Subsidies in the Energy Sector: An Overview

Background Paper for the World Bank Group Energy Sector Strategy

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Acknowledgments

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Abbreviations

cif	cost, insurance, and freight
CGE	computable general equilibrium
CO_2	carbon dioxide
ECA	Europe and Central Asia
EEA	European Environment Agency
fob	free on board
G-20	Group of Twenty Finance Ministers and Central Bank Governors
GDP	gross domestic product
GFS	Government Finance Statistics
GHG	greenhouse gas
IEA	International Energy Agency
IMF	International Monetary Fund
ISIC	international standard industrial classification
kWh	kilowatt hour
LPG	liquefied petroleum gas
OECD	Organisation for Economic Co-operation and Development
OPEC	Organization of Petroleum Exporting Countries
PSIA	poverty and social impact analysis
RMSM	revised minimum standard model
RMSM-X	extended revised minimum standard model
SAM	social accounting matrix
SITC	standard international trade classification
SSA	Sub-Saharan Africa
UN	United Nations
UNEP	United Nations Environment Programme
USAID	United States Agency for International Development
WTO	World Trade Organisation

All dollar amounts are U.S. dollars unless otherwise stated.

Subsidies in the Energy Sector: An Overview

Executive Summary

Developing countries need more energy and cleaner energy to overcome poverty and to set them on strong growth paths. At the heart of the debate about the future of global energy is how to expand supplies and access to energy for the world's poor in ways that meet the needs of both the current generation and all future generations. The World Bank Group's new energy sector strategy will address how the Bank Group can balance competing demands, promote synergies, and address trade-offs.

The purpose of this background paper is to inform the forthcoming energy sector strategy by providing arguments for and against the use or change in particular types of subsidy. Despite the length of the paper, it is not designed to give detailed treatments of different situations but rather provide a starting point for a detailed discussion on specific proposals.

Many governments provide subsidies for energy, either explicitly or implicitly, to producers and consumers. Arriving at a global value for the total energy subsidy is not straightforward because different agencies focus on narrower or wider definitions of what exactly constitutes a subsidy and use different methodologies for their calculation. Also, until recently such estimates have been published only occasionally and not always on a consistent basis. Nevertheless, all globally based estimates are large as emphasized in the recent report to the Toronto G-20 summit (IEA et al. 2010). The International Energy Agency (IEA forthcoming) estimated that fossil fuel subsidies to consumers in 37 countries, representing 95 percent of global subsidized fossil fuel consumption, reached $557 billion in 2008. The Global Subsidies Initiative estimated in 2009 that global subsidies to fossil fuel producers amounted to approximately $100 billion (GSI 2009). Coady et al. (2010) estimated that globally consumer subsidies for petroleum products had been $57 billion in 2003, $519 billion in 2008, and $136 billion in 2009, while projecting a rebound to reach $240 billion in 2010. Including the tax subsidy—the effect of taxes set below optimal levels—the amount of petroleum product subsidies could reach $740 billion in 2010 according to the study. The year-to-year variation in these totals is largely due to changes in the international oil price.

Energy subsidies can be large within a country context and are found in virtually every country. Justifications for their use vary from social welfare protection, job creation, the encouragement of new sources of energy supply, and economic development to energy security. However, large energy subsidies in countries also compete for limited resources that could otherwise be used to deliver other essential services, widen the scope for rent seeking and commercial malpractice, discourage both supply-side and demand-side efficiency improvement, promote noneconomic consumption of energy, and can make new forms of renewable energy uncompetitive.

Concerns about the effects of energy subsidies in increasing energy demand in developed and developing countries with large energy consumption and high per capita emissions have been heightened in recent years against the backdrop of to the debate on how to address climate change caused by greenhouse gas (GHG) emissions, to which the combustion of fossil fuels is the largest contributor. The communiqué following the G-20 summit in Toronto[2] recognized the complexity of these issues, as had been explained in the joint report of the International Energy Agency (IEA), the Organization of Petroleum Exporting Countries, OECD, and the World Bank (2010) on the scope of energy subsidies.

Content of the paper

This paper provides an overview of issues relating to energy subsidies in developing countries arranged into six broad topics:

1. An overview of the concept of a subsidy, where they arise, how they are financed, and whom they affect
2. A description of a simple and practical methodology for measuring energy consumer subsidies for a wide range of developing countries at successive time intervals, and a review of cross-country studies measuring energy subsidies
3. A review of the channels through which subsidy reform affects the economy
4. A review of the literature on the incidence of existing consumer subsidies and of their reduction or removal on households, their distributional benefits, and an investigation of the effectiveness of social safety nets and/or targeted subsidies as an alternative to universal subsidies
5. A discussion of arguments for and against creating, retaining, reducing, or removing subsidies, and replacing universal subsidies with targeted subsidies.
6. The strategy of subsidy reform

Concept of an Energy Subsidy

A number of approaches to the definition of a subsidy are reviewed, and for the purposes of this paper a working definition is taken to include policies that decrease energy prices or production costs through some form of unrequited value transfer to economic agents. A number of government interventions that have this subsidy effect are presented. The financing of subsidies can take place in a number of ways and the paper explains the differences between explicit subsidies, implicit subsidies, cross-subsidies, and tax-subsidies.

[2] http://g20.gc.ca/toronto-summit/summit-documents/the-g-20-toronto-summit-declaration/

Measurement of Subsidies

The financial cost of subsidies funded directly out of the government budget can be measured precisely. However, even for these interventions, their economic impact needs to be estimated. An additional problem is to agree on the list of policies that constitute subsidies, and it is noteworthy that not even the European Union has been able to agree on a standardized list of energy subsidies.

A practical approach to the measurement of consumer subsidies that can be applied to almost any country is the so-called price gap approach. It identifies the gap between the actual price charged and the reference price for that particular form of energy. The difference is the subsidy per unit sold and may be financed either explicitly or implicitly. The reference price is calculated differently in the case of traded and non-traded forms of energy. In the former case the reference price is based on the international price (adjusted for transport costs and quality differentials), applicable particularly to oil, natural gas, and, to a lesser extent, coal. Where an energy source is not traded—most commonly with electricity, followed by coal, and lastly by natural gas—the reference price has to be calculated from assumptions on what would be the cost of domestic supply for an efficiently run firm. For oil exporting countries that face production quotas, the reference price may be lower than the international price and is the higher of the marginal cost of supply and the discounted value of an additional barrel of unproduced oil. The hidden-cost calculator is able to split the difference between the reference price and the actual price into three components: underpricing (setting the price below the level that would be charged by an efficiently run firm in a liberalized market), unaccounted losses (due to theft and excessive technical losses), and collection failure (due to failure to send out bills or to enforce their payment). In Sub-Saharan Africa, one third of the losses to power utilities that have to be covered by explicit or implicit subsidies arise from the latter two components, indicating that these need policy attention as well as the level of power tariffs. Both the price gap and hidden-cost method have been applied to a number of countries and are capable of further extension to other countries and through a wider definition of the costs of an efficient utility.

Channels through Which Energy Subsidies Affect the Economy

Energy subsidies have a variety of aggregate impacts on the economy. The macroeconomic effects include government accounts, the balance of payments, the long-run growth potential of the economy, and the degree of energy intensity of capital investment. Partial equilibrium analysis of the effect of energy subsidies emphasizes the deadweight losses that occur within the sector where the subsidies apply, including an allowance for the presence of externalities. General equilibrium analysis goes beyond this to evaluate the spillover effects into other markets that are themselves affected by the presence of the energy subsidy. A number of studies using computable general equilibrium models have evaluated the impacts of reducing or removing energy subsidies, mainly applied to single countries. These generated estimates of the change in the level of output of the economy, and of use of different energy sources. These studies were conducted along rather different lines and used different assumptions so that a unified approach to modeling the global effect of reducing energy subsidies does not yet appear to have been established. A group of such studies applied general equilibrium modeling to large energy consumers in order to estimate how reducing energy subsidies affect energy demand and the economy.

A further group of studies applied global modeling to analyze the relation between global energy subsidies and associated GHG emissions, taking into account the magnitude of energy subsidies, energy demand, and income levels. By varying the assumptions on the policies followed by different groups of countries, it is possible to use such models to investigate the likely impact of different international agreements on global emissions.

Incidence of Consumer Subsidies and Policies to Ameliorate the Effects of Their Removal

The social performance of an energy subsidy scheme can be evaluated through three dimensions:

- Benefit incidence (how well the subsidy targets benefits to poor households as opposed to other households)
- Beneficiary incidence (what proportion of poor households as a whole receive the subsidy)
- Materiality (how significant is the amount of subsidy received by poor households).

Benefit incidence can be shown to be determined by the product of five factors, two—the share of connected households that receive the subsidy and the average rate of subsidization for eligible households—of which are design factors that can be varied to ensure a more pro-poor design. A number of studies have measured these indicators for subsidies in the power sector, and have also simulated the effects of changing the form in which the subsidy is given. Incremental block tariffs (lifeline tariffs) tend to be regressive because benefits are given to all groups irrespective of income. Volume differentiated tariffs tend to be more progressive. Depending on how the roll-out of new connections is made, connection subsidies can be strongly progressive. In countries with low connection rates, those with connection tend to be mainly better-off households and mirroring existing users (largely through a densification approach) is likely to be regressive. A roll-out that is based on extending connections to areas that do not already have access is likely to be more progressive. A simulation of benefit-targeting for petroleum products suggests that subsidies for gasoline, diesel, and liquefied petroleum gas (LPG) are likely to be regressive, particularly in low-income countries, because the poor do not consume these fuels directly. Subsidies for kerosene could be equity-neutral or even progressive if only fuel consumption by households is considered. The case for subsidizing kerosene, however, is weakened by the ability to use it to adulterate diesel fuel, leading to major diversion away from the poor and towards the better-off.

Household expenditure surveys can be used to examine the pattern of expenditure on different forms of energy by household income level. The findings, in turn, can provide evidence on where energy subsidies are likely to benefit the poor most, and where they will tend to provide most benefit to the better-off. Reviews of a number of studies confirm that certain patterns are widely found. The share of household expenditure tends to rise with income for gasoline, diesel, and LPG, while the share of expenditure on kerosene declines with income. The share of expenditure on electricity does not show uniform variation with income but differs by country. A few studies have gone beyond looking at the potential direct effects of subsidy removal on household welfare and have estimated the indirect effects coming through the increase in prices of other goods caused by the initial increase in energy prices.

These studies found that the indirect effects are important and in some cases are more important than the direct effects.

A further refinement in estimating the welfare impacts of changing energy prices on households would need to incorporate both own- and cross-price elasticities of demand. A recent study suggests that these are low in developing countries, so that calculating changes in household welfare based on the assumption of no change in quantity purchased will be a reasonable approximation. At the same time low values of these price elasticities suggest that to achieve a large reduction in GHG emissions as a result of price changes may require a large change in energy prices.

Objectives of Subsidy-Related Policies

In considering whether to create, retain, reduce, or remove an energy subsidy, governments have to consider a number of questions:

- What are the objectives of the subsidy?
- What activities should be subsidized?
- Who should be subsidized?
- What subsidy mechanism should be used?

The objectives of the subsidy may include supporting the poor and improving equity, achieving energy security, correcting for externalities, and supporting domestic production and the associated employment. A major concern with all these goals is how to make the policies time-bound. Without some predetermined threshold for phasing out such subsidies, these goals can lead to a permanent fiscal burden for the government that is incommensurate with the benefits from achieving the stated purposes of the subsidies.

The government also has to consider exactly what should be subsidized. Possibilities include affordable and reliable energy supplies, clean sources of energy, infant industry producers of energy, innovative forms of energy supply, or investment in energy efficiency. The subsidies can range from universal subsidies, subsidies targeted to the poor, subsidies to rural or remote communities, and subsidies to particular industries or firms.

Having identified the objective of a change in subsidy, the possible group to be targeted, and the form of energy to be subsidized, governments have a wide range of techniques for implementing the policy. Each type of subsidy has advantages and disadvantages and they need to be balanced against each other before a design choice is made.

For a proposal to introduce or change a subsidy, a framework for analyzing the proposal is sketched, consisting of a sequence of questions and calculations.

Strategy of Subsidy Reform

There have been many attempts to reduce or remove energy subsidies. Such attempts have at times led to extensive public protest and policy reversal in the form of cancellation or reduction of the planned price increases, particularly when a strategy of communication and an associated method of protection for key sectors of society were not put in place. A few governments have managed to implement large price increases and reduce subsidies, even if not on a permanent basis. These cases have certain common features that point to strategies for other governments to consider. Some key strategies that emerge from this review include the following:

1. Subsidy reform appears to be possible in situations where the explicit or implicit fiscal costs to the government are so large that the government feels it must act. This strengthens the political willpower, without which little can be achieved.
2. Increasing the availability and transparency of energy subsidy data is essential in overcoming some of the challenges related to reform. This can encourage an informed discussion and debate regarding the subsidies and government policies toward them.
3. Efforts should be made to provide targeted assistance to vulnerable groups, such as lower-income households who will be adversely affected by subsidy changes. Compensation needs to be visible and sufficiently material to offset a good part of the adverse effect in the early years of the change. Consideration should be given to alternative policy tools to protect the poor, such as cash and non-cash transfers, and, for electricity, district heating, or natural gas, lifeline rates or volume differentiated tariffs. Subsidies for connection charges can also be targeted to the poor, but may need to be limited in countries where the connection rate is low.
4. The credibility of the government's plan to compensate vulnerable groups is important for public acceptance, as is its plan to use the funds freed from subsidy reform for social and economic benefits.
5. A well-organized publicity campaign is essential. Governments can reduce uncertainty and persuade the public that the effects will not be as deleterious as might otherwise be feared by explaining, before the changes are introduced, the need for change and the compensating measures that will be implemented.
6. Using a household expenditure survey to provide information on those benefiting from the existing subsidy and the potential effects of subsidy removal on various groups provides an important reference for assessing the adequacy of compensation measures that are planned.
7. An election may provide a window of opportunity to make bold changes, because a new government may initially enjoy a period of greater credibility and legitimacy than the old government that failed to tackle the problem. This suggests that incoming governments need to start preparation beforehand to be able to move early in their term in office.
8. Improving the quality of service ahead of increasing prices lends credibility and increases the willingness to pay higher prices. This is particularly true for energy distributed through networks—electricity, district heating, and natural gas— where the quality of service may be low, possibly because of the financing difficulties caused by subsidies. Steps such as improving bill collection and making the metering system more effective may allow other changes to be introduced that could be linked to the general tariff increases required to reduce the fiscal burden further.

9. Use of transitional arrangements that are phased out as household energy use increases over time can act to protect low-income groups at the time of the policy change.

Conclusions and Suggestions for Future Work

Energy sector subsidies are large and widespread in both developed and developing countries. Consumer subsidies are particularly prominent in many developing countries. Petroleum product subsidies are known to be substantial in certain cases, especially in some major oil-exporting countries. Power sector subsidies that result from underpricing, excessive losses, and bill collection failure are common in those developing countries for which detailed investigations have been conducted. However, more systematic information is needed to give a comprehensive picture.

While subsidies can have benefits in terms of support for the poor, job creation, industry protection, or energy security, they also carry costs. These can include fiscal costs and effects on the balance of payments, growth, and global externalities. In particular, in economies with large energy consumption, the extra demand for energy induced by the lower consumer prices can work against energy security and have global effects by possibly raising prices on the world market by increasing demand (in the case of widely traded fuels) and through higher GHG emissions resulting from consumption of more fossil fuels.

In the light of these costs to their economy it is important that governments design their subsidy scheme so as to achieve the desired benefits with the lowest overall costs. Some broad findings of this review suggest several points for consideration:

- Gasoline, diesel, and LPG subsidies are weakly targeted to the poor, particularly in low-income countries.
- Kerosene subsidies may be targeted to the poor through their direct effects, but the leakage to better-off households, commercial establishments, and the transport sector arising from the ease of adulterating diesel fuel with kerosene means that the subsidies' pro-poor benefits may be limited.
- Electricity subsidies resulting from excessive losses or failure to collect bills do not have economic justification and should be actively reduced.
- Electricity subsidies through generalized underpricing are likely to be regressive, and much better targeting may be achieved through a careful design of the tariff structure. Volume differentiated tariffs appear to perform much better in this respect than increasing block tariffs.
- Subsidies to connection charges for electricity can be designed to be strongly progressive, but their substantial cost per household requires an investigation into the lowest cost method of supply as well as comparative assessment of other options to help the poor.
- Cross-subsidies for tariffs and for connection charges between different classes of users can be an important instrument, but are of limited use where overall connection rates are very low.
- Social safety nets can provide a more effective way of reaching the poor while controlling public expenditure. However, they require a strong administration.

- Because energy subsidies can result in a large fiscal burden, all subsidy schemes should consider the inclusion of natural phaseout provisions. This can help to reduce the expectation of a permanent subsidy that can be very difficult to combat at the time a government feels the need to reduce the fiscal burden. However, some subsidy schemes may be designed to be permanent, such as cross-subsidies between different groups of consumers (such as urban households cross-subsidizing rural households for whom costs of electricity supply can be markedly higher).
- Transparency is important. Proper accounting and public awareness of which groups benefit from subsidies, by how much, and the cost is essential to evaluate government policies.
- Subsidies to support a switch from fossil fuels to renewable energy need to be carefully planned and to consider the inclusion of natural phase-out provisions.

Because of the potential cost of a subsidy scheme and of the different performance of alternative schemes, a full evaluation of costs and benefits should be made before making any changes to the status quo. Governments that have rushed subsidy reform without preparing the population for the changes, and without providing targeted support to particularly disadvantaged groups, have often had to reverse the policy in the face of widespread opposition.

In compiling this overview of the role of different forms of subsidies, arguments for their retention or removal, and the problems of removal, it has become evident that there is a need for some further work of a more focused nature. First, a more systematic analysis of the political economy of retaining or removing subsidies to the various forms of energy would be valuable. Second, refining the discussion of policy options and best practices by a typology of countries (for example, energy exporting or importing, high or low electricity access etc.) would provide a useful tool for those considering the role of energy subsidies in a particular country. Third, some examples of applying the framework for deciding on a particular subsidy change would provide valuable insights in how to deal with an individual case.

Background

Developing and developed country governments alike provide subsidies for energy, either explicitly or implicitly, to producers, consumers, or both. Arriving at a global value for the total energy subsidy is not straightforward because different agencies use varying definitions of what exactly constitutes a subsidy and use different methodologies for their calculation. Nevertheless, all globally based estimates are large, as emphasized by the recent report to the G-20 summit in Toronto (IEA et al. 2010). The IEA (forthcoming) estimated that fossil fuel subsidies to consumers in 37 countries, representing 95 percent of global subsidized fossil fuel consumption, reached $557 billion in 2008.[3] The Global Subsidies Initiative estimated in 2009 that global subsidies to fossil fuel producers amounted to approximately $100 billion (GSI 2009). Coady et al. (2010) estimated that globally consumer subsidies for petroleum products had been $57 billion in 2003, $519 billion in 2008, and $136 billion in 2009, while projecting a rebound to reach $240 billion in 2010.[4] Including the tax subsidy—the effect of taxes set below optimal levels—the study estimated that the amount of petroleum product subsidies could reach $740 billion in 2010. The year-to-year variation in these totals is largely due to changes in the international oil price that affects the level of countries' subsidies.

Justifications for the use of energy subsidies vary from social welfare protection, job creation, the encouragement of new sources of energy supply, and economic development to energy security. However, large energy subsidies in countries also compete for limited resources that could otherwise be used to deliver other essential services, widen the scope for rent seeking and commercial malpractice, discourage both supply-side and demand-side efficiency improvement, promote noneconomic consumption of energy, and can make new forms of renewable energy uncompetitive.

Concerns about the possibly adverse effects of energy subsidies in countries with large energy consumption and high per capita emissions have been heightened in recent years against the backdrop of to the debate on how to address climate change caused by greenhouse gas (GHG) emissions, to which the combustion of fossil fuels is the largest contributor. In this context Spence (2009) and the Commission on Growth and Development (2008) have pointed to the benefits to individual economies of reducing or eliminating energy subsidies in improving growth prospects, while also contributing to a reduction in energy use (increased energy security) and hence a reduction in GHG emissions. The G-20 announced at Pittsburgh in September 2009 that its member countries would work to phase out wasteful energy subsidies in the medium term, as a contribution to reducing the growth of GHG emissions. Globally, the IEA estimates that removing all fossil fuel subsidies would lead to a reduction in demand for fossil fuels that would translate into a 10 percent reduction in the level of carbon dioxide (CO_2) emissions by 2050. However, untargeted energy consumer subsidies—the most common type of subsidies in developing countries—while generally regressive, are politically difficult to phase out. The G-20 finance ministers subsequently called upon the IEA, the Organization of Petroleum Exporting

[3] Figures for earlier years calculated on the same basis and for the same countries are not presently available but will be published in *World Energy Outlook 2010* (IEA forthcoming).

[4] The sample covers countries accounting for approximately 99 percent of world gross domestic product.

Countries (OPEC), OECD, and the World Bank to produce a joint report on energy subsidies, focusing in particular on how to identify and phase out wasteful fossil fuel subsidies while protecting the poor (IEA et al. 2010).

In low-income countries, reducing the growth of GHG emissions is not seen at this time as a critical driver for reducing subsidies on fossil fuel using activities or for providing financial incentives for renewable energy. These policies should be undertaken for a variety of reasons, focusing particularly on improving growth and equity. Over time, as countries' incomes grow they may wish to shift their priorities toward slowing down the growth of emissions, and eventually to their stabilization. At that stage of their development the use of subsidies and of taxes on energy could increasingly reflect their concern with these external effects.

In the context of the World Bank's work, a recent Independent Evaluation Group report "Climate Change and the World Bank Group. Phase 1—An Evaluation of World Bank Win-Win Energy Policy Reforms" (2008) recommended the following:

> *Systematically promote the removal of energy subsidies, easing political economy and social concerns by providing technical assistance and policy advice to help reforming countries find effective solutions, and analytical work demonstrating the cost and distributional impact of removal of such subsidies and of building effective, broad-based safety nets.*

Many governments acknowledge the need to rationalize certain of their energy subsidies. The World Bank is often asked to provide, particularly in respect of fuel prices, price structures in other countries in the region and benchmark prices. Comparison of subsidies across countries on a common basis would also help gain a better understanding of the impact of subsidies on consumption and on the economy. Equally useful are lessons from subsidy removal by typology of countries.

Quantification of subsidies is difficult, because direct cash transfers to producers and consumers are but one way of delivering subsidies. Other forms of subsidies are less transparent, including tax reductions, exemptions, credits, rebates, and other tax benefits such as accelerated depreciation; cross-subsidies across different consumer categories; subsidized loans and other forms of assistance provided to producers or the industry (including financing research and development); price caps benefitting consumers; trade restrictions and consumption targets or mandates that benefit producers; limits on market access; and forgone income from selling below economic opportunity costs, particularly common in countries that are large net oil exporters. There is no widely accepted definition of, or methodology for calculating, subsidies and no harmonized reporting mechanism exists even in such a unified market as the European Union.

Data on energy subsidies in developing countries have not been systematically collected, but data collection and policy analysis have been carried out as the need arises. Larsen and Shah (1992) estimated fossil fuel subsidies for 13 developing countries, while the IEA (1999) quantified energy subsidies in 8 large developing economies, and provided estimates for 37 non-OECD countries in *World Energy Outlook 2009* (IEA 2009). These studies focused mainly on the global effects via induced energy consumption and the resulting emissions from it. With a focus on the impacts on individual economies, the International Monetary Fund (IMF 2008, 2010) has collected information in certain countries on fossil fuel price subsidies and tax reductions in the last few years, but such data collection has not been carried out on a regular basis. For many other developing countries there has been no systematic estimation of the magnitude of energy subsidies.

An important practical issue for individual governments and policy makers is then the quantification of the extent of energy subsidies. There is a large literature on subsidy measurement, linked to the various approaches to identifying which policies constitute a subsidy. In an analysis of approaches to measuring subsidies, Koplow (2009), in looking at the global impact of fossil fuel subsidies, concluded that the so-called price-gap—the difference between the opportunity cost of the energy source and the domestic market price—approach to measuring subsidies, although underestimating the total magnitude of fossil fuel subsidies, is a basic tool for measurement, and should be collected annually for all major fossil fuel producing and consuming countries.

Although the removal of subsidies can improve countries' fiscal and macroeconomic performance and lead to reduced energy consumption and hence reduced emissions, some users of energy will face higher prices. Household will face higher energy costs for those energy sources that they purchase, while intermediate users (factories, transport, etc.) facing higher costs on energy inputs may not be able to pass all of these on to purchasers. Businesses in the tradable sector in particular are constrained by international trade and may have to absorb some or all of the effects of energy subsidy removal. The reduction in subsidies therefore can create a class of consumers who are adversely affected by the change. There is then a balance of interest to consider between direct losers from subsidy reduction or removal and the wider benefits accruing from an improved fiscal position. Governments have an interest in two aspects of this issue: (1) the identification of those consumers who would be affected to a greater or lesser extent by subsidy reduction, and (2) the development of offsetting policies to mitigate the effects of subsidy removal on poor households or other groups of special concern.

Although subsidies for energy as a direct or indirect input can benefit all producing sectors, less attention has been paid to this aspect. Where firms are unable to pass the cost of subsidy removal on to consumers, then support may be given to selected producers to permit them to stay competitive. This is generally in the form of a subsidy to the sector. In a few cases energy subsidies are actually used as a means to support the viability of another sector. A leading example of this is where agriculture is provided with subsidized electricity or diesel for pumping. Attempts to measure the impact of these subsidies on the sector are complex and have rarely been undertaken. Infant industries in the energy sector may also require initial subsidies in order to allow them to grow sufficiently to become self-sustaining.

The removal or reduction of large energy subsidies has not only a direct effect on households faced with higher energy bills, but also a number of indirect effects. Higher energy prices can raise the costs of transport that in turn increase the costs of travel (importantly the journey to work) and of the price of retail goods. These indirect effects on the household cost of living can be as important as the direct effects, as demonstrated in the study by Andriamihaja and Vecchi (2007) for Madagascar.

Beyond these cost-of-living effects are the macroeconomic effects caused by the shift of resources away from households to the government, and the shift away from the demand for energy caused by the rise in prices. The recognition of the ensuing changes in the fiscal balance, the balance of payments, terms of trade for energy importers, and associated CO_2 emissions are important for an understanding of the implications of a policy to reduce subsidies.

There are circumstances in which it would be advantageous to reduce or remove energy subsidies, but there are other circumstances when government policies may justify the introduction or retention of an energy subsidy. Where a balance may be required between the macroeconomic benefits of subsidy removal and the protection of consumers from higher prices, a limited use of targeted subsidies to support certain groups of consumers can still reduce the fiscal costs and general negative effects of universal subsidies. There are a number of alternative schemes for providing such assistance, ranging from price discrimination approaches in electricity supply (either geographically, by amount of use, or for the fixed costs of connection), to income-based subsidies to identified groups of low-income households in order to mitigate the effects of the removal of subsidies to petroleum products.

An emerging area for the use and introduction of subsidies is the support of renewable energy and other technologies that can be used to reduce local pollutant and GHG emissions by correcting for market failure—local and global environmental externalities are at present poorly priced in virtually all countries. Subsidies are proposed in the United States for promoting carbon capture and storage. Feed-in tariffs are used to encourage electricity generation from wind and solar power, and liquid biofuels almost universally enjoy tax reductions, increasingly coupled with consumption mandates. These measures are not always socially beneficial. The subsidies provided for liquid biofuels in the United States and the European Union have been criticized for being misguided, as have the generous feed-in tariffs for solar energy in Germany. In countries with a genuine comparative advantage in alternative energy, as in many developing countries, initial subsidies for alternative energy could be cost-effective in shifting the country to a more environmentally sustainable energy development path. Preliminary estimates for 2007 (GSI 2010) indicate that global subsidies to nuclear energy were $45 billion, to renewable energy (excluding hydro-electricity and biomass) were $27 billion, and to biofuels were $20 billion.

