TECHNICAL REPORT

ENERGY SUBSIDY REFORM IN ACTION

APPROACHES AND INSIGHTS FROM RECENT RESEARCH ON ENERGY SUBSIDY REFORM

THE WORLD BANK
IBRD • IDA

ESMAP
Energy Sector Management Assistance Program

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ABOUT ESMAP

The Energy Sector Management Assistance Program (ESMAP) is a partnership between the World Bank and over 20 partners to help low- and middle-income countries reduce poverty and boost growth through sustainable energy solutions. ESMAP's analytical and advisory services are fully integrated within the World Bank's country financing and policy dialogue in the energy sector. Through the WB, ESMAP works to accelerate the energy transition required to achieve Sustainable Development Goal 7 (SDG7), which ensures access to affordable, reliable, sustainable, and modern energy for all. It helps shape WB strategies and programs to achieve the WB Climate Change Action Plan targets. Learn more at: https://www.esmap.org.

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ABOUT THIS SERIES

This report is part of the "Energy Subsidy Reform in Action" series produced by the ESMAP Energy Subsidy Reform Facility, with the objective of drawing insights from recent experiences and emerging approaches related to reform of energy subsidies in developing countries. The series includes issue-specific reports from various relevant domains such as energy sector reform, macroeconomic and fiscal policy, carbon pricing, poverty and distributional analysis, social protection, political economy, and communications.

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Abbreviations

CGE	computable general equilibrium
CO_2	carbon dioxide
ESMAP	Energy Sector Management Assistance Program
ESRF	Energy Subsidy Reform Facility
GCC	Gulf Cooperation Council
GDP	gross domestic product
GTAP	Global Trade Analysis Project
ICES-XPS	Inter-temporal Computable Equilibrium System–Extending the Public Sector
IEA	International Energy Agency
IFPRI	International Food Policy Research Institute
IMF	International Monetary Fund
LAC	Latin America and the Caribbean
LPG	liquefied petroleum gas
OECD	Organisation for Economic Co-operation and Development
PEP	Partnership for Economic Policy

All currency is in United States dollars (US$, USD), unless otherwise indicated.

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Executive Summary

In the past decade, there have been multiple efforts worldwide to reform energy subsidies, each of them yielding valuable insights and lessons, and along with them, extensive analyses at the country, regional, or global level. Numerous articles and reports have documented country experiences, identifying emerging approaches and analyzing different dimensions of reforms, including their impacts on the economy and the society. Although some of these pieces of literature deployed standard, well-established approaches, several applied novel approaches or adapted those from other academic disciplines. Some themes were less frequently covered than others, indicating potential areas that could benefit from additional work. The identification of areas requiring further research and analysis can inform future work and help strengthen the global knowledge base on energy subsidy reforms. It is within this context that a review of recent literature was carried out by ESMAP's Energy Subsidy Reform Facility (ESRF).

This review of recent energy subsidy reform literature was carried out to understand emerging approaches, trends, and major strands of thinking and evidence related to energy subsidy reforms. The review was undertaken in two phases, one at the beginning of ESRF's multiyear and multidisciplinary stocktaking study and one near its conclusion. The first phase review, carried out in 2020, formed the basis for subsequent technical work commissioned by ESRF. In 2022, a follow-up review of more limited scope was undertaken to capture any significant trends that may have emerged since the first phase. It indeed identified work that covered topics and methods that were previously given little or no attention.

The review focused on a select set of policy and academic journals. The literature reviewed primarily involved work on developing countries; however, research on high-income countries was included when it offered lessons relevant for a broader group. The 2020 review covered more than 90 articles published from January 2015 to December 2019; the 2022 update covered the 2020–21 period and included 22 articles.

The literature reviewed was categorized by themes. The majority of the articles reviewed fell into one of the following categories: (1) definition and measurement of energy subsidies and their magnitude, and models for determination of optimal subsidies; (2) lessons from energy subsidy reform experiences; (3) the political economy of subsidy reforms; and (4) quantitative impacts of subsidy reforms on households, firms, and the macroeconomy. A few articles that did not neatly fit into this framework were categorized into the closest theme. Main findings under each category are summarized in the subsequent paragraphs, with ideas for future work presented in italics.

- **Literature on the definition and measurement of subsidies mainly builds on and consolidates extensive work from the past.** The literature published in the 2015–19 period mainly involved reviews and consolidation of earlier ideas and definitions, with some updating of historical material. In these papers, the analysis tends to attempt to answer the following questions: What constitutes an energy subsidy? And how large (and significant) are energy subsidies? There are fairly well-established, though varied, approaches to defining and quantifying energy subsidies used by agencies active in this space. Key international agencies continue to periodically publish updated estimates of global subsidy totals following their preferred approaches and methodologies. *Substantial additional work to further define or quantify subsidies does not appear to be necessary. However, clear understanding of and communication on the differences between the various approaches and the large variation in estimates published by different entities can be useful for practitioners and policy makers.*
- **The literature on energy subsidy reform experiences covers efforts of countries that attempted energy subsidy reforms, documenting country experiences with reforms that were implemented as planned, or that failed, were paused or reversed.** Several studies attempted to draw insights into reform drivers, outcomes, and factors that affected those outcomes, and to come up with lessons and principles for future reforms. Whereas some articles and books focused on lessons learned from specific country cases, others aimed at broader lessons from multicountry reviews. Several studies highlighted the substantial role of international oil prices in influencing the viability of energy subsidy reforms. Numerous studies emphasized the importance of understanding and mitigating distributional impacts of reform, in particular, on the lowest income groups, while a focus on impacts on firms was fairly limited. *Continued monitoring of country experiences could provide a long timeline of events that may have affected the scale of subsidies and could provide more lessons about factors that contribute to reform outcomes.*
- **Recent literature took a more systematic approach to understanding the political economy of energy subsidy reform.** Earlier literature touching upon the role of political economy in helping understand subsidy reform outcomes tended to treat it as a separate factor in the overall explanation of why reforms did or did not work. The studies covered in this review introduced more formal frameworks for the role of political economy in subsidy reform and offered alternative explanations for the path of subsidy reform in the countries analyzed. Some new areas were introduced, including analysis of the role and behavior of international institutions. The use of opinion surveys to supplement quantitative analyses appeared to offer insights that may be helpful in rendering a more comprehensive understanding of potential impacts of reform, perceptions, and potential coping mechanisms. *Collection of survey data and analysis of societal and industrial perspectives on energy subsidy reform to get a sense of potential support could be valuable. Before and after surveys can offer a helpful tracking tool that continuously monitors factors influencing support.*


Age
80 or older
150
120
90
60
30
0
64
62
55
50
37
30
28
Category 2 90 98 65 50
Category 3 120 110 80 70
Values
150
80
60
40
20
0
Category 1
Series 1
Series 2
Series 3
Series 4
Less than 5,000
5,000 to 9,999
10,000 to 14,999

- **The group of studies analyzing the quantitative impact of subsidy removal comprised the largest share of the literature reviewed.** Quantitative impacts were studied with respect to households, businesses, and the whole economy, but until recently, the overwhelming topic of interest has been the impact on households. The impact on households was often coupled with considerations of income distribution and methods of support for low-income households most affected by subsidy removal. This aspect has strong links to the political economy, where considerations of the existence of winners and losers, and their ability to promote or hinder the reform, provide clues to the identification of the conditions required for the successful removal of a subsidy. A variety of methods, with varying degrees of complexity, were used for evaluating the impact of subsidy removal. These ranged from simpler approaches focusing only on the direct impact of energy price increases and zero demand elasticity to fairly sophisticated computable general equilibrium (CGE) models allowing for the incorporation of indirect effects, economywide transmission of energy price impacts, elasticities, and substitution. An interesting finding is the growing use of CGE modeling in the context of energy subsidy reforms. Nonetheless, relatively limited guidance is available on model choice for researchers looking to use a CGE-type approach to evaluate the impact of subsidy reform on the entire economy. *In view of recently emerging approaches, further work delving deeper into topics that are novel or have had limited coverage in energy subsidy reform literature could be of interest. Areas where future work could be interesting include the following: (1) a review of practical approaches to assessing distributional impacts, and discussion of suitability of approaches in varied contexts; (2) an in-depth look at literature on the impact of energy price increases on firms; (3) an overview of approaches to CGE modeling for analyzing energy subsidy reforms, as well as a comparison of aims, methods, and results of different modeling options.*

Select topics identified by the literature review as areas of interest, and where additional analysis and research could be useful, were the focus of subsequent technical work commissioned by ESRF. These topics included approaches to distributional analysis to assess potential reform impacts on households, the role of cash transfers in supporting energy subsidy reforms, CGE modeling for assessing potential impacts from reforms, research on firm-level effects of energy subsidy reforms, and practical approaches for assessing political economy and stakeholder perspectives on reform. The resulting ESMAP technical reports document main approaches, recent literature, and practical experiences from real world reform efforts.[1]

Other topics highlighted by the literature review can form the basis for future knowledge analytical work in this space. Possible topics are listed below.

- Tracking of reform implementation performance in developing countries over longer periods to provide insights into the stability and evolution of reforms
- For understanding reform impacts on households, exploration of dimensions of vertical and horizontal distribution of benefits and impacts

1. These reports also serve as technical background reports to the forthcoming ESRF Stocktaking Study.

- Analysis of price elasticity of demand and assessment of indirect relative to direct price effects across a wide range of countries
- For firms, in-depth investigation of the relation between energy costs and competitiveness of firms throughout the economy, if suitable data are available
- Analysis of the relative values of energy subsidies to the different agents, including cross-subsidies between firms and households or between industries
- For macroeconomic modeling, an ex post evaluation of the performance of (ex ante) analyses and modeling of reforms and their impacts
- Comparison of the findings of different macroeconomic models in the same country and the performance of models compared with actual results
- Exploration of different approaches for building support for reform and trust in the government's ability to deliver in the context of energy subsidy reform.

