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Measuring Energy Subsidies Using the Price-Gap Approach:

What does it leave out?

Doug Koplow

Earth Track, Inc.

August 2009

This paper is a product of IISD's "Bali to Copenhagen" Trade and Climate Change Project.

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1.0 Overview

Despite growing concerns over climate change and energy security, thousands of subsidies to fossil fuel industries worldwide remain in place. While many of these subsidies are the result of decades of policy evolution, the past couple of years have seen a sharp increase in the scale of subsidies related to fossil fuels in many countries. Some of these subsidies were implemented for social reasons such as regional development. Many, however, exist primarily due to successful lobbying by the beneficiary industries. More effectively focusing subsidies and eliminating them where possible would save governments untold billions of dollars. Such reforms are also a logical first step in supporting, rather than impeding, the transformation to cleaner fuels. Despite these benefits, subsidy reforms have rarely been successfully implemented, and continue to face strong political resistance.

A prerequisite for overcoming these political barriers is accurate and timely information on the magnitude and distribution of these environmentally harmful subsidies. Unfortunately, this transparency has been difficult to obtain. Subsidy recipients and their political sponsors benefit more from opacity than clarity, and hence fight even improved reporting and valuation. However, the complexity of the subsidy programs themselves is an important impediment as well. Consider that subsidies are disbursed not only at the national level, but by state or provincial, county and local governments too. At each level of government, many ministries can be involved with the sector, including those responsible for resource extraction, taxation, energy, environment, commerce and agriculture. Finally, multiple mechanisms of value transfer are employed, ranging from relatively visible direct spending programs to much more opaque mechanisms of value transfer, such as special tax rules, credit subsidies and liability caps. The result is a panoply of programs where national-level subsidies alone number in the hundreds for most countries. Multiply this by the scores of nations important in the fossil fuel industries, and the scale of an effort to track worldwide fossil fuel subsidies becomes evident.

Not surprisingly, systematic policy reviews are done infrequently, and are often more descriptive than quantitative. Country-level coverage can be spotty. Those nations with better governance structures often have better data as well, and hence are analyzed with greater frequency and rigor. The challenge is that the biggest subsidies and policy distortions often lie elsewhere, where information is most lacking. When reviews have covered multiple countries at once, analysts have generally resorted to the "price-gap" approach, a technique that estimates the gap or deviation between domestic energy prices and world reference prices. This gap is often presumed to be a proxy for the aggregate impact of the existing set of policies on market prices within the country.[1]

[1] Because prices are a primary driver of economic behavior and change, government policies that change prices are often considered more distortionary than subsidies that do not result in price changes.

A Quick Primer on Subsidy Measurement

Government policies come in many types—from direct cash payments to more complicated market interventions such as tax breaks, subsidized credit or insurance, or targeted rules that make business opportunities more or less profitable for particular sectors of society. The impacts of these policies can flow from government to producers, from government to consumers, or between producers and consumers as a result of policies the government put in place.

Subsidy measurement efforts focus not only on the cost of the supports provided, but how they affect the competitive position of the recipient, and their impact on factors such as social welfare and environmental quality. There are two commonly used measurement approaches:

- Price-gap measurements examine differences between the observed price for a good or service in the economy against what that price "should" be without the government programs. By definition, the price gap does not pick up government programs that support industries or people, but does not change the final price. This can be confusing. However, consider subsidies to domestic oil and gas producers in the United States. This support helps them stay in business if they have older technology or more expensive reserves. It might help them to pay more to drill in certain areas than they could otherwise afford. But the subsidy is not likely to change the market price of heating oil or gasoline, simply because the subsidized producer is a very small player in the global oil market, and what they do has little effect on the bigger flows of fuel.

  These other payments are certainly subsidies, and do affect market behaviour, though not necessarily through changes in consumer prices. Because the price gap does not capture them, estimates using this approach tend to form the lower bound of government support. The price-gap approach *can* pick up the impacts of government policy that either increase or decrease prices. In practice, however, some estimates often reference past evaluations (World Bank, IMF, IEA) that have focused only on countries where fossil fuels were being sold at subsidized rates.

- Transfer measurements quantify the subsidy flows associated with particular government programs, regardless of whether they end up changing fuel prices. This approach can provide much greater resolution the source of subsidies, and picks up not only shifts from governments to producers, but to consumers as well. The transfer approach does not do such a good job picking up the impact of programs that transfer wealth between producers and consumers, as a fuel use mandate might do. For this reason, integrated metrics such as the OECD's producer subsidy equivalent will integrate a residual price-gap evaluation as well.

The price-gap approach is appealing given the complexity of energy policy interventions. Unfortunately, it misses many subsidies entirely. The International Energy Agency, for example, notes that the "price-gap approach establishes **lower bounds** for the impacts of [subsidies] on economic efficiency and trade" (IEA, 1999, p. 73; emphasis added). In addition, it requires a number of important simplifications that can reduce the policy leverage of the results. An alternative are "ground-up" (or "transfer method") evaluations that examine policy interventions to fossil fuels systematically across the country. Though more difficult to complete, transfer-based subsidy evaluations often provide greater resolution on where subsidies are flowing, who benefits and how much particular programs cost in financial and environmental terms. These data are critical when challenging the political coalitions that routinely form to block subsidy reforms. The more granular resolution on policies is also helpful in identifying appropriate entry points for subsidy reform or challenge, and in formulating transitional policies to mitigate economic dislocations on vulnerable groups, should they be needed as policy conditions change.

Section 2 of this paper provides an overview of the price-gap approach, including how it is calculated and a discussion of the strengths and weaknesses of the measure. Section 3 examines price-gap estimates over time, across estimators and relative to the transfer approach. Section 4 evaluates how systematic bias might show up in price-gap results depending on the type of subsidy, the type of fuel subsidized and the geographic characteristics of the country being analyzed. This information is quite useful in narrowing the areas where supplemental research is most valuable, and in ensuring the price-gap results are appropriately used. Finally, Section 5 provides some conclusions and recommendations.

Although the analysis identifies a number of limitations of the price-gap approach, one should not conclude that tracking price gaps in the energy sector is therefore unimportant. The fact that the approach can be implemented globally underscores its value as a basic metric for tracking fossil fuel subsidies in a comparative way to support international policy planning. However, just as no single metric provides all needed information on the performance of a corporation, a mix of measures are needed to properly guide policy analysis and reform for energy subsidies. Cleary, as climate change mitigation strategies cost out in the trillions of dollars, the importance of ensuring that subsidy policies do not work at cross-purposes to these environmental goals, further escalating the costs, should be immediately evident.