The above background material indicates the complexity and importance of understanding the justification for, and magnitude of, energy subsidies. This is true both at the level of individual countries where the fiscal burden may be unsustainably large and the use of subsidies is deleterious to the economy, and at the global level where the reduction of subsidies in large energy-using economies could make an important contribution to reducing the growth of GHG emissions. In summary, subsidies are difficult to measure, difficult to assess, and difficult to eliminate. The paper provides an overview of approaches that are helpful to appreciate these issues.

This paper is divided into six sections:

1. An overview of the concept of a subsidy, where they arise, how they are financed, and whom they affect

2. A description of a simple and practical methodology for measuring energy consumer subsidies for a wide range of developing countries at successive time intervals, and a review of cross-country studies measuring energy subsidies
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Concept of an Energy Subsidy

Subsidies can be considered from two different perspectives:

- The determination of whether a subsidy exists
- The method of financing the subsidy

The first of these is the key to measuring the magnitude of subsidies, and considerable efforts have been made to provide a meaningful and usable definition. The second is of concern when measurement is to be attempted.

Forms of Energy Subsidies

There have been many definitions of energy subsidies; a broad definition of subsidies encompasses all forms of unrequited value transfer to economic agents (individuals, firms, or other institutions; public or private), and whether in the form of cash transfer or any other form (Koplow 2004). Table 1 summarizes the most common forms of government interventions in energy markets. “By modifying the rights and responsibilities of various parties involved with the energy sector, these actions decrease (subsidize) or increase (tax) either energy prices or production costs” (Koplow 2004).

Table 1: Common Forms of Government Interventions in Energy Markets

Intervention type	Description
Natural resource access [a]	Policies governing the terms of access to domestic onshore and offshore resources (e.g., leasing)
Cross-subsidy [a,b]	Policies that reduce costs to particular types of customers or regions by increasing charges to other customers or regions
Direct spending [b]	Direct budgetary outlays for an energy-related purpose
Government ownership [b]	Government ownership of all or a significant part of an energy enterprise or a supporting service organization
Import/export restriction [a]	Restrictions on the free market flow of energy products and services between countries
Information [b]	Provision of market-related information that would otherwise have to be purchased by private market participants
Lending [b]	Below-market provision of loans or loan guarantees for energy-related activities
Price control [a]	Direct regulation of wholesale or retail energy prices
Purchase requirements [a]	Required purchase of particular energy commodities, such as domestic coal, regardless of whether other choices are more economically attractive
Research and development [b]	Partial or full government funding for energy-related research and development
Regulation [a]	Government regulatory efforts that substantially alter the rights and responsibilities of various parties in energy markets or that exempt certain parties from those changes
Risk [b]	Government-provided insurance or indemnification at below-market prices
Taxes [b]	Special tax levies or exemptions for energy-related activities

Source: Koplow 2004.

a. Can act either as a subsidy or as a tax depending on program specifics and one's position in the market place.

b. Interventions included within the realm of fiscal subsidies.

Koplow's (2004) definition and classification appears to be useful for analyzing behavioral changes in agents resulting from a given energy-related policy, and how these changes transmit to macro and distributional outcomes. On the downside, this broader definition brings along problems in measuring and comparing subsidies across countries or sectors. As discussed below, measurement problems will also make it difficult to identify all the sectors that benefit from energy subsidies based on such a broad definition.

Other inter-governmental institutions have approached the definition of subsidies in a more formal but specialized manner, depending on their needs. The approach of the Government Finance Statistics (GFS) manual of the International Monetary Fund (IMF) is shown in box 1, and that of the World Trade Organization (WTO) in box 2.

Box 1: The IMF Government Finance Statistics Definition of Subsidies

The 2001 version of the IMF's *Manual on Government Finance Statistics* (IMF 2001) states

> Subsidies are current unrequited payments that government units make to enterprises on the basis of the levels of their production activities or the quantities or values of the goods or services they produce, sell, export, or import. Subsidies may be designed to influence levels of production, the prices at which outputs are sold, or the remuneration of the enterprises.

OECD's definition is much in line with the IMF's: "Subsidies are current unrequited payments that government units, including non-resident government units, make to enterprises on the basis of the levels of their production activities or the quantities or values of the goods or services which they produce, sell or import." (See http://stats.oecd.org/glossary/)

Notably, the IMF GFS classification considers that subsidies are payable only to producers, not to final consumers, and includes only current transfers, not capital transfers:

> All transfers that government units make directly to households as consumers and most transfers to nonprofit institutions serving households are treated as either **social benefits** or **miscellaneous other expense** depending on the reason for the payment. Most transfers made to general government units are included in **grants**. Payments to enterprises to finance their capital formation, to compensate them for damage to nonfinancial assets, or to cover large operating deficits accumulated over two or more years are **miscellaneous other capital expense.**

There are many policy instruments and mechanisms that can be used to deliver a subsidy to consumers or producers. Several publications describe such policies (see, for example, IEA 1999 and UNEP 2008). In developed countries the bulk of subsidies are directed towards producers, with the idea of protecting domestic production or employment, or to encourage new technologies that need to grow in the market before they can become commercially self-sustaining (infant industry). These goals can be encouraged through policies such as grants and credit instruments, differential taxation, funding of research and development, or price controls.

In developing countries subsidies in the energy sector are much more weighted towards consumers, with the primary objective of reducing the cost of living for low-income households. The mechanism for delivering such help is the control of energy prices so that they are lower than would occur in the situation in which companies (whether public or private) would have been able to charge sufficiently to cover their costs.

Box 2: WTO's Definition of Subsidies

The WTO's *Agreement on Subsidies and Countervailing Measures* (WTO 1994) provides a definition that is much wider in scope than that of the IMF GFS. Under this agreement, a subsidy shall be deemed to exist if either 1 or 2 is satisfied:

1. There is a financial contribution by a government or any public body within the territory of a Member (referred to in this Agreement as "government"), i.e. where:
   (i) A government practice involves a direct transfer of funds (e.g. grants, loans, and equity infusion), potential direct transfers of funds or liabilities (e.g. loan guarantees);
   (ii) Government revenue that is otherwise due is forgone or not collected (e.g. fiscal incentives such as tax credits);
   (iii) A government provides goods or services other than general infrastructure, or purchases goods;
   (iv) A government makes payments to a funding mechanism, or entrusts or directs a private body to carry out one or more of the type of functions illustrated in (i) to (iii) above which would normally be vested in the government and the practice, in no real sense, differs from practices normally followed by governments;
2. There is any form of income or price support in the sense of Article XVI of GATT 1994; and a benefit is thereby conferred.

In order to provide a practical clarification about what should be considered a subsidy under this Agreement, the document includes an annex that specifies a set of illustrative examples of practices that constitute, for the WTO, export subsidies.

Source: www.wto.org/english/docs_e/legal_e/24-scm.pdf.

A useful way of considering energy subsidies is to recognize that "energy" actually involves several distinct goods and services: actual use of energy, connection to a source of energy, productive capacity for supplying the energy, and underlying knowledge affecting the performance of both energy supply and energy efficiency. Subsidy concepts can then be considered for each of these components to clarify distinctions. Subsidizing energy use involves providing it at a price below opportunity cost. This includes non-collection or non-payment, selling electricity at a cost that does not reflect the long-run marginal cost of supply including capital maintenance, and, for traded energy, its value in an alternative market. The argument for subsidizing access to energy rather than energy use itself can be much stronger on social grounds; further, energy use can still be rationed to reflect the opportunity cost of the energy flow itself. Subsidizing energy supply would reflect subsidization of primary inputs like access to natural resources or soft public financing of capital costs. Subsidizing research and development, in contrast, involves provision of public goods, which is not immediately translated into subsidies of energy supply or use (although they certainly lower cost if research and development is successful).

Financing a Subsidy

A subsidy can be financed through taxes, cross-subsidies, cuts in other expenditure, borrowing, or tax expenditures. Subsidies are not always clearly reported and accounted for. *Explicit subsidies* are transfers from the government budget to the producer or consumer that is receiving the subsidy, and are transparently reflected in the budget. For example, if the utility has to set consumer prices below its cost-recovery level, the government can make up the difference by transferring money to the utility. Such a subsidy is said to be on-budget and is transparent in that details of the government budget are made public. Explicit subsidies have a negative effect on the government's fiscal balance. When governments can no longer afford budgetary transfers to the utility to compensate for below-cost tariffs (or above norm costs), the resulting shortage of funds can lead not only to insufficient funding of system maintenance and the resulting dilapidation of infrastructure, but also to "circular debt" and load-shedding.

Some off-budget activities may involve an *implicit subsidy* where there is no immediate transfer from the government to the company to cover the shortfall in revenue caused by the presence of the subsidy. In this case a public utility may cover the shortfall by borrowing (which creates a contingent liability for the government), or by reducing expenditure on maintenance and repair below the optimal level. In certain cases the utilities may be making losses that are not immediately financed by a transfer from the government. Eventually these will have to be made good and do have fiscal consequences at some later date. As discussed by MacKenzie and Stella (1996) and Saavalainen and ten Berge (2006), these off-budget subsidies constitute a quasi-fiscal activity and create a quasi-fiscal deficit because there is a long-run link to the need to finance such subsidies from the budget. A similar form of implicit subsidy occurs when there is an off-budget transfer to a firm. For example, oil bonds issued by the government of India to oil companies in lieu of payment for oil subsidies were for many years not on-budget.

Cross-subsidies involve a group of consumers paying more than the general cost of supply and the surplus is used to subsidize the provision to the other group at a price that is lower than the cost of supply to the subsidized group. This cross-subsidization may be formulated with varying degrees of transparency. A variation on this theme is where the cost of supply is higher to the targeted group (because of distance from main supply points or low local load density), but the price to both groups is set the same (pan-territorial pricing). This has the result that one group pays above cost and the other pays below cost. Such schemes transfer resources between two groups of users rather than from the general group of taxpayers (through the government budget) to the selected group. Such schemes tend to be administratively simple in that no additional financing mechanism needs to be set up, while the utility can still cover its total cost. However, as pointed out by Irwin (1997), a policy of allowing a utility to charge above full costs will not be sustainable in the presence of competition whereby new entrants could target just the more profitable high-tariff part of the market while undercutting the firm that is using cross subsidies to reach lower-income households. Cross-subsidies can be combined with the first or second financing mechanisms, so that, even with cross-subsidies, all consumers combined are collectively subsidized.

For internationally traded forms of energy (petroleum products especially) a different form of *implicit subsidy* can arise when the country is a producer of the energy source. The national energy company could be mandated to set domestic prices just above cost-recovery levels but below the international price they would receive if they had exported the product instead (export-parity). There is no financial loss to the company and no quasi-fiscal deficit, but there is an opportunity loss through not setting the domestic price at the export price level. This constitutes a quasi-fiscal activity and is an implicit subsidy as explained by Petri, Taube, and Tsyvinski (2002). In an extreme case where domestic prices were set below cost-recovery levels, there would also be a quasi-fiscal deficit of the amount equal to the loss due to the difference between the domestic price and the domestic cost-recovery level. In the case of member countries of OPEC that have production quotas, the opportunity cost of the oil is then the larger of the marginal cost of production and the discounted value of an additional barrel of unproduced oil. The implicit subsidy is the difference between this opportunity cost and the domestic selling price. Estimates based on valuing opportunity cost at the international price would tend to overstate the amount of subsidy in this case.

Faced with rising international energy prices, some governments reduced the taxation of fuels in the last few years. This loss of revenue meant that other fiscal adjustments (present or future) were needed to offset its effects. This effect is referred to as a *tax subsidy*. A tax subsidy is defined with reference to a normative or baseline tax system, and can be considered explicit in the budget if the normative tax can be defined. A normative tax system would take into account the optimum structure of taxes required to achieve the government's social objectives. The calculation of this set of optimal taxes is complex, and calculations of tax subsidies as deviations from this normative baseline may use a simpler reference framework in order to arrive at an operational valuation of this amount of subsidy.

Measurement of Subsidies

The definition given above for identifying the presence of a subsidy leads to a framework for measuring the magnitude of the subsidy in cases where either the costs of production, or prices charged to consumers, are affected by the subsidy. This leads to the price gap approach that can be applied with varying levels of complexity, as explained below.

However, as the IEA (1999), the European Environment Agency (EEA 2004), and Koplow (2009) make clear, there are various categories of subsidies that do not affect producer costs or prices, but that do have costs to the government and do affect the supply and demand for energy. These include public research and development expenditures, preferential tax treatments for sub-groups of producers, lending and loan guarantees, and various forms of regulation.

Where subsidies are directly funded out of the government budget, it is possible to identify the total transfers to producers and consumers to evaluate the explicit subsidy component. The difficulty with this approach is that of standardization. Even the European Union has not been able to agree a uniform format for evaluating subsidies, except for on-budget state aid to the coal industry. Earlier studies of the European Union by Oosterhuis (2001) and the European Commission (2003) were not able to provide a basis on which a regular evaluation of explicit subsidies could be conducted. Studies of individual countries would need to work with whatever level of detail is available in the fiscal accounts to identify such explicit subsidies.

Three methods of quantifying the magnitude of subsidies have been proposed. These are (1) the price-gap approach; (2) the program-specific approach; and (3) the measure of producer or consumer subsidy equivalent. The price gap approach constitutes a measure of the difference between observed prices and a reference price that would prevail in a competitive (efficient) market with no price intervention or support to producers. The program-specific approach attempts to measure the value transferred to stakeholders from a particular government intervention. A fuller picture is provided by the producer or consumer subsidy equivalent. This is a mix of the first two, but is a more data-intensive measurement approach. An overview of these approaches, their strengths, and their weaknesses is shown in Table 2. All of these methods are partial and provide only a limited view of the extent of subsidies.

A commonly used method of measuring consumer subsidies follows an approach that is capable of standardization across countries and over time. The key to this measurement is the reference price of the energy commodity. This is the efficient price that would exist in the absence of subsidies and corresponds to the price that would prevail in a competitive market. The difference between the reference price and the price charged to consumers is the subsidy, and it has to be financed either explicitly or implicitly by the government. For traded goods, where there are no import or export restrictions, the reference price corresponds to the international price adjusted for transport and internal distribution costs (import or export-parity). Where the energy commodity is not traded, the reference price is given by the domestic cost of supply. For the different sources of energy, the calculations are based on the same underlying approach but involve distinctly different calculations.

The use of the international price as a reference when energy is traded is based on arguments of opportunity cost. For a country that can export energy the true value of production at the margin is what it could obtain on the international market. If the country can produce at a cost that is lower than the international price, domestic production should be valued at international prices rather than at domestic supply costs. For an importing country the true cost of the energy is the import price.

Table 2: Overview of Subsidy Measurement Approaches

Approach / description	Strengths	Limitations
Price gap: Evaluates positive or negative gaps between the domestic price of energy and the delivered price of comparable products imported or exported, or the cost of efficient market supply	1) Can be estimated with relatively little data; useful for multi-country studies 2) Good indicator of pricing and trade distortions	1) Sensitive to assumptions regarding efficient market and transport prices 2) Understates full value of supports because ignores transfers that do not affect prices
Program specific: Quantifies value of specific government programs to particular industries; aggregates programs into overall level of support	1) Captures transfers whether or not they affect end-market prices 2) Can capture intermediation value (which is higher than the direct cost of government lending and insurance)	1) Does not address questions of ultimate incidence or pricing distortions 2) Sensitive to decisions on what programs to include
Producer subsidy equivalent / consumer subsidy equivalent: Systematic method to aggregate transfers plus market supports to particular industries	1) Integrates transfers with market supports into holistic measurement of support 2) Separates effects on producer and consumer markets	1) Data intensive 2) Little empirical producer subsidy equivalent / consumer subsidy equivalent: data needed primarily for fossil fuel markets

Source: Koplow 2004.

Koplow (2009) presents an assessment of the price gap approach. This approach is useful in particular for identifying consumer-side subsidy rates, and thus also the magnitude of any inefficiencies that may result from such subsidies. The interpretation of the price gap is straightforward and suitable for standard measurement across countries. It may present fewer difficulties than some other measures (aiming in particular at identifying producer-side subsidies) in terms of data requirements.

One disadvantage is that its simpler conceptualization leaves unaccounted many forms of non-cash, non-price-affecting subsidies. If an inefficient producer is subsidized and domestic costs are as high as or higher than import parity levels, the price-gap approach would not identify the existence of the subsidy, even in cases where producers are given subsidies in cash from the government. Consequently, the IEA considers the price gap approach as a lower bound for the impacts of subsidies on economic efficiency and trade. As Koplow (2009) explains, the price gap measure "is often presumed to be a proxy for the aggregate impact of the existing set of policies on market prices within the country". He discusses the benefits and limitations of the approach. Strengths and weaknesses relate to the use of the price-gap measure as opposed to other measures of subsidies, and to the problems of actually implementing the price-gap approach itself.

The IEA database and statistical service provide much of the needed information required for calculation of energy subsidies based on the price gap approach. Some of the information can be freely downloaded from the IEA website (available at www.iea.org/stats/index.asp). Restricted information can be accessed through World Bank-IMF database services.

In addition, the IEA's "Energy Efficiency Policies and Measures Database" (available at www.iea.org/textbase/pm/ee_background.htm) provides information on policies and measures taken or planned to improve energy efficiency, including incentives or subsidies conferred through the following channels:

- Feed-in tariffs
- Grants
- Preferential loans
- Rebates
- Third party financing.

It also records other policy interventions that would qualify as subsidies according to Koplow, including

- financial support (by means of tax incentives),
- public investment in research and development,
- regulatory instruments, and
- tradable permits.

The database covers measures in IEA member countries,[5] Brazil, China, the European Union, India, Mexico, the Russian Federation, and South Africa. This online service aims to complement the policy analysis carried out by the IEA on energy efficiency improvements and climate change mitigation.

The U.S. Agency for International Development (USAID) analyzed best practices in subsidy policy and reform and estimates the cost of energy subsidies for several categories of energy commodities in the United States and selected countries (USAID 2004). It describes existing subsidies and provides a set of criteria for evaluating these subsidies, thus generating a framework for a proper energy subsidy reform. Morgan (2007) surveyed different approaches to measuring energy subsidies and quoted figures from several different sources.

The price gap approach to subsidy measurement formed the basis of calculations made by the IEA (1999, 2008, 2009, and forthcoming). In addressing the need to take action to mitigate global GHG emissions, the extra energy use encouraged by the presence of subsidized prices on a large scale is a concern. The removal or reduction of such subsidies would slow down the growth of emissions while at the same time improving the fiscal balance and energy security in the countries following such policies. The IEA estimated consumer energy subsidies using the price gap approach for the group of non-OECD countries that were the largest energy consumers (accounting for 80 percent of non-OECD primary energy consumption) (IEA 2008). Koplow (2009) provides numerical values derived from the IEA of subsidies in current U.S. dollars. These figures indicate that energy consumer subsidies were substantial relative to GDP in most of the large energy-using non-OECD countries. With the exception of Brazil, the

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[5] IEA member countries are Australia, Austria, Belgium, Canada, Czech Republic, Denmark, Finland, France, Germany, Greece, Hungary, Ireland, Italy, Japan, the Republic of Korea, Luxembourg, Netherlands, New Zealand, Norway, Poland, Portugal, Slovak Republic, Spain, Sweden, Switzerland, Turkey, United Kingdom, and the United States.

shares of total energy consumer subsidies to GDP, especially for oil, were very high for the oil-producing countries within the group.

For petroleum products Baig et al. (2007) estimated both explicit and implicit petroleum product subsidies as a percentage of GDP for a number of developing countries. The results are shown in annex table A.1. In some countries (notably Azerbaijan) explicit and implicit subsidies were both substantial.

Traded sources of energy

Oil and gas are widely traded on the international market. Although the vast majority of coal consumed is not yet internationally traded, the share of coal that crosses national borders has been rising. Subsidies on internationally traded commodities need to take the world price into account. A number of adjustments are needed to convert the international price into a reference price for domestic consumers. These relate to the following:

- International transport and insurance costs
- Internal transportation and distribution costs
- Quality adjustments
- Contractual basis of pricing
- Internal taxes.

International transportation and insurance costs have to be paid on imported commodities and form part of the reference price, while for exported commodities the country can receive only the price excluding international transport and insurance. The first component of the reference price is therefore linked to the import border price—cost insurance and freight (cif)—for imported commodities, and to the export border price—free on board (fob)—for exported commodities. The calculation of the border price itself (whether import or export) may require further adjustment. For example, petroleum product prices are published with reference to a particular hub (for example Rotterdam or Singapore) and need to take shipping costs from the hub to the specific country into account. Such costs are not always available on a country- and product-specific basis. The IMF (2010) used a factor of $0.10 per liter for all petroleum products and all countries for the costs of international shipping between the hub and the country. This is clearly a first-order approximation that can benefit from refinement where country-specific data are available: small landlocked, remote, or island economies usually incur much higher transportation costs than larger, more conveniently located markets. For exporters this margin is subtracted from the hub price to give the border price, while for importers this margin is added to the hub price.

Internal transportation and distribution costs have to be added to international prices, for both exported and imported commodities, to allow for the difference between the price at the border and the price to consumer. Details of breakdown of such costs are not generally available and some simplifying assumption is usually made with respect to this item. The IMF (2010) assumed that the internal distribution and retailing cost, based on US experience, was also $0.10 per liter for petroleum products. For gas, where there is usually a pipeline distribution system, the costs from the border to user may be available on a country-specific basis. The treatment of internal transport costs can take into account the difference between transporting for export and transporting to the user. For example, the IEA's sample calculation for China, at that time an exporter of coal, subtracted the transport cost from mine-mouth to export terminal from the export price to give the mine-mouth equivalent. It then added the internal transport cost to the user to give the delivered cost that could be compared to the actual consumer price charged (IEA 1999). Petroleum products for exporters leave from the refinery, but these tend to be located near the port so that internal transport costs need to take into account the transport cost from the refinery to the user. For importers the transport cost is that from the terminal to the user.

For crude oil and coal there can be large differences in quality between the domestically produced product and the standard international commodity for which price quotations are available. Natural gas can also vary in its calorific content, and contracts are quoted based on the calorific value to standardize for quality. For the oil market it is petroleum products which are sold to consumers, rather than crude oil, and their international prices reflect the global market balance between supply and demand for different products and their quality. For products of different specifications (particularly with respect to sulfur content) the appropriate quality should be used to calculate the reference price. If products of the same quality are not available on the world market, assumptions have to be made to adjust for the quality differences. The existence of large quality differentials for coal, ranging from lignite to anthracite, means that domestic coal cannot be directly compared with internationally traded coal unless they are of similar quality. The IEA (1999) illustrated a calculation for Chinese export coal making an adjustment for the different calorific values and ash content of domestic and export coals and, although they suggested that there is a non-linear relation between quality and price, a strict proportionatility was used in sample calculations.

The international price data used to estimate border prices are normally taken from published sources. These are primarily spot prices, although for certain petroleum products and U.S. natural gas, futures price are also published. Because contract prices diverge from spot prices, there is a question of which international price to use as a reference. For gas and coal, if countries chose to export to achieve maximum market value, they would tend to receive the contract price, since they would not be likely to engage in a large amount of spot trade. Similarly for import prices, the relevant reference should be the contract price that they could have obtained through an import strategy. For crude oil or petroleum products countries engage in spot trade, and hence spot prices are appropriate for calculating the reference price. Studies of subsidies to petroleum products have mostly used international spot prices, while there are few studies that have quantified subsidies to gas or coal because they are traded mainly through contract prices, which are difficult to obtain. The IEA (1999) gives reference prices for all forms of energy (traded and non-traded) for four large producing countries. The source for these prices is the IEA's own database, which is based on spot prices or export unit values. The latter do take into account contract prices for that amount of export which is sold on a contract basis, and also allows for quality differences.

The treatment of taxes is important in making comparisons because actual tax rates vary considerably among countries, and because there may be taxes at both national and sub-national levels. The downward adjustment of taxes on energy commodities, following recent rises in international prices, has highlighted the possible importance of tax subsidies, in which taxes are set below the optimal level, or below the level at which non-energy commodities are taxed. The calculation of an optimal tax in practice is complicated and requires a good deal of information. It has to take into account the whole structure of taxation in order to match government expenditure needs, and then make adjustments for local externalities as well as distributional effects. It is generally agreed that, for energy commodities that are inputs into the production process, the optimal tax rate, excluding externality corrections, should be zero. Examples of the calculation of optimal taxes for gasoline are given by Parry and Small (2005) for the United States and the United Kingdom, and by Ley and Boccardo (2009) for the OECD countries, Brazil, Russia, India, China, and South Africa. The latter study concluded that the latter five countries, as well as the United States, undertax gasoline, resulting in a tax subsidy to consumers.

The IEA (1999) recommended that the level of value-added tax be included in the reference price for forms of energy sold to end-users, on the grounds that this approximates the general rate of taxation required on all consumer goods. For petroleum products this would exclude excise duties, which raise substantial government revenue in many countries. Excise duties reflect attempts to incorporate Ramsay pricing[6] on goods for which demand is price inelastic and capture distributional concerns in that certain petroleum products are more intensively consumed by higher-income households. The IMF (2010) included in the reference price for petroleum products a tax of $0.30 per liter, suggesting that the optimal tax rates for all petroleum products would be similar to leading order. Other studies, such as Shah and Larsen (1992), carried out subsidy calculations on a net-of-tax basis.

The practical difficulty of calculating any form of optimal tax for a country where information is scarce means that the calculation of the tax subsidy element of prices would be difficult to carry out on a comparable basis for a number of countries. The distinctions between universal price subsidies and low petroleum product tax rates are not always clear. Some governments levy high fuel taxes and provide subsidies; others may levy low taxes and provide no subsidies. The result may be identical: end users pay lower prices, and government collects lower net revenue from the downstream petroleum sector, than they would otherwise.

For individual country analysis it may be possible to construct a meaningful estimate of the tax subsidy, so that changes over time reflecting variations in actual tax rates charged (including excise duties) are reflected in variations in the calculated total effective subsidy. In countries where detailed information on actual tax rates charged is difficult to obtain, the gap between the reference price and the retail price may have to include the actual tax component in the latter price. Even when this gap indicates that the retail price is above the reference price, suggesting that the good is not being subsidized, this need not be the case. Where the government has controlled retail prices so that the net-of-tax price would be below the reference price, there is a subsidy as well as a tax. Either the government must compensate the companies for this margin or else their long-term financial position will deteriorate.

In summary, to calculate the total consumer subsidy using the price gap approach on a tradable source of energy for a particular year, the following steps need to be taken:

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[6] The Ramsey theory of taxation recommends higher tax rates on goods with the most inelastic demand as a means of raising a given amount of revenue in the most efficient way possible.

1. Establish the average retail price for the year (with and without taxes if possible).
2. Estimate the total sales to consumers during the year.
3. Identify the local product quality and the international traded commodity equivalent.
4. Identify the relevant international hub and the price at that hub for the traded commodity averaged over the year.
5. Where the quality differences are large, adjust the international price to bring it to an equivalent quality basis. This adjustment is likely to be needed especially for coal, where a price adjustment related to calorific value and ash content could be made.
6. Identify the international transport and insurance costs per unit from the hub to the border averaged over the year, and add these for an imported commodity and subtract for an exported commodity to arrive at cif or fob prices, respectively.
7. For an export commodity, identify the transport cost from the border to the point of domestic production (mine-mouth) and subtract from the border fob price.
8. Identify the internal distribution costs (from mine-mouth, terminal, or domestic refinery to the consumer) per unit averaged over the year, and add these to the border price.
9. Depending on tax information available, add the local per-unit tax averaged over the year to the price calculated in step 8.
10. Calculate the price gap as the difference between the average reference price and the average domestic retail price over the year.
11. Calculate the total subsidy as the product of the price gap and the total sales during the year.

The case of coal in China, taken from the IEA, is presented in box 3.

