functioning of the government and the energy market and, depending on the subsidy delivery mechanism, potentially to other sectors in the economy. Both financial and subsidy reporting need to address complex measurement challenges in a transparent and standardized way, and to integrate information from a wide variety of actors operating under many different sets of regulatory and statutory systems. The International Federation of Accountants and the International Accounting Standards Board develop international accounting standards for the public sector and private sector, respectively. Similarly, the International Organization of Supreme Audit Institutions develops and issues international auditing standards for the public sector and the International Federation of Accountants does the same for the private sector. Compliance with international financing reporting requirements is mandatory for some or all companies in a number of developing countries (Cattaneo et al. 2010, 274–275). These organizations have resolved complex issues gradually over time. Some issues are similar to those facing subsidy accounting, such as long-term contingent liabilities, valuing credit guarantees, and reporting of tax benefits.

Learning from other countries that are farther down the road on subsidy tracking helps avoid duplication of efforts and frees up resources to make more rapid progress. Global efforts can also contribute by making data sources and calculations publicly available.

- **Disclosure in user-friendly format**. The OECD makes all values available in spreadsheets for its member countries, and its country reports document all sources. While intellectual property rights may prevent disclosing the details of calculations containing proprietary data, spelling out all data sources, assumptions, and calculation methodologies would go a long way in enabling appropriate interpretation of the results as well as replication. The IMF's public disclosure of the spreadsheet that computes costs of externalities is exemplary from the point of view of transparency and aiding the global research community.
- **Data sharing with regularity**. GIZ's biennial survey of retail gasoline and diesel prices and its monthly newsletters on fuel pricing policy developments around the world are helpful not only because the information itself is useful but also because they are regularly issued and the price data collected are directly comparable across countries and across time. The ideal end goal is

for every government to collect data and make them publicly available, as a growing number of governments are already doing for liquid fuels.

Increasing standardization and pursuing a common approach can leverage the work of individual institutions, broaden data on common metrics, and make more efficient use of limited resources for a shared goal. These benchmarks could help country researchers identify administrative and operational problems, and estimate their financial scale. Where there is already common ground, it would be good to pool resources to make more rapid progress in data collection and analysis. Where comparison is required for policymaking—such as allocation of budgetary transfers to agricultural versus energy subsidies—consistent application of a common approach would be essential.

Appendix

The tables below provide more tables for the entries in Table 1 and Table 2. Effects A, B, and C listed in the third column are those found in the definition of a subsidy in this paper:

A. Reducing the net cost of energy purchased
B. Reducing the cost of production or delivery of fuels, electricity, or heat
C. Increasing revenues retained by resource owners, or suppliers of fuel, electricity, or heat

Table A.1 Subsidy categories, examples, data sources, and ease of evaluation

Sector	Potential concern	Nature of subsidy and subsidy delivery mechanism (effect A, B, or C)	Common data sources and ease of data acquisition	Ease of evaluation if data are available
All sectors				
	Budgetary and off-budget transfers to producers or consumers	1. Transfers of government funds to compensate producers for price controls that keep prices below cost-recovery or trade-parity levels (A), or for producer's inefficiencies (C). Examples include transfers to an oil price fund to keep end-user prices low (A), to a rural electrification fund (A), to utilities to upgrade transmission and distribution lines to reduce technical losses or to make district heating systems more efficient (B, C), to refineries for modernization to produce cleaner fuels (B), and to any energy company to install new capacity (B).	For budgetary transfers, budget as executed, and in its absence, budget as presented; company financial statements; EITI audit reports for upstream production. Off-budget transfers are generally difficult to obtain. The level of disaggregation in the government budget may not be sufficient. Publicly traded companies are more likely to have detailed financial statements, but if numerous companies are involved, such as in the downstream sector, it may become difficult to keep track. District heating is often subsidized by municipalities, making data collection across the country challenging.	For SOEs not operating on commercial principles (for example, an upstream oil company that is not allowed to retain earnings and is funded through the budget), separation of transfers for legitimate business expenditures from support over and above them can be difficult.
		2. Transfers of government funds to enable consumers to purchase specific energy items where the compensation cannot be used for other purposes. Heating degree-days, share of expenditures exceeding a threshold level, and energy price levels (possibly combined with monthly consumption) are examples of factors determining the level of compensation.	For budgetary transfers, budget as executed, and in its absence, budget as presented. Ministry Web sites and press releases. Off-budget transfers to consumers would be rare.	If data are available and disaggregated sufficiently, evaluation is straightforward.