2.0 Understanding the Price-Gap Approach

Price-gap studies quantify large deviations in energy prices within a country from world prices of those commodities. While the focus of this paper is on energy subsidies, it is important to remember that the deviations can act as a de facto tax as well. Domestic prices that are higher than global reference prices are indicative of policies that can act as a tax on consumption. In some cases, these surcharges may depress consumption below baseline levels, reducing energy-related environmental concerns. In many cases, however, the above-market prices are actually in place to protect domestic industries (think of corn ethanol in the United States, domestically-produced coal in Europe until the mid-1990s), and may actually generate negative environmental effects despite the higher prices. Where domestic prices are regulated such that they lag behind global prices, as is common for gasoline sales in large oil-producing countries such as Iran and Venezuela, the policies generate transfers to consumers and generally encourage overconsumption (as well as depress export earnings).

The basic formula for calculating price gaps appears straightforward:

Price-gap = Reference Price - End-User Internal Price

The equation compares current internal prices to consumers with the price that theoretical "replacement" supplies of the same energy resource either brought in from the border (for net importers) or delivered to the border (for net exporters) could be supplied at. As discussed below, the application of the formula is a good deal more complex than it first appears. Estimating the world reference price, a representative end-user price and the adjustments needed for moving the fuel to the border can all be complicated; each has its own methodology, and inevitable assumptions and simplifications. Nonetheless, a combination of existing international data sets on energy prices and reasonable assumptions on transport and delivery costs can be used to generate a rough sense of pricing distortions worldwide.

2.1 Benefits of the Price-gap Approach

The primary benefit of the price-gap approach is its relative simplicity compared with other subsidy valuation methods. Rather than having to analyze hundreds of individual energy-related policies in specific countries, analysts can focus instead on market-clearing prices and a handful of adjustments to improve the comparability of the pricing data. This simplification is particularly important in countries that lack the capability or will to provide accurate information on energy-related government activities.

The ability to analyze subsidies to some degree, even without the cooperation of government, should not be understated. In the late 1990s, the IEA developed a survey instrument to track energy subsidies among member countries. Participation was poor, and the quality of information even for those few countries willing to complete the survey instrument was inadequate and inconsistent. A similar experience has plagued the supposedly mandatory reporting of subsidies required by the World Trade Organisation's Agreement on Subsidies and Countervailing Measures. Only in agriculture has a systematic monitoring process been in effect for multiple countries and over extended period of time. OECD's Producer Subsidy Equivalent (PSE) and Consumer Subsidy Equivalent (CSE) metrics went through testing in the late 1970s, and was made mandatory in 1987. (OECD, July 2008: 26). At least the price-gap approach can provide a comparable subsidy metric across a set of countries with widely varying governance structures.

The approach does have some other advantages as well. For example, by providing only information on subsidies that alter end-user prices, price-gap data provide insights into the factors most likely to affect short-term energy supply and demand decisions. The format of price-gap outputs can be fed fairly easily into global macroeconomic models. This enables broader testing of how subsidy reforms might affect energy markets (including inter-fuel substitution), consumer welfare and trade flows.

The ability to quantify important pricing distortions quickly across countries is extremely important, even if the results are not perfect. Ideally, the relative simplicity of the measures should enable international agencies to replicate price-gap data on an annual basis, a data set that would provide a useful benchmark and time trend for policy-makers around the globe. In reality, even the relative simplicity of price-gap approaches has not been sufficient to overcome political or financial barriers; the data are not reported on a regular schedule and often cover only a small subset of countries.

2.2 Price-gap Limitations

While price-gap data should form a recurring data foundation for subsidy analysis, relying solely on this metric would be a mistake. For, despite its simplicity, the price-gap calculations have many limitations that affect both their accuracy and their use. These limitations stem from two separate main sources: challenges in estimating the data inputs needed to calculate an accurate price gap and types of interventions or market effects that are simply not captured by this analytic tool. These are described below.[2]

(1) Measurement challenges reduce the accuracy of price-gap calculations and the ability to track patterns across countries and fuels

[2] Additional detail on policies often missed by price gap approaches can be seen in Steenblik & Coroyannakis (1995) and Steenblik & Wigley (1990).

Accurate price-gap measurements require clean data on world reference prices, domestic taxes and imputed transport costs to move particular fuels to key terminals where they can be substituted for other benchmark fuel sources. All of these elements face measurement challenges.

World reference prices may be lacking. The concept of a world price against which to compare domestic prices is alluring, though not so simple to calculate in practice. While oil is a globally-traded commodity, prices for natural gas and even coal are not as uniform and transparent. Even with oil, adjustments must be made based on the specific type of fuel, as some are easier to refine than others.

The difficulty of establishing pricing benchmarks grows when evaluating commodities that are not as easily traded. Electricity utilities (the primary outlet market for coal) are a good example. Even within national borders, regional pricing disparities have long existed in electricity markets due to a lack of interconnections and balkanized market regulations. Electricity trade across large natural barriers such as oceans does not exist at all. While deregulation has reduced intra-national variation in wholesale electricity rates, there is no global reference price. Instead, price-gap evaluations have generally used long-run marginal cost (LRMC) estimates as a proxy.[3] The assumption has been that the alternative supply would come via new construction rather than global trade. A similar situation applies to natural gas in parts of the world where fields are "stranded," lacking pipelines or Liquid Natural Gas (LNG) conversion facilities that would enable real trade.

Pegging the cost of new capacity in advance is never easy for complicated and expensive capital projects. However, the recent volatility in commodity prices (raw materials are a significant factor in the construction cost of all utilities) and dysfunctional credit markets suggest developing accurate values for LRMC will be more challenging now than ever.

Global prices themselves may be affected by subsidies or other distortions. In some cases, even the global price for a commodity may be distorted. Oil prices, for example, can be driven up by the supply cartel or artificially lowered due to very large expenditures by world powers on oil security. Rising concentration in Russian natural gas holdings suggest that similar pricing distortions could arise in that market as well.

Other fuels are subsidized in similar ways all over the world such that any observed reference price would actually be a subsidized one. Liability caps and socialization of nuclear waste management, for example, apply in virtually every country producing electricity from nuclear fission. A similar issue applies to benchmarks based on the LRMC of new infrastructure. It is difficult to evaluate exactly

[3] Long-run marginal cost is the estimated cost to bring a new unit of supply onto the market. A long-run perspective is used because in the short-run existing contracts, factories or other conditions limit one's ability to enter or exit a market. The metric is used in price-gap calculations where alternative sources of supply are unable to enter a domestic market via trade.

what cost attributes these numbers include, whether they have been produced from government or private engineering estimates, or by benchmarking the delivered cost of infrastructure in nearby countries. In all cases, the values may well include some level of embedded subsidies, though back-calculating the actual magnitudes can be difficult or impossible in many parts of the world.