Box 3: Calculating the reference price for steam coal in China as an exporter

1. Export (fob) price of coal was 266 yuan per tonne.
2. Calorific quality of export coal was 0.531 , and for domestic household coal was 0.499. Hence export price for same calorific quality as domestic household coal was 266 × 0.499 ÷ 0.531 = 250 yuan/tonne.
3. Discount for other quality differentials (ash and sulfur) was 50 yuan so export price for identical coal quality to household use was 200 yuan/tonne.
4. Transport cost from mine-mouth to export terminal was 79 yuan/tonne, so value at mine-mouth was 121 yuan per tonne.
5. Domestic distribution and transportation costs from mine to households were 149 yuan/tonne, so household door equivalent was 270 yuan/tonne.
6. VAT, as was charged on coal sales, was 13 percent so that final reference price to consumers was 305 yuan/tonne.

The reference price can be compared with the actual household price paid per tonne to determine the opportunity loss of not exporting the coal, which would be entirely an implicit subsidy in the case where the actual price charged covered the costs of domestic production.

Source: IEA 1999.

Non-traded sources of energy

In most developing countries electricity is a non-traded good, since there are rarely sufficient interconnections to permit substantial import or export. Where substantial electricity can be traded, the border price should be used in calculations of subsidies. Where there is little effective trade, the reference price must be based on domestic costs of supply as the only feasible comparator. For domestically produced gas or coal, where there is no export and import terminal, a similar consideration applies.

For the non-traded good there is no international transport cost adjustment to be made, because the reference price is based on the costs of domestic supply. That is, the reference price and the actual price relate to idealized supply and the actual product supplied at the identical location. However, the particular nature of the power sector and its commercial arrangements leads to other adjustments to take into account any difference between the amount of electricity produced and the amount paid for. Since any shortfall in payments will have to be covered by the utility or the government, this also constitutes a subsidy to users.

For the power sector the World Bank and the IMF have carried out a number of studies estimating the price gap or quasi-fiscal activity. The objective of these studies has not been to permit a global aggregation that relates to GHG emissions and their potential for reduction, as was the case for some studies relating to of petroleum products, but rather to provide insight onto the fiscal and sector implications of the pricing policy. Petri, Taube, and Tsyvinski (2002) suggested two alternative approaches to estimating the quasi-fiscal activities of the power sector. The end-product approach is a generalization of the conventional price gap approach, but allows for failure to collect bills on the energy sent out. The financial-balance approach also adjusts for underinvestment, the underpricing of inputs, and arrears on inputs and taxes. Although the financial-balance approach would give a fuller picture of the financial state of the utility, the data requirements are such that it was not used in the paper and would be difficult to apply in many countries.

The end-product approach was generalized to the so-called hidden cost calculator by Ebinger (2006) and by Saavalainen and ten Berge (2006) to take into account excess costs of producing electricity (or natural gas) that are not covered by tariff revenues and that require an explicit or implicit subsidy. If the company were run efficiently, costs would be covered by revenues, but there are a number of factors that lead to a hidden cost of production:

- Tariffs may be set below efficient cost levels.
- There is a failure to actually bill some known users.
- There is theft by non-registered users, or meter tampering by registered users, resulting in use that is not billed or is under-billed.
- Some users do not pay the bills but continue to be served.
- There are excessive physical (technical) losses in transmission and distribution that would not be included in the costs of a well-run company.

All of these result in a loss of revenue relative to an efficient level of costs and have to be covered financially either by a direct subsidy from the government or by reducing other costs (such as maintenance and required investment). Although technical and commercial losses apply to all forms of energy, they are relevant mostly for electricity and natural gas. The sections that follow focus primarily on electricity. The measure of efficiency under investigation by the hidden cost calculator is productive efficiency, but there may also be allocative inefficiency which is not considered in the hidden cost calculation.

The issue of technical losses is known to be important in many countries. Some losses are inevitable because energy is used in the transmission and distribution process. However, there are a large number of design adjustments that can help to reduce these losses. Given the design characteristics of the system, there are performance norms that are conventionally used to estimate what would be an acceptable level of transmission and distribution technical losses, and efficient costs would be related to this level of losses.

Commercial losses include theft, either through illegal connections or by some form of meter tampering. For both of these categories the company is unable to bill the user and hence is supplying electricity for free. This results in a loss that has to be financed by other means, and in effect is a subsidy to these groups of users.

As well as theft, for which no invoice can be sent out but which can be reduced by more extensive supervision and better metering, the company may fail to bill some known users, or not insist that other known users pay what is due according to meter readings. In some countries non-paying users may include government departments for which it would be difficult to stop supply. In all these cases the loss of revenue on electricity sent out will have to be carried by the utility or by other users through a cross-subsidy. The sum of technical losses, commercial losses, and non-realization of billed demand may be referred to as the aggregate technical and commercial loss. To allocate losses to these various categories, data collected by utilities identifies electricity sent out and electricity billed. From the data collected it is possible to estimate the actual loss rate (theft plus technical loss) and the bill collection rate.

The hidden cost is the difference between the revenue that the utility would receive were it to be in operation with cost-recovery tariffs based on efficient operation (net of taxes), with normal losses and with full bill collection, and the actual receipts. It is wider than a conventional price-gap measure since it not only includes the gap between actual costs and prices, but also the gap between costs of an efficient firm and actual costs. The gap could be covered by some combination of an explicit subsidy, paid to the utility, and an implicit subsidy in which the utility is left to bear the revenue shortfall. Depending on the balance of financing used, the hidden cost calculator may include both producer and consumer subsidies. Using these values the hidden cost calculator equation is expressed as

$$H = Qe\,(Tc - Te) + Qe\,Tc\,(\lambda m - \lambda n) / (1 - \lambda m) + Qe\,Te\,(1 - Rct) \tag{1}$$

where

H = hidden cost

Qe = end-user consumption volume

Tc = average cost-recovery price at a technical loss rate of λn and full bill collection

Te = weighted average end-use tariff

λm = total loss rate

λn = normative loss rate

Rct = bill collection rate.

The three terms of hidden costs are the sum of the underpricing effect, the unaccounted loss effect, and the collection failure effect. To calculate the hidden cost, data from utility performance for a country are required, and lack of such data or inaccuracies will limit the precision of the estimates of total hidden costs. Actual end-use tariffs, loss rates, bill collection rates, and energy sent out are usually collected and are updated on a yearly basis. The two factors that are not readily available are the normative losses and the cost-recovery price. The former may be taken from international norms, making allowance for the nature of the system. For example, data published by the World Bank (2009a) indicates that transmission and distribution losses (including theft) in 2006 averaged 6 percent of output in high-income countries and 12 percent in middle-income countries. By contrast, South Asia averaged 24 percent and Latin America and the Caribbean averaged 16 percent. Ebinger (2006), in the analysis of 20 countries in Eastern Europea and Central Asia (ECA), and Briceño-Garmendia, Smits, and Foster (2008) in an analysis of 21 SSA power utilities suggested that 10 percent could be taken as normative for power (and 2 percent for gas) in the absence of other information.

The determination of the cost-recovery tariff is based on the costs of supply, assuming normative losses, and includes maintenance and repair costs but not costs of capacity expansion. In this respect it is not the true long-run marginal cost of supply, but rather the short-run average cost. These costs were estimated in the above two World Bank studies by country specialists with knowledge of the individual power systems and access to utility data. The estimation of the hidden-cost calculator for these 41 developing countries indicates that extension to other regions and countries would be feasible if required, and already provides a base for country-level evaluations of the magnitude of power sector subsidies and the elements contributing to their magnitude. Where there are inaccuracies in the data provided by the utility, such as underestimating end-user consumption, losses may be understated.

For the above ECA study, results were derived for the power and gas sectors for the 20 countries for each year from 2000 to 2003. Estimates for 2004 and 2005 were prepared but not published. For the SSA study estimates were made for the power sector for the 21 countries averaged over the period 2001 to 2006. The shares of the three components in total hidden costs for the two regions on an aggregate basis are shown in Table 3 while details of total hidden costs as a share of GDP in individual countries are shown in annex tables A.2–A.4.

Table 3: Percentage Shares of Cost Components in Total Hidden Costs of Power for Eastern Europe and Central Asia (2000–2003) and for Sub-Saharan Africa (2001–2006)

Region	Underpricing	Unaccounted losses	Collection failure
ECA (20 countries)	72	16	11
SSA[a] (21 countries)	62	16	17

Sources: Ebinger 2006; Briceño-Garmendia, Smits, and Foster 2008.

a. Total for SSA does not add to 100 percent because country level data have been weighted by GDP shares.

In both regions underpricing was the dominant source of hidden costs and hence required the largest subsidy (either implicit or explicit). However, the sum of unaccounted losses and collection failure was responsible for at least one quarter of total losses. Even in the absence of policies to reform prices because of concerns about the effects on consumers, utilities in these countries had the opportunity to raise revenues or reduce costs considerably, and hence improve the viability of the sector and reduce the need for long-term government support.

Annex table A.2 reveals that, in many countries in the ECA region at the beginning of the period analyzed, hidden costs in power were equivalent to a very large share of GDP. The majority of countries experienced substantial reductions in this share by 2003, but for some the size of the subsidy was still large even at the end of the period. The detailed tables in the report showing the breakdown between the three cost components enabled individual countries to see where their losses were arising. For many, underpricing was the major source of loss, but for some (such as Croatia) bill collection failures were important, and for others (such as Georgia) unaccounted losses were the largest component. The hidden costs in the natural gas sector in ECA shown in table A.3 were much smaller than those in the power sector, and also tended to decrease over the period. However some countries still experienced a total hidden cost for natural gas of more than one percent of GDP at the end of the period. The hidden costs of power in Sub-Saharan Africa in the period 2001–2006, shown in table A.4, were generally smaller than those in ECA but still amounted to a substantial share of GDP in some countries—reaching more than 4 percent of GDP in Malawi and the Democratic Republic of the Congo.

In the hidden-cost framework, underpricing and collection failure can be seen as direct subsidies to consumers, who are paying less than the costs of supplying them. The unaccounted losses include both theft and technical losses in transmission and distribution. The former are clearly a subsidy to those illegally connected or who have tampered with the meter, but the latter component is either a producer subsidy if tariffs do not reflect this aspect of costs and the government eventually bear the cost, or a transfer from consumers to producers if tariffs have been adjusted to reflect high losses. If the utility collected sufficient information to separate these two components, it would be possible to identify the effects of underpricing, collection failure, and illegal consumption.

The use of a reference price based on a cost-recovery tariff assuming normal losses and full bill collection raises two conceptual issues:

1. Cost recovery should ideally relate to the cost of an efficiently run company. In addition to technical and commercial losses as defined in the hidden cost calculator, the company may also

suffer from inefficiencies such as over-staffing (extra labor taken on for job creation rather than to facilitate extra production), in which case the costs have to be carried by those paying the tariffs, or else through the company increasing its losses. Governments may even extend subsidies to state-owned utilities to cover losses created by employment creation policies. The tolerance of excessive costs leads to the need for a subsidy, whether explicit, implicit, or a cross-subsidy. Because excess labor appears to be common in many state-owned utilities, the hidden-cost calculator could be extended to base the calculation of cost recovery on a benchmark labor utilization figure, thus providing a fourth source of costs carried by the utility that require subsidies. Similarly, utilities suffering from lack of investment funds will under-invest in maintenance, with a resulting increase in technical losses.

2. System expansion requires capital expenditure. Most calculations of normal costs have excluded costs of new investment, partly because of the difficulty of obtaining sufficient details of utility expansion plans, and partly because subsidies are related to benefits accruing at the present time to current users, rather than to future users or existing users at higher usage levels. However, because expansion of the power sector is important in all developing countries, especially those with shortages or with low rates of access, merely covering costs in an efficient manner would be inadequate to finance such expansion.

Energy Subsidies and the Economy

To obtain a full understanding of the role of subsidies, it is necessary to be able to evaluate their impact on other sectors and on the macro-economy. Models of the impact of subsidies look at their relation to growth as well as their immediate effects and carry out dynamic analysis. Such models use financial programming tools, computable general equilibrium (CGE) models, and integrative models that combine a CGE model with modules that attempt to assess distributional effects of energy subsidies. Certain energy subsidies may have local and global external effects on sectors and economies beyond their immediate origin, and these externalities also need to be taken into account.

Although the comparative static, partial equilibrium approach corresponds to the realm of microeconomic analysis, a brief description is included because it throws some light on the integrated macro-distributional approach and on the impact on externalities.

Macroeconomic Impacts from Subsidies: Overall Picture

Energy subsidies have a variety of different distributional and aggregate effects on the economy. Some of the most important are the following:

1. Energy subsidies directly affect government accounts, as they lead to a worsened fiscal balance due to larger government expenditures, smaller revenues, or net current transfers.
2. Energy subsidies are also likely to affect the balance of payments, because changes in prices of imports or exports subject to the subsidy affect trade flows via price and real exchange rate elasticities. Most directly, energy subsidies lead to increased domestic demand for imported, or potentially exportable, energy products, thus worsening the trade balance. When the induced demand changes are significant for the market as a whole, terms of trade may also change and these effects tend to be negative (positive) for fossil fuel importers (exporters). Energy subsidies may also divert consumption away from or toward other products, depending on their degree of substitutability or complementarity.
    - For energy exporting countries, subsidies represent the opportunity cost of forgone foreign exchange earnings, which in the case of countries with dwindling reserves or limited export capacity can be significant.
    - For energy importing countries where subsidies are used to prevent retail prices from rising as rapidly as import prices of energy, oil price hikes on the world market cause an immediate drain in the government accounts and in international foreign exchange reserves.
3. Subsidies also affect the long-run growth potential of an economy. One reason is that they may constitute an incentive or deterrent to innovation, technological development, and productivity growth, and affect individuals' decisions in the allocation of factors and distribution of consumption over time. They affect relative prices and investment decisions by the firm and may have significant adverse effects on allocation of resources across sectors and economic agents, due to these price signals not reflecting overall social costs of energy use.

4. A significant distortive effect is that on investment in physical plant, which may tend to be more energy-intensive in the presence of energy subsidies than in their absence. This is particularly harmful for infrastructure with very long lifetimes, which tend to entrench high energy consumption for a long period into the future.
5. A range of adverse secondary macroeconomic effects result from the existence of a constrained budget situation. One such problem is the reduced ability of governments to meet immediate fiscal needs during economic downturns, if a substantial fraction of fiscal space is used up by energy subsidies. The same applies to governments' ability to directly support low-income groups during downturns—a particularly compelling argument when much or most of energy subsidies flow to middle- or high-income households.

Government interventions by means of explicit or implicit subsidies to particular products are transmitted to other agents, markets, and to the economy in general, shifting relative prices and access to commodities, and thus create incentives for changes in individual behavior. From this perspective general equilibrium analysis of government interventions is generally thought to be the most appropriate way to understand their macroeconomic implications.

On the other hand, a single-market analysis of impacts of government interventions still has merits and offers valuable insights to policy makers. This is because it helps to shed some initial light on the rather complex issues pertaining to efficiency, equity, and distributional effects. Also, as explained below, when there are few subsidy beneficiaries and they can be easily isolated, so that there are only small spillover effects to other economic activities, a simpler model specification can be valuable.

The analysis of macroeconomic impacts begins by describing the areas within the sector classification of economic activities, government accounts, balance of payments, and trade that are directly linked to energy subsidies.

Sectors of Economic Activity

Using the United Nations' (UN's) Standard International Trade Classification, Revision 4 (SITC Rev4) or the International Standard Industrial Classification, Revision 4 (ISIC Rev4), it is possible to identify goods and services, or sectors of economic activity that are linked to subsidy-related energy products (see annex B).

However, as discussed, it is not always the case that energy subsidies accrue directly to products or producers of these commodities. Often, energy subsidies are granted to households or to other sectors of economic activities that use the commodities as an input in their productive processes. From this point of view, a more appropriate first approximation to measuring macro-economic impacts of energy subsidies will take into account the input-output, interlinked, multi-sector, multi-agent nature of economic activity. This approximation can, in turn, be made by looking at the so-called social accounting matrix (SAM). In the words of Lofgren et al. (2002), a SAM is "a comprehensive, economy-wide data framework, typically representing the economy of a nation. More technically, a SAM is a square matrix in which each account is represented by a row and a column. Each cell shows the payment from the account of its column to the account of its row. Thus, the incomes of an account appear along its row and its expenditures along its column. The underlying principle of double-entry accounting requires that, for each account in the SAM, total revenue (row total) equals total expenditure (column total)."

The general structure of the SAM is presented in annex C. Four groups of agents are aggregated in the annex: households, enterprises, government, and the rest of the world. "Activities" and "commodities" are normally disaggregated using a classification of economic activities, such as the UN ISIC. Highlighted in this SAM are the "cells" or transactions where government interventions under the form of subsidies have an impact on the flow of resources to activities, commodities, or agents of the economy. This way, one can trace effects of subsidies regardless of whether they are granted directly to households, private enterprises, or public enterprises; or whether they are granted via changes in prices of goods and services of final energy products or energy commodities. However, the SAM will not be able, by itself, to pick up the *secondary effects* that transmit within the system once behavioral changes occur as a result of the government intervention. For this to be accomplished, a general equilibrium analysis, by means of a CGE model, could be used.

For energy subsidies, the use of SAMs as a first approximation to direct effects from subsidies will benefit from the highest possible disaggregation of energy activities (ISIC) or products (SITC) so as to be able to pick up changes in specific government interventions that may not target all energy sources in general, but rather particular commodities or sub-sectors.

Government Accounts

Annex D presents IMF's Government Finance Statistics Manual 2001 classification of government expenditures (IMF 2001) which include monetary values of cash transfers to public and private firms (codes 251 and 252). Again, as explained above, these include just a fraction of all possible subsidies, namely, the cash transfers to public or private producers, and thus render an incomplete picture of the degree of intervention on the energy sector. As observed in the GFS's definition (box 1), one should also account for subsidies classified as social benefits or other expenses targeting households or not-for-profit institutions to have a more exact estimate of the magnitude of cash transfers. Government Finance Statistics Manual numbers, however, may often fail to provide a good approximation of the degree or intensity of government intervention in the energy sector, as different governments may have different preferences or mixes of cash and non-cash subsidies.

Nonetheless, it is common for government, in their budgetary analysis and forecast process, to produce estimates of expected expenditures on subsidies, based on assumptions on prices and quantity demanded of products. These constitute additional sources of information for sensitivity analysis to changes in energy policy.

Balance of Payments and Trade

Effects of energy subsidy policies on balance of payments can take a variety of forms, but the most important are the direct effects through changes in imports and exports of energy products. These can in principle be measured by means of the analysis of trade flows of energy or energy-related exportable products. In addition, there may be several more indirect effects, such as those coming via changed terms of trade and imports and exports of secondary products (as when subsidized energy is used as inputs in production of commodities that require other imports as inputs, or are exported). As explained by the United Nations the commodity structure of external trade flows of goods is analyzed using various internationally adopted commodity classifications that have different levels of detail and are based on different classification criteria. The basic reason for applying a goods nomenclature is "to be able to identify details of the commodities in order to satisfy a variety of purposes, including customs, statistical and analytical purposes, particularly for the presentation of external trade statistics with the most detailed commodity specifications"(UN 1998).

Partial Equilibrium Analysis: Comparative Statics

Distortions to optimal resource allocation result from the existence of imperfectly competitive markets, government interventions, or externalities arising from producers' or consumers' activities involving goods whose price does not incorporate the environment cost. Government interventions can occur via the application of taxes or subsidies, quantity restrictions, or any other policy that alters the outcomes from otherwise free market interactions.

Often, government interventions via taxes and subsidies are justified by arguments regarding the existence of market power, differences in social and private marginal valuations of products (externalities), or by equity considerations. With respect to subsidies justified on equity grounds, it is argued that the efficiency losses from the excess government expenditures above the sum of changes in consumer and producer surplus are more than compensated by the equity gains. The government's (normative) view is that benefits to targeted subsidized groups are socially more important than the benefits that other groups would obtain from government support. According to supporters of the subsidy, this aspect is not picked up by market price solutions.

Government interventions, by means of selective taxes or subsidies, result in a gap or wedge between the price consumers pay and the price producers receive for the targeted products. Welfare consequences of these types of interventions have been traditionally assessed under a single-market, comparative statics analysis. The analysis measures the resulting net economic change after considering all changes in consumers' and producers' surpluses, plus the changes in the government fiscal balance. Taken together, they yield the well-known deadweight (or efficiency) loss, which results from price distortions—linked to the intervention—that occur in a hypothetically competitive market, where pre-intervention prices would have equalized social and private marginal valuations of the product.

In the case of subsidies, efficiency losses occur because, in the absence of positive externalities, the gains in consumer and producer surplus are insufficient to compensate for the total government expenditures associated with the subsidy.

Externalities arise when the activities of some economic agents affect another agent's welfare or profits, and this impact is not fully accounted for (internalized) by the first agent. For example, a coal-fired power station that emits oxides of sulfur, causing damage to building materials or human health, imposes external costs.

Some types of energy generation and consumption produce greater external effects than others. Some of the external effects are largely local (such as carbon monoxide pollution), others (such as GHG emissions) are global, and some are transboundary and in between (e.g., acid rain or fine particulate pollution).

Since energy subsidies affect the type and quantity of both production and consumption of energy, they can play a significant role in correcting externalities (e.g., subsidies for cleaner technologies)[7] or a harmful role when they translate into incentives for less desirable sources or lead to over-consumption of energy when it is underpriced.

General Equilibrium Analysis

An obvious criticism of comparative-static analysis is the lack of regard for general equilibrium considerations. These are important for deadweight loss measures whenever a change in the price of a subsidized product affects the supply or demand in other markets that are subject to distortions, as discussed by Hines (1998). In what follows some of the most widely used methods for a dynamic, general-equilibrium analysis of changes in energy subsidy policies are described.

1. A financial programming tool: the Revised Minimum Standard Model (RMSM). RMSM is a macro simulation tool used for the analysis of macroeconomic policies and financial flows across developing countries. It models an economy by means of a comprehensive flow-of-funds framework. This includes the core national accounts as designed by the UN system, a representation of public sector accounts, stocks and flows from the monetary sector, and a representation of the rest of the world via a detailed specification of trade flows and of the balance of payments. An extended version (RMSM-X) also includes a stock-flow characterization of foreign debt. The model is used for policy analysis and for producing the standard World Bank reports such as the Country Assistance Strategies' annexes, and the Unified Survey through a linkage to World Bank's Live Database.

   RMSM uses a set of deterministic equations, a large number of assumptions, and the fundamental macroeconomic identities. it uses the flow of funds approach to discern, in a recursive manner, what values of certain endogenous variables are necessary to reach equilibrium simultaneously in every sector. It offers the user the possibility of generating a public, private, or a policy closure.

   RMSM can help analyze the impacts of changes in subsidies on the fiscal balance, on trade flows, on the external sector accounts, and on the real sector. The transmission mechanism of changes

[7] The European Community guidelines on state aid for environmental protection explicitly foresee that EU member states may grant operating aid, calculated on the basis of the external costs avoided, to new plants producing renewable energy.

in subsidies to sectors of the economy, via flow of funds, will depend, of course, on the way subsidies are introduced in the model. In the simplest specification, subsidies to local production are introduced as a fraction of GDP, whereas those to exported or imported products can be specified in U.S. dollars per unit. In a nutshell, changes in subsidies affect the fiscal balance via changes in current expenditures (or in net current transfers) and on the fiscal balance, which then may transmit to the monetary, private, and external sector via changes on public net domestic or foreign borrowing. In turn, changes in prices of imports or exports affect local demand or demand in the rest of the world via a specified price elasticity for the subsidized products.

A more realistic (albeit more complex) model specification may include the following additional transmission possibilities: changes in price indexes resulting from subsidy modifications, which may lead to changes in real monetary flows and in private consumption when the variable is specified in a behavioral way (this is, for the public and policy closures); changes in the real effective exchange rate for the subsidized items, which affects external trade of these products based on the assumed real effective exchange rate elasticity; and changes in private investment when investment is broken down by sectors that respond to changes in relative prices. RMSM allows for model extension and further detail complexity based on user needs.

Empirical applications of RMSM or financial programming models used for analyzing macroeconomic impacts from changes in subsidies can be found in Kannapiran (2002) and Serven (1990).

2. Computable general equilibrium models. Government interventions aimed at specific commodities will induce significant changes in the flow of resources across markets, beyond that of the targeted product. From this perspective, analyzing macroeconomic impacts and micro-level incidence by focusing on an isolated market (partial equilibrium analysis) may be misleading from both the quantitative and qualitative standpoint (IMF 1995). By the same token, an industry not directly subject to government intervention may be indirectly affected by the imposition of taxes or concessions of subsidies in other industries that produce inputs to, require output from, or are complementary or substitutes to the former.

   Under these circumstances, it is necessary to consider market interactions, observing relative changes in prices and resource flows, which have ultimate consequences on macroeconomic and distributional outcomes. Ignoring general equilibrium consequences of government interventions may be a safe, reasonable approach only if the considered sector is small in terms of economic activity compared to the rest of the economy and there are negligible substitutions or complementarities with other commodities. But when interactions are significant, a general equilibrium approach is necessary.

   A standard CGE model is a set of simultaneous equations that define the behavior of the economic actors and sectors considered to be relevant for the analysis, and that explain all of the payments across sectors recorded in an economy by means of the SAM described above.

The equations define the behavior of the different actors. In part, this behavior follows simple rules captured by fixed coefficients (for example, ad valorem tax rates). For production and consumption decisions, behavior is captured by nonlinear, first-order optimality conditions, that is, production and consumption decisions are driven by the maximization of profits and utility, respectively. The equations also include a set of constraints that have to be satisfied by the system as a whole but are not necessarily considered by any individual actor. These constraints cover markets (for factors and commodities) and macroeconomic aggregates (balances for savings-investment, the government, and the current account of the rest of the world). Integrative models combine elements from CGE models with individual or household level data for analyzing the distributional effects of given policies.

Empirical Studies of the Impacts of Energy Subsidies on the Macro-economy

A number of studies have constructed general equilibrium models to explore the impact of changing the rate of energy subsidies on the macro-economy of an individual country. A brief review of some applications of this type of modeling in the context of developing countries is presented.

1. Kancs (2007) developed a CGE model for assessing socio-economic effects of alternative renewable energy policies, applied to the bio-energy sector in Poland. The main sources of bio-energy considered were wood and straw for district and domestic heating and biogas. The multi-sector model integrated energy, the economy, and the environment in a single system, and allowed for comparative analysis by adjusting renewable energy policies or other macroeconomic conditions (such as world market prices). Distributional and welfare changes were subsequently analyzed. Scenarios included a 50 percent tax reduction for bio-energy (S1), the abolishment of fossil energy subsidies (S2), and a world market price increase of 50 percent for energy goods (S3). Scenario outcomes were decomposed into price, output, and welfare effects. Compared to a baseline case, output prices decreased by 2.26 percent in the bio-energy sector when indirect taxes are reduced by 50 percent; increased by 1.94 percent in the coal and peat sector when fossil energy subsidies were eliminated; and increased in the hydrocarbon sector (oil and natural gas) and the electricity-steam-hot water sector by 2.1 percent and 1.8 percent, respectively, when energy world prices were increased by 50 percent. Aggregate output in the bio-energy sector increased 6.4 percent in S1; output of the bio-energy and the oil plus natural gas rose by 3 percent and 1.7 percent, respectively, in S2; and the hydrocarbon sector, the bio-energy sector, and the electricity-steam-hot water sector increased by 4.0 percent, 1.5 percent, and 1.05 percent, respectively, in S3.
2. Essama-Nssah et al. (2007) employed an integrative approach to assess the impact of an oil shock in South Africa. The model combined a disaggregated CGE model to assess macro and structural implications of oil price changes. It also had a micro-simulation component that attempted to capture the heterogeneity of stakeholders affected by such price changes. The latter piece of the analysis was conducted under two alternative approaches: one that followed the envelope theorem (see Ravallion and Lokshin 2004) and another that followed a model of earnings generation (as in Bourguignon and Ferreira 2005). The model simulated two scenarios:

one of a 125 percent increase in the world price of imported crude and refined oil (equal to the price change observed between 2003 and 2006); and another equal to the first scenario plus a 30 percent increase in the world price of imported basic chemicals and a 6 percent increase in the world price of all other imported goods. The main results are summarized in Table 4. Bringing all these aspects together, the study also concluded that a 125 percent rise in the international price of oil, relative to that in the baseline year of 2003, would lower the per capita incomes of the bottom six deciles and raise those for the top four deciles. As a result the distribution of household welfare would become more unequal.