Sector	Potential concern	Nature of subsidy and subsidy delivery mechanism (effect A, B, or C)	Common data sources and ease of data acquisition	Ease of evaluation if data are available
		3. Applied R&D benefiting largely sellers of fossil fuels (B)	Government sources, but level of disaggregation may not be sufficient except for very large grants (such as for demonstration carbon capture and sequestration projects)	Research grant amounts may be easy but financial benefits would be difficult to quantify
	Tax expenditure	4. Reduction of taxes paid. Examples include exemptions or reductions from taxes normally applied, such as VAT (A), tax holidays for petroleum profit tax or corporate income tax (C), and tax credits (C); special rules to accelerate deductions from taxable income (C); and access to special tax-favored corporate forms (C)	Finance ministry; ministry or regulator in charge of the sector; EITI audits for upstream oil, gas, and coal. Costs and revenue data, and all tax terms with and without tax concessions, may be needed. Tax concessions often target specific investments without public disclosure in developing countries. Sub-national tax expenditures are particularly challenging to collect. Where taxes are frequently adjusted, it may be difficult to ensure the accuracy of time-series data.	A good fiscal specialist should be able to compute the loss of government revenue. A significant challenge that requires analyst judgment is the definition of the reference tax structure, which depends on the reference time period and other factors (such as estimation of costs). Tax expenditure estimation can vary, depending on how the reference tax structure is selected.
	Shifting of risk burdens	5. Limits on commercial liability and ability of injured parties to sue for compensation (B)	Government sources for statutory limits. Damage costs covered by government or citizens would require compilation of all such cases, which would be difficult. Information on the ability to sue may be difficult to obtain.	Quantifying the ability to sue would be difficult. Value of liability caps can be estimated by extrapolating from required coverage or comparable liabilities in related sectors.
		6. Government assumption of risks and damages, including assumption of legacy or current HSE problems in violation of regulations and standards, such as environmental damage associated with field abandonment, oil spills, and mine closure (B). Other examples include severance package for employees for mine closure (B), oil price hedging for refineries (B), and insurance against price surges (A)	Government sources. For large remediation projects, the total cost may not become known for a long time, making data collection difficult.	If data are available and disaggregated sufficiently, evaluation is straightforward.
		7. Soft budget constraints for companies with partial or full state ownership, leading to contingent liabilities for government (C)	Government sources and SOE financial statements.	Difficult to quantify across each sub-sector, and virtually impossible where the effect is on the sovereign borrowing rate

Sector	Potential concern	Nature of subsidy and subsidy delivery mechanism (effect A, B, or C)	Common data sources and ease of data acquisition	Ease of evaluation if data are available
		8. Debt cancellations and clearance of arrears, typically for SOEs (C) but can also be for consumers (A)	Government sources; company financial statements.	Relatively straightforward.
	Subsidized inputs	9. Subsidized water, fuel (crude oil for refineries, fuels for power or heat producers), electricity (for energy suppliers other than power), heat (for energy suppliers other than heat), rail freight transport of coal and oil, trucking of refined products (B)	Various government ministries and agencies. If the oil sector is opaque, data on subsidized crude sold to a state-owned refinery may be difficult to obtain.	Difficult to keep track of various sources of subsidized inputs. Quantification may require calculating subsidies in other sectors, such as water and transport.
		10. Underpricing of goods and services provided by government, such as state-owned utilities during privatization and access to land (B)	Various government ministries and agencies. Data difficult to obtain, although a review of leasing or sale procedures may highlight whether subsidies are likely to exist.	May be difficult to quantify market values of some items, such as land
		11. Subsidized loans, guarantees, and other forms of concessional financing or financing support for exploration, development, production, transport, delivery, or export. Examples include support for development of unconventional oil and gas, and setting up filling stations for rural residents or for CNG[2] (B)	Government sources. Total amounts may be available, but disaggregation by sector or sub-sector is not common, making data collection difficult.	Subsidized interest rates and loan terms can be quantified, although assumptions must be made about risk-adjusted market rates for the companies involved. Challenges to quantifying loan guarantees are similar.
		12. Underpricing of permits, such as allowances for carbon or sulfur dioxide in a market with emissions trading (B)	Ministry or regulator in charge of the permits	Relatively straightforward at the market price of the permit, but calculating what the price might have been is not straightforward.
	Cross-border trade restrictions	13. Maintenance of low domestic end-user prices by export restrictions on crude oil, refined products, natural gas, or coal (export ban, export quota, domestic supply obligation, high export tariffs) (A); or of high prices paid to producers enabled by import restrictions (import ban, import quota, high import tariffs) (C)	Ministry of trade, finance ministry, or ministry or regulator in charge; press releases and announcements. Data generally available, but there may be a long time lag for data on quantities sold.	The subsidy value is not tariff x units taxed but the market price support enabled by the tariff. Note that high tariffs represent additional government revenue, not government spending. Estimating the counterfactual may not be straightforward, especially