ONE
Background and Approach

1.1. Background and Objective

This report summarizes the findings of a review aimed at understanding emerging approaches to energy subsidy reform, discerning trends, and identifying major strands of thinking and research in the field, as reflected in major policy and academic journals relevant to the subject.

The review was initiated in early 2020 as part of a multiyear stocktaking study on energy subsidy reform experiences in developing countries by the ESMAP Energy Subsidy Reform Facility (ESRF). The study objectives were achieved through a two-stage process involving screening of select policy and academic journals focusing on energy policy, economics, and other related fields. The process was used to identify relevant articles on energy subsidy reform and explore themes and trends related to scope, substance, and messaging. The review focused on identifying recent trends in the selected literature, in particular the coverage, focus, themes, and approaches related to energy subsidy reforms. Recent literature was compared with earlier approaches, and commonalities and changes in methodology and focus were documented.

The main elements of the review are summarized in box 1.1 and detailed in subsequent sections of the report.

BOX 1.1

COVERAGE, FOCUS, AND SELECTION PROCESS

Period covered. At the outset, in early 2020, the review focused on a five-year period from January 2015 to December 2019, and included any relevant papers already published in 2020. The update for 2020 and 2021 included papers for 2022 already published at the time of the follow-up survey (early months of 2022).

Topics of focus. The papers considered in this review are exclusively focused on reforms related to subsidies for the production and consumption of fossil fuels and of power. Incentives to promote the use of renewables are excluded from the review.

(continued)

Literature search and selection process. The literature selection process began with several thousand articles published in specialist energy journals as well as articles in other relevant journals. From this, a subset of 114 studies (92 from the period 2015–19 and 22 from the period 2020–21) was considered. During the selection process, which is further described in section 1.2, emphasis was placed on those studies that provide global insights, and articles that focus on a single industry in a single country were generally given less weight unless they provide lessons of broad applicability.

1.2. Literature Search and Selection Process

The search for articles or books on energy subsidy reform began with a list of journals regarded as both important and relevant to applied policy issues and likely to attract articles on this topic. In the original search conducted in early 2020, the aim was to include every relevant article on energy subsidy reform published in these journals from January 2015 through December 2019. A separate, follow-up search was later conducted in early 2022, focusing on 2020–21.

The journals searched are listed in table 1.1. World Bank Policy Research Working Papers and International Monetary Fund (IMF) Staff Working Papers were also considered, as were several other papers and books. It should be noted that, because the literature review focused on research and analyses that were featured in academic and policy journals, and the main research outlets by IMF and the World Bank, it does not reflect work by other international agencies, multilateral partnerships, bilateral agencies, think tanks, and issue-specific advocacy groups.[1] Although not within the scope of the formal literature review, reports produced by these organizations make valuable contributions to global knowledge and would be relevant for practitioners.

1. These include the World Trade Organization (WTO), the International Energy Agency (IEA), the Organization for Economic Co-operation and Development (OECD), the United Nations Environment Program (UNEP), Asia-Pacific Economic Cooperation (APEC), Friends of Fossil Fuel Subsidy Reform (FFSR), the Coalition of Finance Ministers for Climate Action, the International Institute for Sustainable Development, and the Overseas Development Institute (ODI).

TABLE 1.1

Journals Searched for the Review

Applied Energy	Energy Reviews
Economics of Transition	Journal of Development Economics
Energy	Journal of Economic Literature
Energy Economics	Journal of Economic Perspectives
Energy for Sustainable Development	Journal of Economic Surveys
Energy Policy	Renewable and Sustainable Energy Reviews
Energy Procedia	World Development

The detailed process of article selection from the journals targeted is presented in appendix A, and table 1.2 lists the number of articles and their sources used in the final analysis for 2015–19, and for 2020–21. The journal *Energy Policy* (29) and the World Bank's Policy Research Working Paper series (18) were the sources that contained the most articles on the topic in both rounds of review. Many of the articles and books yielded by the direct internet search were published by international organizations or think tanks.

TABLE 1.2

Sources of Articles and Papers Analyzed, 2015–19 and 2020–21

Journal or other source	Number of articles retained for review	
	2015–19	2020–21
Energy Policy	29	14
Other (including books and general Google search)	21	
World Bank (Policy Research Working Papers)	18	5
Energy Economics	5	3
International Monetary Fund (Staff Working Papers)	4	
Energy Reviews	3	
Energy	3	
Applied Energy	2	
Renewable and Sustainable Energy Reviews	3	
World Development	2	
Energy for Sustainable Development	1	
Climate Policy	1	
Total	**92**	**22**

Source: Author's compilation.

The search method, which is outlined in appendix A, was intended to capture as many relevant studies as possible. The approach aimed to capture a comprehensive picture of topics and trends in the literature on energy subsidy reform during 2015–19, with a snapshot also offered for 2020–21.

After selection, the 92 articles considered for 2015–19 were grouped by four main themes, as listed in table 1.3.[2] Only a handful of papers dealt explicitly with impacts on other sectors of the economy (such as transport and agriculture), while the papers on the macroeconomy included effects on households. A few articles did not fit easily into this framework but were categorized by the theme most similar to their focus.

TABLE 1.3

Articles Organized According to Theme

Theme	Article count
The definition of energy subsidies, the measurement of energy subsidies, the magnitude of subsidies, and models of optimal subsidy determination	11
Lessons from energy subsidy reform experiences	18
The political economy of subsidy reforms	4
The quantitative impacts of subsidy reforms[a] • On households • On firms • On the macroeconomy	59

a. While the papers that focus on impacts on firms and households were mostly separate and mutually exclusive, the papers on broader macroeconomic impacts incorporated other aspects, and in particular, environmental impacts.

The heterogeneity of articles by theme is worth highlighting; for instance, the search rendered only 4 papers on the political economy of subsidy reforms, while there were 59 papers on the quantitative impacts of reforms. Although it was not possible to establish the exact reasons for this heterogeneity, it could be due to research interest, data availability, journal coverage, or a combination thereof, as well as the review's own selection process.

2. These themes were identified by the authors after reviewing the body of literature to organize them into categories with similar characteristics. In that sense, these themes emerged from the bottom up, rather than being preconceived categories into which papers had to be organized.

1.3. Report Structure

Following the introduction of the study background and approach in chapter 1, the next two chapters explore findings from the literature review.

The original review covering the period 2015–19 and the follow-up review covering the period 2020–21 are presented in separate chapters. This organizational choice was made because the selection approach and coverage of the original review (outlined in chapter 2) was more comprehensive compared with the follow-up search (summarized in chapter 3), which focused on a smaller set of journals and is therefore slightly less comprehensive. Both chapters summarize the approaches, findings, and themes in the papers reviewed, discuss omissions and unexpected trends, and highlight areas for possible further study.

Chapter 4 captures the main insights, conclusions, and takeaways from the review and identifies topics for further investigation.

Appendix A outlines the article selection approach from the journals targeted for the literature review. Appendix B summarizes the main modeling approaches used in the papers for estimating the impact of energy subsidy reforms on households. Appendix C presents the main themes from the papers published in 2020–21 that were identified in the follow-up review.

All the papers included in the review are listed in the bibliography, as are some earlier studies that had an important role in the development of the literature.

TWO
Review of Energy Subsidy Reform Literature, 2015–19

This chapter covers the studies identified in the first round of the literature search in early 2020, and chapter 3 discusses the findings of the follow-up review carried out in early 2022, focusing on a smaller sample of journals.

The review summarizes the main findings of the papers identified and has a particular emphasis on studies breaking new ground. Key points are highlighted at the beginning of each section. Recommendations for further analysis are italicized.

2.1. The Definition and Measurement of Subsidies and Models of Optimal Subsidies

The definition of energy subsidies, their measurement, and models for their optimization have been extensively covered in the past. The studies published since 2015 as identified in the literature search largely comprise reviews and consolidation of earlier work on these topics, with some updating of historical material. In these papers, the analysis of energy subsidies and their reform typically tends to attempt to answer the following questions: (1) what constitutes an energy subsidy, and (2) how large (important) are energy subsidies?

2.1.1. Definition and Measurement of Energy Subsidies

There are various approaches to defining and quantifying energy subsidies used by practitioners and international organizations, as briefly summarized in box 2.1.

The publications that this review identified on this topic were mainly reviews of previous literature or approaches **(Kojima 2017; Kojima and Koplow 2015)**.[3] Of the two considered, Kojima 2017 provides a comparison of global energy subsidies as estimated by the International Energy Agency (IEA), the Organisation for Economic Co-operation and Development (OECD), and the International Monetary Fund (IMF), and the author discusses the reasons for the differences between them. In the period covered in this review, the IMF, the OECD, and the World Bank published papers that further explore the definition of energy subsidies. Papers by **Coady et al.** published in 2015 and 2017 contain updates to earlier IMF papers that introduced concepts and definitions related to energy subsidies,[4] and include a much wider range of countries than Clements et al. (2013). A further update is provided by **Coady et al. (2019)**. These studies provide both pretax and posttax values for energy subsidies. Furthermore, in the run-up to the 2019 G-20 meeting in Japan, the

3 Formating note: The articles and papers that are highlighted in bold font are the primary focus of the literature review and that were further analyzed as part of the review. Other papers that are referred to but are not in bold font are those that are relevant, but were not reviewed in detail, as they were outside the review period or journals covered. They were nonetheless referenced as they were considered to be relevant for the readers interested in those topics.

4. In the 2013 paper, the IMF introduced the concept of posttax valuation of subsidies by comparing "efficient" prices with actual prices (Clements et al. 2013). The efficient price includes the cost of supplying the product to the consumer, a Pigovian tax reflecting environmental costs (local and global), and a consumption tax to raise revenue (typically a value added tax).