Adjustments to border prices can be challenging. World prices are not the same thing as delivered prices, but must be adjusted by the cost to move fuel to export markets (for net exporters) or to the point of consumption (for net importers) in order to accurately measure the cost of substitute supply. These adjustments require assumptions and estimates that generally reduce the accuracy of the resultant price-gap calculations.[4]

The quality of information on transport margins varies widely across countries, and is especially challenging where short-term options for export do not exist, as with stranded natural gas. The assumptions used are not always easily discerned in published price-gap reports, and the degree of uncertainty or variance for the adjustments is likely to differ both by fuel and geographic location.

A few approaches seem to have been used in past energy price-gap studies to make these adjustments:[5]

- Examining the differences between import and export values in countries with efficient transportation networks (e.g., for coal in Koplow, 1998).
- Using the delivered price of a fuel in an efficient market as the benchmark (e.g, for oil in Rajkumar, 1996).
- Using published studies and expert input on transport and distribution costs for an efficient network (e.g., natural gas in Rajkumar, 1996). The IEA has also made adjustments for transport costs. An example calculation for China (IEA, 1999, p. 78; detailing the approach used in IEA 2006 and 2008 as well) suggests they may have used country-specific market information to make these adjustments; however, this has not been verified.

In all cases, these decisions represent simplifications. A single value per distance travelled (or the average of a handful of values) was estimated for each fuel type. That point estimate was then

[4] The exact adjustments required vary by circumstance. For net importers, both long-distance transport costs and intra-city delivery charges are included to assess the delivered price. For net exporters, a seller interested in diverting exports to the domestic market would incur local delivery charges, but would avoid the distribution costs to move fuels to the point of export. See Koplow (1998).

[5]Similar types of issues also arise in other areas of economic activity—for example, setting regulated tariffs for natural gas or electricity transmission and distribution or for conditional loan terms with IMF lending agreements (e.g., raising prices to reflect costs). The experience in these areas can be useful in refining price-gap calculations. The precision and level of effort for rate-setting in utility districts normally exceeds that available for country-wide price-gap evaluations. In addition, similar distortions in incentives can arise with rate-setting, where a focus on achieving a specific level of gross revenues to cover costs can introduce a range of cross-subsidies.

applied to all of the countries in the analysis. Unit costs were assumed to be level regardless of how far the particular volume of fuel had to travel to its outlet, or the terrain it had to cross. As noted by the World Bank (Rajkumar, 1996), the logic of these point estimates is that they were a reasonable proxy for what an efficient infrastructure should cost, and that, in many countries, poor government policies were the cause for the lack of existing infrastructure to begin with (Koplow, 1998). In reality, even countries with sound transport infrastructure would likely see some substantial variation in costs—not only based on the type of terrain, but also on the size of the deposit since there are economies of scale bulk fuel transport, especially via pipeline.

Use of net-of-tax values for internal prices may not always be appropriate. Standard price-gap calculations done by the World Bank have adjusted the end-user internal price value by subtracting taxes. The goal was to focus the measurement on non-tax interventions only, under the assumption that the same taxes will be levied on a fuel regardless of where it comes from. As a result, the tax policy would not affect the absolute size of the price-gap.

The IEA (1999, p. 81) seems to have taken a somewhat different approach, noting that a "normal" level of taxation reflects the cost of doing business in a particular country, and should therefore be included in the domestic price of a fuel. An additional benefit of this approach is that tax expenditures would then be visible within the standard price-gap calculations. To estimate this normal rate, the IEA included value added tax (VAT) within the price where household and transport consumption were concerned. They excluded them for industry and power sectors, arguing that tax exempt production was the norm for these segments.

Reality is even more complicated than it is presented in the IEA discussion. Many "taxes" on energy are really user fees, with collections linked to remediation or amelioration of a problem related to the fuel being taxed, or linked to building or maintaining infrastructure directly related to that fuel. Examples include leaking underground fuel tanks, oil spills, abandoned mine or well funds and highway construction and maintenance. In these circumstances, there is a strong argument to treat the taxes as an element of the cost structure for the fuel, rather than as a fiscal charge to be netted from the domestic price.

Again, the impact of this simplification on estimates by fuel type or by country is difficult to predict in advance. Most countries tax different fuels at different rates internally. Variation across countries—and across levels of government within a country—further complicate the adjustments. Finally, the proportion of government tax burden associated with energy-related uses (i.e., the user fee portion of total taxes) is likely to be larger for coal and oil than for natural gas. Thus, adjustments to the calculation of internal prices will not affect all fossil fuels equally.

(2) Transfers that do not affect prices do affect policy reform strategies, fiscal cost and domestic environmental impacts

As noted above, the ability to isolate subsidy impacts on pricing via the price-gap approach can be helpful in terms of integration with macro-economic models and in tracking short-term distortions in market behaviour. However, the many transfers that the price-gap misses because they do not affect energy prices to consumers are also quite important from a fiscal, environmental and policy reform perspective.

Fiscal impacts. Because the price-gap measures are only the net impact of policies on prices, the large cost of transfers that leak to other factors of production, but do not influence market-clearing prices at a particular point in time, are ignored. These subsidies can be enormously expensive for governments. Sometimes the mechanics of the price-gap formula actually create subsidy "blind spots." Oil in the United States is a good example: the reference price is defined as the U.S. market price, resulting in a zero price-gap. Yet past fuel-specific studies have documented oil benefits from many large and important subsidies in the U.S. Being able to quantify the full magnitude of subsidy transfers is important not only in ensuring that limited financial resources are well deployed, but in highlighting the savings to taxpayers from subsidy reform—a key building block in their engagement to challenge subsidy policies.

Political economy. Price-gap metrics apply broadly to a specific fuel, country, and sometimes, sector (e.g., power, commercial). However, the calculation does not attribute portions of the observed pricing distortion to specific programs, or link the subsidy programs to named beneficiaries. As a result, price-gap studies do not provide the type of detailed financial and attributive data that is normally needed to challenge entrenched political coalitions, often a prerequisite for reforming specific subsidy programs.

Supply composition. Subsidies that "leak" to other parties without affecting equilibrium prices often prop up uneconomic suppliers. Unfortunately, these uneconomic suppliers are often energy resources with good political connections rather than the best firms. At present, the entrenched interests in energy markets tend to be older, generally conventional, energy producers rather than firms involved with renewable energy or demand-side reduction strategies. Government-owned energy enterprises are surprisingly large beneficiaries of government financial subsidies in many countries, reducing the pressure on governments to more effectively deploy public capital. Ironically, the net result is that the subsidies can actually create competitive barriers to emerging, cleaner industries, and entrench older, more polluting resources.