[2] The government may decide to subsidize establishment of retail outlets for rural residents who might otherwise not be served, or to kick-start establishment of a network of filling stations for CNG—which is much more costly than those for liquid fuels—to promote fuel diversification.

Sector	Potential concern	Nature of subsidy and subsidy delivery mechanism (effect A, B, or C)	Common data sources and ease of data acquisition	Ease of evaluation if data are available
				for fuels sold on long-term contracts.
Upstream oil, gas, and coal				
	Licensing and contract award	14. Overly generous fiscal and other terms offered in contract award (C)	Typically no data except where information is leaked to the media or there is some type of a commission of inquiry	Difficult except where market-tested analogous situations exist, but even so consideration of the impact of geopolitical and other risks unique to the country makes quantification challenging
	Non-tax fiscal concessions	15. Concessions on non-tax fiscal terms, such as production share in production sharing contracts, royalties, and bonuses (C) Note: royalties and bonuses are not taxes.	Finance ministry; ministry or regulator in charge of the sector; EITI audit reports. These concessions tend to be investment-specific and often not disclosed. Sub-national fiscal concessions are particularly challenging.	If royalties and bonuses depend only on gross revenues, production, physical characteristics of fields (such as water depth), or some combination of these, they are relatively easy to calculate.
	Price controls and support	16. Government control of crude oil, gas, or coal prices on the domestic market at levels lower than trade parity (A)	Finance ministry; ministry or regulator in charge of the sector; government announcements; company financial statements. Data on controlled prices generally available. Trade parity prices are more difficult to obtain, especially for gas and coal purchased on long-term contracts. Data on quantities involved may become available with a time lag, which can be long.	Once controlled and trade-parity prices and quantities are known, subsidies are easy to calculate.
		17. Cross-subsidization of domestic downstream end-user subsidies using upstream oil and gas earnings, often from exports[3] (A)	Government sources for end-user prices, and company financial statements for cross-subsidies. Level of disaggregation may not be sufficient to enable estimation.	Benchmark market prices of downstream prices, which are always location- and time-specific, will need to be calculated.

[3] Governments seldom explicitly order upstream companies to subsidize downstream consumers. One exception is India (Kojima 2009, 46–47). The presence of upstream operations in the country, however, is an important consideration in the government's decision, formal or otherwise, to set low domestic fuel prices. See Kojima (2009, 37–38) for the case of Brazil and Bacon and Kojima (2006, 192) for the case of Argentina. Further, these low prices may be "voluntary," as in Argentina and Brazil.