OECD and the IEA produced a progress report on reforms to fossil fuel subsidies using their own definitions and methodology **(OECD and IEA 2019)**. The article shows that, between 2016 and 2017, in 40 countries reviewed, the value of subsidies using the IEA methodology increased by 12 percent; growth is lower, at 5 percent, when combining IEA and OECD data. These international organizations periodically publish updated estimates of global subsidy totals following their preferred approaches and methodologies.[5] *There are fairly well-established, though varied, approaches to defining and quantifying energy subsidies used by agencies active in this space, and key agencies periodically publish updated estimates;*

5. The IEA, OECD, and IMF publish periodic updates to their energy subsidy estimates and substantive analyses based on their respective methodologies.

BOX 2.1

APPROACHES TO DEFINING AND MEASURING ENERGY SUBSIDIES

According to the ESMAP ESRAF Good Practice Note 1 on the definition and measurement of energy subsidies (Kojima 2017), an energy subsidy is "a deliberate policy action by the government that specifically targets electricity, fuels, or district heating and that results in one or more of the following effects: (1) it reduces the net cost of energy purchased; (2) it reduces the cost of energy production or delivery; and (3) it increases the revenues retained by those engaged in energy production and delivery (energy suppliers)."

There are different approaches to defining and measuring energy subsidies that vary based on their coverage, focus, and objectives, each with corresponding data requirements. The two commonly used methods for measuring subsidies are the price-gap approach and the inventory approach, which follow different channels to come up with estimates. The price-gap approach compares end-user prices paid by consumers with reference prices that correspond to their full costs or prices that would have prevailed in a competitive market. The inventory approach involves building an "inventory" of government support measures for production and consumption of energy. The methods, which are discussed in greater detail in Kojima (2017), are not mutually exclusive, and their complementary use can reveal information that would otherwise not be possible to discern by using them alone.

(continued)

The main approaches to measuring energy subsidies used by key international organizations are summarized below.

- The International Energy Agency (IEA) uses the price-gap approach for estimating fossil fuel *consumption* subsidies, focusing on the gap between actual domestic retail prices and what the price would have been in a competitive market.
- The Organisation for Economic Co-operation and Development (OECD) uses the inventory approach to estimate government support—in the form of direct budgetary transfers and tax expenditures—for the *consumption and production* of fossil fuels, as well as general services support measures.
- The International Monetary Fund (IMF) uses a combination of the two, mainly based on the price-gap approach, to estimate whether retail prices charged to *consumers* are able to recover reference prices (which vary based on whether the commodity or the energy carrier can be traded internationally). The methodology incorporates elements of the inventory approach, given that it also takes into account direct government support to *producers*. The IMF also distinguishes between explicit subsidies, which focus on whether average retail prices recover efficient or full costs, and implicit subsidies, which focus on whether retail prices, inclusive of standard consumption taxes, cover external costs associated with fossil fuel consumption (such as greenhouse gas emissions, health damage due to local air pollution, and traffic congestion and accidents).

therefore, substantial effort to further define or quantify subsidies does not appear necessary. However, clear understanding of and communication on the differences between each approach and the large variation in estimates published by different entities can be useful for practitioners and policy makers.

During the same period, the World Bank monitored the evolution of government policies related to fuel subsidies and their pricing, particularly following the sharp fall in international oil prices at the end of 2014. Kojima (2016) analyzes 35 developing countries, including cases where reform had not started or had started and been abandoned after the oil price bounce-back. *Further monitoring of country experiences could provide a longer timeline of events that may have encouraged the reduction of subsidies and would provide more lessons about the factors that contributed to changes in policy.*

Few studies provide estimates of the total subsidies in a particular country as well as evidence on how the benefits are shared among different income groups. The studies that do include **Soile and Mu (2015)** on Nigeria; **Cardenas and Whittington (2019a, 2019b)** on electricity in Addis Ababa, Ethiopia; and **Mills and Berkeley (2017)** on the global total of kerosene subsidies.

Pizer and Sexton (2019) extend the usual attempts to measure the vertical distribution of subsidy benefits (households at different income levels) by introducing the horizontal distribution, which is the degree of variation of benefits across households at the same income level. They report that within a given income decile, variation in energy expenditure can be large, but typically declines at higher decile levels. They also report that even when policy makers value horizontal equity, it is difficult to address using compensation measures because it requires information on energy use. Detailed analysis of household expenditure surveys could produce evidence on the causes of lack of horizontal equity, for example, the gender of the head of household, as identified by **El-Hamidi (2016)**. *Horizontal equity has been little explored and further investigation could be useful. There could be policy implications such as those relating to the gender of the head of the household.*

2.1.2. Models of Optimal Subsidy Determination

One topic that had not been given much attention in the literature until recently was that of constructing a formal model of the optimization of the welfare benefits of energy subsidies. The traditional approach called on the Diamond-Mirrlees (1971) theory of optimal taxation and argued that subsidies related to the price of the product are suboptimal, and that if the distribution of income is a concern, then lump-sum taxes should be used.

Breton and Mirzapour (2016) start from the idea of a representative consumer, whose utility is determined by the amount of energy and of nonenergy consumed, and who maximizes welfare subject to a budget constraint. There is an international price for energy, and the government subsidizes energy consumption through the price on the domestic market. The government plans a compensation program to restore consumers' welfare after the removal (or reduction) of the subsidy. Starting from this framework, a number of formal results are derived relating to the impact of subsidy reduction. For example, the analysis shows that the feasibility of beneficial subsidy reform depends on certain parameters: the initial subsidy rate, the share of energy in the consumer's bundle, and the energy portion of the price of other goods. Values for these parameters are estimated for the Iranian economy, and model predictions are compared with actual outcomes. *The approach of testing of the model against actual outcomes can be of interest given that most studies on subsidy reform do not test any hypothesis but instead show different outcomes under different assumptions.*

Pani and Perroni (2018) also construct a formal model. The focus of their model is on incumbent policy makers. The authors explore the conditions under which policy makers may decline to make a credible commitment to reduce subsidies (even when they have the

technical and institutional capacity to do so). In another study, **Ferraresi, Kotsogiannis, and Rizzo (2018)** analyze a different aspect of the determination of the level of a subsidy by focusing on intercountry differences in the subsidy rate. Drawing on the new literature of "second generation fiscal federalism," they construct a model in which the greater decentralization of government (the number of levels of government) decreases the rate of fossil fuel subsidies. The model is tested by using data on gasoline prices from several countries and relating them to a variable distinguishing between low and high numbers of layers of government as well as to a number of other explanatory variables. The empirical testing of the model indicates that adding one level of government led to a statistically significant decrease in diesel and gasoline subsidies in developing countries but not in developed countries. This study builds on work on the differences between subsidy levels, such as in **Coady, Flamini, and Sears (2015)**. *These models of subsidy determination, using a formal algebraic specification and a maximization operation, generate interesting and novel results but are not at a stage of development where they can be readily absorbed into a program in a country setting. It would be sensible to first check the mathematics and evaluate the various assumptions (mathematical and economic).*

2.2. Lessons from Reform Experience

The literature regarding reform experience follows the lines of earlier work, focusing on experiences drawn from the individual country studied. A few studies propose reform principles based on the experiences of many countries. The use of surveys as an analysis tool is highlighted by a small group of studies.

The continued presence of energy subsidies in many countries during the decade following the 2009 G-20 summit, which endorsed the intention to phase out subsidies, raises several questions: (1) Which countries reformed completely? (2) Which countries tried but fell short? (3) Which countries did not try to reform? (4) What were the conditions in these groups of countries that led to these different outcomes?

A substantial number of articles and reports attempting to answer these questions through "lessons learned" was in place well before the period that is the focus of this literature review. Vagliasindi (2013) and Clements et al. (2013) provide comparative analyses of several countries where reform had been contemplated and attempted to various degrees. Many individual country case studies were also produced, and the failure of purely economic factors to explain when or whether reform took place led to an interest in the role of political economy.

During the 2015–19 period, which is the focus of this chapter, several articles and books on lessons learned from energy subsidy reform experiences were published, some for an individual country and others aiming at broader lessons from multicountry cases. Some of the literature focuses on the political economy aspect in a more sophisticated way than the

earlier studies; therefore, this report offers separate sections on "lessons learned" and "political economy." The distinction is somewhat blurred, but is nonetheless helpful in highlighting some new issues treated in the most recent political economy literature.

The group of studies focusing on the experiences of individual countries is diverse and introduces factors particular to the country under consideration. Those relating to specific countries are grouped together and included in table 2.1, and the principal findings, as proposed by the authors, are included.

Some of these studies—those that emphasize why subsidy policy changed—highlight a large role for international oil prices. In fact, several of the studies summarized in table 2.1 were written shortly after the very sharp fall in oil prices commencing in June 2014. It is important to note that the fall in oil prices that started in 2014, reaching a low point in January 2016, was partially reversed by a steady rise until September 2018. Studies that were written and published shortly after the policy change would not have been able to judge the stability and durability of reforms against these changes in the oil market. *Therefore, it is important to understand whether, in those countries where action on subsidy removal had been encouraged by the magnitude of the price fall, the new subsidy policy held firm in the face of the oil market's partial recovery.*

TABLE 2.1
Studies Offering Lessons Learned from Energy Subsidy Reform Experience, 2015–19

Authors	Countries surveyed	Energy source	Findings
Atansah et al. 2017	India; Iran, Islamic Rep.; Nigeria	LPG; petroleum; and petroleum, respectively	Lasting support for reforms depends on clearly communicating the plan to the public in advance of a price increase, phasing in adjustments over time, providing targeted cash transfers for low- to middle-income households, and using favorable macroeconomic conditions.
Benes et al. 2015	Indonesia, Malaysia	Fossil fuel subsidies	Long-term oil exporters are often seen by the public as being owned by the public themselves, and hence the members of the public support low prices.
Boersma and Griffiths 2016	United Arab Emirates	Electricity, petroleum, diesel	Transferability of successful policy (partial subsidy removal) is limited because of the ability to segment the market by removing subsidies mainly for expatriates.
Calvo-Gonzalez, Cunha, and Trezzi 2015	El Salvador	LPG	The article focuses on why individuals consider themselves to be winners or losers in a proposed reform. Satisfaction with reforms might have been affected by efforts to disseminate more information.
Clarke 2015	India	Diesel	The paper highlights the benefit of phased price increases; taking advantage of the opportunity created by a fall in product price; and the importance of communicating effectively on use of savings for compensatory social transfers.