Table 4: Percentage Changes in Macro-economic Variables in South Africa Resulting from an Oil Price Shock

Variables[a]	Oil price shock	Oil & general price shock
Real exchange rate	16.2	22.4
Exports	7.7	9.1
Imports	-6.2	-10.3
Household consumption	-6.5	-8.8
Total investment	-7.0	-10.8
GDP (market prices)	-1.8	-2.5
Total employment	-2.1	-2.7
Consumer price index	1.9	2.7

Source: Essama-Nssah et al. 2007.
a. All monetary variables are measured in real terms.

3. ESMAP (2004) used a CGE model to simulate the effects of the removal of electricity subsidies in Mexico over the period 2000–2015 under the assumption that the increased government revenue from the subsidy removal would be spent on goods and transfers in the same proportion as historically. The overall effects at the macroeconomic level were small, with GDP, exports, imports, and employment all experiencing small declines. Welfare decreased for all income classes, but the poor were affected most because electricity subsidies were more important in proportionate terms for the lower-income households. However, the terminal capital stock increased as the fall in consumption led to more money being channeled to investment. An alternative scenario assumed that real wages were sticky downwards, and in this case there was a large fall in employment.
4. Clements, Jung, and Gupta (2003) constructed a CGE model to explore the impact of subsidy removal on petroleum products in Indonesia. Two scenarios were run. The first used a Keynesian scenario in which real output declined, leading to a fall in household incomes. The second was a non-Keynesian scenario that left aggregate output unchanged. In both scenarios the prices of all goods rose as a result of the subsidy removal. Although the higher-income households were more affected by the subsidy removal, the overall level of poverty in the economy increased, in part because employment fell among low-income households. The authors suggest that these results point to the need for targeted support to the poor if universal subsidies were to be removed.

This brief review indicates that a number of different approaches have been used to model general equilibrium effects of changes originating in the energy sector. Further development of these approaches is needed to give experience on which is likely to prove the most useful for further policy simulations at a country level.

Empirical Studies on the Link between Energy Subsidies and Global Greenhouse Gas Emissions

There has also been interest in analyzing the impact of reducing subsidies on the demand for fossil fuels, and hence on the emissions of CO_2, for groups of countries that would be large enough to make a difference at a global level. CGE models provide a tool for simulating such changes. Morgan (2007) and Ellis (2010) review selected studies of this type, and two representative studies are described below. By including the majority of economies in the model, it is possible to simulate the impact of different groups of countries adopting various policies to reduce global GHGs.

1. Larsen and Shah (1992) reviewed existing fossil fuel price regimes across the world and estimated global fossil fuel subsidies and their welfare costs. They used a price gap approach that estimated differences between domestic fuel prices and their opportunity cost referred to as world prices. World energy subsidies were estimated at $230 billion, or 0.9 percent of 1992 global GDP. A simple framework was used to estimate the impact of subsidy removal on global carbon emissions, based on the assumption that world prices of fossil fuels would not change in response to demand reduction in subsidizing countries. A second exercise incorporated changes in world prices and the resulting change in fuel consumption from a simple model for global demand of fossil fuels. Welfare estimations are made under both scenarios. In the first scenario the removal of all subsidies would result in a global reduction of carbon emissions by 9 percent, while the second scenario resulted in a global reduction of 4.5 percent. A third scenario examined a counterfactual on what OECD carbon taxes would be required to achieve world emission reductions similar to those achieved under a hypothetical elimination of fossil fuel subsidies. This last scenario indicated that, at the time of writing, a carbon tax in the range of $50–90 a tonne of carbon would be required.
2. Küster, Ellersdorfer, and Fahl (2007) presented a ten-region CGE model that included all major developed and developing economies for the evaluation of energy policy measures, with an emphasis on employment effects. Their model assumed an economy with a dual labor market that did not clear (due to minimum wages constraints, given the wage demand and supply curves) and a technologically detailed description of electricity generation. The model was applied to assess the economic and employment impacts of energy system decisions in the context of climate protection. The authors analyzed the effects of investment subsidy on electricity generation technologies using renewable energy sources in combination with, and in contrast to, emission caps as imposed by the Kyoto protocol on selected economies. Two scenarios were examined: a business-as-usual case that incorporated only Kyoto protocol GHG emission caps; and a counterfactual that had the same Kyoto protocol caps assumptions plus subsidies to renewable energy sources. Impacts on GDP, employment, and CO_2 emissions were

among the variables calculated. The introduction of capital subsidies for renewable sources of energy led to an increase in the share of renewable in generation mix, but at the same time the total amount of generation increased. The shift to renewable energy within the increased total generation meant that CO_2 from fuel combustion decreased in most countries but in some cases only slightly. The introduction of subsidies also decreased the level of GDP relative to the baseline case of no subsidies.

Incidence of Consumer Subsidies and Policies to Ameliorate the Effects of their Removal

Fuel and electricity subsidies often have as their justification the benefits of providing low-income households with energy at affordable prices. Suggestions that subsidies be reduced or removed are often met with opposition on the grounds of the increased cost to the poor. In this context, the evaluation of the extent to which energy subsidies are actually received by the poor is important.

Benefit Incidence, Beneficiary Incidence, and Materiality

The measurement of the performance of a consumer subsidy scheme has been described in detail by Komives et al. (2005). Their work, which focuses on the electricity and water sectors, proposes three dimensions of subsidy performance:

- Benefit incidence (how well the subsidy targets benefits to poor households as opposed to other households)
- Beneficiary incidence (what proportion of poor households as a whole receive the subsidy)
- Materiality (how significant is the amount of subsidy received by poor households).

It is possible to have a scheme in which the subsidies are well targeted (most of benefits go to poor households) but beneficiary incidence is low because only a few poor households actually receive the subsidy. Alternatively, a subsidy might reach most poor households and only poor households, but be small in value relative to household income.

The detailed measurement framework suggested to measure these indicators has been used in the context of electricity consumption, but if sufficient data are available, these indicators can be applied to all fuels purchased by households. The starting point is the benefit-targeting indicator (Ω), defined as the ratio of share of total benefits received by poor households to the proportion of households that are poor. If the indicator takes a value of unity, the scheme is neutral and the poor receive benefits in proportion to their numbers. A value greater than unity is progressive and a value less than unity is regressive, with non-poor households receiving a larger share of the total subsidy pool than their proportion in the population. Beneficiary incidence is measured by the exclusion rate—the percentage of poor households that do not receive the subsidy—while materiality is defined as the average value of the subsidy received by poor households benefitting from the subsidy as a percentage of their household income.

The benefit-targeting indicator can be shown to be equal to the product of five ratios:

$$\Omega = (A_p / A_H) \times (U_p / U_H) \times (T_p / T_H) \times (R_p / R_H) \times (Q_p / Q_H) \qquad (2)$$

where

A = percentage of households that have potential access to the energy source

U = percentage of households with access that are connected to the energy source

T = share of households that are connected that are eligible for the subsidy

R = average rate of subsidization for eligible households

Q = average quantity consumed by subsidy recipients

p = group of poor households

H = group of all households.

To compute Ω from these components it is necessary to have household survey data as well as information from the utility. From the survey, if information has been collected, it is possible to determine whether a household lives in an area where access is available, and if so whether it is connected (that is, uses the energy source). Without this information the factors have to be combined to yield the proportion of households using the energy source. The quantities consumed can also be determined from the household survey, possibly from expenditure information that can be used to back-calculate the quantity using information on the tariff or price charged to end-users. For electricity this requires knowledge of the tariff scheme in which different prices may apply to different blocks of consumption. Knowledge of the subsidy scheme will indicate which households are eligible. A universal subsidy would have a value of T of unity. The rate of subsidization is calculated from comparison of household consumption valued at cost-recovery prices and the actual payment.

To compare poor households with the population as a whole it is necessary to define the poverty level. This can be done either by identifying a national poverty line or by reference to some internationally agreed definition of poverty. For example, in a study by Angel-Urdinola and Wodon (2005) for Cape Verde, the national poverty line was set at 60 percent of median household expenditure for the year in question. All households below this level were considered poor and those above non-poor. Having identified the two groups of households and their energy consumption levels as well as the nature of the subsidy scheme, it is possible to construct the three performance measures.

The method outlined above can in principle be applied to both electricity and fuels. For petroleum products it is unlikely that there will be separate data on access and connection—information on whether kerosene or LPG are available at a location (allowing for normal distances travelled to purchase such products) is rarely available. Instead the data from household expenditure surveys can be used to determine whether a household uses a particular fuel. Petroleum products, if there is a subsidy to consumers, nearly always attract a universal subsidy with no change in the rate for the volume purchased. This is primarily because it is difficult to record quantities already purchased by a household that would allow differential pricing by quantity used per period. Electricity or natural gas can more easily discriminate between consumers and also by amount purchased. Accordingly, pricing schemes using increasing block tariffs or volume differentiated tariffs are commonly found. The various alternatives are discussed below. A volume differentiated tariff reaches only households whose metered consumption is below a certain threshold, while an increasing block tariff is universal but charges different amounts for successive amounts consumed. These features enter both Ω and the average rate of subsidization indicator.

Electricity Tariffs and Incidence

The study for Cape Verde investigated the power sector in which the lifeline first block of up to 40 kilowatt hours (kWh) per month was charged at $0.15 per kWh, and all amounts above 40 kWh were charged at $0.19 per kWh. To calculate the subsidy rate it was assumed that the second block rate corresponded to the cost of supply per unit. The results of the study on subsidy performance are shown in Table 5 .

Table 5: Benefit-Targeting Performance for Electricity in Cape Verde

Variable	Poor households	All households	Ratio
Share of HH with access (A)	0.72	0.82	0.88
Share of HH with access that are connected (U)	0.34	0.54	0.63
Share of connected HH who receive subsidy (T)	1.00	1.00	1.00
Rate of subsidization (R)	0.11	0.06	1.70
Average quantity consumed per month in kWh (Q)	56.8	111.7	0.51
Average HH expenditure per month in U.S. $	9.6	19.7	n.a.

Source: Angel-Urdinola and Wodon 2005 as reported in Komives et al. 2005.

Note: n.a. = not applicable.

The targeting performance indicator (Ω) was 0.48, indicating substantial regressivity of the subsidy scheme, while the exclusion rate of the poor was 76 percent (comprising the 28 percent of poor households without access and the 48 percent of poor households that have access but are not connected). For poor households the materiality of the subsidy was equivalent to 0.5 percent of their total household expenditure, and for non-poor households it amounted to 0.2 percent of expenditure. The poor performance of Ω in Cape Verde was due in large part to the much lower access and connection rates of the poor than those of the better-off. Where these are low the rate of subsidization (R) must be much higher for the poor than for the non-poor in order to compensate. The use of an increasing block tariff, resulting in a value of T equal to unity (all households benefit from the cheaper first block), also works against the subsidy being pro-poor. In a case like this, the two subsidy design features (R and T) would need to be substantially adjusted to offset the low rate of connection among poor households.

Angel-Urdinola and Wodon (2005) also simulated the effect of replacing an increasing block tariff with a volume differentiated tariff, where the threshold was the same as the first block of the increasing block tariff (40 kWh per month) and the price of those receiving the volume differentiated tariff was the same as that of the first block, while all others paid the full cost, namely the price of the second block. In this case the ratio of T_p to T_H rose to 1.99 (the subsidy was confined mainly to the poor), with the result that Ω rose to 1.06, showing slight progressivity. A similar study for Mexico by Komives et al. (2009) simulated various alternative subsidy schemes for electricity and found that means-tested discounts or a volume differentiated tariff would increase Ω. The high rate of connections meant that exclusion rates would be low under any scheme.

Komives et al. (2005) give the values of Ω and beneficiary incidence for electricity purchases in a number of countries. Annex table A.5 reports a series of calculations on subsidy performance in the power sector in various countries. These results confirm that, where there is almost universal connection (for example Croatia and Hungary), virtually no poor households are excluded from receiving some benefit from the subsidy program. Countries that relied on an increasing block tariff tended to have a regressive distribution of the total subsidy pool, while those that were able to use some more precise targeting criterion (such as a means-tested subsidy) had better benefit targeting and in some cases had a progressive structure of assistance to poor households. For Sub-Saharan Africa, where connection rates are low, a recent study by Foster and Briceño-Garmendia (2010) reported calculations by Banerjee et al. (2008) and Wodon (2008) indicating that Ω for electricity ranged between 2 and 80 percent for the 19 countries analyzed. That is, in all cases the subsidies were regressive, often severely so.

Electricity Connection Subsidies and Incidence

A similar approach can be used to analyze the performance of connection subsidies for electricity. Because existing connection rates are low and are largely confined to better-off households in low-income countries, a subsidy on new connections may have good benefit-targeting performance. In the case of Cape Verde Ω was 1.35, indicating that such a policy would be progressive. Foster and Briceño-Garmendia (2010) point out that the targeting performance of connection subsidies depends strongly on how the roll-out of new connections is made. In countries with low existing connection rates a roll-out policy that mirrored the existing pattern of household connections would tend to be regressive since these will tend to be the rich. A simulation for Sub-Saharan Africa indicated that where new connections mirrored the existing pattern Ω would be only 0.37; when only households beyond the reach of the existing network were connected Ω would rise to 0.95; and providing a connection subsidy equally likely to reach all unconnected households would raise Ω to 1.18 (a progressive result). This finding has to be seen in the context of the relative costs of the subsidy programs. Grid-based roll-outs that concentrate on connecting households in areas where there is already access (densification) are likely to be considerably less expensive per connection than roll-outs that seek to expand the area covered. In Lao PDR, a pilot power-to-the-poor program provided eligible households with a no-cost basic 3/9 ampere meter (low voltage) together with interest-free credit to cover additional costs of installation and indoor wiring. In the villages targeted this resulted in the connection rate increasing from 78 to 95 percent, and from 63 to 90 percent among female-headed households (Boatman and Chanthalinh 2009).

Petroleum Products Prices and Incidence

For petroleum products in virtually all cases subsidies are universal (T equals unity) and the rate of subsidy is constant for all quantities purchased, so that the ratio of the R factors is also unity whatever the level of subsidy. If the price paid by all users is the same, then using these two assumptions, it follows that Ω is equal to the ratio of the average expenditure of the poor to the average expenditure of all households on the fuel in question. This result makes it relatively simple to calculate what would be the benefit targeting performance of a universal, single rate subsidy, where there is pan-territorial pricing. In countries where prices are not uniform across the country, poor households tend to pay more than better-off households for petroleum products. Thus a given expenditure ratio would indicate a lower quantity ratio for the poor versus all households. This in turn means that Ω calculated from household expenditure rations would be an upper bound for the indicator. Where prices are substantially higher for the poor, then allocation of the subsidy pool would be considerably more regressive than indicated by the ratio of expenditures. Actual expenditure patterns for different countries can be used to simulate what would be Ω if such a subsidy scheme were to be applied in that country irrespective of the rate of the subsidy that would affect only materiality.

Based on the foregoing assumptions, Bacon, Bhattacharya, and Kojima (2010) used a series of household expenditure surveys to simulate Ω and the exclusion rate of the poor (E) (Table 6). The poor were defined as those households whose per capita incomes fall in the bottom 40 percent of the population. The simulation illustrates what would be the performance of the two indicators were the government to have introduced a flat-rate universal subsidy with pan-territorial pricing. For those countries where there were such subsidies the results would refer to actual performance.

Table 6: Benefit-targeting (Ω) and Exclusion (E) Indicators for Simulated Flat-Rate Universal Subsidies with Pan-Territorial Pricing on Petroleum Products in Selected Countries

Country	Ω	E	Ω	E	Ω	E
	Kerosene		LPG		Gasoline + diesel	
Bangladesh	0.96	10	—	—	0.07	99
Cambodia	1.09	11	0.02	99	—	—
India	0.99	5	0.05	98	0.04	99
Indonesia	0.72	11	0.02	99	0.21	91
Kenya	0.59	19	0.00	99	0.01	100
Pakistan	1.13	61	0.25	96	0.08	91
Thailand	1.45	99	0.51	82	0.38	30
Uganda	0.72	8	—	—	0.02	99
Vietnam	0.75	56	0.14	93	0.28	64

Source: Bacon, Bhattacharya, and Kojima 2010.

Note: — =information not available from household expenditure surveys.

The results show a very clear pattern for Ω. Focusing on kerosene consumed only by households, a subsidy on kerosene would be mildly progressive in some countries and only modestly regressive in the others. The proportion of the poor that would not have benefitted from such a subsidy (because they do not consume kerosene) would generally be low; although there are notable exceptions. In Pakistan, Thailand, and Vietnam, more than half the poor households did not use kerosene and the percentage of exclusion would have been correspondingly high. These findings should be interpreted with caution, however, because the data analyzed exclude kerosene consumed by other users. If diesel prices are higher, then subsidized kerosene is inevitably diverted to the automotive sector and added to diesel fuel because kerosene is a nearly perfect substitute for diesel. When this diversion is taken into account, a kerosene subsidy can become highly regressive. A study of the kerosene subsidy scheme in India found that subsidized kerosene consumed by households was evenly shared between the rich and the poor, but up to as much as half of subsidized kerosene might have been diverted to non-household users (ESMAP 2003a).

For LPG, gasoline, and diesel, Ω would be very low, indicating extreme regressivity. The main exception to this pattern was Thailand where the much higher per capita consumption and income (twice the next country, Indonesia, when measured at purchasing power parity) led to a wider-scale use of these fuels and a smaller difference in consumption between low-income and other households. The exclusion figures indicate that the great majority of the poor would be excluded from receiving any direct benefit from subsidies on LPG or gasoline and diesel. These simulated results based on the expenditure patterns of a variety of countries with different fuel use patterns and price levels suggest that subsidies on transportation fuels and LPG are likely to be strongly regressive in countries with low to moderate income levels.

Policy Tools to Protect the Poor[8]

If subsidies linked to the price of energy are to be phased out, there are a number of alternative policies that can provide direct assistance to the poor who would be adversely affected by the subsidy removal. These policies, known as social safety nets, can take a number of forms (Grosh et al. 2008). Direct transfers may include targeted cash payments, or near-cash payments (such as vouchers and food stamps), while indirect transfers may include fee waivers for essential services such as health, education, or transport. The advantage of these policies is their ability to be well targeted to the poor, resulting in a lower cost to the government to deliver the same benefits to low-income households. In particular, in countries where several different consumer goods are subsidized, there can be an important economy of scale and scope in using a social safety net program to protect poor households from the removal or reduction of all these different subsidies.

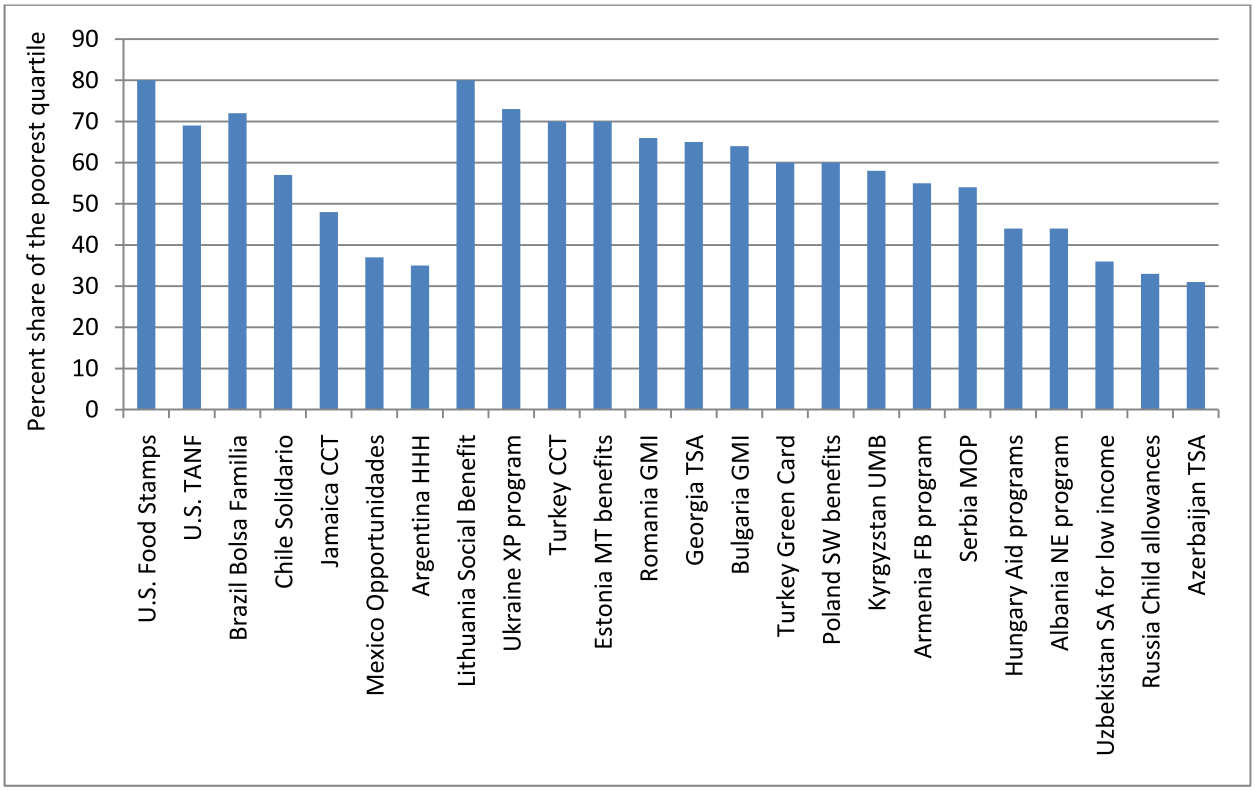
The use of targeted cash or near-cash programs has been relatively successful in ensuring that the benefits reach the poor. Out of 24 schemes analyzed for the period 2005–2008, two thirds were transferring more than half of the funds to the poorest quartile of the population (Figure 1).

Komives et al. (2007) compared the mean benefit-targeting performance of utility subsidies versus other targeting instruments. Although based on different samples of countries, the results shown in Table 7 give a clear picture. The average consumption subsidy for electricity is regressive, and only one in five of the 37 cases studied was progressive. By contrast, cash transfers and near-cash transfers (food stamps, etc.) were progressive in the great majority of cases studied.

[8] This section draws on the background work on social protection drafted by Bassam Ramadan and Lucian Pop for the World Bank's contribution to the "Analysis of the Scope of Energy Subsidies and Suggestions for the Implementation of Their Phasing Out," a joint report of the IEA, OPEC, OECD, and the World Bank for the April 23, 2010, meeting of G-20 finance ministers.

A number of different targeting methods have been used for trying to ensure that resources are directed to their intended recipients. These include individual or household assessments, categorical targeting, or self-targeting (Grosh et al. 2008). The different approaches have different costs of making the assessment and have different success rates of meeting the policy goals. However, the effectiveness and efficiency of targeted cash transfer schemes depend on both the targeting method and the administrative capacity. Where capacity is weak, the program may experience significant errors of exclusion (poor not receiving benefits) and inclusion (non-poor receiving benefits).

Figure 1: Share of Targeted Funds Reaching the Lowest Quartile of the Population



Source: Adapted from Vagliasindi (forthcoming).
Notes: TANF = temporary assistance for needy families, CCT = conditional cash transfer, HHH = Heads of Household, XP = program for the extremely poor, MT = means test, GMI = guaranteed minimum income, TSA = targeted social assistance, SW = social welfare, UMB = Unified Monthly Benefit, FB = family benefit, MOP = Material Support to Families Program, NE = Ndihma Ekonomike, SA = social assistance.

Table 7: Benefit-targeting Performance of Utility Subsidies Relative to Other Targeting Instruments

Type of transfer	Number of cases	Mean Ω	Range of Ω	Percentage of cases with progressive distribution (Ω > 1)
Electricity consumption subsidy	37	0.76	0.20–1.50	22
Cash transfers	28	1.53	0.40–3.47	82
Near cash transfers	16	1.26	0.58–1.63	94
Public works	4	2.30	1.48–4.0	100
Social funds	6	1.13	0.93–1.30	83
Food subsidy	15	0.84	0.28–1.23	27

Source: Komives et al. 2007.

The use of output-based aid can take the form of a connection subsidy. The aid is conditional on the service first being provided to the targeted households, which has the advantage of requiring the identification of the households that need the subsidies most. In Armenia grants were given for the fitting of gas heaters, and in Colombia connections for 35,000 homes to natural gas were financed in this way. A way of avoiding the long-term commitment of a universal energy subsidy is to use a transitional tariff subsidy that is phased out as user contributions increase over time.

The government also needs to be able to monitor and carry out the targeting scheme. The presence of low-level and high-level corruption can severely limit the effectiveness of targeted subsidy schemes, and add to the administrative cost that must be considered in deciding whether to implement a particular approach. A further difficulty for some schemes is that they can give incentives to certain members of the population to become eligible for receipt of the subsidy. Geographical targeting (with subsidies based on the location of the household's residence) may encourage households to relocate. Income-based schemes may create a poverty trap in which the benefits from increasing earned income are largely offset by the loss of benefits from subsidies contingent on earned income.

Patterns of Household Expenditure on Energy

To obtain a more detailed picture on materiality, household expenditure survey data can provide the shares of expenditure on electricity (or other forms of energy) by quintile. If this share declines at higher expenditure quintiles, materiality is pro-poor with a universal subsidy. The IMF and the World Bank have published a number of studies on household energy consumption. Some of these refer only to the expenditure on petroleum products and others just to the consumption of electricity. Komives et al. (2005) provide information on shares of household expenditure spent on electricity by quintile group for a number of countries. The shares for the bottom quintile and the top quintile are shown in annex table A.6. For most countries the share of household expenditure on electricity is greater for the lowest quintile than for the highest quintile, indicating that a universal constant subsidy would have greater materiality for the poor. However, the majority of such cases were either countries in the ECA region that had near universal connection because of historic policies, or high-income countries where most households were connected.

Material from a number of other studies is summarized in Bacon, Bhattacharya, and Kojima (forthcoming). Several of these studies refer just to expenditure on individual petroleum products, and some only to expenditure on electricity. The main patterns found for these countries (referred to as group 1 hereafter) are summarized in Table 8. Although this table does not indicate the extent of subsidies in the various countries it illustrates some relevant aspects of energy demand that relate to the incidence of any subsidies in these or similar countries. In half of the countries for which information was available the share of household expenditure on energy (excluding biomass) was greater than five percent of total household expenditure for the lowest quintile. To the extent that these countries are representative of a wider range of developing countries, the importance of commercial energy for low-income groups suggests that, where subsidies are prevalent across the energy sector, removal could have an important adverse direct effect on the standard of living of this group. For individual fuels the share of spending on kerosene fell across income groups in virtually all countries: kerosene is important for the poor and removal of subsidies is likely to hit such households hardest. By contrast, the share of expenditure on LPG and on gasoline rose with the income level—these are fuels of the better-off and subsidies may well not benefit the poor to a great extent. For electricity many surveys did not report expenditures, but where this was recorded the picture was mixed. The share rose with income in some countries, while it declined in others.