Sector	Potential concern	Nature of subsidy and subsidy delivery mechanism (effect A, B, or C)	Common data sources and ease of data acquisition	Ease of evaluation if data are available
		18. Price support for producers, such as for unconventional gas in a sector with regulated gas prices (for example, where the price of conventional natural gas is low, and government sets a higher price for unconventional gas) (C)	Ministry or regulator in charge of the sector. Usually information readily available.	Quantification is straightforward.
Midstream oil, gas, and coal				
	Pricing policy	19. Regulated transport and storage fees below cost recovery (A)	Fees from asset owners or operators; ministry or regulator in charge. Fees at long-run cost recovery in a sector with growing demand require data to estimate the cost of capacity expansion.	Calculation of long-run cost recovery is likely to require dedicated studies.
		20. Government policy, explicit or implicit, of keeping ex-refinery prices low partially through financial losses suffered by refineries not covered by budgetary transfers (A)	Finance ministry; ministry or regulator in charge; cabinet decision; company financial statements. If the price control is at the ex-refinery level, data may be difficult to obtain. In addition to ex-refinery price levels, the cost of transport to or from ports is needed to derive reference prices from international benchmark prices.	It may be difficult to separate losses from normal business cycles—losses are common especially in refining even in completely deregulated markets—and from producers' lack of competitiveness from those from prices that are set artificially low.
	Purchase mandate	21. Mandate imposed on oil marketing companies to purchase certain quantities from domestic refineries (C)	Ministry or regulator in charge. The text on the mandate is generally available.	Quantification is straightforward if alternative free-market sources also exist.
Downstream oil and coal				
	Pricing policy	22. Price controls at wholesale or retail to keep end-user prices lower than in a competitive market, with losses not covered by government compensation to oil or coal marketers. Variations in government control of prices include cross-subsidies across fuels (such as gasoline sales cross-subsidizing kerosene sales), and differentiation prices for the same product by consumer category or geographical locations. (A)	Finance ministry, or ministry or regulator in charge of controlling price levels. The counterfactual requires largest data collection at the end of the supply chain because of all the costs incurred in the different stages in the chain. Data on transportation and storage may be difficult to obtain.	Because of the large number of suppliers involved, assumptions will have to be made to arrive at reference retail prices. This may not be straightforward where costs vary significantly from location to location.
Network energy – electricity, natural gas, and district heating				

Sector	Potential concern	Nature of subsidy and subsidy delivery mechanism (effect A, B, or C)	Common data sources and ease of data acquisition	Ease of evaluation if data are available
	Access	23. Priority access to the grid, equivalent to a purchase mandate, such as electricity from certain plants to help with their capital cost recovery rather than dispatch based on merit order (C)	Ministry or regulator in charge, and utilities. "Must-run" power plants are usually renewable or nuclear energy but fossil fuel plants (for example in financial trouble) can be among them.	Estimating the utilization factor in the absence of the mandate may require some work.
	Tariff structure and connection charges	24. Tariffs and other charges below cost recovery (A)	Government policies and regulations; ministry or regulator in charge of tariffs and other charges; utilities. Tariffs for residential and other small to medium-size consumers are usually available, but connection charges and tariffs for larger consumers are often not readily available. Long-run recovery costs in an expanding market require data on expansion costs, which requires a study.	Dedicated studies required
		25. Cross-subsidies across consumer categories and geographical regions[4] (A)	Government policies and regulations; ministry or regulator in charge; utilities; specialized studies commissioned. Tariffs are easy to obtain for residential consumers, but for larger consumers they are often bilaterally negotiated and undisclosed.	Dedicated studies required

Source: Authors.
VAT = value added tax; HSE = health, safety, and environment

[4] Cross-subsidization is an important component of an electrification program to achieve universal access (World Bank 2010), one of the three goals of *Sustainable Energy for All*.

Table A.2 Additional issues for consideration

Sector	Potential concern	Issue and potential effect (A, B, or C)	Common data sources and ease of data acquisition	Ease of assessment if data are available
Network energy – electricity, natural gas, and district heating				
	Operational inefficiencies	26. Operational inefficiencies, including excessive technical losses, covered by higher tariffs than otherwise (C), or increasing financial losses harming operation, maintenance, modernization, and capacity expansion	Company reports for technical losses, although in practice it is difficult to separate technical from non-technical losses; benchmarking studies for operational inefficiencies. Difficult where there are significant geographical variations, as with district heating, requiring intensive data collection.	Easy to quantify financial losses from excessive technical losses. Other inefficiencies, such as procurement inefficiencies and over-staffing, likely require dedicated studies.
	Commercial losses[5]	27. Under-billing from commercial malpractice (the most common form of which is collusion between large consumers and utility staff to under-report consumption), absence of metering, or under-metering due to equipment malfunction or meter tampering (A)	Accurate data absent by definition.	Data not available
		28. Theft (A)	Accurate data absent by definition.	Data not available
All sub-sectors				
	Regulatory oversight	29. "Weak" HSE and other regulations that would otherwise require higher expenditures for compliance (B), such as those for abandonment at the end of the operating life of a field, coal mine safety in upstream production, and a delay in tightening fuel specifications that can be met with imports at no additional costs; or inadequate third-party access and other policies that reduce price competition (C). If weak regulations lead to government assumption of liabilities, such spending moves to item 6 in Table A.1.	Regulations in effect generally available on the Web site of the ministry or agency in charge, although old regulations or fine technical details may not be.	Defining benchmark regulations not considered "weak" is highly subjective, because regulations and standards need to consider country circumstances. Large variation across sectors within the same country, infrequent updates, or large gaps in controls between one country and its peers are indications of a problem. HSE regulations attract public attention in cases of gross negligence leading to large publicized damages and hardships,