(continued)

Authors	Countries surveyed	Energy source	Findings
Inchauste and Victor 2017	Dominican Republic, Ghana, Indonesia, Jordan	Varies by country	In general, successful reforms nearly always involve substantial work on political aspects, including active efforts by policy leaders to identify forces that created subsidies and then to redirect those forces, and to offset the impact of well-organized interest groups.
Jain 2018	India	Petroleum	The paper emphasizes gradual withdrawal of the state from pricing, developing mechanisms for sharing rent between the state and oil companies, insulating the poor from high prices of cooking fuel, and adopting efficient subsidy delivery mechanisms.
Krane 2019	Gulf Cooperation Council countries	Liquid fuels, gas, electricity	Subsidies tend to be seen as a "customary privilege," which can challenge the social contract of "no tax, no vote" as seen by traditional analysts.
Mittal, Mukherjee, and Gelb 2017	India	LPG	The paper underlines the importance of articulating reform objectives, capping consumption of subsidized LPG cylinders and removing market price distortions, using information campaigns and social media to encourage self-targeting, and using information technology to target subsidies.
Moerenhout, Sharma, and Urpelainen 2019	India	Electricity, commercial and industrial sectors	The paper recommends that state governments increase visibility and availability of compensatory mechanisms and tighten the targeting of cross-subsidies to agriculture and households.
Overland, Suryadi, and Win 2016	Myanmar	Electricity	The paper highlights the importance of having a proactive communications strategy, strengthening key government institutions, and clearly allocating powers in electricity pricing.
Scobie 2017	Trinidad and Tobago	Transport fuels and electricity	The paper presents a subsidy intractability framework, emphasizing increased importance of fiscal prudence norms, increased transparency and improved data, and environmental stewardship norms.
Skovgaard and van Asselt 2018	Colombia; Egypt, Arab Rep.; India; Indonesia; South Africa; Trinidad and Tobago	Varies by country	The following factors influence subsidies and their reform: interests, strategies, and organization of actors; knowledge, norms, and beliefs of actors; and structural factors (socioeconomic characteristics).
Verme 2016	Djibouti; Egypt, Arab Rep.; Iran, Islamic Rep.; Jordan; Libya; Morocco; Tunisia; Yemen, Rep.	Varies by country	The paper reviews policy options chosen in actual reforms, documenting whether they involved the radical versus gradualist approach, compensation versus noncompensation, public information versus no information, poor versus middle class receiving compensation, and direct versus indirect effects, then discusses the reforms' relation to political timing.
Whitley and van der Burg 2015	Angola; Argentina; Egypt, Arab Rep.; Germany; Ghana; India; Indonesia; Iran, Islamic Rep.; Mexico; Nigeria; Peru; Tunisia; Turkey	Fossil fuels	The paper notes that a whole-of-government approach is preferable to that of an individual ministry. The existing situation and possible impacts of reform are best researched beforehand. The authors emphasize the importance of transparent and extensive communication and consultation before implementation, efficient and visible reallocation of resources to those most affected by reform, and having ambitious goals but a slow and specific timetable for phaseout.

Source: Author's compilation.
Note: LPG = liquefied petroleum gas.

Another element that appears to be missing in the body of literature reviewed is an ex post evaluation of the performance of earlier analyses of subsidy reform. For example, did the countries studied by Vagliasindi (2013) fail to maintain their policies and reverse course? Some tracking of subsidy reform in the period immediately following the oil price fall is provided in Kojima (2016), who sought to provide a record of what happened. That study provides evidence on 35 developing countries, and an updated study might be able to further broaden the coverage as well as consider the stability of reforms over a longer period. *The need for an update that could provide a broader view of the evolution of the behavior of fossil fuel subsidies is evident*.

Two country studies introduced a new aspect of subsidy reform, namely, the impact of energy price reform on industries and firms, and the lessons from these studies could be valuable in other country contexts. First, **Moerenhout, Sharma, and Urpelainen (2019)** carry out a detailed sampling of commercial and industrial consumers in India by administering a questionnaire on electricity pricing reform. It is notable that no other such studies appear to use surveys to examine the reactions of industrial or commercial consumers to subsidy removal. The role of coping mechanisms by industries affected by the increase in energy costs when consumer subsidies are reduced or removed is crucial, as found in this survey and argued in **Rentschler, Kornejew, and Bazilian (2017)** and **Rentschler (2018)**. Second, **Calvo-Gonzalez, Cunha, and Trezzi (2015)** analyze the case of El Salvador, where the subsidy for liquefied petroleum gas (LPG) was removed and replaced by generous direct cash compensation. Households in all but the top two deciles were expected to benefit. An opinion survey carried out before the reform suggested that only one-third of the electorate supported it. Many potential winners saw themselves as "losers." A survey carried out shortly after the reform was implemented showed less than 45 percent support; a further four surveys showed the satisfaction rate climbing slowly until it reached about 65 percent a year and a half later. The authors, building on this valuable data source, analyze why the cash compensation was originally unpopular and why support gradually increased until winners felt like winners. In the survey, the decision of a household to respond "very satisfied" or the opposite was modeled using a probit function. For the prereform survey, the level of information about the reform, expectations about the government's ability to deliver, and political partisanship were all important. The increase in the satisfaction rate over time was explained mainly by the increasing perception of the government's ability to deliver. This 2015 paper was innovative in using opinion surveys and made an interesting contribution to the "lessons learned" literature. Opinion surveys can reveal the unpopularity of a proposed reform even among those the policy makers may expect to benefit. This phenomenon of winners seeing themselves as losers may be important in explaining why certain governments have been unable to undertake reforms that appear to benefit a large part of the population. *The need for further work on the impact of consumer energy subsidy removal on commercial and industrial customers is supported by Moerenhout, Sharma, and Urpelainen (2019). Calvo-Gonzalez, Cunha, and Trezzi (2019) illustrate how the use of before and after surveys can be a valuable tracking tool when reforms are actually undertaken. These are areas where further investigation could be welcomed; understanding and periodically monitoring factors influencing support or opposition to a reform can*

help policy makers develop and monitor the impact of solutions to address stakeholder perspectives in reform design, implementation, and communication.

A different approach to lessons learned is taken by **Overland, Suryadi, and Win (2016)** as they examine Myanmar. The authors look for experience related to reducing energy subsidies in similar countries, and use multivariate matching with rank order data on several variables to identify countries that faced similar issues, the most relevant cases turning out to be Uzbekistan, Vietnam, and the Republic of Yemen. The study then proposes a number of elements that would be important when developing reform policy, including the allocation of responsibilities between different government agencies, reform design, good communications strategy, stakeholder management, and improving data availability on electricity costs and prices. *Although there are few countries where reform discussions are only just beginning, the use of matching techniques, as in this Myanmar study, to identify countries with similar problems and economies could be a useful tool for other countries to explore.*

A number of studies that explore "lessons learned" from country experiences offer some general principles for subsidy reform. **Coady, Parry, and Shang (2018)** argue for the following key design steps: (1) develop a comprehensive reform plan, (2) develop a comprehensive communications strategy, (3) undertake a gradual and sequenced reform, (4) implement target measures to protect lower-income groups, (5) implement measures to reform the energy sector (especially state-owned enterprises) and support energy-intensive sectors, and (6) depoliticize energy pricing. **Rentschler and Bazilian (2017)** and **Rentschler (2018)**, offer a broader set of principles: (1) communication and compensation are key to managing the political economy; (2) fossil fuel subsidy reform offers an opportunity to use and strengthen social protection schemes; (3) transparent systems for reinvestment and distribution of reform revenues should be established; and (4) smoothing measures and smart timing can be used to manage energy prices. The principles suggested by Rentschler and Bazilian (2017) place emphasis on ensuring that most, if not all, members of society will benefit in some way from the reform. Of course, as demonstrated by **Calvo-Gonzalez, Cunha, and Trezzi (2015)**, not all of the potential winners may believe that they will gain, and the government may find it difficult to convince them. **Sovacool (2017)** reviews evidence on the size and costs of subsidies worldwide and proposes that policy reform should encompass a number of aspects: (1) adopt best practices in subsidy measurement, (2) eliminate "inappropriate" subsidies, (3) conduct a subsidy impact study, (4) implement an adjustment package, (5) learn from successful case studies, and (6) reorganize the political economy structure. Sovacool (2017) also proposes a research agenda, based on Rentschler and Bazilian (2017), that complements this list, including continual updating of best practice methodologies in measurement and valuation alongside efforts that examine politics, social protection, revenue distribution, and reform strategies. *Understanding and mitigating the distributional impacts of reform, in particular, on the lowest income groups, is an element emphasized by several papers that draw lessons from reform implementation. While focusing on lower-income groups may indeed satisfy concerns about vertical equity, it is possible that the reform design may not be sufficient to win popular*

support—in practice, the "losing" groups may not place the same emphasis on distributive justice for others, hence the importance of the emphasis on how the reform revenues will be used. Following real-world reforms and drawing lessons from implementation experiences can add value to the global knowledge agenda.