Local price variation, cross-subsidies and differentiated products. As described above, price-gap calculations generally rely on average values. This averaging occurs across time (a single value for a year with widely fluctuating prices), regions (market access costs and subsidies can vary significantly by region of a country) and by product delivered (for example, a standard unit of electricity with no differentiation of peak versus baseload).

It is the variation in markets that matters most for new technologies and business models, however. In large, homogenous energy markets, economies of scale become increasingly important, benefitting large, baseload players. In reality, energy markets contain a variety of market niches that are often hidden by cross-subsidies in the current power sector. Within those niches, a greater diversity of price and performance options can survive, providing critical entry points for new technologies and business models. From this foothold, the entrants can gain market experience, and slowly expand to take on the more entrenched market segments. For example, local price variation is what drives the ability to use distributed generation, either to avoid the capital cost of grid extensions to low-density areas, or to bypass grid congestion points. To the extent that intermittent renewables can serve remote or peak market niches, they can be competitive at much higher price points. Unfortunately, the averaging inherent in the price-gap approach makes the distortionary impact of subsidies on market variation very difficult to see.

Price variation is a normal element of all markets. With competitive markets, this variation can open up opportunities for arbitrage—basically, intermediaries taking advantage of these differences to earn a profit. This arbitrage tends to eliminate inefficient price variation fairly quickly. In regulated markets, prices may be set by regulators at a level to ensure adequate revenue generation. While there are attempts to segment types of users, and to charge each different prices depending on their relative cost of service, these models tend to be imprecise. As a result, cross-subsidies can remain for extended periods of time.

(3) Price-gap metrics do not fully capture the effects of subsidies on marginal investment decisions

Governments around the world grapple with how to transition their economies onto a new energy path that properly incorporates concerns over climate change, energy security and other factors. Because even energy-related capital wears out, the longer-term trajectory of this energy path will be driven primarily by the new investments the country makes over the coming decades. These investment choices, in turn, will be driven by the economics and related government subsidies for new, marginal capacity. Unless subsidy evaluations capture the policy distortions associated with these new investment decisions, they may miss important patterns of support—such as those for coal—that can slow the speed of desired energy transitions.

By definition, price-gap metrics quantify distortions in current energy prices. This information is quite important, as the existing pricing anomalies provide clues as to what type of investments might become economic (or uneconomic) were existing policies to be modified. However, recent years have seen a global surge of increasingly large subsidy programs. Most of these programs have yet to be taken up by the energy sector in the form of installed capacity. As a result, the price-gap evaluations entirely miss the influence that these newer policies have on marginal investment by altering the competitive framework for new research, investment and infrastructure development.

To be fair, this can also be a problem with the measurement of other transfers, if the evaluators examine only existing subsidy uptake.[6] It is important for all subsidy evaluations to add a marginal investment scenario to capture the benefits of in-place policies on a new construction project even if these subsidies have not been (or cannot be) adopted by existing plants.

Because energy capital is long-lived, and the future energy path of the economy is driven by the incentives to new construction, subsidy evaluations that ignore these policies will miss perhaps the most important issues. Some examples demonstrate this point:

- *Cap-and-trade rules.* Many policy formulations relating to carbon constraints offer initial grants of emissions rights to incumbents, or earmark spending from permit sales to flow back to incumbent energy sectors. The dollars are immense: The value of these windfalls under the Lieberman-Warner proposal last year in the United States is estimated at more than $2 trillion over the next few decades (McMahon & Pica, 2008).
- *Liability transfer on carbon capture and sequestration (CCS).* The coal industry will need to figure out a way to reduce carbon emissions per unit energy produced, and CCS is expected to be a key strategy. Government subsidies are now flowing through funding, tax credits and even the transfer of liability for CCS projects onto taxpayers. These programs will affect the economics of new construction in material ways, but as of yet are barely showing up in any subsidy calculations.
- *Loan guarantees.* Capital risk for baseload power is quite large, particularly in the "clean coal" and nuclear segments. Loan guarantees are being introduced around the world, with plans to support hundreds of billions of dollars of project spending. A government-owned "energy bank" is also being proposed in the United States, and will operate in a similar manner to the loan guarantees by subsidizing credit for new energy capacity. These programs normally include eligibility for emerging energy resources as well. Nonetheless, a combination of facility scale and political sophistication suggest that the largest beneficiaries will be large-scale conventional energy resources, albeit perhaps in slightly new formats such as

[6] This is an important limitation of the US Energy Information Administration's evaluations of energy subsidies within the United States (the most recent of which was released as *Federal Financial Interventions and Subsidies in Energy Markets* in April 2008).

"advanced" nuclear reactors or "clean coal." In addition, if history is a useful guide, the allocation of this support is likely to be based as much on political considerations as technical merit or market feasibility alone.

2.3 Patterns in Price-gap Estimates

To further demonstrate the importance of relying on multiple approaches to measuring energy subsidies, this section evaluates a number of examples where energy subsidies have been quantified using both a transfer and a price-gap approach. Moving beyond the theoretical discussion of subsidies missed by the price-gap approach to real numbers is helpful. Table 1 maps price-gap values for 2005 and 2007 as calculated by the IEA. The sharp increases in values within only two years demonstrate how sensitive the measure is to shifts in world reference prices for key fuels.

The data also suggest that most of the price-gap distortions are linked to oil products. However, it is useful to ask where this pattern might also be associated with the greater difficulty in measuring appropriate price-gap values for the other, less well-traded sectors. Across this sample of countries, for example, price-gaps related to coal comprise only 0.7 per cent of total price-gap subsidies in 2007 (down from roughly 4.5 per cent in 2005), even though coal fed half of the electricity generated in the developing world in 2007. This level, in part, reflects the broader consumption of oil products (in transport), and perhaps the embedding of coal-related supports in the electricity price-gap values produced by the IEA. However, measurement challenges may be an additional factor, and all of the factors together may result in insufficient attention being paid to coal-market reforms. Given the fuel's carbon intensity, this would not be a satisfactory outcome.