[5] Consumers who exploit commercial losses pay less than they would otherwise, but these losses in turn may be covered by other consumers through higher tariffs. See Kojima, Bacon, and Trimble (2014, 13) for a brief overview of commercial losses and World Bank (2011) for a detailed discussion.

Sector	Potential concern	Issue and potential effect (A, B, or C)	Common data sources and ease of data acquisition	Ease of assessment if data are available
				but quantifying such damages may still be difficult.
		30. Weak enforcement[6] of HSE and other regulations, such as not monitoring restrictions on gas flaring; failure to fine those found in violation (B); and not monitoring commercial malpractice in the form of fuel adulteration, mislabeling, and short-weighting[7] (C). If weak enforcement leads to government assumption of liabilities, such spending moves to item 6 in Table A.1.	Media reports; investigations by government agencies, parliamentary committees, or other stakeholders. Where enforcement is lacking, so is monitoring, which means statistics on violations are not being systematically collected, making data collection extremely challenging. Compliance with fuel specifications requires fuel analysis by independent laboratories. Accurate data on commercial malpractice are not available by definition.	Quantification as well as attribution of causality difficult. For example, if there is a major coal mine accident killing dozens of miners, it may be difficult to determine if the accident was due to weak HSE regulations or weak enforcement of regulations.
	Underpayments of taxes and other payments due to the government	31. Under-reporting of production or revenues earned by companies (C)	Government sources. Being illegal, these activities are not publicized by those engaged in them, making data collection difficult. Under-reporting of production would require independent measurement.	Quantification may require expertise in tax administration and possibly the application of upstream oil and gas fiscal terms. Quantification of under-reporting of production is straightforward.
		32. Manipulation of transfer pricing, improper applications of fiscal terms, and other measures to reduce payments to government (C)	Government sources; data generally not available, although may surface in litigation or inspector general reviews	Quantification is possible but may require specialized skills in taxation
		33. Under-collection of taxes and other payments, for example due to government's inability to calculate payments due correctly or through company payments going "missing" (C)	Reports dedicated to examining under-collection; EITI audit reports for upstream oil and gas	Dedicated studies needed
		34. Fiscal payment arrears, for example due to financial difficulties arising from price subsidies offered to, or non-payments by, consumers (C)	Data from the tax collection agency; ministry or regulator collecting fees, royalties, and other payments; EITI audit reports	Relatively straightforward

[6] Compliance would likely result in higher production costs, and conversely lack of enforcement would lower production costs to the benefit of producers, especially when selling prices are not linked to production costs, as in the case of oil.

[7] See Kojima and Bacon (2001).

Sector	Potential concern	Issue and potential effect (A, B, or C)	Common data sources and ease of data acquisition	Ease of assessment if data are available
	Under-collection of payments from consumers	35. Late or no payments for fuels or energy services provided due to administrative errors on the part of sellers, or inability to cut off supplies to those who do not pay (A)	Company financial statements; statistics from the regulatory agency or ministry in charge; commissioned studies	Relatively straightforward.
	Shifting of risk burdens	36. Price risks assumed by producers or government in schemes that are intended to be financially neutral, such as price smoothing (C)	Price stabilization fund; ministry or regulator in charge; central bank.	The net outcome depends on the time horizon, but for any given time period quantification should be straightforward.
	R&D	37. Basic R&D	Government budget as executed, or in its absence, budget as presented. The level of disaggregation may not be sufficient to identify spending on basic R&D vs. more applied projects.	Depends on level of disaggregation
	Social protection	38. Unconditional cash transfers and other compensation given to consumers linked to factors such as end-user price increases and household income.	Finance ministry, ministry for social protection, ministry in charge of the sector, press releases. Ease of data collection depends on the government's record keeping and level of disaggregation.	Relatively straightforward. Bottom-up estimation faces the challenge of "ghost" recipients and other problems with identification of beneficiaries.
	Costs of externalities	39. Negative externalities that are neither regulated adequately nor charged for. Examples include greenhouse gas emissions in a market with no emissions trading, carbon tax, or limits on emissions.	Dedicated studies on costs of externalities. IEA and other databases for CO_2 equivalent emissions from fossil fuel combustion.	Dedicated studies generally needed to monetize externalities.