Table 8: Patterns of Energy Use from Selected Household Surveys (group 1)

Country	Year	Share of expenditure on energy of lowest quintile > 5%	Kerosene share falls with quintile group	Electricity share rises with quintile group	LPG share rises with quintile group	Gasoline share rises with quintile group
Angola	2005	Y	Y	N	N	Y
Bolivia (P)	2000	N	—	—	N	Y*
Brazil (C)	96–97	—	—	—	—	—
Gabon (P)	2005	—	Y	—	—	Y*
Ghana (C)	98–99	—	—	—	—	—
Ghana (P)	1999	Y	Y	—	Y	Y
Guatemala	2000	Y	—	—	—	—
Iran	1999	N	Y	N	—	Y
India (C)	99–00	—	Y	Y	Y	—
Jordan	02–03	Y	Y	N	N	Y
Madagascar	2005	N	Y	Y	—	Y
Mali	00–01	N	Y	Y	—	Y
Nepal (C)	95–96	—	—	—	—	—
Nicaragua (C)	1998	—	—	—	—	—
S. Africa (C)	93–94	—	—	—	—	—
Sri Lanka	1999	N	Y	Y	Y	Y*
Vietnam (C)	97–98	—	—	—	—	—
Yemen	2003	Y	Y	N	N	—

Source: Authors' calculations derived from World Bank 2005; Coady et al. 2006; ESMAP 2003a, 2003b, 2003c and 2005; Andriamihaja and Vecchi 2007.

Notes: Y = yes, N = no, — = not available. (C) indicates that survey focused on fuels for cooking and lighting. (P) indicates that survey focused on petroleum products only. Y* indicates that information related to both gasoline and diesel.

Bacon, Bhattacharya, and Kojima (2010) also analyzed a series of household expenditure surveys dating from the period 2004–2006, using a similar methodology in each case. The results they found for these countries (referred to as group 2) confirm those of the earlier surveys and are summarized in Table 9. The total expenditure on energy includes biomass and so the results on the share of expenditure on energy (third column in the two tables) are not directly comparable to those for the group 1 countries.

Table 9: Patterns of Energy Use from Selected Household Surveys (group 2)

Country	Year	Share of expenditure on energy of lowest quintile > 5%	Kerosene share falls with quintile group	Electricity share rises with quintile group	LPG share rises with quintile group	Gasoline share rises with quintile group
Bangladesh	2005	Y	Y	Y	ND	Y
Cambodia	2003–04	Y	Y	Y	Y	ND
India	2004–05	Y	Y	Y	Y	Y
Indonesia	2005	Y	N	N	Y	Y
Kenya	2005–06	N	Y	Y	Y	Y
Pakistan	2004–05	Y	Y	N	Y	Y
Thailand	2006	Y	Y	N	N	Y
Uganda	2005–06	Y	Y	Y	ND	Y
Vietnam	2006	Y	Y	Y	Y	Y

Source: Bacon, Bhattacharya, and Kojima 2010.
ND indicates that category was not included in survey.

This study also provides information on the expenditure shares by fuel as well as the degree of connection for each quintile. The findings for the bottom and top quintiles are reported in annex tables A.7 and A.8. With the exception of Thailand whose per capita income is considerably higher than in the other countries, the shares of expenditure on electricity, LPG, gasoline, and diesel are higher for the top quintile than for the bottom quintile, while the reverse is true for kerosene. In most countries the connection rate is also much lower for poorer households for electricity, LPG, gasoline, and diesel. In the majority of countries kerosene connection rates are highest for the bottom quintile.

The low rate of connection for electricity in so many developing countries, as documented in the Energy Strategy Approach Paper (World Bank 2009), indicates that untargeted subsidies for electricity in such countries could not be justified on the grounds that they are helping the poor. Similarly the figures cited above support the view that for LPG and gasoline subsidies would tend to go to the rich. Only for kerosene are such subsidies likely to be progressive and material in the absence of diversion, but diversion is difficult to avoid if there is rationing of subsidized kerosene—in which case subsidized kerosene will be diverted through the black market—or if diesel prices are higher. These findings suggest that governments should investigate whether a subsidy is worth keeping, and if it is whether it can be made more effective in reaching and benefiting poorer households through the use of a non-price based subsidy, such as a cash transfer.

A few governments have used cash transfers or other benefits as a direct form of support to low-income families at the time that oil prices were increasing or subsidies for energy products were being reduced (Bacon and Kojima 2006). Chile in 2005 compensated 5 million low-income households to offset the impacts of rising fuel prices, and another 1.6 million households whose electricity consumption was less than 150 kWh per month. A further payment to low-income families was made in 2006. In Thailand, when the diesel subsidy was terminated in 2005, the government accompanied this with social measures designed particularly to help the poor and those in rural areas. These measures included a pay rise for civil servants, higher pension payments, and a provision of a fund to support villages nationwide. In Ghana the government accompanied the removal of petroleum product subsidies with the elimination of fees at government-run primary and secondary schools and a program to improve public transport.

The case of Indonesia, as described by Widjaja (2009), Kojima (2009b), and the World Bank (2006), illustrates how redesigning a subsidy scheme can work to ensure benefits are better targeted to the poor. In 2005 the Government of Indonesia decided to reduce the large universal subsidies on gasoline, kerosene, and diesel by raising their domestic prices twice, resulting in increases of by 149, 186 and 161 percent respectively. To compensate lower-income households for this price increase, the government distributed to each eligible household identified a sum of 100,000 rupiah per month over a six month period in 2005–2006. In 2005 the definition of an eligible household was one where the per capita expenditure was 175,000 rupiah (around $17.5) per month. Calculations indicated that, without the targeted cash transfer scheme, the number of people living below the poverty line of 110,000 per month would have increased from 17 percent to 22 percent following the petroleum product subsidy reduction. The success of the targeting scheme in countering this effect depended on the ability of the scheme to reach eligible households. To this end the government commissioned a new survey of households and identified 15.5 million poor or near-poor households that fell below the eligibility ceiling. It was estimated that if all these households had received the full amount of the transfer the number of people below the poverty line would have risen by about 1 percentage point. In practice, during the first three months of the scheme, 94 percent claimed to have received 100 percent of the transfer, and during the second three months 90 percent claimed to have received the full amount. Based on these figures it was estimated that the percentage of people living below the poverty line as a result actually rose by about 2 percentage points. Analysis of expenditure patterns suggested that households in the bottom three deciles would have been fully compensated had the targeting been perfect, while the upper deciles would not have been fully compensated. This is explained by the fact that household expenditure increased modestly by decile for kerosene, but increased very sharply for gasoline, with the result that the total monthly petroleum product subsidy received per person before the price increase was just less than 10,000 rupiah for the lowest decile and was about 45,000 rupiah for the top decile. The partial replacement of universal subsidies by targeted cash transfers was markedly pro-poor, and also appeared to have a low exclusion rate. Some information was collected on how household spent the cash transfer and this revealed that virtually all household spent some on the purchase of rice. Eighty percent spent some on purchases of kerosene, while about five percent spent some on purchases of gasoline. Debt repayment, health, and education were mentioned by at least one quarter of the households. These figures tend to confirm the general proposition that, where a subsidy is replaced by extra cash income, households obtain the greatest utility not from spending only on the formerly subsidized commodity but from a reallocation of expenditure. The low number of household spending on gasoline also supports the view that the subsidy on this fuel was reaching only a few poor households and was a low priority for the poor.

Following its experience with targeted cash transfers to support households affected by the decrease in kerosene, gasoline, and diesel subsidies, the government of Indonesia launched a kerosene-to-LPG conversion program in 2007 to reduce the overall fiscal burden on the treasury. The government provided free LPG stoves and 3 kilogram cylinders targeted to reach some 42 million families by 2010. Because the fuel cost of LPG was lower than that of kerosene, even when the latter was subsidized, this program reduced fuel costs to households. At the same time the government estimated that the total subsidy bill had been reduced considerably (*LKBN Antara* 2009). These measures notwithstanding, about $7 billion (more than 1 percent of GDP) has been allocated for subsidized fuels in the 2010 budget bill (*Jakarta Post* 2009).

Studies examining household energy expenditure patterns before and after subsidy removal appear not to have been carried out in developing countries. This is in part because household expenditure surveys are fielded infrequently and, when they are repeated, they may not use the identical questionnaire. An example of the analysis of changing energy patterns of use during a period of changing prices, but not of the impacts of changes in subsidy schemes, was carried out by Bacon, Bhattacharya, and Kojima (2009) for Indonesia and Pakistan.

The Effect of Subsidy Removal on Households

The subsidy performance indicators measure the transfer of resources to households and its progressivity for the current levels of consumption. Several other factors influence the effects of subsidy removal on households:

- The increase in the cost of living caused by knock-on effects of higher energy prices onto other prices
- The changes in quantities purchased as a result of an increase in the energy price
- The macroeconomic effects caused by the shift in resources from the energy sector and by the impacts on the government budget.

The estimation of the effects on household expenditure and welfare caused by a change in the price of an energy product needs to take into account both the direct effect of the increase in energy price and the indirect effects of the increase in other prices caused by the increase in energy prices. To establish the links between energy prices and the prices of other goods an input-output table is required. From this table the energy input into other goods can be calculated—for example public transport uses a certain amount of petroleum products and its price will increase when petroleum product prices rise, unless there is a further subsidy introduced. A more complex chain would arise in the case of (say) foodstuffs. Higher petroleum product prices lead to higher input costs in agriculture (fertilizers, diesel for tractors and irrigation pumps) and higher costs of transporting food to the market, resulting in higher foodstuff prices at retail. The use of an input-output table can capture all these links and reveal the total effect on final prices of a change in energy prices. Where a household expenditure survey is also available, the effects on the cost of living for different income groups can be calculated. An important limitation of this type of analysis is that substitution is not modeled and households are assumed not to change the quantities purchased of each item or to switch to new items, despite the changes in real income and relative prices that would have occurred.

A few studies have applied such a methodology. The World Bank (2003) carried out an analysis for Iran of the potential increases in the final prices of all goods following the removal of all energy subsidies; Coady and Newhouse (2006) carried out a similar exercise for Ghana on the assumption that subsidies were removed on gasoline, kerosene, and LPG; Kpodar (2006) analyzed the impacts of removing subsidies on gasoline, diesel, and kerosene in Mali; and Andriamihaja and Vecchi (2007) considered the impact of removing subsidies on electricity, gasoline, diesel, and kerosene in Madagascar. For Iran the direct and indirect effects were not shown separately, but results from for the three latter studies are shown in Table 10. All three studies indicated that the indirect effects on the cost of buying the same bundle of goods were large, and in some cases were even greater than the direct effects.

Table 10: Real Income Effects of Removing Energy Subsidies (percentage change in total expenditures)

Country	Effect	Quintile 1 (poorest)	Quintile 2	Quintile 3	Quintile 4	Quintile 5 (richest)
Ghana	Direct	2.9	2.0	1.7	1.3	1.4
	Indirect	6.2	6.6	6.7	6.9	6.8.
	Total	9.1	8.7	8.5	8.2	8.2
Mali	Direct	0.9	0.8	0.7	0.8	1.0
	Indirect	0.9	0.8	0.8	0.8	0.9
	Total	1.8	1.6	1.5	1.6	1.9
Madagascar	Direct	2.3	1.6	1.4	1.2	1.1
	Indirect	0.9	0.9	0.9	1.0	1.2
	Total	3.2	2.5	2.3	2.2	2.3

Sources: Coady and Newhouse 2006; Kpodar 2006; Andriamihaja and Vecchi 2007.
Note: Energy sources for which subsidies are removed are gasoline, kerosene, and LPG in Ghana; gasoline, diesel, and kerosene in Mali; and electricity, gasoline, diesel, and kerosene in Madagascar.

The table also indicates the importance of direct energy subsidies for the sources studied. Overall the subsidies were most important for the lowest quintile in two of the countries and were equivalent to 3 percent of total household expenditure for that group in Ghana. These results suggest that taking indirect as well as direct price effects into account is important when considering the likely effects of subsidy removal on household welfare. However, there are a number of practical difficulties to implementing this approach:

- Many countries do not have input-output tables.
- Even where an input-output table exists it may relate to a time several years in the past, and the various coefficients may have changed since then.
- The categories of commodities in the household survey and input-output table may be different, and converting to a common set may be difficult.

- The household survey, the input-output table, or both may not contain sufficient detail to separate the various energy sources. This is important where consideration is being given to raising the prices of a subset of energy sources through subsidy reform.

One of the reasons advanced for removing subsidies is that, where their distributional benefit is low, an increase in prices will result in a more optimal use of domestic resources by reducing demand for energy[9] and increasing expenditure on other goods. This reduction in demand for energy would in turn result in a reduction in CO_2 emissions in all sectors where the subsidized energy is used. Concern for the effects of global warming has led to a number of calls to remove consumer (and producer) subsidies in both developed and developing countries. The full effect of subsidy removal on energy demand is complex, as explained in the section on macro-economic linkages above, but a central parameter is the price elasticity of demand for energy sources. The price elasticity is defined as the percentage change in quantity that would result from a one percent change in prices. For developing countries there is little information on the magnitude of energy price elasticities, and some studies have referred to work done on developed countries to provide an estimate of their magnitude. Larsen and Shah (1992) used values of long-run elasticities predominantly in the range of 0.15 to 0.35 for petroleum products, while the IEA (1999) used default values of 0.25 for transport related fuel demand, 0.5 for fuels used in stationary uses by households and industry, and 0.5 for electricity for cases where country-based estimates were not available. Serletis, Timilsina, and Vasetsky (2009) provide long-run own price elasticities for the main sources of energy for a number of countries and these are shown in Table 11. In virtually all cases these are small, suggesting that large price increases would be needed to reduce the demand for the various energy sources by a significant amount. These low price elasticities would suggest that evaluating the welfare losses to households following a reduction in an energy subsidy based on the assumption of no change in the quantity purchased (zero price elasticity) is a reasonable first approximation.

Table 11: Own Price Elasticities for Selected Countries

Country	Oil	Gas	Coal	Electricity
Canada	-0.04	-0.15	—	-0.00
France	-0.03	-0.00	-0.08	-0.01
Japan	-0.03	-0.00	-0.19	-0.01
Italy	-0.03	—	-0.02	-0.07
UK	-0.04	-0.13	-0.18	-0.56
USA	-0.01	-0.00	-0.03	-0.40
Poland	-0.06	-0.01	-0.24	-0.00
Hungary	-0.07	-0.08	-0.21	-0.53
Mexico	-0.01	-0.05	-0.09	-0.17
Turkey	-0.07	—	-0.12	-0.02
Venezuela	-0.04	-0.06	—	-0.03

[9] Although higher prices usually depress demand, the opposite could occur where price subsidies have led to energy shortages whereby those who are willing and able to purchase more energy at higher prices have been prevented from doing so. Removing subsidies under such circumstances could lead to an increase in energy supply that in turn could increase, rather than decrease, energy consumption and CO_2 emissions.

Country	Oil	Gas	Coal	Electricity
China	-0.01	—	-0.04	-0.25
India	-0.00	—	-0.04	-0.02
South Africa	-0.05	-0.03	-0.14	-0.10
Thailand	-0.14	—	-1.11	-0.12

Source: Serletis, Timilsina, and Vasetsky 2009.
Note: — = no estimate made.

Cross-price elasticities are also important for a comprehensive evaluation of the impacts of different price increases for the various energy sources. A high value of the cross-price elasticity between oil and gas (say) would have an important modifying effect on total energy demand if the price of oil were increased through subsidy removal. Although the demand for oil would fall by an amount related to the own price elasticity, there would be substitution towards using more gas, potentially resulting in a smaller cut in total energy demand. The total effect on the demand for energy following an increase in one (or more) energy price is complex, depending on all the own and cross-price elasticities, and on the relative magnitudes of the demands for individual energy sources. Serletis, Timilsina, and Vasetsky (2009) found that the possibility of price-induced inter-fuel substitution at the national level appeared very limited for the majority of countries investigated. Hence price-based policies to switch to lower GHG-emitting fuels are not likely to deliver substantial results. For those countries that did exhibit some potential of substitution between energy inputs, the main potential was for a switch between fossil fuels and electricity (from all energy sources), rather than between fossil fuels. At a sector level the developed countries in the sample exhibited higher potential for substitution between energy inputs in the industrial and transportation sectors than did developing countries. A study on the relation between economy wide oil-intensity of GDP and the level of the oil price found that for Latin America there was no significant correlation, while for high-income OECD countries and for non-Latin American middle-income countries there were significant negative correlations (Alaimo and Lopez 2008). If these results were found to be more widely established it suggests that policies to remove petroleum product subsidies or increase taxes for the purpose of reducing global GHG emissions would be more effective in high-income countries.

Changing the Level of Subsidy

In considering whether to create, retain, reduce, or remove an energy subsidy, governments have to consider several questions:

- What are the objectives of the subsidy?
- What activities should be subsidized?
- Who should be subsidized?
- What subsidy mechanism should be used?

Once these questions have been answered, advantages and disadvantages of a proposed scheme, or change to an existing scheme, can be evaluated. A brief discussion of the above issues is provided.

Objectives of the Subsidy

The analysis of an energy subsidy and of possible changes to the subsidy scheme starts from an articulation of the objectives of the subsidy. Goldstein and Estache (2009) provide a discussion of possible objectives, as does the IEA (1999). Major goals include the following:

1. Supporting the poor and improving equity. In developing countries access to modern forms of energy is important for enhancing standards of living. Households that are not connected to electricity (either grid or off-grid) rely on kerosene and candles for lighting and batteries to power a radio and other small electric appliances. These sources are expensive in costs per unit of energy and limited in their ability to allow households to move to other activities. However, most low-income households, particularly those that are credit constrained, cannot afford the costs of grid connection and supply. Accordingly some governments have subsidized both the connection charges and metering fees as well as the consumption of energy. The goal of permitting low-income households to consume a small amount of electricity that they would otherwise be unable to afford can be justified on the grounds of both long-term economic growth for the economy and equity. The challenge for governments facing low access and use of electricity is to find a method of subsidy that is cost-efficient and does not spill over to other recipients who do not need the subsidy to enjoy the benefits of electrification. One-off subsidies for connection charges are attractive from this standpoint since they tend to be well targeted to the poor (higher-income households are much more likely to be already connected) and having a natural phaseout as the economy reaches high levels of connection.

   The treatment of subsidies on petroleum products is less clear cut. Gasoline, diesel, and kerosene have no equivalent to a connection charge, but the cost of a cylinder for LPG constitutes an upfront charge that can act as a barrier to the use of that fuel. Gasoline, diesel, and LPG are primarily used by high-income households in low-income countries and there is little justification in directly subsidizing their use. Large petroleum exporters, benefitting from export prices above the costs of production, may wish to share these benefits with the citizens of the country, but the regressive subsidies on these fuels could be used in other ways that are more beneficial for long-term growth and for equity. The case of kerosene, which is used mainly by low-income households for lighting until they can afford electricity, is more complex. There are grounds for subsidy in terms of direct household welfare and equity. The practical difficulty is to find a method of subsidy that targets only poor households and avoids leakages through diversion of kerosene to other markets. Attempts to discriminate between segments of the market through a two-tier pricing system require identification of poor households and a distribution system that provides them with kerosene at the lower price. Voucher schemes have been used, but the costs of administration are high given the large number of retail outlets involved and vouchers suffer from leakage. The existence of the two-tier price gives dealers an incentive to sell quantities identified for low-income households at black market prices for use as an additive to the more expensive diesel fuel, as explained in Kojima and Bacon (2001). For this reason means-tested cash transfers present a better way of protecting the poor against high kerosene prices.

A different approach to the use of two-tier petroleum pricing as a means of providing support to low-income households is to use smart cards. Where petroleum products are sold at well defined locations with the possibility of introducing electronic recording equipment, households could be issued with a smart card that allows them to buy a limited amount at a subsidized price. Outside the quota, the product could be sold at a higher price (possibly the market clearing price). Because of the technical requirements of issuing a card to all households and installing the necessary equipment, such schemes have rarely been tried. Smart cards have been used to ration subsidized fuels in Iran (gasoline) and Malaysia (gasoline and diesel for fishing boats and transport operators). Because the poor consume very little gasoline or diesel, these examples are not informative for the purpose of protecting the poor. In 2007 Iran introduced smart cards to ration gasoline which was sold at a heavily subsidized price. Rations were different for private cars, passenger carriers, taxis, and government vehicles. Initially no quota was available at higher prices, leading to gasoline solid on a black market. Later extra supplies became legally available at higher prices. Over time the number of classes of users given larger rations was extended, with the result that the efficacy of the scheme was considerably weakened. Indonesia considered introducing smart cards and Malaysia considered expanding their use, but administrative complexity has deterred their adoption (Kojima 2009b).

Where the objective is to support poor households against prices that are too high, one solution has been to use some form of cross-subsidy. An electricity tariff structure that charged users the marginal costs of their supply would result in higher tariffs for rural households than for urban households. Moreover the access rate in rural areas is much lower than in urban areas in many low-income developing countries. Governments wishing to support the poor rural households often use cross subsidies as a method of reducing prices charged to rural areas. In particular, industry and businesses generally may be asked to pay tariffs above costs in order to finance the cross-subsidy. The practicality of using this approach depends on the relative numbers of poor and non-poor users. Where there are few non-poor users and many poor users, the risk is that the tariff differential required to support lower prices to the poor could be so high as to have serious effects on the non-poor. For example, if the small group of non-poor consists of business enterprises, the associated cost increase could damage their commercial viability, with associated negative effects on economic growth. Where there are many non-poor and fewer poor the use of a cross-subsidy may be a relatively efficient method of improving equity (rather than using general taxes to achieve the same end). Cross-subsidies are widely used in the power sector in developed countries to subsidize electricity provided to rural households who are more expensive to supply.

A common way of providing direct support to low-income households is to place a ceiling on prices of petroleum products or of electricity tariffs. This has the effect of providing the subsidy to all consumers and not just the poor, with consequentially greater costs of support. These price caps should be distinguished from those used by utility regulators to determine the maximum price or tariff that an efficient utility should be allowed to charge. The latter will acknowledge the level of input costs charged, while the former do not permit these to be fully transmitted.

A key issue in designing subsidy schemes to protect poor households is the breadth of coverage to provide. This could range from providing some protection to a large percentage of the poor households to focusing exclusively on a very narrow group of the poorest households. The wider the range of incomes that are protected the less protection that can be given for a fixed total fiscal cost. However, since the middle class are often better organized and more vocal, as well as consuming more energy than the lowest-income group, governments may be under pressure to widen the scope of subsidies, even if this means that the benefits per household are smaller.

2. Achieving energy security. The provision of a subsidy to a particular source of supply may improve its competitiveness and hence reduce dependence on other sources of energy, notably imported fuels. Lack of energy security can arise from over-dependence on a single fuel. The recent volatility of energy prices (especially oil) highlighted the risks of over-dependence. By diversifying energy sources the total risks to the economy are reduced. However, substitute fuels may be more expensive for the economy in question, so that a subsidy would be needed to encourage the switch to a competing energy source. A subsidy related to the amount of energy use could be very expensive and commit the government to a permanent fiscal burden. An alternative form of subsidy to achieve the same end would be a one-off capital subsidy to encourage the construction of plants that would produce the alternative form of energy. The costs of the subsidy would need to be balanced against the value of the reduced risk arising from energy source diversification. Jensen, Beurskens, and van Tilburg (2006) illustrated the use portfolio analysis to investigate the costs and benefits of increasing the renewable share of the generation portfolio through the possible use of subsidies.

   Another example is the import protection provided to uneconomic refineries. Governments have cited enhanced security of supply among the justifications for subsidizing domestic refineries whereby domestic supply was counted as more “reliable” than international supply that could be disrupted. In countries with no domestic oil, however, it is not clear that importing crude oil and refining it enhances supply security any more than importing refined products.

The increasing oil prices of the period from 2004 to mid-2008 led to a number of governments actively supporting the biofuels market in order to reduce consumption of conventional gasoline and diesel. Kojima (2009b) detailed various measures, such as blending mandates and tax reductions, which have been used in order to ensure biofuels were competitive. In 95 of the 120 months between January 2000 and December 2009 sugar prices were such that, without a subsidy, sugarcane producers in a market facing both world sugar and world gasoline prices would have been better off selling to sugar producers than to ethanol manufacturers, this despite the fact that ethanol manufacture from sugarcane is by far the most efficient and has the lowest cost. This case illustrates the need to consider the co-movements of the fuel in question and the planned substitute fuel before using a subsidy program to promote energy diversification. The extent of the subsidy required may well have been much larger than originally anticipated, when governments may have thought of the initial support as a mechanism to kick-start what would become an economically self-sustaining business.

At the global level, an argument against energy price subsidies has been put forward in recent years in the context of energy security. Starting with the proposition that an imbalance between supply and demand is pushing up world oil prices, it is argued that petroleum product subsidies in countries that are large consumers of oil exacerbate the supply-demand imbalance by not allowing higher oil prices to be transmitted to the domestic market and restrain consumption, thereby threatening the energy security of all countries that import oil.

3. <u>Correcting local externalities.</u> Fossil fuel use—primarily in the power, industrial, and transport sectors—is associated with negative local externalities, largely associated with indoor and outdoor air pollution. The use of biomass for cooking and heating, which is widespread in many developing countries and especially among low-income households, results in indoor air pollution which has been shown to be deleterious to health. In India it has been estimated that annually approximately half a million premature deaths and nearly 500 million cases of illness result as a result to exposure to smoke emissions from biomass use (ESMAP 2003a).

   The increased awareness of the importance of reducing such emissions has led to a number of offsetting policies. These can include (1) an increase of taxes on offending fuels, thereby encouraging a reduction in their use and a switch to other cleaner non-taxed fuels; (2) a subsidy to cleaner fuels; or (3) mandates that enforce a switch to cleaner fuels. The most desirable form of intervention is agreed generally to be one in which the polluter pays the full cost of their actions through some form of environmental tax.

   However, in the case of indoor air pollution, where the various forms of biomass (firewood, dung, straw) are freely collected by many household, the polluting fuel cannot be taxed. Instead the policy approach has to be to subsidize either a cleaner fuel such as LPG or kerosene (when used at high pressure) or cleaner appliances (improved cook stoves, lamps) that reduce the emissions. When governments remove kerosene or LPG subsidies, households using them as cooking and heating fuels may revert to an increased use of biomass that could lead to land use change, resulting in an associated increase in GHG emissions. Because unsustainable harvesting of biomass can lead to deforestation, and even desertification, the use of subsidies to LPG or kerosene as substitute fuels for cooking can have further external benefits.

4. Reducing emissions of greenhouse gases. With respect to global emissions, policies in the power sector may focus on encouraging a switch from a higher to a lower emitter. This could include a switch from coal to gas, or a switch from any fossil fuel to a renewable source of energy. The results of Serletis, Timilsina, and Vasetsky (2009) suggest that very large price incentives may have to be used in order to achieve substantial fuel switching. The tax on the polluting fuel, or subsidy to the cleaner fuel, may need to do more than provide a minimal cost advantage in order to induce a switch from one fuel to another. Moreover, policies to address one fuel may have unintended consequences if there is more than one substitute fuel available. For example, reducing the subsidy (increasing the tax) to natural gas could lead to an increase in the use of coal, a more polluting fuel. The whole structure of energy taxes and subsidies has to be reviewed together and the likely switching between fuels has to be viewed within a portfolio of fuel choices.

   In many cases there is no substitute source of energy readily available or available at a competitive price, and policies need to be enacted to kick-start the domestic production or use of cleaner energy. Two factors are associated with the slow entry of new energy. Where a technology is globally relatively new or untried, its current costs may be high but can be expected to fall as the scale and experience of production increases. For technologies that have already benefitted from such cost reductions but have not yet been deployed in a particular country, there are barriers to adoption due to lack of experience in the operation of the technology. In these cases it may be necessary to give positive inducements to the energy source in order to compensate for these factors. In addition, governments will need to adapt their planning and regulation to suit the needs of the new energy source.

   For wind, solar, and other renewable sources of energy, a temporary subsidy can be provided by feed-in tariffs that provide above-market tariffs to the suppliers for an initial period. Several developed countries—including Australia, Canada, Germany, the Netherlands, Spain, the United Kingdom, and the United States—have used such schemes to encourage the introduction of renewable forms of energy. However, as governments have started to phase down subsidies (as for solar in Spain and Germany) the market for new entry is collapsing. In these cases the primary objective was to kick-start the use of the renewable, with the hope that over time their costs would fall so that further expansion would take place without subsidies. The difficulty with such an approach is to plan a phaseout of the subsidy in a way that is consistent with the fall in costs. In addition, early movers will not have benefitted from the later technology improvements so that their subsidy would need to continue to make their operation viable.