Table 1: Price-gap Sensitive to Shifts in World Energy Prices (in billions of current USD unless otherwise noted)

Country	Oil products			Natural Gas			Total		
	2005	2007	% Change	2005	2007	% Change	2005	2007	% Change
Argentina	0.9	4.6	418%	4.2	4.7	12%	6.6	9.4	43%
Brazil	n/a	1.2	n/a	-	-	n/a	-	1.2	n/a
China	6.7	24.2	259%	3.9	2.0	-48%	25.0	38.5	54%
Chinese Taipei	n/a	0.5	n/a	-	0.1	n/a	-	1.7	n/a
Egypt	9.2	11.6	27%	1.2	1.3	9%	12.2	15.7	29%
India	7.0	13.3	89%	2.1	2.4	15%	19.2	23.4	22%
Indonesia	14.1	14.8	5%	0.0	0.0	-45%	16.1	17.2	7%
Iran	24.4	35.8	47%	9.4	15.9	69%	36.6	56.3	54%
Kazakhstan	1.2	1.5	27%	3.6	5.2	44%	6.8	8.6	26%
Malaysia	3.2	6.8	112%	-	-	0%	3.5	7.3	106%
Nigeria	1.5	1.8	19%	-	-	0%	1.9	2.5	32%
Pakistan	1.7	1.9	14%	2.7	5.3	94%	4.4	8.3	89%
Russia	0.2	1.3	522%	25.4	29.6	17%	40.4	51.0	26%
Saudi Arabia	10.1	17.0	69%	4.3	-	-100%	19.7	25.2	28%
South Africa	0.0	0.4	6675%	-	-	0%	3.9	8.8	128%
Thailand	1.7	1.9	7%	0.5	0.3	-36%	3.4	3.0	-12%
Ukraine	0.3	-	-100%	12.4	10.6	-14%	15.4	15.2	-1%
Venezuela	8.1	14.5	79%	-	0.5	n/a	9.2	17.8	93%
Vietnam	0.6	0.5	-13%	-	-	0%	1.2	1.7	44%
Total	91.0	153.7	69%	69.6	78.0	12%	225.5	312.8	39%
% Shares	40.4%	49.1%	21.7%	30.9%	24.9%	-19.3%	100.0%	100.0%	0.0%

Sources: International Energy Agency, World Energy Outlook, 2006 and 2008.

What about the consistency in price-gap values for a given fuel and year, but calculated by a different organization? Given the assumptions and estimations required with regard to transport, distribution, fuel type normalization (e.g., to equalize heat rates or ease of refining) and treatment of taxes, value differentials are to be expected. While there are only a handful of countries where more than one estimate exists for the same year, these examples demonstrate that consistency in the methodology and data inputs may not yet be where they should be if the price-gap approach is to be relied upon worldwide.

Table 2 presents price-gap values for oil products in 2007—one produced by the IEA, the other by the IMF. Even beyond adjustments to the price-gap formula elements themselves, a host of reasons could be driving the results, from slightly different time frames, measurement errors and conversion inaccuracies (e.g., regarding GDP values used in this paper). As price-gap calculations become more regular, the various parties producing the estimates should endeavour to make input assumptions more transparent, and to flag and explain variances in assumptions or approaches.

Table 2: Price Gap Estimates: Differences Across Analysts, 2005 Values for Oil Products (Billions of current USD)

Country	IEA	IMF
Argentina	0.9	-
Egypt	9.2	3.8
Indonesia	14.1	11.6
Nigeria	1.5	2.2
Pakistan	1.7	0.2

Sources and Notes:
(1) International Energy Agency, World Energy Outlook 2006
(2) Baig, Mati, Coady, and Ntamatungiro (2007)
(3) Data in IMF paper converted from subsidies as % of GDP to billions of dollars using GDP data from the International Monetary Fund's World Economic Outlook Database, April 2006 version

Finally, Table 3 examines quantified results from price-gap measures and studies of total transfers. This table is illustrative only; there are likely additional data sets that could be normalized and compared should IISD desire to do so.

Finding quantified data for exactly the same geographic area, fuel and year for both subsidy measures is difficult to do. As a result, the comparisons are not always exact. Nonetheless, the key conclusion is that price-gap values alone tend to be far below total transfers—even when considering a narrower range of fuels or geography than for the price gap.

Subsidies within the OECD are illustrative. The IEA notes that consumer subsidies are negligible within the OECD. However, even excluding credit subsidies, Koplow (2007) pegs U.S. energy subsidies at roughly USD$75 billion per year. IEA statistics on energy R&D show spending of more than USD$12 billion per year (a portion of which is from the United States). EU state aid to the coal sector, though down sharply from years past, still topped USD$4 billion in 2007. Clearly, there is much here that distorts energy choice, greenhouse gas emissions and trade patterns that the measurement of market transfers simply does not pick up.

The IEA's analysis of price-gap subsidies has primarily focused on non-OECD countries, for which there are limited transfer evaluations to serve as a comparison. However, Table 3 shows the small portion of price-gap subsidies linked to coal, relative to the large role coal plays in the electricity sectors of this part of the world. It is very likely that government financial transfers to coal are much greater than what it being shown here. A similar pattern likely applies even within the OECD, as illustrated by the last section of Table 3. Historically, subsidies per tonne of coal produced in key OECD countries were much lower using the price-gap approach then when calculated with the detailed producer subsidy equivalent method by OECD.

Table 3: Subsidy Value Estimates Using Price-Gap Method Far Below Estimates Using Transfer Approaches

	Price Gap *Billions of USD*	**Government Financial Transfers** *Billions of USD*		**Data Year, Coverage**	**Sources and Notes**
I. OECD	neglible				(1)
R&D Subsidies		12.0		2007	(2)
EU State Aid Budget, coal sector		4.3		2007	(3), (4)
US Energy		75.0		2007	(5)
II. Coal in non-OECD countries					
Coal, price gap	2.3			2007, 19 significant energy countries	(1)
Electricity, price gap	78.8			2007, 19 significant energy countries	(1)
Coal share of Electricity in non-OECD world	50.4%			2006	(6)
III. Historical data, price gap vs. PSE (1996$)	**Price Gap, 1996** $/tonne	**PSE, 1995** $/tonne	**PSE, 1996** $/tonne		
Germany	-93.5	119.7	116.3	1995, 1996	(7), (8)
Japan	2.2	149	no data	1995, 1996	(7), (8)
Spain	no data	57.6	72.3	1995, 1996	(7), (8)
United Kingdom	2.2	3.4	no data	1995, 1996	(7), (8)

Notes and Sources:

(1) IEA noted that "Consumption subsidies are minimal in OECD countries." (IEA, 2008: 62).
(2) IEA (2009).
(3) European Commission (2007).
(4) Euro converted to USD using annual average exchange rates from US Federal Reserve Publication G.5A, released January 2, 2009.
(5) Koplow (2007).
(6) Coal share of generation in 2006 for the non-OECD was actually much higher than for inside the OECD (IEA 2008: 523).
(7) Koplow (1998).
(8) IEA (1997).