Source: Authors.

HSE =health, safety, and environment

References

Anderson, David L. 1990. "Subsidy measurement problems in new mining project." *New Resources Policy* September 1990: 162–171.

Bacon, Robet, and Masami Kojima. 2006. "Coping with Higher Oil Prices." ESMAP Report 323/06. Washington, DC: World Bank. www.esmap.org/sites/esmap.org/files/FR323-06_GBL_Coping_with_Higher_Oil_Prices.pdf.

BP. 2014. BP-Statistical_Review_of_world_energy_2014_workbook.xlsx for *Statistical Review of World Energy 2014*. www.bp.com/en/global/corporate/about-bp/energy-economics/statistical-review-of-world-energy.html.

Briceño-Garmendia, Ceilia M., and Maria Shkaratan. 2010. "Africa Infrastructure Country Diagnostic Country Report Kenya's Infrastructure: A Continental Perspective." Washington, DC: World Bank. www.infrastructureafrica.org/library/doc/806/kenya-country-report.

Burniaux, Jean-Marc, and Jean Chateau. 2014. "Greenhouse Gases: Mitigation Potential and Economic Efficiency of Phasing-Out Fossil Fuel Subsidies." *International Economics* 140: 71–88.

Cattaneo, Olivier, Michael Engman, Sebastián Sáez, and Robert M. Stern. 2010. Eds. *International Trade in Services: New Trends and Opportunities for Developing Countries*. Washington, DC: World Bank. http://go.worldbank.org/7IJDSX9CI0.

Clements, Benedict J., David Coady, Sanjeev Gupta, Trevor Serge Coleridge Alleyne, and Carlo Sdralevich. Eds. 2013. *Energy Subsidy Reform: Lessons and Implications*. Washington DC: International Monetary Fund.

Coase, Ronald. 1960. "The Problem of Social Cost." *Journal of Law and Economics* 3: 1–44. www2.econ.iastate.edu/classes/tsc220/hallam/Coase.pdf.

Devarajan, Shantayanan, Ricardo Martin, and Sweder van Wijnbergen. 1987. "The Shadow Price of Natural Gas." Discussion paper series (John F. Kennedy School of Government. Energy and Environmental Policy Center), E-87-04.

Ebinger, Jane. 2006. "Measuring Financial Performance in Infrastructure: An Application to Europe and Central Asia." Policy Research Working Paper 3992, World Bank, Washington, DC. http://elibrary.worldbank.org/doi/book/10.1596/1813-9450-3992.

EITI (Extractive Industries Transparency Initiative). 2013. "The EITI Standard." Oslo: EITI International Secretariat. https://eiti.org/document/standard.

G20 (Group of Twenty). 2009. "Leaders statement: The Pittsburgh summit September 24–25 2009." www.g20.org/sites/default/files/g20_resources/library/Pittsburgh_Declaration_0.pdf.

———. 2013. "Methodology for G-20 Voluntary Peer Reviews on Inefficient Fossil Fuel Subsidies That Encourage Wasteful Consumption." ru.g20russia.ru/load/783530379.

Friedman, L.S. 1991. "Energy Utility Pricing."in *Regulatory Choices: A Perspective on Developments in Energy Policy,* edited by Richard Gilbert, 10–62. Berkeley: University of California Press.

GIZ (Gesellschaft für Internationale Zusammenarbeit). 2014. “International Fuel Prices 2012/2013.” Bonn and Eschborn: GIZ. www.giz.de/expertise/downloads/giz2014-en-international-fuel-prices-2013.pdf.