Because of this feature capital subsidies may be more suitable because they offer a solution that does not commit the government to a permanent fiscal contribution. Other forms of subsidy, including tax concessions, can also be used to encourage a more rapid and greater uptake of renewable energy technologies.

Biofuels were initially promoted to increase self-reliance. More recently, policies supporting biofuels have also been justified on the grounds that they could reduce CO_2 emissions. The effectiveness of these policies, consisting mainly of consumption mandates and tax reductions, is increasingly questioned on account of limited mitigation benefits, disproportionately high costs, and growing concerns about unintended side effects on the world food markets (FAO 2008, UNEP 2009). The more direct policy of taxing transportation fuels could be preferable since it would promote fuel-efficient driving.

5. <u>Supporting domestic production and associated employment.</u> Where a domestic energy industry is no longer competitive with the world market and foreign energy can be imported more cheaply, or former export markets have disappeared, then governments have resorted to production subsidies. This has been especially true of the coal industry in Europe where the very large employment in the sector persuaded governments to provide domestic support in order to avoid large-scale unemployment that would have resulted as domestic sales fell following the arrival of lower-cost competition from elsewhere. The use of an ongoing subsidy to avoid unemployment has been expensive, and it might have proved cheaper to have given earlier very large severance payments to redundant workers. A further reason to support domestic production of energy has been to fuel economic growth and encourage export competitiveness. A problem with these objectives is that, were the subsidy to be withdrawn, the industries that had been encouraged to grow would no longer be sustainable and the economy would need to face a readjustment towards sectors that could be sustainable. As is the case with most subsidy schemes, an exit strategy is required in order to avoid the expectation of a permanent commitment.

6. <u>Dealing with uncertainty.</u> A feature of the international energy market is the high degree of uncertainty about future prices of fossil fuels. Importing countries can address this price risk by encouraging diversification of fuel choice. This could be engineered by removing any subsidies on extensively used fuels (for example, transportation fuels) and possibly by providing some form of temporary subsidy for alternative sources of energy (for example, capital subsidies for renewable energy). This strategy aims to reduce risk by diversification, and as such could even justify some increase in the total costs of supply as the price for risk reduction.

A particular problem with energy subsidies is that, once established, they become difficult to reduce or remove, especially when they have been given on a universal basis. Kojima (2009a) and the IMF (2008) noted that, when faced with the large oil price increases prior to the August 2008 peak, many developing countries preferred to stay with a subsidy scheme, or even to increase or re-introduce subsidies or decrease taxes, despite the enormous fiscal burden this represented. Because of potential opposition from beneficiary groups, governments have to take their likely reaction into account in determining the objective of any plan to alter the subsidy level.

What to Subsidize

Once the objectives of subsidizing an energy source have been determined, the government is faced with a choice of what activities to subsidize. Depending on the objectives, the choices are to subsidize consumers, existing producers, or new producers, and the possible activities include innovation, infant industries, and clean energy, as well as traditional sources of supply. Where the objective is to encourage the supply of a given type of energy, production subsidies may be the most effective way of encouragement, being directly targeted to the objective. A related target for subsidies is energy efficiency improving investment. This can help to improve energy security and reduce GHG emissions.

1. <u>Affordable conventional energy.</u> Where the objective is to make energy supply more affordable, subsidies to consumers either for connection (electricity, LPG) or for consumption (all energy sources) can most easily be given through existing suppliers. Firms already in the market have the infrastructure for retailing, billing, and customer support that is necessary to deliver the subsidies to users. They will also have established accounting and recording systems that make it possible to audit the costs of the subsidy that they are incurring on behalf of the government, and that should be recompensed from the budget. A different reason for wishing to make energy more affordable is to provide support to key industries that have large energy inputs, such as the metals and minerals industry, mining, or transportation. This can also serve to protect employment in these sectors.

   The major concern for governments wishing to promote affordable energy is the cost of so doing. Many subsidy schemes have high leakage and include many high-income households as beneficiaries, while demand for energy will increase with rising income. The subsidy bill will be linked to economic growth unless it is designed to have a natural phaseout mechanism. In some countries at a low stage of development, the use of commercial energy can even grow faster than the economy as households switch away from non-commercial sources, thus leading to the possibility that the subsidy bill will grow faster than the economy itself.

   Where conventional energy is more GHG-intensive, subsidies given to such conventional energy deter penetration of cleaner energy with lower GHG emissions. New, cleaner energy is generally more costly than conventional energy, and is certainly in no position to compete with subsidized conventional energy in the absence of significant government support.

2. <u>Clean Energy.</u> Policies to encourage fuel switching away from traditional biomass have focused on subsidies to kerosene, to a lesser extent to LPG, and even to natural gas in a few countries. The main impediment to the use of kerosene has been the cost of the fuel itself, relative to that of biomass that is often free although needing time and effort to collect the latter. For LPG, in addition to the cost of the fuel, the cost of the initial cylinder purchase can be a barrier to low-income households and some governments have provided subsidies to cylinders as well as to

the cost of the fuel. Natural gas has much higher connections costs, and these may need to be subsidized if the government wishes to achieve a high rate of connection in the main urban centers.

An alternative is to subsidize appliances and vehicles with lower emissions of harmful pollutants. To combat indoor air pollution in homes that continue to use biomass, governments and development agencies have supported clean stove programs through subsidizing the manufacture and distribution of improved stoves. These programs have had mixed results. In recent years some governments have subsidized the infrastructure for using natural gas as an automotive fuel, because vehicles running on natural gas have much lower emissions than conventional diesel vehicles.

With respect to policies designed to reduce GHG emissions, governments have a range of choices. They can choose to stimulate innovation (e.g. biofuels from algae), support new commercial technologies (e.g. solar power), and encourage well-known but under-utilized market solutions (e.g. improved building insulation). The barriers to free market introduction of innovation and new technologies in the sphere of clean energy are discussed under infant industries below.

3. Infant industries. Within the energy sector the emergence of new solutions to reduce energy consumption or to supply clean energy sources is focusing attention on new technologies. These range from cases that have already been developed but only on a small scale (such as thermal storage using molten salt for solar power), so that costs of production are still high, to technologies that are still at the research stage. For technologies that are ready to move to commercial application, costs of production of the equipment itself are typically lowered as economies of scale can be utilized and as the benefits of learning by doing are reaped. Wind power presents an example of this experience. As turbine sizes have increased and as more manufacturers have entered the market, the costs of wind power generation from commercial scale plants are estimated to have fallen as much as 80 percent since the 1980s. This pattern is seen in many technologies that have been successful. These technologies are likely to steadily lower costs and become more widely utilized, but the time taken until there is broad acceptance may be lengthy without government intervention. When there is a need for more rapid penetration of the market, intervention can be justified according to the reasons for needing the product sooner.

   Where the technology has only recently been introduced and only in a few countries, low-income countries may prefer to wait until other countries have carried the initial costs of production. However, developing countries with large domestic markets, an established manufacturing sector, and low production costs (especially labor) may see an opportunity to start production once the technology is proven and viability in the market is established. China (wind turbines) and India (solar power) have both taken this route and are large enough to be driving down costs by their own efforts. Subsidies given to production of equipment as well as to sales of electricity are helping to establish these industries and both of these countries have started to export these technologies, having established themselves as low-cost producers. Smaller countries, with less well established manufacturing sectors, will probably need to import the technology and will have to wait for the early movers to make this attractive. Subsidies may be needed to overcome cost differentials with traditional energy sources that still remain and to provide incentives to firms to take up the new technology. If costs are expected to decline to the point where the technology would be fully competitive with existing energy sources, the justification for a subsidy would disappear. This possibility points to a preference for using capital subsidies that are time bound—they can be more easily terminated than tariff subsidies which may be more difficult to remove since they benefit existing players in the market.

Where the goal of a subsidy is to support an infant industry, or even a new technology, the government has to determine how recipients are to be identified. It is unlikely that such subsidies would be granted to all firms that could claim to be in the industry. Some form of bidding to obtain such subsidies can be used, including research proposals for new products and output-based aid where clear deliverables can be determined (Global Partnership on Output-Based Aid 2005).

4. Innovation. Technologies that are as yet commercially unproven and that may still be at the research stage may offer large energy savings or clean energy supply if they can be successfully developed. The costs of moving to commercial scale for such technologies can be large and the risks are high because of the presence of unknown difficulties. Because of these factors, companies can find it difficult to attract finance to support the research and development expenditures needed. This financing gap has led some governments to subsidize the basic stages of product development. Large governments, for whom the project is very small in relation to the government finances, can support a variety of such projects at an early stage, and by pooling the risks can afford for some projects to fail at the various stages of development. At later stages, as the performance and viability of certain projects becomes clearer, more funding can be provided to a narrower group of likely winners. Governments that have attempted to support very large-scale innovations have found that these can be extremely costly. For these reasons it would appear that developing countries should place little emphasis on subsidies for innovation unless the projects are small scale, are supported by an experienced manufacturing sector, and there is a potentially large domestic market to support the product were it to be successful. However, subsidies to specific energy technologies can undermine the development and commercialization of other technologies that might ultimately become more economically (as well as environmentally) attractive. That is, subsidies can lock in certain technologies and deter the development of alternatives that may prove to be more promising in the longer run.

5. Energy efficiency investment. The arguments for supporting demand-side or supply-side energy efficiency investments are usually distinct from those involved in supporting innovation. Many energy efficiency technologies and policies have been known for many years. Where they have not already been adopted this is not necessarily because of high costs that could be brought down with the advent of economies of scale, but rather because their benefits have not seemed sufficiently attractive to users or producers. Improved building insulation, reducing technical

losses of power sector transmission and distribution, and running air conditioning at higher cut-off temperatures are examples of policies that can save energy and reduce emissions, both of which are benefits for the society as a whole. However, without a willingness to pay for these improvements or investments by the users, or to accept lower convenience, they will not be voluntarily adopted. In some cases governments have a policy choice between encouraging the take-up of such investments by some form of subsidy, or by the use of regulation to enforce the take-up. The latter approach forces the polluters to pay, while in the former case the cost of the subsidy has to be borne by the population as a whole. With established technological solutions there is no need for the government to carry up-front risks that may not lead to improvements, or to buy down costs by supporting industries at small scale until their performance improves.

The improvement of supply-side energy efficiency, for example the reduction of transmission or distribution losses, usually requires both technical and organizational changes from the utility supplying electricity. Policies to combat this depend on the source of the loss. Where theft and incorrect billing is prevalent, improved metering and enforcement is required. Where there are a large number of low-income households, it may not be feasible to pass on the costs of metering improvement to users in proportion to the energy savings to their supply. A household willing to connect and to consume, say, 100 kWh per month is not likely to be able to afford the costs of replacing a traditional meter with smart metering. In this case considerations of equity can come into play in deciding the best approach to take. The options are either to provide a subsidy to the utility (energy service company) based on an agreed action plan to improve the delivery, or else to permit them to use a cross-subsidy from large consumers through charging a tariff that includes a component for system upgrading. Where the losses relate to the transmission system, strengthening it may require substantial investment. However, improvements in the transmission system are more likely to be able to pay for themselves and may even lead to tariff reduction.

Whom to Subsidize

The choice of whom to subsidize depends on the objectives of the policy. For consumer subsidies the choices range from universal subsidies to subsidies to poor households and remote communities. For producers, subsidies can be industry-wide or available on some form of competitive bidding basis.

1. Universal subsidies. Universal subsidies, whether to consumers or producers, are usually the simplest scheme to operate since they require no mechanism for identifying and transferring resources to selected recipients. Because of their universal coverage, these subsidies tend to be the more expensive and difficult to phase out because they create the widest constituency to support their introduction or retention. If the government wishes to achieve a given degree of materiality for subsidies to low-income households, the costs rise as the scope of the subsidy is broadened. Universal subsidies in the energy sector have been widely used and include increasing block tariffs in the power sector and general subsidies (or tax reductions) on petroleum products. More recently governments have focused on moving away from such schemes because of their expense and unnecessary support to groups not in the greatest need.

Improved targeting of the poor through a variety of means is seen as lower cost and more equitable.

2. The poor. Where the objective is to support low-income households, the government faces two issues: it must be able to determine which households qualify as poor, and it must find a delivery mechanism to reach these households. Poverty is defined according to country conventions, but identifying which households are poor is difficult and may be expensive. Household surveys, of the type used in Indonesia for the cash transfer scheme, are not widely available and are difficult to organize if the government is in a hurry to make a change to its subsidy policy. A number of approaches to identifying low-income households have been developed using means testing and proxy means testing as detailed in Grosh et al. (2008) and in World Bank (2008b). For example, in Chile the Ficha Caracterisación Social is a two-page form that is used to determine the eligibility of households for a variety of government programs, ranging from water subsidies to cash transfers and low-income housing. The survey collects information on housing conditions of each dwelling unit, material assets of households, and on the occupants (occupations, education, age). From these indicators a composite score is determined and households are considered poor if their score falls below a certain pre-determined value. The survey is updated every three years. This approach is particularly suitable for determining which households should receive a cash transfer.

   Where the government prefers to use a direct subsidy for electricity, then the use of volume differentiated tariffs as opposed to increasing block tariffs is more effective in targeting low-income households and does not spill over to high-income households. Where metering is incomplete or absent, these schemes cannot be used and some form of proxy for the level of consumption has to be used. Several governments have used geographical targeting where households in identifiable low-income urban areas are charged a lower tariff or a lower connection fee.

   Output-based aid can be effective in ensuring that a connection fee or equipment costs is subsidized once it has been delivered to a target household. If the choice of households has been made efficiently, this approach has little leakage and can be highly cost-effective.

   Support to poor households will include a high proportion of women and children, but governments may be concerned with certain features of energy use that have particularly adverse effects on women and children. Access to electricity improves children's ability to study and obtain the long-term benefits from education, while for women the improved lighting can increase the productivity of commercial activities (such as sewing). In many low-income developing countries, poorer households (both rural and urban) cook with biomass. Only at high income levels do households turn to LPG or kerosene. Indoor pollution from biomass is extremely damaging to health, although many who are exposed to smoke are not fully aware of the harm caused. Policies to improve cooking stoves (adding chimneys, increasing combustion efficiency) have used subsidies to encourage households to purchase these improved stoves that otherwise they would have ignored.

3. <u>Rural communities.</u> Rural communities tend to face much higher connection costs for electricity because of their greater distances from the grid and the low number and density of households in a particular location. Where governments are concerned to increase access, it is important to look for low-cost solutions, of which off-grid electricity is an important step. Evidence from a number of countries (World Bank 2008) suggests that the subsidy required to support off-grid electrification is less than that required to support grid electrification to rural communities. However, even with the most appropriate type of supply, connection costs may be too high for households to pay, particularly if these have to be fully paid in advance. Governments have looked at various subsidy schemes for bridging this financing gap. Utilities can reduce rural connection fees through cross-subsidies from existing users, or can respond to performance based subsidies from the government. Cross subsidies are widely used to support rural electrification schemes but their effectiveness depends on the existence of a relatively large number of better-off consumers (businesses and households) that can afford to pay more than the cost of supply. In countries where even the urban rate of access is low, as in much of Sub-Saharan Africa, cross-subsidies alone could not support an extensive rural electrification program. Where the main providers of the cross-subsidy are businesses—being the entities most likely to connect to the grid system in the early stages of national electrification—too great a cross-subsidy could interfere with the competitiveness of these entities, and could slow down growth and development.

   An alternative to a simple lowering of the connection charge is to provide the household with the ability to repay these charges over a fixed number of months. If the total collected is equal to what would have been the up-front charge, the interest forgone through spreading receipts is a subsidy to consumers. For households that are credit constrained the ability to spread over a long period with low monthly repayments may be much more important than the reduction in the lifetime cost of paying for the connection.

   There is no connection fee for petroleum products, but the costs of rural supply are typically higher than the costs of urban supply. Again the product has to be transported further, and the sales at local distribution centers tend to be lower, losing possible economies of scale. In a free market this would typically result in rural prices being higher than urban prices. Indeed, for LPG it is often not commercially viable to supply villages because there are too few customers who can pay the market price including the costs of distribution. Some governments have acted to avoid this geographical price differentiation by regulating pan-territorial pricing in which the retail price is the same everywhere. The price is typically set so that urban users pay more than the cost of supply in order to provide the cross-subsidy to rural users who pay less than the costs of supply. Pan-territorial pricing by definition, however, means that true costs are not reflected in market prices and may reduce incentives to lower supply costs, because offering lower prices—through, for example, improving efficiency—in the hope of expanding market share is not an option.

4. <u>Special industries.</u> Some governments have, for reasons of policy, decided to subsidize certain industries. For example, the government of India has subsidized electricity and diesel (used for

pumping and tractors) sold to farmers for food security. The form of the electricity subsidies has encouraged excess consumption and theft because the farmers were required to pay a flat rate per unit of horsepower per pump, while the actual use of electricity was not metered. The cost of the electricity subsidies to agriculture has been estimated to be equal to about 25 percent of the country's fiscal deficit and to be double the annual public spending on health or education (Monari 2002). The farmers' lobby, including many middle-class and large-scale producers, is influential and has strongly opposed any suggestion of reducing subsidy support for the sector.

Transport is another sector where subsidies to diesel are frequently granted. Although general principles of energy taxation suggest that diesel, if used as an intermediate good, should not be levied a tax, arguments for granting a subsidy rest in part on the direct benefits to consumers of public transport. In particular, the cost of urban public transport—providing an essential service in allowing people to travel to work and school that would otherwise be inaccessible—can be an important fraction of household budgets. In addition, a more intensive use of public transport may reduce road congestion and the total amount of local air pollution from traffic if users are encouraged to refrain or switch from other motorized forms of transport. Again, once such a subsidy is granted it becomes very difficult to remove even when workers' incomes rise and they could afford to pay the true costs of travel.

These examples illustrate the danger of introducing subsidies, even for good reasons, that do not have some natural phaseout. Groups with vested interests tend to benefit strongly from such subsidies and oppose their subsequent removal. Unless the subsidies can be targeted to groups that will tend to disappear over time, energy subsidies will require a great deal of effort by the government to remove.

What Subsidy Mechanism to Use

The issues raised above indicate that there are various advantages (+) and disadvantages (–) to all subsidy schemes, and by extension to changes in a subsidy scheme, whether to introduce, and, having introduced, whether to increase, reduce, or remove. Given that the costs of most subsidy programs are large, and that it can be extremely difficult politically to reduce a subsidy scheme, governments should be encouraged to undertake a full impact analysis before making any policy change. In comparing the different alternative schemes available it is important to make a detailed assessment of costs and benefits, not only in the immediate future but also over the longer run. Important considerations for each type of subsidy discussed in this paper are summarized below.

1. <u>Universal consumer subsidies</u> (both electricity and petroleum products)
    - \+ Easy to apply and administer
    - – Difficult to remove because many beneficiaries
    - – Has no natural phaseout point
    - – Can encourages non-essential or inefficient use of energy and associated emissions

- – Weak targeting of poor unless high degree of access by poor and similar use across income groups
- – Exclusion index is high when connection rate is low
- – Materiality for poor is likely to be low because need to subsidize all households and all levels of consumption
- – Fiscal burden tends to be large even with modest materiality for the poor
- – Petroleum product subsidies tend to be linked to international prices and hence subsidy amounts can be volatile and difficult to predict
- – Can have adverse financial effects on energy suppliers if they are not fully reimbursed in a timely manner

2. <u>Increasing block tariff or two-tier pricing</u>
    - \+ Moderately easy to apply to electricity but requires metering
    - \+ Moderate targeting of benefits to poor if first block is set at a low level
    - \+ General principles can be adapted to time-of-day and peak load pricing
    - – Difficult to apply for petroleum products, apart from use of smart cards, and this requires administration burden to identify households and distribute cards as well as suitable electronic recording equipment
    - – Difficult to remove because a benefit to all in the case of increasing block tariff
    - – No natural phaseout point
    - – Exclusion index is high when connection rate is low
    - – Fiscal cost large if first block is wide or is heavily subsidized
    - – Materiality for poor is likely to be limited by overall fiscal cost
    - – Tends to have high leakage to non-targeted users when applied to petroleum products
3. <u>Price caps and price control</u>
    - \+ Effective in reducing upside risk to all households from price shock; mainly relevant to petroleum products where international prices are highly volatile
    - – Governments face very large upside risk and inability to insulate budget from price shocks
    - – Very difficult to remove when users become accustomed to a certain price especially because of wide range of beneficiaries
    - – Works against benefits of competition since firms will tend to charge price ceilings even when costs do not justify it
    - – Poor targeting because it is a universal subsidy with no special pro-poor features
    - – Can encourage excess consumption of energy
    - – Difficult to calculate precisely how much suppliers should be compensated
    - – Can have adverse financial effects on energy suppliers if they are not fully reimbursed in a timely manner
4. <u>Volume differentiated tariff</u>
    - \+ Good targeting of poor if volume limit is set at small size unless access is very low
    - \+ Exclusion will be low if there is a high rate of connections
    - \+ Fiscal cost can be contained by setting volume limit relatively small

- \+ Does have a natural phaseout as households gradually raise consumption above volume limit
- \+ Volume limit relatively easy to change depending on circumstance
- \+ Natural situation for cross-subsidy from higher-use to low-use customers
- \+ Moderately easy to remove because beneficiary group tends to be small and have weak voice in national decisions
- – Requires metering
- – Political pressure to increase the volume limit
- – Problems for households transitioning to above volume limit consumption and facing large jump in electricity bills, particularly when these can switch from month to month
- – No practical application to petroleum products because of inability to track a household's total monthly purchases

5. <u>Connection charge subsidy</u>
    - \+ Tends to be well targeted to poor where access rates are low among the poor and better-off are connected and roll-out is targeted to different groups from those already connected
    - \+ Better-off tend to be excluded unless access is very low
    - \+ Easy to combine with geographical targeting—for example, rural areas with higher costs of connection can be targeted for special subsidies
    - \+ Natural long-term phaseout when majority of households become connected
    - \+ Program can be slowed or stopped if fiscal situation demands less expenditure. Those already connected would not oppose these changes
    - \+ Suitable for cross-subsidy from large users to new users
    - – Not suitable for petroleum products except for LPG
    - – Costs incurred in order to have an appreciable effect on access rates tend to be high because of magnitude of subsidy needed to persuade households to connect; needs to be combined with drive for low-cost supply of connections
    - – Roll-out to groups typically not connected will require higher subsidies than to groups typically connected, leading to higher costs to support low-income groups
    - – More difficult to control from central administration because costs of connection are not standardized
6. <u>Cash transfers to the poor</u>
    - \+ Can be well targeted to poor even when many of the poor are not connected
    - \+ Excludes spill-over to better-off
    - \+ Can be time bound through use of one-off payments or schemes, but political acceptance of one-off schemes may be difficult to achieve
    - \+ Because of good targeting fiscal cost may be reasonable (but where connection is very low, targeting all poor to compensate for subsidy removal would have to incorporate low materiality in order to keep fiscal cost at a manageable level)

- – Complex and expensive to administer unless there already is a census of low-income households and a delivery mechanism working through widely available outlets (such as post-offices)
- – Vulnerable to low-level corruption of the administration
- – Household take-up depends on good public information service

7. <u>Cross-subsidies between high- and low-volume users, or between users remote from supply and those closer to supply</u>
    - + Good redistribution from better-off to less well-off users
    - + Relatively easy to manage when system exists for identifying different classes of users and their bills
    - + Can work well when sufficient high-volume users (businesses) and not too many low-volume users
    - – Distortionary in that neither group is paying the correct price for energy
    - – Can adversely impact the competitiveness of businesses providing the cross-subsidy
    - – Not pro-poor where remote users are well off
    - – Cannot be used with petroleum products effectively because of ease of creating black market by middlemen, without benefitting the poor
8. <u>Performance-based subsidies</u>
    - + Suitable to reach markets where cost reductions are feasible and competition could bring these about
    - + An effective method of choosing business to deliver the output (for example, rural electrification) where it is difficult to monitor costs and performance of traditional firms
    - + Subsidy can be given in relation to plant installed, so that it can be time bound by placing a limit on number of units to be installed
    - – Not suitable for situations where there is adequate connectivity or plant ownership and help is needed with operating costs
    - – Not suitable for petroleum products
    - – Where amount of subsidy required to reach a desired level of plant ownership/connection is high relative to potential cost savings, fiscal burden would be large
9. <u>Feed-in tariffs for new energy sources that are not cost-competitive (electricity)</u>
    - + Can be effective in encouraging the take-up of sources of energy that have the potential to see cost reduction developing over time
    - + By making the tariff structure time-bound, a limit can be placed on fiscal cost
    - – Where costs of new product do not decline as expected the subsidy would continue to be needed to encourage continued entrance of the technology
    - – Even when new entrants find costs of production have fallen, early movers would require subsidy to cover their higher costs—possibly met through a capital subsidy linked to a regulated tariff.

The list of possible approaches to subsidies and their reform indicates that there are many factors to be taken into account before deciding the best approach. Some studies have suggested assigning weights attached to advantages and disadvantages of various schemes in order to arrive at the best overall choice. Reiche and Teplitz (2008) extend an example constructed by Lovei et al. (2000) for choosing between 10 alternative power sector subsidy schemes.

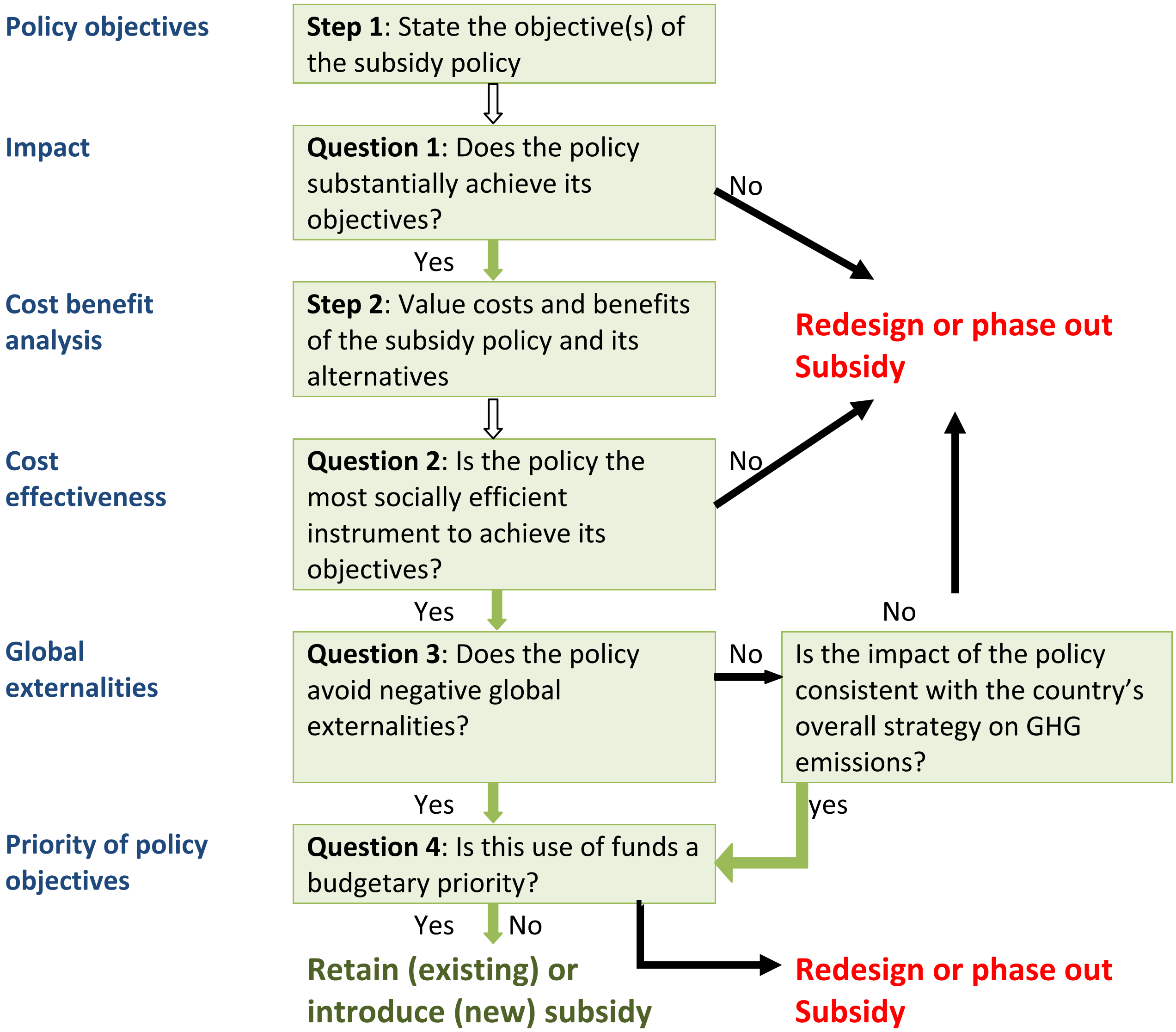
Framework for Analyzing Whether to Introduce, Retain, Redesign, or Remove a Subsidy[10]

Policymakers considering whether to introduce, retain, redesign, or remove a particular energy subsidy may find it helpful to ask a number of questions concerning the subsidy. A suggested list of questions is given in Figure 2. If any answer is negative, the policymaker should consider either phasing out the subsidy or redesigning the subsidy and checking on the list of questions again.