2.4 Exploring Potential Systematic Bias in Price-gap Results

Because price-gap evaluations are the most common approach used to evaluate energy subsidies across multiple countries, it is important to understand whether the metric generates any systematic bias in what it captures or misses. This information can help ensure that price-gap results are used appropriately; and that situations where it may greatly understate the subsidy problem can be more effectively highlighted.

To better understand these potential issues, this section examines the price-gap approach from three different perspectives: subsidy patterns by intervention type; subsidy patterns by fuel; and subsidy patterns by geography. Subsequent sections evaluate the potential variance in greater detail. Is variance proportional across fuel sources, so that price-gap patterns are accurate even if the magnitudes are not? Or, are there certain types of policies or fuels for which the total transfers are more likely to be understated than others? Section 2.4.1 evaluates this question in reference to intervention types; Section 2.4.2 in reference to fuel type; and Section 2.4.3 in relation to geography.

2.4.1 Does price-gap systematically miss certain types of policy interventions?

Table 4 summarizes the main subsidy transfer mechanisms used by governments around the world to subsidize energy. Criteria assessed include how well the price-gap metric captures each type of subsidy, and the circumstances under which subsidy values will be under- or overstated. A number of important conclusions are evident:

- The type of bias likely to arise from price-gap calculations is not the same across all types of interventions.
- Subsidies to extractive fuels with relatively transparent world prices, such as oil and coal, are likely to be greatly understated in countries with poor governance systems. This is because resources will likely be sold at world prices even if much of the domestic value is diverted away from the government.
- Government support to pre-commercialization activities or post-closure cleanups is unlikely to be well characterized relying solely on price-gap methods, regardless of the subsidy mechanism used.
- Credit and insurance subsidies tend to enable higher risk producers to remain viable in the market rather than depressing market prices for the produced commodities. These types of interventions will not be well captured by the price-gap approach.

Table 4: Capture of Subsidy in Price-Gap Metric Varies by Type of Intervention

Transfer Mechanism	Capture in Price-Gap Metric	Potential Bias
Access to public natural resources	Partial at best. Profit maximizing firms will sell resources at world market price regardless of acquisition costs, pocketing the savings. Some pickup through artificially high volumes of sale, as country liquidates its resource base more quickly than would otherwise have occurred.	Understates subsidies in countries with higher levels of corruption. Affects extractive energy resources (primarily oil, gas, coal, uranium; potential impacts with hydro-electricity and geothermal power as well).
Cross-subsidies	-May capture cross-subsidies between energy and other sectors (e.g., hydro-electricity dams taxing electricity sales to subsidize irrigation). -Capture of cross-subsidies across generating technologies will depend on whether prices to customers from their utilities reflect a blended rate or not or if the marginal supply is subsidized. -Will not pick up cross-subsidies based on type of customer, location of generation, or peak vs. non-peak.	-Hides high-cost portions of the market where newer technologies could gain a foothold. -Where cross-subsidies exist within government-owned power utilities, data resolution may be insufficient to identify which types of generators are being subsidized. -A similar problem may exist in the rate of return regulation for investor-owned utilities. If delivered electricity prices from a utility represent a blended rate of multiple generating resources, fuel-specific subsidies or cost drivers will not be observed.
Direct spending	Captured only to the extent the spending reduces delivered market prices.	Much spending props up emerging or uncompetitive resources. A price-gap will not capture this.
Government ownership	Will capture price disparities relative to other non-government owned energy resources. However, in many countries, these enterprises provide funds to support the ruling party, and books of account are by design opaque or missing.	-Poor information tends to be a larger problem with globally-traded extractive industries such as oil. -State ownership of gas and electric utilities is also common, with similar potential pressures to mask accounts. and institute cross-subsidies. Since not as often globally traded, patronage is often done between regions or groups of citizens (e.g., farmers versus city-dwellers). -Even where some accounting exists, most of these enterprises do not properly account for their subsidized access to capital, tax-exempt status, low or absent required return rate, or cost of working capital when benchmarking their services. To the extent that proper accounting would make them uneconomic with other providers, these transfers will not be picked up in a price-gap.
Import/export restrictions	Well captured.	Price distortions are the main economic impacts of these of interventions. Price-gap metrics therefore capture them well.

Transfer Mechanism	Capture in Price-Gap Metric	Potential Bias
Information and services provided by governments	Not well captured. As with government-owned enterprises, these indirect service providers benefit large swaths of the energy industry (e.g., via infrastructure construction and maintenance for key bulk energy shipping routes), but are often poorly costed.	Indirect effects on cost structures benefit many energy producers at the same time, often through the transmission and distribution (T&D) costs used as adjustment factors in the price-gap approach. Impact on price-gap calculations will vary depending on the local circumstances. Historically, most of this support has benefitted bulk energy commodities (oil and coal, nuclear power).
Lending (loan and loan guarantees)	Lending subsidies primarily affect the mix of supply that can be brought to market by underwriting the capital costs and default risk of more risky technologies. They are often used to influence marginal investment decisions, and unlikely to be well captured in price-gap calculations.	-Credit subsidies are most valuable to the highest risk, largest capital energy enterprises. These tend to be nuclear, coal and baseload infrastructure in higher risk parts of the world. Large pipelines and dams are also regular recipients; cellulosic ethanol has been a growing recipient in recent years. -Credit subsidies may involve both domestic industry and support for exports. However, most guarantees for nuclear power have been domestic, since international lending facilities have restricted support to this technology for decades—though this may now be changing.
Price controls and mandates	Price controls should be visible using a price-gap approach; compliance with mandates forces costs onto a broader range of market participants, so will be less visible.	-Price controls have primarily affected fossil fuels; mandates affect biofuels, renewable electricity and some coal. -Stranded asset rules acted as mandates by requiring consumers to pay for the uncompetitive portion of high-cost electricity generation. This, historically, has supported nuclear, though could be applied to older coal plants subsequent to carbon controls.
Research and development	Steady-state funding may, over time, reduce the cost structure of recipient industries. However, profit maximizing firms will still sell output at the market clearing price, so R&D subsidies may not show up in price-gap calculations	Price-gap will miss R&D subsidies related to emerging technologies or uncompetitive ones, since any cost structure improvements will be reflected not in a price-gap, but in being able to supply some energy at the prevailing market price.