2.3. Political Economy of Reform

Earlier literature touching upon the role of political economy in helping understand subsidy reform efforts' success or failure tended to treat it as a separate factor in the overall explanation of why reforms did or did not work. The 2015–19 studies considered for this review introduce more formal frameworks in which to view the role of the political economy. To some extent these studies offer competing explanations for the path of subsidy reform in the countries analyzed. Few studies reviewed carried out explicit political economy analyses of subsidy removal. Some new themes were introduced, including analysis of the role and behavior of international institutions toward energy subsidy reform.

Inchauste and Victor (2017) present a conceptual framework built around two questions: (1) Given that subsidies have distributional consequences, why did governments prefer the particular distribution embedded in their policy? (2) Why was it politically desirable to achieve these objectives through subsidies as opposed to, for example, cash transfers? With regard to the first question, the authors argue that governments care about the welfare of both vested interests and citizens, but the weight they place on each varies from place to place. With regard to the second question, it is suggested that special interests may prefer universal subsidies that give the average citizen an incentive to support the policy. Special interests can then mobilize average citizens to act collectively in defense of the subsidies. For example, large farmers, who are the biggest beneficiaries of free electricity for agriculture, can count on small farmers to protect their interests because of the difficulties they face mobilizing by themselves. Starting from these ideas, four scenarios emerge: (1) both vested interests and citizens derive large benefits from subsidies; (2) vested interests get most of the benefits and citizens get few; (3) citizens' benefits are large and vested interests' benefits are minimal; and (4) neither special interests nor general citizens benefit significantly. In each case, the framework proposed in Inchauste and Victor (2017) provides a hypothesis about the circumstances that could lead to a subsidy reform being more (or less) likely. The study develops a number of such hypotheses and then applies them to four country case studies: the Dominican Republic, Ghana, Indonesia, and Jordan. Detailed timelines of external events (including oil price changes) and internal decisions are presented. With these tools, the framework can be evaluated for the insights that it provides on the policies toward energy subsidy reform. Beyond these four case studies, more country cases, covering a wider range of circumstances, would be needed before conclusive answers can be given to the two questions introduced in the framework.

The strategy of developing a framework based on the political economy and then applying it to a particular country case is used by **Scobie (2017)** and **Skovgaard and van Asselt (2018)**, in a study of Trinidad and Tobago. Scobie (2017) seeks to determine the principal drivers of a change in fuel subsidy policy in Trinidad and Tobago. A survey of local experts was carried out and respondents were asked whether the subsidy was transparent, whether it benefited the poor, and whether government spending could be used more efficiently through other measures. They were also asked which were the strongest and which the least powerful arguments for keeping or removing the subsidy, and which were the most influential means used to exert pressure on the government to keep or remove the subsidy. These questions allow an understanding to be gained of the possibly contesting norms adopted by the various actors. From the results of the questionnaire and the actions taken by the government, the relations between actors, norms, and substitute measures are summarized in table 2.2.

Skovgaard and van Asselt (2018) aim to uncover (1) why, how, and with what effects international institutions and actors address fossil fuel subsidies—and why, in some cases, they do not; and (2) why and how fossil fuel subsidies are maintained or reformed at the domestic level. An introductory chapter discusses the construction of an analytical framework for understanding the politics of fossil fuel subsidies. Four political factors are identified that help explain whether and how international institutions address fossil fuel subsidies and, through a set of dynamic channels, exert influence over subsidy reform at the domestic level. Following the introductory chapter of the study, a series of chapters address the role of certain international institutions. The second part of the book contains several country case studies—including of Colombia, the Arab Republic of Egypt, India, Indonesia, South Africa, and Trinidad and Tobago. These are helpful additions to the "lessons learned" literature, with a strong focus on domestic political economy.

TABLE 2.2

Subsidy Reform in Trinidad and Tobago—Sector, Subsidy, Actors, and Norms

Sector	Subsidy type	Status of reform	Interested actors	Contesting norms
Transport	Private	Subsidy removed	Middle- and high-income groups	Redistributive justice Fiscal prudence Environmental stewardship
Transport	Public	Subsidy reduced	Low-income groups	Redistributive justice Fiscal prudence
Transport	Commercial and industrial	Subsidy reduced	Business sector	Fiscal prudence Redistributive justice
Electricity	Residential	No change	All income groups	Redistributive justice
Electricity	Commercial and industrial	No change	Business sector	Redistributive justice
Oil producers	Incentives to promote exploration	Subsidy increased	Petroleum sector	Redistributive justice

Source: Scobie 2017.

McCulloch (2017) also focuses on the role of international institutions. The paper compares the magnitude of subsidies to the magnitude of aid from OECD countries for as many countries as for which subsidy data were available. A small group of countries receive a large amount of aid relative to their gross domestic product (GDP) but, aside from this group, subsidies dominate aid, an observation that may suggest that financing for government activities could be available via subsidy reform. This is not necessarily an argument against aid, however, given that aid includes financing for technical assistance and capacity-building. The paper then queries the relation between development partners and countries with large subsidy burdens. First, the paper reviews the standpoints of the large bilateral aid development partners, and then the attitudes of the multilateral organizations, including through programs such as the Energy Sector Management Assistance Program (ESMAP). It suggests that a new approach to supporting energy subsidy reform is required and that the "thinking and working politically" model is suitable. This approach has two key characteristics: (1) it is flexible and adaptive, so that rather than specify a set of deliverables in detail in advance, the approach allows local program managers to identify and implement the projects they believe will have the most impact on the reform objective; and (2) it is locally driven, with key proposals being devised by local teams (with oversight from the funder). Adopting such an approach could help with politically sensitive reforms. The suggestions from McCulloch (2017) are strategic in nature and consider how institutions might approach development financing and technical support.

2.4. Analyzing the Quantitative Impact of Subsidy Reforms

The group of studies analyzing quantitative impacts comprised the largest portion of the set of papers covering energy subsidy reform in 2015–19.

A variety of methods were used for evaluating the impact of subsidy removal, including (unexpectedly) many that used a computable general equilibrium (CGE) model. Most of these studies focus on the impact on households, but a handful investigate the impact on industry. There were few attempts to compare approaches to impact estimation, and there was virtually no econometric testing of hypotheses concerning the benefits and costs of subsidy removal.

Quantitative impacts have been studied with respect to households, businesses, and the whole economy, but until recently the overwhelming topic of interest has been the impact on households. The impact on households was often coupled with considerations of income distribution and methods of support for low-income households most affected by subsidy removal. This aspect has strong links to the political economy, where considerations of winners and losers, and their ability to promote or hinder the reform, provide clues to the identification of the conditions required for the successful adoption of a subsidy removal program.

Methods for analyzing the impact on the whole economy also include households, and for some studies the motivation for analyzing the impact on the whole economy is to obtain the most reliable measure of the impact on households. For this reason, in this review, the group of studies relating to the impact on the macroeconomy is included in the group of studies providing estimates of the effect of subsidy removal on households. This combination results in a group of 44 papers focusing on the impact of subsidy removal on households. These studies are discussed in section 2.4.1. A separate group of 15 papers analyze the impact of subsidy removal on firms. This latter group includes studies of the impacts of consumer and producer subsidy reductions. These are discussed in section 2.4.2.

2.4.1. Approaches to Quantifying the Effect of Subsidy Removal on Households

In analyzing the impacts of subsidy removal on households, a key assumption relates to the way in which the higher (post–subsidy reform) price affects households purchasing the subsidized commodity. The assumptions used, in order of increasing complexity, are designated by a series of models. These models are summarized in box 2.2. Appendix B contains a deep dive into specific modeling exercises from the literature that attempted to estimate the impact of energy subsidy removal on households, summarizing the modeling approach, context, coverage, and findings.

BOX 2.2

MODELING APPROACHES FOR ESTIMATING IMPACTS OF PRICE CHANGES

Model 1: Direct price impacts and zero demand elasticity. The only price assumed to change is that of the subsidized fuel (there are assumed to be no impacts on the prices of other goods), and there is no change in the quantity of demand as a result of the increased price. This model is the simplest to apply, requiring no information except for quantities purchased by households before reform and the magnitude of the price increase due to the removal of the subsidy. All households lose by an amount proportional to their original consumption, and the absolute and relative impacts

(continued)

on households at different income levels can be calculated. This simple model has been used many times to estimate losses incurred by different households (particularly as distinguished by income level). A household expenditure survey is the sole data requirement for this approach. Model 1 likely overstates the impact on households **(Coady, Flamini, and Sears 2015)** because some reduction in use of the higher-priced fuel is likely, although it may take some time to occur (the short-run price elasticity of demand is low but not zero, while the long-run elasticity may be somewhat greater). An associated problem comes from the built-in assumption of no quantity change. The assumption that there would be no quantity change implies zero impact on the creation of externalities, in particular emissions of carbon dioxide (CO_2). Modeling of the relation between energy subsidies and global CO_2 emissions has, since the pioneering study of Larsen and Shah (1992), recognized the importance of obtaining a reliable value of the own price elasticity of demand for all fuels whose subsidies are to be removed so that subsidy removal can be linked to a reduction in externalities. This implies that Model 1 cannot be used where subsidy reform is to be linked to a reduction in CO_2 emissions.