Goldman, Marshall. 1999. “Privatization, Property Rights and Development Potential: Lessons from Poland and Russia.” *Eastern Economic Journal* 25(4): 389–398.

Hollingshead, Ann. 2010. “The Implied Tax Revenue Loss from Trade Mispricing.” Global Financial Integrity. http://gfintegrity.org/storage/gfip/documents/reports/implied%20tax%20revenue%20loss%20report_final.pdf.

IBP (International Budget Partnership). Undated. “Open Budget Survey 2012.” http://internationalbudget.org/what-we-do/open-budget-survey/.

IEA (International Energy Agency). 2014a. “IEA Statistics: Coal Information 2014.” Paris: IEA/OECD.

———. 2014b. *World Energy Outlook 2014*. Paris: OECD/IEA.

India, Ministry of Petroleum and Natural Gas. 2014. “Launch of PAHAL (DBTL) scheme on 1st January 2015 in entire Country.” Press release, December 31. http://pib.nic.in/newsite/PrintRelease.aspx?relid=114245.

Jones, Daryl, and Ronald, Steenblik. Eds. 2010. “Subsidy Estimation: A survey of current practice.” Geneva: Global Subsidies Initiative of the International Institute for Sustainable Development. www.iisd.org/gsi/sites/default/files/sub_manual.pdf.

Kojima, Masami. 2011. “The Role of Liquefied Petroleum Gas in Reducing Energy Poverty.” *Extractive Industries and Development Series* #25, World Bank, Washington, DC. http://siteresources.worldbank.org/INTOGMC/Resources/LPGReportWeb-Masami.pdf.

———. 2013. “Petroleum Product Pricing and Complementary Policies: Experience of 65 Developing Countries since 2009.” World Bank Policy Research Working Paper 6396, World Bank, Washington, DC. http://go.worldbank.org/QBLBPAD200.

Kojima, Masami, and Robert Bacon. 2001. “Abuses in Fuel Markets: How to Protect Consumers and Public Health.” Public Policy for the Private Sector Note 237, World Bank, Washington, DC. http://siteresources.worldbank.org/EXTFINANCIALSECTOR/Resources/282884-1303327122200/237Kojim-831.pdf.

Kojima, Masami, Robert Bacon, and Chris Trimble. 2014. “Political Economy of Power Sector Subsidies: A Review with Reference to Sub-Saharan Africa.” http://documents.worldbank.org/curated/en/2014/07/19804151/political-economy-power-sector-subsidies-review-reference-sub-saharan-africa.

Koplow, Doug. 2009. “Measuring Energy Subsidies Using the Price-Gap Approach: What does it leave out?” Geneva: Global Subsidies Initiative of the International Institute for Sustainable Development. www.iisd.org/pdf/2009/bali_2_copenhagen_ff_subsidies_pricegap.pdf.

———. ‘‘Phasing Out Fossil-Fuel Subsidies in the G20: A Progress Update.” Earth Track Inc. and Oil Change International. www.iisd.org/gsi/sites/default/files/g20lib_oilchange_2012_phasingoutffs.pdf.

Koplow, Doug, and Chris Charles. 2010. Eds. “Mapping the Characteristics of Producer Subsidies: A review of Pilot Country Studies.” Geneva: Global Subsidies Initiative. www.iisd.org/gsi/sites/default/files/mapping_ffs.pdf.

Koplow, Doug and Cynthia Lin. 2012. “A Review of Fossil Fuel Subsidies in Colorado, Kentucky, Louisiana, Oklahoma, and Wyoming.” Cambridge, MA: Earth Track, Inc. http://earthtrack.net/files/uploaded_files/ET_state%20fossil%20fuels_final.pdf.

Kraan, Dirk-Jan. 2006. "Off-budget and Tax Expenditures", *OECD Journal on Budgeting*, 4(1): 121–142. DOI: http://dx.doi.org/10.1787/budget-v4-art6-en

Lucas, Deborah. 2014. “Evaluating the Cost of Government Credit Support: The OECD Context.” Working paper prepared for the Inaugural Conference of the MIT Center for Finance and Policy, September, 12-13, 2014, Cambridge, MA. http://cfpevents.mit.edu/wp-content/uploads/2014/09/EconomicPolicyMFM.pdf.