Transfer Mechanism	Capture in Price-Gap Metric	Potential Bias
Regulations	-Disparities in regulations across industries should affect the cost structure, and be partially picked up in price-gap assessments. -As with other types of interventions, subsidies that enable high cost resources to enter the marketplace at the market price will not be well measured in price-gap values. -In addition, a range of regulatory interventions are addressed via fuel-specific user fees. However, even though these fees are in many ways similar to a cost of production, they are generally classified as taxes and deducted from internal energy prices in price-gap calculations. -Regulatory disparities relating to legacy costs, especially those associated with government-owned enterprises (such as nuclear fuel cycle facilities) may also be missed entirely in price-gap evaluations.	-Legacy costs related to nuclear, coal and oil-and-gas extraction are common. Industry oversight fees are common for mine sites and nuclear fuel-cycle facilities. -User fee-financed programs to address remediation, oversight, and accidents are common for oil, gas, coal and nuclear power. Some energy resources, such as large hydro-electric power, perhaps should have more regulatory-related fees than they do; the absence of proper oversight may also be missed by price-gap approaches. -Different countries apply widely differing standards to the same industry around the world.
Risk subsidies	Risk subsidies provide statutory caps on private insurance, subsidized insurance programs provided by the government, or allow de facto transfer of risks from the operator to the surrounding community. This category includes only physical risks, not financial risks. Price-gap values may capture a fraction of these subsidies, but most will likely be captured by a profit-maximizing industry that sells at prevailing prices regardless of risk subsidies or in cost reductions to bring otherwise non-competitive energy resources to market.	These subsidies primarily benefit large-scale energy resources with significant impacts on the environment or surrounding community if there were an accident: fossil, large hydro-electric power and nuclear power.
Tax expenditures	Tax expenditures may be partially captured in the price gap via reduced cost structures; and partially missed due to leakage to other factors of production.	Tax expenditures exist for every form of energy; the relative magnitudes will vary by country. There are also very large differences between tax expenditures benefitting existing production and those available to new construction.

2.4.2 *Does a price-gap understate subsidies to some fuels more than others?*

Fuel cycles vary widely across resources, and with this variation come big differences in the most important policies to specific fuels. Emissions regulations are irrelevant to wind and solar energy, but a core driver of competitiveness for coal. Accident liabilities are potentially very large for nuclear power, much less so for renewable energy. Cost of capital matters much more for baseload supply plants than for smaller-scale technologies or demand-side options.[7] More generically, key differences across fuels include ease of transport and trade; fuel sourcing (extraction versus capture); complexity of conversion; quantity and toxicity of by-products; and the scale and length of deployment of capital.

This variation, summarized in Table 5, suggests that there will be systematic bias in how well the price-gap metric is able to capture the full range of distortions for one fuel versus another:

- Subsidies to emerging resources, including coal with carbon capture and storage, cellulosic ethanol, and oil shale will not show up well in price-gap metrics because much of the spending has yet to materialize in products sold in the marketplace. For some of these resources (such as oil shale), even after market entry, the subsidies will not be reflected in a price-gap as the market clearing price will be driven by conventional oil.
- For other emerging resources governed by purchase mandates, the ability for price-gaps to pick up the associated subsidies will vary by the form of the mandates. Renewable energy portfolios or feed-in tariffs may be visible in observed pricing—the former because there are auction-based premiums for the power; the latter because there are per unit bounties set by government.[8] Renewable fuel standards that embed mandate costs through selling renewable fuel credits may not be visible in pump prices at all.
- Although nuclear energy is not an emerging resource, it behaves like one since very large subsidies are targeted at new plants. None will be reflected in price-gaps for quite some time.
- Price-gap will not pick up support to decentralized or small-scale energy resources well. This is partly the result of a paucity of pricing data on the smaller-scale installations, and partly due to other attributes of the prices that are available: that there may be discounting for the

[7] Even though some smaller-scale plants are more capital intensive, a large-scale technology such as nuclear has a variety of characteristics that drive the cost of capital very high. These include large economies of scale, increasing the pool of capital at risk; a long, and often uncertain construction period, increasing the need for financing during construction and the risk of mis-estimating market conditions at the commencement of operations; and technology and regulatory risk. Many of these same characteristics are likely to apply to "clean" coal facilities.

[8] Renewable portfolio standards are used by a number of U.S. states to boost the use of alternative energy (often renewable) within a state's electricity pool. While the rules differ across programs, the states normally set a quantity target for specific eligible fuels, then run reverse auctions to award capacity contracts to these resources for the smallest price premium bid. Feed-in tariffs, commonly used in Europe, set an allowable price premium per unit energy delivered by pre-specified technologies. Providers are then able to sell power into the grid at that premium price level.

intermittent nature of their generation, or that the observed prices mix in components of both generation and distribution that are difficult to disentangle.

- For conventional energy resources such as natural gas that is produced in countries with wide geographic variation, or with poor indigenous distribution networks, the use of average or imputed prices for transportation and distribution adjustments will yield much less precise results.

Table 5: The Capture of Subsidies via Price-gap Method Varies by Fuel Type

Fuel Cycle	Characteristics Supporting Price-gap Accuracy	Characteristics Impeding Price-gap Accuracy
General	-Widely traded. -Established production base and distribution infrastructure -Homogenous geography	-Difficult to move or sell -Emerging, immature technology -Geographic diversity within country
Oil - conventional	-Fungible; established price relationships for different types of crude -Infrastructure exists to make real competition between internal and external oil supplies a real option in most key supplier and consumer markets	-World reference prices influenced by cartels and government spending on oil security -U.S. product prices normally used as the "intervention-free" reference price -Refined production markets less transparent -Large subsidies to niche sources do not affect market-clearing prices -Government ownership of reserves and oil producing assets in many countries makes transparency difficult -Transfer pricing between multinationals for tax planning or other purposes can skew observed prices
Oil – shale and tar sands	-Benefits from market price visibility of conventional oil -Fairly good data on existing production levels	-Mostly a potential supplier where large subsidies not yet showing up in the marketplace -Heavy government involvement in leasing reserves and subsidizing infrastructure makes pricing relationships more difficult to gauge -Likely to be significant economic impacts on carbon control regimes on this energy resource
Gas	-Growing internationalization via LNG trade	-Many pockets of stranded gas and flaring remain; world prices for these areas not particularly accurate -Large government ownership of reserves and associated assets in this sector for many countries. -Increased use of royalties-in-kind