Model 2: Direct and indirect impacts with zero price elasticities of substitution. The large increases in energy prices that would arise as a result of energy subsidy removal, and the importance of fuels as inputs to other goods, imply that nonenergy sectors may create noticeable price changes as their costs change, and in turn these price changes will affect households. This indirect effect requires an input-output table to trace the effects of price changes originating in one sector on the prices in other sectors. If the elasticities of substitution are zero, then households would make no quantity adjustments when relative prices change (and this model is also unsuitable for relating emissions to the level of subsidies). To estimate the changes in the prices of all goods caused by the initial fuel price increase, an important distinction is made between (1) cost-push sectors (costs are fully pushed through to prices), as for nontraded goods; (2) traded goods for which the price is set in the international market and cost increases are borne by firms through lower profits; and (3) sectors with controlled prices. Allowing for these rigidities in nontraded and controlled prices, the impact of subsidy removal on all prices can be calculated (Coady et al. 2006; World Bank Group 2003) using an input-output table, and from this the increased cost to households of purchasing the fixed amounts of goods is derived using a household expenditure survey. The sum of direct

(continued)

and indirect effects on household expenditure provides a measure of welfare change. Coady et al. (2006) point out that the assumption of zero elasticities of substitution leads to an upper bound for the total impact of the subsidy removal, but suggest that realistic values of the elasticity would result in the upper bound being fairly close to the correct total effect. This approach is used by Coady, Flamini, and Sears (2015) in their multicountry study of the welfare impact of reducing fuel subsidies, which finds that the larger the indirect effect relative to the direct effect, the greater the impact on households of a given price increase. It is worth highlighting that the omission of indirect effects in analyses can understate the impact on poorer households by a substantial amount.

Model 3: Direct impacts with price elasticity of demand. Some studies have introduced a demand function for the fuels whose prices are to be raised, yielding a price elasticity that can be applied to the price change. The assumption of zero price shifting to other goods is retained, so that no input-output table is required for this evaluation. The IMF used this approach in evaluations of the magnitude of global energy subsidies (Coady et al. 2015; Coady et al. 2019). The key issue here is the determination of the price elasticity of demand. Some studies have used values taken from experiences in other countries, whereas others have used domestic experience to estimate their own price elasticities for the different fuels. Again, the omission of indirect effects could lead to a large underestimation of the effects on lower-income households.

Model 4: Direct effects with price elasticity plus indirect effects with no elasticity of substitution. A hybrid model introduces price elasticities for direct demand but ignores them for indirect demand. The identification or estimation of the elasticities of substitution can be a major task, and data may not be available. Taking values from other country studies can raise many issues because of the different economic structures of possible comparator countries.

The four models in box 2.2 provide estimates of the impact of energy subsidy reduction or removal on households, but do not offer insights into impacts on the macroeconomy, nor allow for feedback from the macroeconomy to households. The government's extra revenue could be used for other purposes than being redistributed to low-income households that have been hardest hit by the subsidy removal, and this choice could affect household incomes. Where fuels are traded, a reduction in domestic demand will have a tendency to increase exports and reduce imports (this possibility was an important issue for Larsen and Shah [1992]).

An approach to the evaluation of subsidy reform that includes both households and the rest of the economy is provided by CGE models, for which the data requirements are much greater than for the four partial equilibrium models referred to above. This approach is described in box 2.3.

BOX 2.3

CGE MODELS

Model 5: CGE models allowing for own price elasticities and for elasticities of substitution. A variety of CGE models have been used to investigate the impacts of subsidy removal. Extending to other sectors of an economy would mean that considerably more data would be required for such a model; these data are usually supplied through a social accounting matrix.

Several insights emerge from the review of different approaches adopted in the literature examined for this exercise. High-level observations from this review are summarized below, complemented by the detailed overview in appendix B.

- **First, most impact studies focus on households.** Of the studies reviewed, 44 estimate the impact on households, and another 15 focus on the impact on firms.
- **Second, of these studies, the most popular approach is the use of a CGE model** (Model 5; 19 studies), followed by Model 3, which uses the direct effects related to an estimate of the price elasticity of demand for each fuel (15 studies). This latter group of studies avoids the need for an input-output table, which in many cases may have been unavailable or substantially out of date. The large percentage of studies using CGE models appears to be a recent and distinct shift. Earlier periods appear to have concentrated

far less on quantifying effects on households, and few such studies used CGE models. A survey of issues with subsidies in the energy sector (World Bank Group 2010) prepared in 2010 as a background paper for the Toronto G-20 meeting identified only a handful of studies on the quantitative impact of subsidy removal, and none of these used CGE models. A typical study quantifying the impacts of electricity subsidies was that of Komives et al. (2005).

- **A third notable feature of the choice of modeling approach is the wide variety of models used for CGE.** The most popular is the Lofgren modification (Lofgren, Harris, and Robinson 2002) of the International Food Policy Research Institute's static CGE model; models based on the Global Trade Analysis Project (GTAP) are also used in several studies. Some of the alternative models are presented in detail, while others are less fully documented, but in all cases, there is little discussion of why a particular model structure and form is chosen (as opposed to other possibilities), and what the implications are for the results obtained.
- **Fourth, among the group of World Bank working papers, eight focus on the impact of subsidy removal on households.** Three of these use CGE models, of which two are purpose built by the authors.
- **Fifth, some calculation of the impacts of subsidy reform on households has been undertaken for a large number of countries.** In particular there has been substantial coverage of countries in the Middle East and North Africa region. In addition, some countries are analyzed more than once; within the period 2015–19 seven studies were published on the impacts of subsidy reform in Egypt (including four CGE models).
- **A sixth feature of the modeling of subsidy removal impact, and energy subsidy reform more generally, is the lack of econometric studies** (apart from those estimating the elasticity of demand for energy). Impact analysis largely compares two hypothetical situations—one with the policy off and the other with the policy on. Actual values are not used as an indicator of the "policy-on" scenario. Econometric analysis was commonly found in the literature on the impacts of power sector reform **(Bacon 2018)**, whereas in the context of energy subsidy reform, in the set of papers identified for this review, little attention appears to have been paid to the use of econometric testing of the basic hypotheses driving reform in which actual outcomes (with policy "on") are compared with an estimate of what the value would have been with policy "off."
- **Several analyses of macroeconomic implications also explored environmental impacts.** Even though the assessment of environmental impacts alone did not appear to be a focus in the papers identified for the review, eight of the papers that assessed macroeconomic impacts explored environmental impacts of energy subsidies and their reform. This group included seven country-specific modeling exercises.

In addition to high-level insights, the review of recent literature offers insights on the way in which the main modeling approaches introduced above have been applied.

- **It appears that the first four approaches (Models 1–4) to estimating the quantitative impact of energy subsidies on households and on the distribution of income are well established and well understood.** The IMF, in its estimation of energy subsidies at a global level, has provided updates to the magnitude of the subsidies and

refined its methodology for measuring and allowing for posttax subsidies **(Coady et al. 2015**; **Coady et al. 2019)**. It also provided estimates of the distribution of impacts by income quintiles for a large number of countries **(Coady, Flamini, and Sears 2015)**. The World Bank has developed a uniform approach to assessing the impact of subsidy removal on households, as can be seen in the studies on Morocco **(Verme and El-Massnaoui 2015)**, Jordan **(Atamanov, Jellema, and Serajuddin 2015)**, and the Middle East and North Africa region **(Araar and Verme 2016)**. The questions asked in these studies and the methodologies followed are well understood, and the results are important for the particular country being studied; however, they do not constitute new directions or substantive changes in the approaches captured in the global typology. For the purposes of this review, therefore, the papers focusing on single countries using Models 1 through 4 do not serve as possible sources for new directions in approach. On the other hand, the multicountry studies using these methodologies (**Araar and Verme [2016]** for the Middle East and North Africa; **Feng et al. [2018]** for Latin America and the Caribbean) are valuable for showing how comparisons between countries can be made through the use of a common approach.

- **The studies using the approach in Model 2 do not come to a clear consensus about the importance of indirect impacts relative to direct impacts. A large range of experiences was identified.** In some countries, indirect effects were small, so that the direct effect conveyed the basic picture, while in other countries, indirect effects were as large as direct effects, indicating that the impact on the poor would be much higher than assessed by the direct effect alone. The relative importance of indirect effects may be related to observable factors such as the specific fossil fuel, the level of GDP, the relative size of the energy sector, and so on. *Because the possible undervaluation of the compensation needed to offset the impact of subsidy removal due to the omission of indirect effects can be large, a systematic study on the importance of the indirect effects across a range of countries could be valuable.*
- **The studies following the approach in Model 3 use a range of values for price elasticity.** Some of these elasticities were purpose built from estimates based on current country data, while other elasticities were either historical or even taken from other countries' experience. Because cash compensation levels could depend strongly on the elasticity (the lowest elasticity requiring the largest compensation), a better understanding of elasticities would be important. *A review of up-to-date evidence on price elasticities could be helpful for future policy makers.*
- **The final group of studies (Model 5) is more varied, with different aims and different models, even though all provide estimates of the impact of energy subsidy removal on households.** This methodology is less well known, and the goals of a study can be expanded through the modeling approach utilized. *There is relatively limited guidance on model choice for researchers looking to use a CGE-type approach to evaluate the impact of subsidy reform on the entire economy, and there could be value in providing an extensive write-up on approaches to CGE models for analyzing energy subsidy reform.*
- **No simulations of results for different models using the same data source (structure sensitivity analysis) appear to exist, and only a few models present results for a given model using different assumptions about key parameters.** A further

point is that complex models are not tested against simpler models for the same country and where data would permit. With the data required for CGE (Model 5), it should be simple to reestimate predictions for households using Models 1–4. It appears that with respect to the prediction or estimation of household response to subsidy removal or reduction, no "best" approach can be identified. An analysis of the differences in performance of different modeling approaches, for instance, Model 5 and those following Model 2 or Model 4, could be of interest in establishing the value added of the much more demanding specification and estimation of a CGE model compared with simple partial equilibrium models when analyzing the impacts of subsidy reform on households. *A comparison of aims, methods, and results from different modeling exercises on energy subsidy reform for a country for which several modeling exercises were conducted could be very helpful. It would be interesting to explore the sensitivity of the results to the modeling approach and to highlight common approaches as well as points of different emphasis.*

2.4.2. Studies Modeling the Impact of Subsidy Removal on Firms

The impact of energy subsidy removal on firms includes two different types of subsidy—consumption and production. The key to analyzing these effects is to understand exactly how the initial subsidy is "fed" into the system.