Meyler, Aidan. 2009. “The Pass Through of Oil Prices into Euro Area Consumer Liquid Fuel Prices in An Environment of High and Volatile Oil Prices.” *Energy Economics* 31: 867–81. doi:0.1016/j.eneco.2009.07.002.

OECD (Organisation for Economic Co-operation and Development). 2001. “Environmental effects of liberalizing fossil fuels trade: Results from the OECD GREEN Model.” Joint Working Party on Trade and Environment, COM/TD/ENV(2000)38/FINAL. www.oecd.org/tad/envtrade/environmentaleffectsofliberalisingfossilfuelstraderesultsfromtheoecdgreenmodel.htm.

———.2010a. “Measuring Support to Energy – Version 1.0.” Background paper for the joint report by IEA, OPEC, OECD, and World Bank, “Analysis of the Scope of Energy Subsidies and Suggestions for the G-20 Initiative.” www.oecd.org/env/45339216.pdf.

———. 2010b. “OECD’s Producer Support Estimate and Related Indicators of Agricultural Support: Concepts, Calculations, Interpretation and Use (The PSE Manual).” www.oecd.org/tad/agricultural-policies/psemanual.htm.

———.2010c. “Tax Expenditures in OECD Countries.” Paris: OECD Publishing.

———.2013a. *Inventory of Estimated Budgetary Support and Tax Expenditures for Fossil Fuels 2013.* Paris: OECD Publishing. http://dx.doi.org/10.1787/9789264187610-en.

———.2013b. “Budgeting for Contingent Liabilities: Discussion Paper.” GOV/PGC/SBO(2013)7.

Pakistan, Planning Commission. 2013. “The Causes and Impacts of the Power Sector Circular Debt in Pakistan.” www.pc.gov.pk/hot%20links/2013/Final_USAID-Pakistan%20Circular%20Debt%20Report-Printed%20Mar%2025,%202013.pdf.

Parry, Ian, Dirk Heine, Eliza Lis, and Shanjun Li. 2014. *Getting Energy Prices Right: From Principle to Practice.* Washington DC: International Monetary Fund.

Saavalainen, Tapio, and Joy ten Berge. 2006. "Quasi Fiscal Deficits and Energy Conditionality in Selected CIS Countries." IMF Working Paper WP/06/43, IMF, Washington DC. www.imf.org/external/pubs/ft/wp/2006/wp0643.pdf.

Steenblik, Ronald. 2002. "Subsidy Measurement and Classification: Developing a Common Framework." Paper presented at the OECD Workshop on Environmentally Harmful Subsidies, Paris, November 7. http://www.oecd.org/site/agrehs/35218605.pdf.

———. 2007. *"A Subsidy Primer."* Geneva: Global Subsidies Initiative. www.iisd.org/gsi/sites/default/files/primer.pdf.

U.S. Government Publishing Office. 2015. "Analytical Perspectives-Budget of the U.S. Government, FY 2016." http://www.whitehouse.gov/sites/default/files/omb/budget/fy2016/assets/budget.pdf.

World Bank. 2010. "Addressing the Electricity Access Gap." Washington, DC. http://siteresources.worldbank.org/EXTESC/Resources/Addressing_the_Electricity_Access_Gap.pdf.

———. 2011. "Reducing Technical and Non-Technical Losses in the Power Sector." http://siteresources.worldbank.org/EXTESC/Resources/Background_paper_Reducing_losses_in_the_power_sector.pdf.

———. 2012. "BLT Temporary Unconditional Cash Transfer: Social Assistance Program and Public Expenditure Review 2." Jakarta. http://documents.worldbank.org/curated/en/2012/02/15893823/bantuan-langsung-tunai-blt-temporary-unconditional-cash-transfer.

———. 2014. "Heat Tariff Reform and Social Impact Mitigation: Recommendations for a Sustainable District Heating Sector in Belarus." Report 89695. www.worldbank.org/en/country/belarus/publication/heat-tariff-reform-and-social-impact-mitigation.

WTO (World Trade Organization). Undated. "Uruguay Round Agreement: Agreement on Subsidies and Countervailing Measures." http://www.wto.org/english/docs_e/legal_e/24-scm_01_e.htm#ArticleI.