Some questions require detailed calculation, which may be difficult to carry out in some circumstances. Nevertheless, the simple consideration of the question can be a help in the decision-making process. The exercise begins with a statement of the objective(s) of the subsidy and then uses a number of tests to see whether the subsidy should be introduced (if proposed) or retained (if already in place), redesigned, or rejected (proposed) or phased out (if in place). Although the questions are presented in a sequence, it is not necessary to adhere strictly to this sequence and undertake all the associated calculations, if it is fairly clear that the policy would fail one of the tests.

[10] This section is based on "Phasing out energy subsidies: A decision tree and evidence from case studies" (Vagliasindi forthcoming), a background paper for the World Bank's contribution to the "Analysis of the Scope of Energy Subsidies and Suggestions for the Implementation of Their Phasing Out," a joint report of the IEA, OPEC, OECD, and the World Bank for the June 26-27, 2010, G-20 Summit Meeting in Toronto.

Figure 2: Schematic Approach to Assessing Energy Subsidies



Step one

State the objective(s) of the subsidy policy. Examples include protecting the poor against the adverse effects of higher fuel costs on electricity prices, improving energy security, correcting externalities, or promoting industrial growth.

Comments:

- *Many subsidy policies can have several objectives and all should be articulated. For example, a subsidy for biofuels may be intended to reduce dependence on imported oil, promote rural development, reduce subsidies to agriculture, and reduce GHG emissions.*

- *The policy should be articulated in sufficient detail that the financial costs to the government can be calculated. This would require, for example, an exact description of a lifeline rising-block subsidy scheme designed to help the poor with electricity costs.*

Question 1 (impact test)

Assess the impact of the policy: does the policy (existing or proposed) substantially achieve its objectives? If "yes," proceed to step 2. If "no," redesign and start again, or phase out/reject.

Comments:

- *Judging whether a policy meets its objectives requires the goals to be formulated with some precision. For example, "helping the poor" would be too imprecise to allow a reasonable evaluation.*
- *Where there are multiple objectives, it would be necessary to check to what extent each goal had been or would be achieved.*

Step two

Value all benefits and costs of the subsidy policy and its alternatives. Costs should include not only direct financial costs but also any other economic costs and relevant externalities at the national level, such as local environmental damage, costs of resettlement, loss of jobs elsewhere in the economy (for example, where a subsidy supports one industry at the expense of another), and so on. This provides a social cost-benefit valuation for the policy.

Comments:

- *The valuation should also be carried out for the main alternatives that would meet the objectives of the policy.*
- *The valuation would not include global externalities from the emission of GHGs because they are supra-national, and because it is not obvious how to value them at this time. GHG emissions are dealt with separately in question 3.*

Question 2 (cost-effectiveness test)

Is the policy the most socially efficient instrument to achieve the objective(s)? If there are alternative policies that could reach the same objectives, a cost-benefit comparison should be carried out to identify the policy that provides the highest net social benefit. If the current policy passes this cost-benefit test, proceed to question 3. If the answer to question 2 is "no," redesign and start again, or phase out/reject.

Comments:

- *The use of social cost benefit analysis to compare alternative policies to achieve the same primary goal follows a well-established procedure for checking on the efficiency of the policy.*

- *Estimating and monetizing externalities—such as higher morbidity and premature mortality from pollution—can sometimes require data that are not available. Similarly, benefits of some stated goals—such as supporting an infant industry—may be difficult to quantify. Parameter ranges taken from the literature could be used to estimate bounds for net benefits.*
- *When the main difficulty lies in valuing some of the benefits (e.g., poverty reduction), nonfinancial costs, or both, a simpler, and less data demanding, approach would be to use a reduced or limited cost-effectiveness criterion. This approach would compare the quantifiable elements of the alternative policies to achieve given goals of the subsidy policy, including all financial costs. It would over-estimates a policy's net benefits if some of the nonfinancial costs are omitted, and conversely under-estimate if some benefits are excluded.*

Question 3 (global externalities test)

(A) ***Does the policy avoid negative global externalities?*** *If "yes," go to question 4. If "no," go to question 3B***.**

(B) Is the impact of the policy consistent with the country's overall strategy on GHG emissions? If "yes," proceed to question 4. If "no," redesign and reapply tests, or phase out/reject.

Comments:

- *The first question checks whether the subsidy policy would avoid leading to a clear increase in GHG emissions. Hence policies to support renewable or energy efficiency would automatically pass this test.*
- *For policies that do increase GHG emissions, the reaction of the policymaker will depend on the government's overall strategy on its current level of GHG emissions. For example, countries that may have taken a decision to reduce their overall emissions may find the subsidy policy inconsistent with that position. However, a government's overall strategy to reduce GHG emissions may focus on other policies to achieve this, thus allowing subsidies for a particular project to be implemented to achieve other goals (e.g. poverty reduction) despite their direct encouragement of emissions.*
- *The dynamics of climate change discussion, as well as the development of the economy, may well change the policy of a government to its GHG emissions over time. In this case the criterion for deciding whether or not to accept a policy that increases emissions will evolve.*

Question 4 (priority of objective test)

Is this use of funds a budgetary priority? If "yes," retain the existing subsidy or introduce the proposed subsidy. If "no," redesign to reduce costs, or phaseout/reject.

Comment:

- *The priority of the objective can be assessed once the net social benefit and effectiveness of the scheme have been evaluated.*

These tests may be difficult to apply in a precise form to any specific proposal for lack of data. Nevertheless, they encapsulate a framework for thinking about the various barriers that a proposed or existing subsidy scheme should have to pass before being accepted. Even if a scheme passes all these tests in an informal or formal context at one point in time, it is imperative that the subsidy be checked against the above set of questions from time to time to check that it continues to pass all the tests.

Strategy of Subsidy Reform

The preceding discussion has focused on the issues of why a change in energy subsidies may be desirable, and which form of subsidy, if any, might be utilized. However, the widespread occurrence of energy subsidies in developing countries and the large focus on removing or reducing them suggests that there is a disconnect between advocated reforms and actual practice. Two reasons may explain this. There may be no wish to change the level of subsidies: the government is achieving its own objectives and sees no need for change, even though there may be external pressure for change. Alternatively, the government may recognize that there could be an economic improvement from a change in subsidy policy but not have the will or political capital to achieve this. Thus, the economic cost-benefit analysis recommends change but the political cost-benefit analysis discourages it.

Reasons for governments to resist changes in their subsidy policy while the international community calls for such a change may relate to a global externality, as in the case of petroleum product subsidies by large consumers for both GHG emissions and energy security. This case requires explanation of the costs of the subsidies to the global community and to the country itself before there is any possibility that the government would revisit its subsidy policy. Recent discussions on climate change policies have highlighted the possibility that governments could be compensated in some way for reducing their GHG emissions, and this opens the possibility that such help might be tied to subsidy removal. International assistance could, for example, help with cash transfers to the poor who would otherwise be made worse off by the reduction in subsidies.

Where the government recognizes the need to change the level of subsidies but it is unwilling or unable to do so effectively, a deeper analysis of the factors leading to this situation is required. Without understanding the reasons for the circumstances that have so far stalled a change in the subsidy policy, the subsidy reform, if initiated, may fail, and indeed the opposition created by an ill-prepared reform may make another attempt at reform impossible for a number of years. Gupta et al. (2000) give examples of failed subsidy reforms that illustrate the risk of political disruption where rapid reform was attempted without credible social protection mechanisms and governments were unpopular (box 4). However, as pointed out by Bienen and Gersovitz (1986), protests over subsidy removal have rarely led to political instability.

Box 4: Subsidy Reform and Civil Unrest

In *Jordan*, in April 1989, an attempt to raise fuel prices resulted in riots that brought down the unpopular prime minister. In August 1996, Jordanians again took to the streets in response to a 200 percent increase in the price of bread and associated price increases for other items. Observers noted that the unrest was also rooted in the absence of economic opportunities (GDP per capita fell by 2.5 percent in 1996) and dissatisfaction with the lack of public participation in decision making.

Indonesians took to the streets in May 1998 to protest energy price increases proposed by the Suharto regime. In March 2000, there were renewed protests against a proposed hike in fuel prices and the price increase was been postponed until a compensatory scheme for the poor households can be put in place. The government, elected in 1999, has been actively campaigning to explain why subsidy cuts are needed to support economic recovery and to finance the expansion of social programs.

In *Ecuador*, in September 1998, the government increased prices of cooking gas, gasoline, and diesel. To compensate poor households, the government introduced a cash-transfer program targeted to poor women with dependent children, senior citizens, and the disabled. Despite the success in reaching 1.3 million beneficiaries (50 percent of households), the government changed its position on the price increases after street protests in July 1999. Subsidies for fuels reemerged in 1999 as import costs increased and the exchange rate continued to depreciate.

In *Nigeria*, in June 2000, the government increased the price of gasoline by 50 percent. This price increase followed an effective doubling of civil service wages and a major adjustment of the minimum wage in May. However, in reaction to protests by organized labor and students in the major cities, the government agreed to a reduced price increase of 10 percent, while apologizing for not consulting various stakeholders more widely. Observers have linked the protests to an IMF-supported program and the absence of social safety nets in an environment of widespread poverty.

Source: Gupta et al. 2000.

Political economy analysis has been increasingly used to identify the reasons why subsidy reform may be difficult in a country. By identifying these factors it may be possible to find approaches that address the concerns of the interested groups and that permit the reforms to be successfully carried out. Fritz, Kaiser, and Levy (2009) suggest that there are three steps to problem-driven political economy analysis:

- Identifying the problem, issue, or vulnerability to be addressed, and establishing whether it appears to have a political economy dimension
- Mapping out the institutional and governance arrangements and weaknesses
- Drilling down to the political economy drivers, both in identifying obstacles to progressive change, and in understanding from where potentially a drive for positive change could emerge.

The first step leads to consideration of whether there has been repeated failure to adopt or only partially implement the reform policy and, if so, whether this failure has a political economy dimension. The second and third steps are similar but not identical. Political economy analysis must identify both governance weaknesses as expressed through the institutional arrangements and the reasons why such weaknesses exist.

Victor (2009) gives an account of the reasons fossil fuel subsidies have arisen and, once having arisen, are so difficult to remove. He points out that political economy analysis often begins with the assumption that the government acts with the goal of staying in power. Policies that provide subsidies channel resources to organized interest groups that can affect government survival, for example by voting. In addition to “populist” subsidies that are aimed at voting consumers, there is also the “populist paradox” where the largest subsidies (cheapest fuels) are often provided by governments that do not face popular referenda. Here, he suggests that the threat of social instability induces such governments to offer highly visible benefits in terms of subsidized fuel prices. It is particularly difficult for oil-producing countries to phase out petroleum product subsidies because many citizens consider cheap oil an entitlement, and also feel that a bird in the hand (today’s subsidies) is worth two in the bush (future better economic performance generally).

A different type of vested interest that leads to opposition to sector reform was illustrated by Lal (2006) in a study of the Indian power sector. He pointed out that among the primary stakeholders are the staff of the utilities themselves as well as intermediaries such as politicians and trade unions. Secondary stakeholders include consumers, and among them important organized groups such as farmers and transportation operators. The primary or secondary stakeholders may see jobs or livelihoods threatened by reforms, including subsidy reform, and this can make it more difficult to implement policies aimed at improving the efficiency of the sector.

A noteworthy feature of the power sector in many developing countries is its poor performance. Blackouts and brownouts are common, leading to increased costs through loss of production, the need to invest in back-up generation, and damage to equipment (Monari 2002; Lal 2006). In this situation consumers may not be willing to pay higher prices for a poor service. Sequencing of subsidy reform and improved supply needs to be considered in order to make the reform both acceptable and sustainable. Without an improved service the willingness to pay higher prices will be low, while mere promises of improvement, once the financial situation of the utility has been restored via the higher revenue, will not be credible, given previous poor performance. The policy strategy needs to find a way of improving performance ahead of the tariff increases.

Programs of sector reform that have coupled the liberalization of power tariffs with corporatization or privatization of the sector suggest that the efficiencies gained from the wider reform would pay, at least in part, for the higher tariffs that would otherwise accompany cost-recovery. This has been seen as a way to break the cycle of inefficient operation requiring unnecessarily high tariffs, leading to government subsidies to protect consumers that in turn lead to further losses for the sector and a lack of investment in maintenance and improvements, further increasing costs.

Where there are large subsidies that a government wishes to substantially reduce or remove, one important question is the dynamic adjustment path. A series of small changes in successive years compounds to a large change after a few years and is less likely to provoke a strong reaction from those affected. However, to carry out such a sustained policy governments need commitment to stay the course. Where the government is politically strong enough to weather any ensuing social disruption, a "big bang" approach with a large initial adjustment may be the approach most likely to endure. Once the subsidy has been nearly or totally removed, it would be possible to move the pricing decision from the government's direct control to a regulatory agency.

Victor (2009) offers some general lessons with respect to reforming petroleum product subsidies and that can be applied also to power sector subsidies.

1. Reform strategy must address the political logic that led to subsidy creation. The reform strategy must either compensate the political interest that would otherwise oppose the subsidy reduction or removal, or must find a way to insulate the reform from their opposition.
2. Ensure transparency of the costs and purpose of the subsidy. Reforming subsidy may be easier if all members of society are fully aware of the costs they are paying, and the extent to which they or others are benefitting.
3. For essential subsidies ensure the best design to carry out the stated purpose. Better subsidy design can reduce the overall costs to the economy, the excess demand for energy and the associated negative externalities. In particular, subsidy design should focus on long-term costs, use pre-announced conditions for subsidy recipients, should have explicit adjustment mechanisms, and should utilize performance targeting.
4. Governments need to develop more selective policy instruments. Broad-spectrum subsidies are less effective in meeting their stated purpose but are popular because they tend to spill over to a wider group of users, making it increasingly difficult to reverse such policies later.

A number of studies have addressed in detail the wider issues involved in reforming energy subsidies. These include UNEP/IEA (2002), USAID (2004), Reiche and Teplitz (2008), and the World Bank (2008b). All these propose criteria for successful subsidy reform. As well as highlighting the various practical considerations, suggestions have been made as to how subsidy reduction or removal could be made more acceptable to the public, so as to avoid strong reaction and the need to reverse policy that has been seen on occasion. The government needs not only to work towards equity improvement in subsidy design, but also needs to communicate this in a transparent and verifiable way. The UNEP/IEA (2002) suggested that reforms may need to be introduced in a gradual, programmed fashion; compensating measures to support incomes of specific groups could be introduced; and politicians should communicate clearly to the public the benefits of subsidy reform to the economy and steps being taken to protect weaker members of society. USAID (2004) provided a list of pitfalls to be avoided in launching a subsidy reform policy. Most of these relate to the public relations aspect as shown in box 5.

Box 5: Communicating a Tariff Increase

The social implications of energy pricing make it a very sensitive political issue. In the short-term it may be possible to achieve some popularity and contain social discontent by deciding not to allow any increase in energy prices. However, it should be stressed that when the inevitable upward adjustment is to be made, the resultant fuel price increases may indeed be enormous, and may cause more serious political and social repercussions.

If the government and regulator can effectively convince the public and politicians that low income customers receive energy at prices they can afford, then the reform initiatives can move forward, needed tariff reforms can be made, and there should be less resistance to disconnections.

An overriding issue is that the benefits from any tariff subsidy structure, including a lifeline, will be severely limited until cash payments from all customers (poor and non poor) reach the same levels as those for other commercial goods and services. Otherwise, indiscipline through theft and nonpayment will destroy any reform effort. As long as theft and non-payment are tolerated, the consumer sees the "ultimate subsidy" as already available and in place, and as long as the government continues allowing such behavior, electricity is essentially being treated as a free good.

Based on the Consultant's experience working with energy utility companies in a number of countries in the Former Soviet Union and Asia, and judging from the public reaction, media reports, and stakeholder responses, energy tariff increases usually become one of the most discussed and often controversial issues. Sometimes, tariff increases, which are viewed as a very unpopular measure among the general public, could represent a threat to the reform process and get in the way of communications on energy topics. The challenge is to seize upon such sudden interest and communicate in a way that motivates people to look at energy from a fresh perspective. In this regard, it can be useful for the regulator to learn from the experiences of other countries and avoid the following pitfalls/mistakes that can create a public and political commotion:

- Lack of transparency—It is critical to ensure that the general public and all stakeholders do not perceive the tariff review process as the one happening behind closed doors.
- No public participation—It is critical to provide an opportunity for the public to participate in the tariff setting process through hearings.
- No advanced warning—Prevent sudden announcements of tariff increases; the public must have prior warning.
- Announcements on Holiday—Avoid making tariff increase announcements on national holidays. The timing might give an impression of having something to hide.
- Very high increase—Avoid a very drastic increase in tariffs that could come as a shock to the consumers.
- Non-credible reason for increase—Provide credible, consistent and straightforward explanations for the need to increase tariffs.
- Affordability factor missing from tariff calculations - When determining tariffs, it is important to examine energy costs. It is equally important to examine poor people's ability to pay. Otherwise, the sudden price shock could affect the public's acceptance of the reforms.
- Public reaction missing from calculations - By not factoring in the anticipated public reaction to the tariff increases, the energy reforms might be put at risk.

Source: USAID (2004)

As part of this communications strategy the quantification of subsidy costs and benefits, as well as its targeting performance, should be undertaken. This should be done not only for the proposed subsidy reform but also for alternatives schemes that might be proposed by potential opponents of the change, in order that an informed discussion can take place at an early stage on the policy dialogue. Further, a communication strategy concerning possible subsidy removal (reduction) should place this issue in the wider context of how the government plans to address the various ailments of the sector—such as inefficiencies, incorrect planning decisions, corruption, and tariff setting.

Some case studies of energy sector subsidy reform

A number of governments have managed to reduce energy subsidies involving a substantial increase in prices, without incurring sufficient public opposition that the policy had to be subsequently reversed. Brief accounts of some such cases are given in boxes 6–11, while a wider range of case studies is given by Vagliasindi (forthcoming).

Box 6: Reducing Petroleum Product Subsidies: the Case of Jordan

Jordan had been subsidizing petroleum products for many years, but the system came under pressure beginning in 2003 when it lost preferential fuel supply from Iraq. The government then implemented a series of price increases to limit the budgetary effect. Nevertheless, by 2008, the subsidy bill for energy amounted to about 5 percent of GDP.

Earlier the government had considered raising prices to international levels but had backtracked on an agreement to do so reached with the IMF, because of fears of social unrest such as had happened in 1989 and 1996. In February 2008 the government announced that the fiscal burden of the subsidies was not longer sustainable and raised petroleum product prices to international levels by amounts ranging from 9 percent for premium gasoline to 76 percent for diesel and kerosene. A plan to remove the subsidy on LPG used for cooking was abandoned after intervention by King Abdullah (Kojima 2009b).

The government, conscious of the effects on the population, announced that it would adopt some mitigating measures, including increases in the salaries of state employees, an increase in food subsidies, the reduction of certain import duties, and the introduction of projects to combat unemployment and poverty. The compensation package was estimated to be equivalent to 7 percent of GDP. One aspect of this reform package was the scaling up and improved targeting of the National Aid Fund to the poor using an existing cash transfer system. The compensation package was also designed to direct a portion of the budgetary savings to benefit low- and middle-income households. Recent household expenditure survey data were used for in-depth analysis of middle-class risks in setting the limits for support. Before the scheme became operational an extensive media campaign was launched to prepare the public for the subsidy removal.

Despite the very large international oil price increase that followed immediately after the government's decision to liberalize prices, the policy has so far been successful and domestic prices have continued to follow international levels. The subsidy phase-out appears to have been successful in part because it was well-designed and the public understood that it was needed. In addition there were a number of factors individual to the Jordanian situation: there had been earlier a successful withdrawal of a food subsidy program; the impetus for change was provided by the external shock of the Iraq war; and emigrant remittances were particularly high during high price period of 2008 (most coming from the Gulf region) and increased by more than subsidies were reduced. An additional factor is that the government increased food subsidies just as fuel subsidies were being reduced, particularly following the food crisis of 2007–8. This helped partially offset the adverse effects of fuel subsidy removal. As a share of GDP, fuel subsidies fell from 5.6 percent in 2005 to 1.4 percent in 2008, but food subsidies increased from 0.6 to 1.8 percent during the same period (IMF 2007, 2009).

Box 7: Reducing Petroleum Product Subsidies: the Case of Indonesia

Indonesia is an oil-producing nation that recently became a net oil-importer. Because of its former oil status it has had a history of subsidizing domestic prices, and attempts in 1998 and 2003 to reduce subsidies met with such fierce public opposition that the increases had to be rolled back. The rise in international oil prices in 2003 and 2004 led to a rapid increase in subsidies as the government sought to limit the impact on households by introducing a price freeze. The fiscal implications of the freeze were severe with the cost of the petroleum product subsidies reaching 5 percent of GDP (Pallone 2009).

The incoming government of President Yudhuyono was able to respond to this challenge by increasing the prices of gasoline, kerosene, and diesel twice in 2005, by amounts totaling at least 150 percent. Although domestic prices still did not reach international levels these were substantial increases, and it was remarkable that they did not generate mass opposition as such moves had done in the recent past.

Several factors may have contributed to this success, as suggested by Bacon and Kojima (2006) and Grosch et al. (2008). The success of the first increase in March 2005 may be linked to the status of the then incoming new government, that was seen as strong and credible. By August the government had taken a decision to link a second price increase to a targeted cash transfer scheme. The overall strategy was to reduce fuel subsidy expenditure by about half. One quarter of the funds were to be used to fund the targeted, unconditional transfer program, and the remainder was to be used for block grants to schools, basic health care and health insurance for the poor, and for a village improvement program. It was decided to target not just those who fell below the official poverty line, but the near poor as well. The magnitude of the cash transfer was such that it was expected to more than compensate targeted households for the increase in fuel prices. The full distributional impact of the fuel pricing reform has been analyzed by Yusuf and Resosudarmo (2008) using a CGE model.

The government supported the subsidy reform program with public information campaigns to publicize the scheme. Information was presented in announcements in newspapers, TV talk-shows, notices on village announcement boards, and through the distribution of brochures covering frequently asked questions. The disbursements were made in two tranches and this allowed the government to rectify some problems. It organized public hearings with program beneficiaries and worked to improve the logistics of distribution at the post office and complaint resolution procedures.

Despite this initial success of the subsidy reform program, the government, faced with continually increasing international oil prices, decided to freeze the price of the subsidized fuels between October 2005 and May 2008. The result was that the cost to the budget of the subsidy rose sharply. The main beneficiaries of the subsidies had been the better-off members of society and their opposition to subsidy reduction at a time when oil prices were high may have prevented the government from repeating its earlier strategy sooner. The government increased fuel prices by 25 percent or more in May 2008, accompanied by another round of targeted cash transfers. In a reversal of policy, the government stated in early 2010 that it would no longer consider raising fuel prices and planned for a higher fuel subsidy bill in the 2010 budget (IIF 2010). Without an automatic price adjustment mechanism, a cycle of price freeze, fiscal burden, and emergency policy response may have to be repeated if world oil prices were to start rising with global economic recovery in the coming years.

Box 8: Reducing Petroleum Product Subsidies: The Case of Ghana

Ghana has been a small producer of oil, importing the bulk of its needs either in the form of petroleum products or as crude oil to be processed in its domestic refinery. Prior to 2005 domestic product prices had been subsidized by the government, sometimes by large amounts. In January 2003 the prices were increased by 90 percent in an attempt to link the domestic prices to world prices. There was widespread popular opposition to this move but not sufficient to cause the government to back down.

From this date on the government—facing an election in December 2004—did not maintain the link to international prices and, as the world price of oil rose, the total cost of subsidies increased sharply. After the election the incoming government announced in February 2005 fuel price increases of 50 percent, coupling the announcement with an extensive public information. A series of mitigation measures were also introduced that were transparent and easily monitorable. These included the immediate elimination of fees as government-run primary and junior-secondary schools, and a program to improve public transport. As a result, although there was opposition to the increases from trade unions, there was general acceptance of the policy and no large scale demonstrations against the increases took place campaign (Bacon and Kojima 2006).

A key ingredient in the public relations campaign was the use of the results of a poverty and social impact analysis (PSIA) for fuel that had been launched during 2004 when it had become evident that action to increase prices would be needed. The PSIA was administered by a steering committee drawn from ministries, the national oil company, and academics. The process was completed in less than one year and by the time of the fuel price increase announcement the results were available to the government to support its case. The potential effects of reducing petroleum product subsidies on the public were analyzed and it was shown that the better-off members of society benefitted most from the presence of the subsidies (Coady and Newhouse 2006).

The public relations campaign commenced with the Minister of Finance making a radio broadcast to explain the need for the price increases and to announce the mitigation measures. Radio interviews with various government officials followed. The energy ministry took out advertisements in newspapers showing that Ghana's prices were the lowest in West Africa after Nigeria.

From February 2005 until May 2008 the government continued with its policy of liberalized prices subject to price ceilings in line with world prices but, in the face of the surge in oil prices, froze the price ceilings between May and November 2008. The election at the end of 2008 saw a pledge by the later victorious opposition party to abandon serial oil price increases that had been experienced under the then government. In fact the incoming government has resorted to an ad hoc pricing approach with price increases coming in April, June and November 2009 (IHS Global Insight Daily Analysis 2009).

The reintroduced subsidies resulted in the net debts of the domestic oil refinery mounting to around $600 million in 2009. As a result of this debt the refinery could not buy crude and had to shut down for most of 2009 (International Oil Daily 2009).

Box 9: Reducing Electricity Subsidies: The Case of Armenia

In the first half of the 1990s, Armenia's power system was at a state of near collapse. This followed the disintegration of the Soviet Union and the effects of Armenia's war over Nagorno Karabakh. The latter led to an economic blockade cutting off the only source of gas and oil for power plants, while an earlier earthquake had forced a shutdown of a nuclear plant supplying almost one third of total generation. During the winters customers suffered from rationing to little more than two hours per day. At the same time the sector was running a huge quasi-fiscal deficit equivalent to about 11 percent of GDP in 1995. Collections were barely above 50 percent, and commercial losses were nearly 25 percent.

The government took a number of steps to address these problems. These began with improvements in energy supply that resulted in 24-hour supply being restored by late 1996, while the government emphasized the link between better supply and bill payment. The metering system was improved to address unaccounted losses and collection failure. This was followed by a privatization program that proceeded slowly, due in part to the turmoil in power markets caused by the failure of Enron and the California electricity crisis.

By 2004 the sector had been transformed. Collections had reached nearly 100 percent, and commercial losses had been reduced to 4 percent. Tariffs set by a regulator were near medium-term cost-recovery levels (that is, recovering short term-cost of service, depreciation, and some part of new investment). The drain on the government budget ceased and the sector became a net tax-contributor to the budget. Between 1996 and 2004 the average tariff level doubled in real terms.