2.4.2.1. Studies Focusing on Consumption Subsidies

Consumption subsidies are addressed in the modeling of the household impacts of subsidy removal. The government sets the price that energy producers can charge consumers below costs. Energy producers then receive a transfer from the government to cover this price gap. There is no incentive for them to increase efficiency and lower costs—the price is fixed and the impact on households is determined. Models 1 and 3 evaluate no further impact than this direct link. However, Models 2, 4, and 5 all allow for a further indirect impact on households through the change in prices of nonenergy goods induced by the initial rise in energy prices. Several studies have found the magnitude of the total indirect impact on household expenditure and welfare to be similar to that of the direct effect, and in some it has been substantially larger. The passing on of the increased costs to non-household purchasers of energy also means that there will be an impact on firms and no compensation from the government.

The total effect of the changes in prices of all goods can be calculated through the "price-shifting" model introduced by Coady et al. (2006). This model treats tradeable and nontradeable goods differently. The prices for tradeable goods are set in the international market, and the country facing higher energy input prices (as a result of domestic subsidy reform) will not be able increase the prices of its tradeable outputs because of the threat of loss of its domestic market. (Methods for coping with the increased costs of inputs are

discussed below.) In practice, domestic firms will have some element of local market power, and prices may be increased somewhat. Prices for nontradeable goods can be increased without a complete loss of market. The Coady price-shifting model assumes that prices increase by the same amount as costs rise—for a particular good the increase in price of the good is determined by the increase in the price of energy multiplied by the share of energy production in total output, plus the share of other inputs whose prices also increase as a result of the energy price increase. The complete calculation requires the use of an input-output table. The key assumption is that, at every stage of this process, prices are increased by enough to cover the increase in costs. If there were some elasticity of demand greater than zero for any good affected by these cost increases, then the volume of sales for those goods would fall. **Li and Lin (2015b)** use this approach to assess the impact of fossil fuel consumer subsidy removal in China. They calculate the change in energy consumption and CO_2 emissions for 22 sectors. Total consumption of energy was reduced by 3.8 percent and emissions by 2.9 percent, but there were important sector variations. The transport, storage, and post sector, and the electricity, gas, and water sectors were most affected by subsidy removal.

Commander, Nikoloski, and Vagliasindi (2015) simulate the impact of energy subsidy reduction on the demand for gasoline and diesel and hence on travel, CO_2, PM10,[6] and congestion costs in Cairo. The analysis explores different policy scenarios and finds that the biggest change in energy use and emissions is observed in a scenario where a gradual elimination of fuel subsidies takes place alongside a 20 percent international oil price increase; these two elements combined would lead to a 20 percent decline in energy use and CO_2 emissions. A similar exercise is carried out for water. Only direct effects are considered for these two sectors. Increases in costs arising from other sectors used as inputs to transport or agriculture are not included.

Aune et al. (2017) take into account the impact of the oil subsidy changes on the global oil market, thus producing more complex effects for oil-producing countries. They simulate the impact of phasing out consumption subsidies on the transportation sector in various countries. The global oil market is modeled as Cournot behavior, where a group of core countries of the Organization of the Petroleum Exporting Countries (OPEC) have market power. Subsidy removal results in a significant decline in fuel consumption in the transport sector in OPEC countries and the oil price falls, stimulating oil consumption in other regions. OPEC consumers are worse off, but total welfare in OPEC increases because of higher profits from oil production.

An alternative and important assumption is that these "intermediate" firms adopt some form of coping behavior and seek alternatives to just passing on all cost increases through price changes. **Rentschler, Kornejew, and Bazilian (2017)** and **Rentschler (2018)** provide a valuable discussion of four possible response measures:

6. Particulate matter with diameter of 10 micrometers or less.

- **Absorption:** If firms had surplus profits, they could choose to absorb some of the cost increase rather than pass it on to consumers, or seek to make changes to the technology or inputs. This is likely to be only a short-term expedient.
- **Substitution:** Firms may be able to replace the energy source whose price has increased with other forms of energy that are now cheaper, thus decreasing the impact of the price increase.
- **Resource efficiency:** Firms may be able to respond by increasing their energy efficiency or efficiency with respect to other inputs. This response also lowers the costs of production so that the overall increase in cost due to subsidy removal is totally or partially offset.
- **Pass-through:** Firms adjust the sales price of their outputs. A firm's willingness to adjust its sales price also depends on consumers' elasticity of demand and the degree of market competition.

To the extent that firms adopt such coping mechanisms when faced with energy-related cost increases, the total indirect effect on consumers would be less than that predicted by the basic price-shifting model. The existence of these coping mechanisms, which can lead to lower degrees of pass-through of costs and hence lower indirect impacts on consumers, has not been studied in great detail, but it is clear that such mechanisms could substantially affect the estimated total indirect impact of energy subsidy reform on households. *This suggests that coping responses could be an important consideration for future work on subsidy reform.*

Rentschler, Kornejew, and Bazilian (2017) and Rentschler (2018) also point to the possible policy implications of the existence of these coping measures. Policies to encourage substitution and efficiency can help lower the extent to which the original energy prices are passed through. This area also merits further investigation.

A crucial point for assessing this literature is the hypothesis that the initial price increases reduce the long-run competitiveness of firms, as would be implied by a situation in which an energy price increase leads to higher end-user prices and cannot be offset by other coping actions. **Rentschler and Kornejew (2017)** and **Rentschler (2018)** point out that empirical studies using microlevel firm data are needed to investigate exposure and vulnerability to high energy prices and firms' ability to cope (e.g., by reducing energy intensity or substituting cheaper energy types). Rentschler and Kornejew (2017) discuss how these hypotheses might be tested and describe a detailed firm survey carried out for Indonesia in 2013 that is suitable for the analysis they propose. The geographic nature of Indonesia, with its many islands of varying sizes, provides obstacles to energy distribution and results in a heterogeneous supply pattern, preventing the even transmission of prices. With this data source, they carry out a series of regressions that show higher energy prices had a small but significant adverse effect on competitiveness. They estimate values of elasticities of substitution between fuels, revealing that kerosene is an important substitute for all other energy types, given the relative prices, and electricity could be replaced by a mix of other fuels, but electricity itself plays only a minor role in replacing other fuels. The study also finds that higher prices for all types of energy are associated with lower energy

intensity of revenue, that is, higher energy efficiency, and that the pass-through of energy costs is significant and should be taken into account in assessing the impact of subsidy removal. *Given the importance of these results and their relevance in the wider subsidy context, there could be substantial interest in further work on this topic. The difficulty will be to find suitable data sets with sufficient information and sufficient heterogeneity to permit the statistical analysis of performance measures.*

A study by **Calì et al. (2019)** carried out tests on data from Indonesia and from Mexico to relate the increases in energy prices (treated separately as electricity and fuels) to the productivity of firms. The results show that fuel price increases result in higher productivity and profits (mainly through older fuel-powered capital being replaced with more efficient and electricity-intensive plants). For electricity prices, a positive impact on productivity was not found because firms using electricity in their production processes had already utilized technical advances in plant design. This finding points to the importance of separately analyzing the results of removing subsidies for each energy source.[7]

Coste et al. (2019), in a study of environmental taxation used to help correct externalities (such as excess emissions), make the point that an increase in environmental taxes and a reduction of consumer subsidies will have similar effects on firms, and there will be parallel methods of coping. They discuss the same set of coping measures mentioned in **Rentschler, Kornejew, and Bazilian (2017)** and **Rentschler (2018)**, adding the possibility of innovation to the list. They also provide a review of the literature on the quantitative economic impacts of environmental regulation and taxes. These reviews are then complemented by an analysis of the impacts of energy price fluctuations on firm performance in developing countries. First, a panel of firms across a sample of middle- and upper-middle-income countries is used to examine the relation between firms' performance and changes in energy prices and taxes. The data do not identify the firms' energy mix, so the responses cannot identify modification to the energy mix or reduction of the energy intensity. To overcome this difficulty, a panel based on a sample of medium and large firms in Indonesia and Mexico is used to provide a more precise test of the effects of energy taxes and subsidy removal on competitiveness. The results cast doubt on the hypothesis that subsidy removal (in this case, environmental taxes) necessarily harms competitiveness. The authors also review policies that would help firms maintain their competitiveness in the face of subsidy removal. *These studies support the suggestion that further investigation of the relation between an increase in the cost of energy (due to subsidy removal) and the price and competitiveness of firms throughout the economy would be valuable, provided that suitable data are available.*

For potential future analytical work exploring the relationship between energy prices and firm competitiveness, possible approaches might include analysis of existing data from past episodes of price shocks, the collection of new survey data or panel data, or a simple

7. The approach of deep dives into firm-level data sets to explore the impacts of energy price reforms on firms is applied in future work for other developing countries in the periods that followed. An example is Amann et al. (2021). The paper was published in the period covered in the follow-up review but not in one of the more limited set of journals used for the review. Therefore, it is highlighted here for interested researchers.

decomposition analysis where two surveys are available (Bacon, Bhattacharya, and Kojima 2009). An important factor to be considered is how quickly each of the different coping mechanisms would adjust to the price shocks.