Fuel Cycle	Characteristics Supporting Price-gap Accuracy	Characteristics Impeding Price-gap Accuracy
		make benchmarking payments to governments more difficult -Large subsidies to niche gas sources do not affect market-clearing prices
Coal - conventional	-Growing internalization of coal trade, with rising pricing transparency	-National policies to protect domestic coal pits remain in some countries -Very large government involvement with regulation of health and safety, mine closure; regulatory gaps in mountain top removal. All of these factors may not be well integrated into existing price relationships.
Coal - advanced with CCS	-Ability to benchmark appropriate reference prices by integrating conventional coal values with carbon permit prices	-Advanced coal facilities are mostly future capacity, not present; hence are not reflected in current price-gap calculations for coal. In addition to the issues with conventional coal, advanced coal and CCS has a number of increasingly large subsidies for R&D, CCS and market access that skew marginal investment decisions but would not show up in price-gap calculations for the current market at all.
Nuclear power	-Relatively small number of facilities -Ability to benchmark wholesale price of power	-Price-gap metrics do not pick up either past waves of capital write-offs (via bankruptcy or stranded asset rules), or the very large subsidies that will flow to new reactor projects going forward. -Majority of subsidies will enable nuclear to (maybe) be cost competitive, though an equal or larger cost per kWh will have been shifted to taxpayers or ratepayers via a mixture of new and old subsidies. This will greatly understate the real subsidies to nuclear power. -Nuclear power often sold as a blended rate with other sources of generation
Renewable energy (general)	-Growing market presence in electricity markets -Increasing integration with the grid -Use of subsidy mechanisms such as purchase mandates or feed-in tariffs that are likely to show up in market prices	-Remains smaller scale, marginal producers -Decentralized resources for which T&D adjustments may be more difficult -For many renewable resources, generation levels remain very low; somewhat of a rounding error than a

Fuel Cycle	Characteristics Supporting Price-gap Accuracy	Characteristics Impeding Price-gap Accuracy
		core focus of international research.
Hydroelectricity	-In many countries, there are relatively good reference prices for electricity, at least at a regional level.	-Many of the largest facilities are government-owned with limited transparency. -Core cost elements such as decommissioning and liability insurance may be systematically missing from hydro costs in many parts of the world -Hydro-electric dams often have many cross-subsidies: by customer classes, and for flood control and irrigation -Many of the public enterprises that own the facilities also own non-hydro-electric assets and sell power at a blended rate of all generating assets. Some have pricing preferential sales agreements with local areas, resulting in regional price variation that will be missed with national end-use prices.
Biomass - electric	-Relatively good reference prices for electricity -Not that many large-scale facilities -Support via feed-in tariffs or renewable portfolio standards is easy to quantify.	-Subsidies to industrial facilities using biomass by-products will not show up in price-gap calculations at all—though they can be significant for some industries (Waste To Energy, paper, sawmills).
Biomass - liquids	-Reference prices via gasoline and diesel prices are available	-Very large subsidies mostly allow high-cost fuels to enter marketplace at a market price. Price-gap calculations will not pick this up. -Subsidies associated with renewable fuel mandates leak to other factors of production or depress the overall market price for blended gasoline.
Wind	-Good reference prices	-Subsidies mostly allow wind to enter the marketplace at prevailing prices; these will not show up in price-gaps. -Implicit subsidies to wind via grid interconnects to remote supply regions may be attributed to general infrastructure rather than to wind.
Solar	-Unlikely to be well characterized in price-gap metrics	-Emerging centralized solar applications not yet showing up in market place calculations -Price-gap issues with averaging

Fuel Cycle	Characteristics Supporting Price-gap Accuracy	Characteristics Impeding Price-gap Accuracy
		distorts reference prices for distributed PV, both because it is generated proximate to use, and because it tends to follow peak loads more closely than other resources. -Solar thermal applications (e.g., hot water) would have some of the same problems as with distributed PV, though less overlap with peak demand.
Geothermal energy	-Geothermal power plants would have reasonable reference prices.	-Use of geothermal for local or district heating or heat-pump applications will occur with far less pricing visibility. A price gap approach will likely miss all of these applications.
Efficiency, conservation	-What is the appropriate reference price? -Benchmarking might be possible using utility Demand Side Management (DSM) models.	-Investments often made outside of industries or price relationships tracked by price-gap calculations.

2.4.3 Price-gap and geographic location

There are a number of characteristics of where the energy is being produced that may reduce the value and accuracy of price-gap calculations.

- **Stage of development.** Price-gap approaches may be the easiest assessments to undertake in developing countries, due to a lack of data, transparency and government cooperation. However, these same types of countries often have extensive involvement of government in extractive industries, operating with little oversight. While the price-gap approach is an efficient way to get some idea about what is happening, the country's energy markets, the massive influx of government money, or poor realization of value in natural resource sales is unlikely to be reflected in price-gaps.
- **Dominant industry.** To the extent that price-gap calculations are more likely to miss the interventions related to fossil, nuclear and large hydro-electric energy, countries with large infrastructure or extraction in these fuel cycles will tend to be more greatly misstated.
- **Urban versus rural.** All sorts of pricing variation related to congested distribution networks, or low loads will be missing from the price-gap calculations done on a national level. Areas of greatest inaccuracy will likely be located near congested distribution infrastructure or low population centres at the fringes of existing distribution networks.

- **Coastal versus central.** For fuel resources for which imports or exports are restricted, price-gap averaging of impacts will tend to understate the problem at the coasts, where trade can more easily bring supplies in or out.

2.5 Conclusions and Implications for Interpreting Estimates of Market Price Support and Market Transfers

- Price-gaps are basic data, necessary for estimating market price support (to producers) and market transfers (to consumers) and should be collected annually for all major fossil energy producing and consuming nations.
- Methodological work to standardize the approach and improve the adjustments done with regards to transport and distribution costs and taxes should be undertaken so as to make the price-gap data as robust and comparable as possible.
- While a number of assumptions have to be made in order to estimate the price-gap, estimates can be made based on current techniques and data. These estimates will be uncertain to some extent but many of these uncertainties must be faced when energy pricing policy is considered and when prices are set.
- However, reliance only on the price-gap approaches will dramatically understate the magnitude of fossil fuel subsidies globally. In addition, results will differ widely based on factors including the fuel being evaluated, the subsidy method and the type of country being evaluated. While patterns in this variance may emerge over time such that they could help to further refine how price-gap values are interpreted, estimating this pattern of bias with any precision based on current information is not possible.
- While usually requiring more work, transfer studies of subsidies to fossil fuels are an efficient way to achieve greater alignment between the energy, fiscal and environmental goals of a nation. With subsidies in the U.S. from carbon cap and trade proposals estimated in the trillions of dollars (McMahon & Pica, 2008), even small improvements in the efficiency of proposed carbon mitigation policies will generate fiscal savings in the tens of billions per year and reduced dislocation for industry.
- Studies of total transfers should be conducted at least once every five years for the top ten global fossil energy producing and consuming nations. In addition, it would be useful to undertake studies in countries deriving a substantial portion of their GDP from extractive industries.

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