A number of factors contributed to Armenia's ability to raise prices and eliminate subsidies.

1. The supply availability was so poor that virtually any change would be seen as an improvement. The costs of blackouts were so high that there was an implicit willingness to pay for better supply at reasonable tariffs.
2. The government was able to improve supply *before* it started on the program of raising tariffs, improving bill collection, and reducing unaccounted losses. This gave credibility to the whole of the subsequent reform agenda.
3. The government was able to increase social transfers during this period of reform. Between 2001 and 2004 social spending increased from 6.5 to 7.2 percent of GDP despite an overall decrease in fiscal expenditure. Although this could not fully compensate the effect of the tariff increases on the poor, it was certainly an important factor both materially and psychologically.
4. The new private sector company showed itself willing to disconnect non-payers even when they were as important as the Ministry of Internal Affairs, the mayor's office, and the Ministry of Energy. This provided credibility to the reform and subsidy removal process.
5. The private sector company not only was able to raise wages, but also gave a significant variable component to its employees based on improvements in losses and collections.

Source: Sargsyan, Balabanyan, and Hankinson 2006.

Box 10: Removing Power Sector Subsidies in Conjunction with Wider Sector Reform: Some Latin American Experience

A number of governments in the region followed a program of commercialization or privatization as a means of solving the persistent underperformance of a state-owned power sector utility. In some cases the underperformance was linked to a substantial explicit or implicit subsidy given to prevent the needed high cost-recovery tariffs being passed on to consumers. Raising tariffs to cost-recovery levels could have resulted in a substantial increase in certain cases. One of the goals of the reform was to provide conditions under which the sector would improve its efficiency. Efficiency improvement would moderate tariff increases needed to achieve cost recovery. Besant-Jones (2006) describes the power sector reforms carried out in a number of countries and provides the following commentary on the course of tariffs post-privatization.

In Chile, power suppliers increased their capacity substantially by more than doubling annual generation from 1990 to 1998. Privatization also increased the productivity of utilities by cutting energy losses by more than half to 8.3 percent in 1997, by doubling labor productivity in distribution, and by tripling energy generation per worker in the largest generating company. Although privatized companies became substantially more efficient, these gains were transferred to customers only in areas under competition. In the main market, the regulated wholesale price of electricity fell by 37 percent, and technological change rendered uneconomical a large fraction of existing thermoelectric plants. In contrast, the final price to customers did not fall to reflect the huge productivity gains that were achieved after privatization, since between 1987 and 1998 the regulated price to consumers fell by only 17 percent. This situation led to spectacular increases in the profit rates of distribution companies: the rate of return of the largest distributor rose from 10.4 percent to 35 percent in this period, which is striking considering the low market risks carried by distribution monopolies.

In the case of Argentina, wholesale power prices and unserved demand fell substantially following market reform. The average electricity spot price dropped steadily from about $0.045 per kWh in 1992—the first year of operation—to $0.025 per kWh by 1998 under intense competition among the privatized generators. Retail power prices did not decline as much, however, because of contracts between distributors and generators concluded before the parties were privatized. Electricity prices for industrial users declined more than prices for residential users. Similar price trends occurred in other South American countries (Bolivia, Colombia, Peru) that followed the same reform model as Argentina, with wholesale prices falling by more than retail prices.

Box 11: Reducing Electricity Subsidies: The Case of Kenya

In the early 2000s, the Kenya Power and Lighting Company (KPLC)—the distribution company in the country—had substantial hidden costs in underpricing, collection losses, and distribution losses which absorbed 1.4 percent of GDP. The company managed to improve revenue collection from 81 percent in 2004 to 100 percent in 2006. Steps to improve revenue collection included disconnecting government ministries and departments. Technical and non-technical distribution losses, target values of which are incorporated in the tariff formula, have not fallen as fast as hoped for: the losses actually increased from 18.8 to 19.6 percent between fiscal 2004 (July 2003-June 2004) to fiscal 2006 before falling gradually to 16.3 percent by fiscal 2009. The company is listed on the Nairobi Stock Exchange and the government share of the company has fallen over the years to 40 percent today.

The Electricity Regulatory Board (Energy Regulatory Commission since 2007), established in 1998, maintains a significant degree of autonomy. The board in 2005 issued its first tariff policy since 1999. The 2005 policy bases tariffs on long-run marginal costs and continues two pass-through adjustment mechanisms, one for fuel costs and the other for currency fluctuations. Noting that the existing subsidy is not particularly targeted, the policy recommends a volume differentiated tariff structure whereby only those households consuming less than 50 kWh a month will be charged a subsidized lifeline rate and those consuming more will be charged a much higher rate for all their consumption. However, volume differentiated tariffs have not been applied to date.

As in other countries, tariff increases have encountered difficulties. In 2004, the government approved a 10 percent increase, but in the end a 5-percent increase was implemented after intense negotiations with large consumers. Earlier in July 2003, owing to KPLC's serious financial difficulties, the Kenya Electricity Generating Company (KenGen) signed an agreement with KPLC, lowering the price of electricity sold to KPLC from 2.36 ($0.032) to 1.76 ($0.024) Kenyan shillings per kWh for three years. When the agreement expired in 2006, KenGen began charging KSh 2.36 but KPLC continued to pay 1.76, prompting the government to step in and pay the difference to KenGen. One problem is that KPLC could not pass on the higher tariff to consumers without approval by the regulator. With general elections scheduled for December 2007, the government continued to provide the KSh 0.60 subsidy throughout 2007. The subsidy was removed only in July 2008, when consumer power prices (excluding fuel and exchange rate components) were adjusted upward by 21 percent on average.

Power pricing reforms allowed tariffs to rise in line with escalating costs, from $0.07 on average in 2000 to $0.15 in 2006 and to $0.20 in 2008. The hidden costs of the power sector fell to 0.4 percent of GDP in 2006 and were eliminated by 2008.

Although the tariff formula is intended to enable power companies to expand their infrastructure, attracting investment for expansion has been difficult. The need for significant capital investment is illustrated by data collected in 2007. Close to 80 percent of firms in Kenya experienced losses because of power interruptions. That percentage was higher than that of all the comparator countries. As a consequence, almost 70 percent of firms had generators, which are costly to purchase and operate. Power disruption cost Kenyan firms approximately 7 percent of sales. The government has recently set up two new state-owned companies—one for transmission and the other for geothermal development—with the intention of funding their projects directly.

Sources: Foster and Briceño-Garmendia 2010; WMRC Daily Analysis 2004; KPLC 2009; ERC 2005, 2008; *All Africa* 2004; Global Insight Analysis 2007; Iarossi 2009; *Daily Nation* 2009.

These case studies of governments that have managed to reduce subsidies and raise energy prices, even if not permanently, have certain common features that point to strategies for other governments to consider. Some key strategies that emerge from this review include the following:

1. Subsidy reform appears to be possible in situations where the explicit or implicit fiscal costs to the government are so large that the government feels it must act. This strengthens the political willpower, without which little can be achieved.
2. Increasing the availability and transparency of energy subsidy data is essential in overcoming some of the challenges related to reform. This can encourage an informed discussion and debate regarding the subsidies and government policies toward them.
3. Efforts should be made to provide targeted assistance to vulnerable groups, such as lower-income households who will be adversely affected by subsidy changes. Compensation needs to be visible and sufficiently material to offset a good part of the adverse effect in the early years of the change. Consideration should be given to alternative policy tools to protect the poor, such as cash and non-cash transfers, and, for electricity, district heating, or natural gas, lifeline rates or volume differentiated tariffs. Subsidies for connection charges can also be targeted to the poor, but may need to be limited in countries where the connection rate is low.
4. The credibility of the government's plan to compensate vulnerable groups is important for public acceptance, as is its plan to use the funds freed from subsidy reform for social and economic benefits.
5. A well-organized publicity campaign is essential. Governments can reduce uncertainty and persuade the public that the effects will not be as deleterious as might otherwise be feared by explaining, before the changes are introduced, the need for change and the compensating measures that will be implemented.
6. Using a household expenditure survey to provide information on those benefiting from the existing subsidy and the potential effects of subsidy removal on various groups provides an important reference for assessing the adequacy of compensation measures that are planned.
7. An election may provide a window of opportunity to make bold changes, because a new government may initially enjoy a period of greater credibility and legitimacy than the old government that failed to tackle the problem. This suggests that incoming governments need to start preparation beforehand to be able to move early in their term in office.
8. Improving the quality of service ahead of increasing prices lends credibility and increases the willingness to pay higher prices. This is particularly true for energy distributed through networks—electricity, district heating, and natural gas— where the quality of service may be low, possibly because of the financing difficulties caused by subsidies. Steps such as improving bill collection and making the metering system more effective may allow other changes to be introduced that could be linked to the general tariff increases required to reduce the fiscal burden further.
9. Use of transitional arrangements that are phased out as household energy use increases over time can act to protect low-income groups at the time of the policy change.

However, in two of the cases reviewed governments were unable to adhere to a permanent policy of subsidy reduction. It should be noted that the extreme high oil prices of 2008 led to such pressure on consumers that some governments felt compelled to limit the price increases. This in turn rapidly escalated the fiscal burden. Without a full liberalization of price setting, governments that are involved in controlling petroleum product prices, either through a formula or on an ad hoc basis, will always be under pressure to adapt the rules to the current circumstances. The benefit of moving to a fully liberalized price system is that it is much more difficult for the government to reintroduce price control since it will be faced with a demand for explicit subsidies, rather than permitting state enterprises to increase the quasi-fiscal deficit through cutting their operating budget and utilizing debt finance, neither of which is sustainable.

Concluding Observations

Energy sector subsidies are large and widespread in both developed and developing countries. Consumer subsidies are particularly important in many developing countries. Petroleum product subsidies are known to be very large in certain cases, especially in some major oil-exporting countries. Power sector subsidies that result from underpricing, excessive losses, and bill collection failure are known to be common in those developing countries for which detailed investigations have been carried out. However, more systematic information is needed to give a fully comprehensive picture.

While subsidies can have benefits in terms of support for the poor, job creation, industry protection, or energy security, they also carry costs. These include fiscal costs and effects on the balance of payments, growth, and global externalities. In particular, in economies with large energy consumption, the extra demand for energy induced by the lower consumer prices can work against energy security and have global effects through increased GHG emissions from the combustion of fossil fuels and possibly higher prices for widely traded forms of energy.

In the light of these costs to their economy it is important that governments design their subsidy scheme so as to achieve the desired benefits with the lowest overall costs. Some broad findings of this review suggest a number of points to be taken into account:

- Gasoline, diesel, and LPG subsidies are weakly targeted to the poor, particularly in low-income countries.
- Kerosene subsidies may be targeted to the poor through their direct effects, but the leakage to better-off households, commercial establishments, and the transport sector arising from the ease of adulterating diesel fuel with kerosene means that their pro-poor benefits may be limited.
- Electricity subsidies resulting from excessive losses or failure to collect bills do not have economic justification and should be actively reduced.
- Electricity subsidies through generalized underpricing are likely to be regressive, and much better targeting may be achieved through a careful design of the tariff structure. Volume differentiated tariffs appear to perform much better in this respect that increasing block tariffs.

- Subsidies to connection charges for electricity can be designed to be strongly progressive, but their substantial cost per household requires an investigation into the lowest cost method of supply as well as comparative assessment of other options to help the poor.
- Cross-subsidies for tariffs and for connection charges between different classes of users can be an important instrument, but are of limited use where overall connection rates are very low.
- Social safety nets can provide a more effective way of reaching the poor while controlling public expenditure. However, they require a strong administration.
- Because energy subsidies can result in a large fiscal burden, all subsidy schemes should consider the inclusion of natural phaseout provisions. This can help to reduce the expectation of a permanent subsidy that can be very difficult to combat at the time a government feels the need to reduce the fiscal burden. However, some subsidy schemes may be designed to be permanent, such as cross-subsidies between different groups of consumers (such as urban households cross-subsidizing rural households for whom costs of power supply can be markedly higher).
- Transparency is important. Proper accounting and public awareness of which groups benefit from subsidies, by how much, and the cost is essential to evaluate government policies.
- Subsidies to support a switch from fossil fuels to renewable energy need to be carefully planned and to consider the inclusion of natural phase-out provisions.
- Because of the potential cost of a subsidy scheme and of the different performance of alternative schemes, a full evaluation of costs and benefits should be made before making any changes to the status quo. Governments that have rushed subsidy reform without preparing the population for the changes, and without providing targeted support to particularly disadvantaged groups, have often had to reverse the policy in the face of widespread opposition.

In compiling this overview of the role of different forms of subsidies for energy, arguments for their retention or removal, and the problems associated with removal, it has become evident that there is a need for further work of a more focused nature. First, a more systematic analysis of the political economy of retaining or removing subsidies to the various forms of energy would be valuable. Second, refining the discussion of policy options and best practices by a typology of countries (for example, energy exporting or importing, high or low electricity access, and the state of tariff-setting methodology for natural gas, district heating, or electricity) would provide a useful tool for those considering the role of energy subsidies in a particular country. Third, some examples of applying the framework for deciding on a particular subsidy change would provide valuable insights in how to deal with an individual case. Finally, consideration could be given to exploring whether a manual on the treatment of energy subsidies should be produced.

Annex A: Supplementary tables

Table A.1: Explicit and Implicit Petroleum Product Subsidies in Selected Countries in 2005 as a Percentage of GDP

Country	Explicit subsidies	Country	Implicit subsidies
Argentina	0.2	**Armenia**	0.0
Azerbaijan	2.8	**Azerbaijan**	13.9
Bolivia	0.8	**Bangladesh**	1.0
Cameroon	0.2	**Bolivia**	5.2
Congo, Republic of	1.0	**Cameroon**	0.0
Dominican Republic	0.5	**Colombia**	1.6
Ghana	0.9	**Congo, Republic of**	NA
Honduras	NA	**Dominican Republic**	0.2
Indonesia	4.2	**Ecuador**	3.6
Jordan	5.8	**Egypt**	4.1
Lebanon	0.1	**Ethiopia**	0.7
Nigeria	0.0	**Gabon**	1.6
Pakistan	0.2	**Nigeria**	2.2
Senegal	0.6	**Sri Lanka**	1.0
Sri Lanka	0.8		
Yemen, Republic of	9.2		

Source: Baig et al. 2007.

Note: — = not available.

Table A.2: Hidden Costs in Power as a Percentage of GDP in Eastern Europe and Central Asia

Country	2000	2001	2002	2003
Albania	10.5	7.4	6.1	4.1
Armenia	1.4	2.2	1.0	1.0
Azerbaijan	11.4	10.1	8.1	6.4
Belarus	2.5	2.2	0.8	0.0
Bosnia	5.4	5.1	3.9	1.4
Bulgaria	9.5	8.1	7.0	3.8
Croatia	2.1	2.1	1.8	0.9
Georgia	12.2	6.9	6.5	6.0
Kazakhstan	3.3	2.9	2.4	1.3
Kyrgyz Republic	18.6	25.2	19.0	9.2
Macedonia	5.0	3.6	3.5	5.6
Moldova	10.8	7.7	3.2	2.7
Poland	0.3	1.4	1.1	0.8
Romania	3.8	3.7	2.5	1.3
Russia	5.4	3.6	3.1	1.0
Serbia and Montenegro	22.5	16.5	8.9	8.7
Tajikistan	28.2	25.0	23.0	16.5
Turkey	1.8	2.1	1.1	0.6
Ukraine	8.6	10.2	13.1	12.1
Uzbekistan	8.6	10.2	13.1	12.1

Source: Ebinger 2006.

Table A.3: Hidden Costs in Natural Gas as a Percentage of GDP in Eastern Europe and Central Asia

Country	2000	2001	2002	2003
Armenia	0.4	0.2	0.2	0.5
Azerbaijan	1.4	1.2	1.1	0.9
Belarus	1.9	2.0	1.3	0.5
Bulgaria	1.4	1.1	0.7	1.0
Croatia	0.0	0.2	0.1	0.0
Georgia	1.0	2.0	1.2	0.0
Kazakhstan	—	—	—	0.7
Kyrgyz Republic	0.4	0.2	0.4	0.0
Moldova	0.8	0.6	0.8	0.9
Poland	0.4	0.2	0.1	0.0
Romania	1.0	0.8	0.5	0.2
Russia	1.2	0.9	0.7	0.4
Tajikistan	2.0	1.9	1.1	0.4
Turkey	0.1	0.2	0.1	0.3
Ukraine	3.7	5.1	1.1	1.0
Uzbekistan	3.0	3.4	5.9	1.3

Source: Ebinger 2006.

Note: —= data not available.

Table A.4: Hidden Costs in Power as a Percentage of GDP in Sub-Saharan Africa (average 2001–2006)

South Africa	0.0	**Ethiopia**	1.8
Benin	0.2	**Uganda**	1.9
Kenya	0.5	**Cameroon**	2.2
Mozambique	0.7	**Zambia**	2.3
Chad	1.0	**Tanzania**	2.4
Cape Verde	1.2	**Senegal**	2.5
Madagascar	1.3	**Ghana**	3.1
Lesotho	1.4	**Niger**	3.5
Nigeria	1.4	**Malawi**	4.4
Burkina Faso	1.5	**DRC**	4.7
Rwanda	1.7		

Source: Briceño-Garmendia, Smits and Foster 2008.

Table A.5: Subsidy Targeting Indicators for the Electricity Sector for Various Countries

Country	**Type of subsidy**	**Benefit targeting performance indicator Ω**	**Error of Exclusion of Poor Households %**
Columbia, urban	Geographically defined with IBT	1.01	2
Guatemala	VDT with 300 kWh/month threshold	0.20	55
Peru	IBT	0.82	60
Mexico	Geographically defined with IBT	0.60	—
Argentina	Provincial means-tested subsidy	1.50	94
Croatia	Uniform volumetric tariff	0.51	1
Hungary	IBT	0.98	2
Georgia	Winter heating allowance	1.20	75
Rwanda, urban	Uniform volumetric tariff	0.26	87
Cape Verde	IBT with 40 kWh/month first block	0.48	76
Saõ Tomé and Principe	IBT with 300 kWh/month first block	0.41	77

Source: Komives et al. 2005.

Notes: —indicates not reported, IBT = increasing block tariff, VDT = volume-differentiated tariff.

Table A.6: Shares of Electricity in Total Household Expenditure of Lowest and Highest Quintile Groups

Country	Year	Q1	Q5
Columbia, urban	2003	10.2	1.6
Guatemala	2000	3.0	3.0
Peru	2003	2.3	2.6
Uruguay	2002–2003	12.3	2.0
Mexico	2002	1.9	9.9
Bolivia, urban	1999	4.0	3.2
Nicaragua	1998	0.6	2.0
Argentina	2002	6.2	3.4
Albania, urban	2002	9.9	5.0
Armenia, urban	2002	10.2	6.4
Azerbaijan, urban	2002	2.0	1.7
Belarus, urban	2002	1.9	0.8
Bulgaria, urban	2002	11.8	8.5
Croatia	1998	4.0	2.4
Georgia, urban	2002	8.2	4.0
Hungary, urban	1997	7.6	4.2
Kazakhstan, urban	2002	3.8	1.6
Kyrgyz Republic, urban	2002	3.2	1.8
Latvia, Riga	1997	3.6	2.4
Moldova, urban	2002	9.3	5.6
Poland, urban	2002	10.1	5.5
Romania, urban	2002	7.1	5.4
Russian Federation, urban	2002	2.2	0.9
Tajikistan, urban	2002	3.4	1.9
Turkey, urban	2002	9.7	6.3
Ukraine, urban	2002	2.9	1.6
Rwanda, urban	2000–2001	4.4	2.2
Cape Verde	2001–2002	4.2	2.9
Saõ Tomé and Principe	2000–2001	5.1	4.4
Yemen, Republic of	2003	1.3	1.8
Philippines	2001	2.5	3.1

Source: Komives et al. 2005.

Table A.7: Shares of Expenditure on Energy by National Quintile Groups (all households)

Country	Quintile	Electricity	LPG	Kerosene	Gasoline & diesel	Biomass	Natural gas	Petroleum products	Modern energy	Total energy
Bangladesh	1	0.4	ND	1.5	0.0	6.2	0.0	1.5	1.9	8.1
	5	1.9	ND	0.5	0.3	2.5	0.9	0.8	3.6	6.1
Cambodia	1	0.1	0.0	1.6	ND	6.6	NA	1.6	1.7	8.4
	5	2.2	0.7	0.3	ND	2.4	NA	1.0	3.2	5.6
India	1	1.3	0.0	2.1	0.0	8.7	NA	2.2	3.4	13
	5	3.5	2.5	0.8	2.2	1.4	NA	5.6	9.1	11
Indonesia	1	2.6	0.0	2.3	0.2	3.5	0.0	2.6	5.2	8.6
	5	3.7	0.5	1.6	1.8	0.3	0.0	4.4	8.1	8.4
Kenya	1	0.0	—	2.2	0.0	1.0	NA	2.2	2.2	3.1
	5	0.5	0.4	1.9	0.7	1.2	NA	3.0	3.5	4.7
Pakistan	1	3.4	0.1	0.5	0.1	4.4	0.3	0.7	4.4	8.8
	5	4.2	0.4	0.1	2.5	1.7	0.9	3.1	8.2	9.9
Thailand	1	3.2	0.3	0.0	4.6	1.6	—	5.0	8.2	9.8
	5	2.9	0.4	0.0	7.0	0.0	0.0	7.4	10	10
Uganda	1	0.1	ND	1.8	—	6.6	NA	1.8	1.9	8.5
	5	0.9	ND	1.1	0.6	2.6	NA	1.6	2.5	5.1
Vietnam	1	2.4	0.3	0.4	1.2	5.3	NA	1.9	4.3	9.7
	5	3.7	4.7	0.1	4.7	0.9	NA	9.6	13	14

Source: Bacon, Bhattacharya, and Kojima 2010.

Notes: NA indicates that the fuel was not available; — indicates that no household in the quintile used the fuel. ND indicates that survey did not ask for information about this fuel.

Table A.8: Percentage of All Households Using Different Energy Sources (connected)

Country	Quintile	Electricity	LPG	Kerosene	Gasoline & diesel	Biomass	Natural gas	Petroleum products	Modern energy
Bangladesh	1	12	ND	92	0.6	99	0.4	92	94
	5	68	ND	63	5.2	98	27	66	93
	Total	**39**	**ND**	**81**	**1.6**	**99**	**8.4**	**82**	**94**
Cambodia	1	1.5	0.2	90	ND	93	NA	90	91
	5	53	29	45	ND	86	NA	73	92
	Total	**18**	**8.0**	**76**	**ND**	**92**	**NA**	**83**	**91**
India	1	32	0.5	95	0.5	97	NA	95	98
	5	92	66	46	36	38	NA	93	99
	Total	**64**	**24**	**79**	**13**	**78**	**NA**	**94**	**99**
Indonesia	1	69	0.2	89	4.9	82	0.4	89	98
	5	94	24	80	46	15	1.2	95	98
	Total	**87**	**7.1**	**89**	**25**	**47**	**0.5**	**93**	**99**
Kenya	1	0.1	0.0	76	0.1	20	NA	76	76
	5	23	14	83	7.2	54	NA	90	92
	Total	**8.3**	**4.3**	**85**	**2.5**	**44**	**NA**	**87**	**88**
Pakistan	1	70	2.7	40	7.6	90	7.4	47	98
	5	93	12	17	39	48	47	56	99
	Total	**83**	**8.0**	**30**	**20**	**74**	**24**	**50**	**99**
Thailand	1	97	8.7	1.1	66	68	0.0	68	99
	5	100	33	0.1	78	6.9	0.0	82	100
	Total	**99**	**27**	**0.6**	**77**	**35**	**0.0**	**81**	100
Uganda	1	1.1	ND	88	0.0	96	NA	88	88
	5	28	ND	82	6.3	86	NA	83	93
	Total	**9.7**	**ND**	**91**	**2.6**	**94**	**NA**	**91**	**94**
Vietnam	1	88	3.4	44	27	95	NA	60	98
	5	99	82	19.	84	36	NA	96	100
	Total	**96**	**38**	**35**	**60**	**73**	**NA**	**81**	**99**

Source: Bacon, Bhattacharya, and Kojima 2010.

Notes: NA indicates that the fuel was not available; — indicates that no household in the quintile used the fuel. ND indicates that survey did not ask for information about this fuel. Modern energy includes electricity, petroleum products and natural gas.

Annex B: Energy Sectors in the Economy

SITC classification revision 4; level 1: energy sector and sub-sectors

Code	Text
0	Food and live animals
1	Beverages and tobacco
2	Crude materials, inedible, except fuels
3	Mineral fuels etc
32	Coal, coke and briquettes
321	Coal, whether or not pulverized, but not agglomerated
322	Briquettes, lignite and peat
325	Coke and semi-coke (including char) of coal, of lignite or of peat, whether or not agglomerated; retort carbon
33	Petroleum and products
333	Petroleum oils and oils obtained from bituminous minerals, crude
334	Petroleum oils and oils obtained from bituminous minerals (other than crude); preparations, n.e.s., containing by weight 70% or more of petroleum oils or of oils obtained from bituminous minerals, these oils being the basic constituents of the prepar
335	Residual petroleum products, n.e.s., and related materials
34	Gas, natural and manufactured
342	Liquefied propane and butane
343	Natural gas, whether or not liquefied
344	Petroleum gases and other gaseous hydrocarbons, n.e.s.
345	Coal gas, water gas, producer gas and similar gases, other than petroleum gases and other gaseous hydrocarbons
35	Electric current
351	Electric current
4	Animal and vegetable oils and fats
5	Chemicals and related products, n.e.s.
6	Basic manufactures
7	Machinery, transport equipment
8	Miscellaneous manufactured articles
9	Goods not classified elsewhere

Source: UN 1998.

Annex C: Structure of a Social Accounting Matrix

	Activities	Commodities	Factors	Households (HHs)	Enterprises	Government (gov't)	Saving-investment	Rest of the world (ROW)	Total
Activities		Marketed outputs		Home-consumed output					Activity income
Commodities	Intermediate inputs	Transaction costs		Private consumption		Government consumption	Investments	Exports	Demand
Factors	Value added							Factor income from ROW	Factor income
Households			Factor income to HHs	Inter-household transfers	Surplus to HHs	Transfers to HHs		Transfers to HHs from ROW	Household income
Enterprises			Factor income to enterprises			Transfers to enterprises		Transfers to enterprises from ROW	Expenditure income
Government	Producer taxes and subsidies; value added	Sales tax, tariffs, export taxes	Factor income to gov't, factor taxes	Transfers to gov't, direct	Surplus to gov't, direct enterprise tax			Transfers to gov't from ROW	Government income
Saving-investment				HH savings	Enterprise savings	Gov't savings		Foreign savings	Savings
Rest of the world		Imports	Factor income to ROW		Surplus to ROW	Gov't transfers to ROW			Foreign exchange outflow
Total	Activity	Supply expenditures	Factor expenditures	Household expenditures	Enterprise expenditures	Government expenditures	Investments	Foreign exchange inflow	

Source: Author's diagram based on Lofgren et al. (2002).

Annex D: IMF's Classification of Government Expenditures

IMF Government Finance Statistics: Economic Classification of Expenses

2		**Expense**
21		**Compensation of employees [GFS]**
211		Wages and salaries [GFS]
212		Social contributions [GFS]
22		**Use of goods and services**
23		**Consumption of fixed capital [GFS]**
24		**Interest [GFS]**
241		To nonresidents
242		To residents other than general government
243		To other general government units
25		**Subsidies**
251		**To public corporations**
	2511	**- To nonfinancial public corporations**
	2512	**- To financial public corporations**
252		**To private enterprises**
	2521	**- To nonfinancial private enterprises**
	2522	**- To financial private enterprises**
26		**Grants**
261		To foreign governments
262		To international organizations
263		To other general government units
27		**Social benefits [GFS]**
271		Social security benefits
272		Social assistance benefits
273		Employer social benefits
28		**Other expense**
281		Property expense other than interest
282		Miscellaneous other expense

Source: IMF 2001.

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