The framework of how industry copes with price increases arising from a change in subsidies could also be applied to the behavior of households themselves. Households faced with higher energy prices can also decide to use the following response measures:

- **Absorption:** The reduction in utility that follows a price increase parallels the reduction of profits to the firm. The extent of absorption depends on the next two responses.
- **Substitution:** Households can switch between energy sources to a certain extent depending on the relative prices and ownership of the items required (e.g., a stove or lantern). A number of studies have investigated the use of different sources of energy by household income level and type, but there has been limited emphasis on switching along the lines of the model used by Rentschler and Kornejew (2017) and Rentschler (2018) to allow household elasticities of substitution between energy sources to be estimated.
- **Resource efficiency:** Households may be able to maintain the output from energy sources while decreasing the input through various measures to improve efficiency. For example, switching off a light when nobody is in the room maintains output (utility from using a lighted room) while decreasing inputs (hours purchased).

There are, no doubt, recent as well as older studies investigating household energy substitution and efficiency responses, but this review found none in the recent literature that specifically relates them to subsidy removal (or reduction). As with the studies of **Rentschler and Kornejew (2017)**, **Rentschler (2018)**, and **Calì et al. (2019)**, data on the response of households to subsidy removal is likely to be hard to come by; it would require either cross-section variation of the type offered by the Indonesia survey discussed earlier or household panel data. *The theme of household coping is an important topic and would be worth investigating in other countries, using the tools developed by these recent studies.*

A further development of the ideas contained in studies that added the indirect and direct costs of subsidy removal relates to the impact on competitiveness. The impact on a traded good is not just the direct impact of the price rise, but also includes the indirect price effects of goods intermediate to it. **Chan, Manderson, and Zhang (2017)** investigate trade flows in a multicountry framework in which indirect as well as direct costs determine the trade flow, and simulate the removal of a 15 percent implicit tax on electricity supplied to industry in India (designed to provide the revenue to finance a cross-subsidy to households). The results indicate that ignoring the indirect effects would understate the impact of the energy price shock by a factor of about two, and the effect is even larger for industries such as machinery and transport equipment for which indirect energy costs account for a large share of total energy consumption. The specification and construction of a trade-flow model is demanding both conceptually and for data requirements, but *simpler approaches to the relation between trade and energy subsidy removal could be worth exploring for those developing countries that have started to build an industrial and manufacturing sector.*

A link to the political economy aspect of energy subsidy removal on industry is provided by **Moerenhout, Sharma, and Urpelainen (2019)**, who carry out a survey of the views of commercial and industrial consumers in India on electricity pricing. The authors find that senior management officials of industry are opposed to the cross-subsidization of other end-uses by industries, and that firms have few coping mechanisms. This study is discussed above.

Two studies on the Chinese economy **(Li and Jiang 2016; Li and Lin 2015a)** consider the extent to which subsidy removal can offset some of the rebound effect following an increase in productivity designed to reduce the overall use of energy. The increase in productivity reduces the inputs required (including energy) and so can be encouraged as a source of the reduction of energy use (with its attendant contribution to slowing CO_2 emissions). However, it has been noted that the increase in productivity can result in a lowering of prices, resulting in an increase in demand. This is the "rebound" effect, and when it is large, the benefits of technical progress are reduced. Using industry-level data for China, these two papers explore the potential impact of removal of energy subsidies on

consumption and whether this can offset some of the rebound effect. The model assumes a constant elasticity of demand function and follows the IEA in calculating the reduction in demand due to the subsidy-induced price increase. The papers also discuss the interaction of energy prices with technological advancement in incentivizing energy conservation. This approach to measuring the impact of subsidy removal follows Model 3 and does not add to the literature on estimating the magnitude of the impact of subsidy removal. The novel part of the papers is the calculation of the aggregate rebound effect.

2.4.2.2. Studies Focusing on Production Subsidies

When production subsidies[8] are in place, some aspect of the production process is subsidized for the producers of energy. These are reviewed in the survey by **Kojima and Koplow (2015)**, but few studies analyze the impact of the removal of any particular production subsidy.

Acar and Yeldan (2016) investigate the Turkish coal sector using a CGE model, simulating the impact of phasing out production subsidies. They find that by eliminating subsidies, Turkey could reduce aggregate gaseous emissions by 5 percent without a significant loss in GDP. **Zhao et al. (2019)**, in a study of the influence of producer subsidies on oil and gas extraction, aim to help policy makers answer two questions: (1) Can phasing out producer subsidies influence the optimal extraction path by encouraging more rapid or more gradual oil and gas production? (2) Does the removal of producer subsidies create more net social benefits or a financial cost to social benefits in the oil industry? The principal innovation of the paper is the incorporation of producer subsidies into an economic optimization model of oil and gas extraction that models specific field costs, including equations for drilled and producing wells. Taking fields in the Gulf of Mexico as illustrations, the authors estimate equations for the number of drilled and producing wells, as well as for the costs of exploration, development, and production. The study also provides a number of references on the impact of the removal of subsidies to energy producers. These references include a study by Golosov et al. (2011) that concludes that the use of general equilibrium modeling also makes no effective difference to a partial equilibrium analysis in the context of fossil fuel taxation. This result supports the suggestion made earlier in this review that studies of the impact of subsidies should compare results from general and partial equilibrium models. Zhao et al. (2019) point out that it is necessary to first know the nature of the subsidy and its transfer mechanism, and they provide an overview based on nine OECD countries. Equations are developed for optimal oil and gas extraction, the costs, the number of drilled and producing wells, the field production profile, and the oil price. In the Gulf of Mexico, producer subsidies include royalties, income tax deductions, and depreciation, and two oil fields are chosen to validate the model. Producer subsidy removal is found to lower the optimal production path and producer surplus, with positive effects on government revenues and negative effects on net social benefits. Extensive sensitivity analysis is also carried out. The complexity of this study is related in part to the nature of upstream

8. Production subsidies are those in which a step of the production process itself is subsidized, not the sales price to consumers.

oil and gas taxes and subsidies. Coal also raises similar issues of more central concern. This paper is a valuable addition to the literature.

Following the quantification of producer subsidies in OECD countries, **Zhao, Dahl, and Luo (2019)** review the transfer mechanisms for these various subsidies. Then, to recommend models with which to analyze the removal of producer subsidies, they review upstream oil and gas models and provide a taxonomy of them. From these the authors recommend the most appropriate model for each type of producer subsidy to model upstream decision-making. The paper reviews a large amount of literature and serves as a valuable reference for anyone analyzing the removal of upstream producer subsidies on oil and gas.

A small group of studies investigate the links between fossil fuel subsidies and world oil prices. **Husaini, Puaha, and Lean (2019)** construct an econometric model for Malaysia of the aggregate price index (consumer price index or producer price index) linked to the international oil price, the oil subsidy level, and other factors. They find that subsidies are negatively related to these price indexes. **Muangjai, Wongsapai, and Damrongsak (2017)** estimate demand functions for petroleum products in Thailand. They relate final demand to product prices inclusive of subsidies and evaluate the impact of the subsidy alone on demand. The price elasticities thus estimated are not stable over subperiods, likely in part because of the omission of other variables, in particular GDP, from the regression. **Hassani et al. (2018)** analyze the use of oil funds to stabilize the domestic oil price against swings in the international oil price. The fund has to take into account subsidies when they exist, but the principles involved are the same regardless of whether there are subsidies. Although these studies are interesting, the methods applied are based on existing approaches, and a new approach is not introduced. Nonetheless, the last paper's exploration of rules for operating an oil fund mechanism could be of interest to practitioners.

Two further papers analyze in quantitative terms links between the potential revenue from reforming fossil fuel subsidies and certain development objectives that could be financed in part or in total from the receipts. **Zinecker et al. (2018)** compare the global cost of subsidizing access to electricity with the potential global revenues from removing energy subsidies. Globally, energy subsidies could finance the "access gap" 7.5 times over. However, the biggest access gaps are not necessarily in countries with the largest subsidies to energy, so some reallocation mechanism would be needed to achieve the 100 percent access target. The first reallocation mechanism would spread the access program over a number of years—the extra revenue from not subsidizing energy will recur each year, tackling a fraction of the access gap. One crucial hypothesis is that households in the lowest income brackets may not be able to afford basic energy sources because their incomes are too low; even a fully subsidized access program may be insufficient to overcome this barrier. In such a case they would not enthusiastically support a subsidy reduction program because it would not benefit them, and the "losers" from the proposed scheme would be in a stronger position to oppose it. The other recommendations of the study concern better targeting of the subsidies that are used, such as ensuring the rich do not benefit. **Gass and Echeverria (2017)** examine the concept of a "just transition" to a sustainable economy and society by financing such a transition using energy subsidy

reform receipts. The authors also explore how the resources freed up by removing energy subsidies could be used to help achieve some of guidelines in the *Guidelines for a Just Transition towards Environmentally Sustainable Economies and Societies for All* **(ILO 2015)**. These guidelines include the following: (1) employment-centered macroeconomic and growth policies; environmental regulations in targeted industries and sectors; (2) an enabling environment for sustainable and greener enterprises; (3) social protection policies to enhance resilience and safeguard workers from the negative impacts of climate change, economic restructuring, and resource constraints; (4) labor market policies that actively pursue job creation, limit job loss, and ensure that adjustments related to greening policies are well managed; (5) occupational safety and health policies to protect workers from occupational hazards and risks; (6) skills development to ensure adequate skills at all levels to promote the greening of the economy; (7) establishment of mechanisms for social dialogue throughout policy-making processes at all levels; and (8) policy coherence and institutional arrangements for mainstreaming of sustainable development and ensuring stakeholder dialogue and coordination between policy fields.

As noted by **Zinecker et al. (2018)**, there is a problem of reallocation from societies with large subsidies to countries with large needs for the just transition. A further difficulty, well illustrated by these two studies, is that there will very likely be competing claims for the use of the receipts from subsidy removal, with political implications for governments. Direct cash transfers to lower-income households is likely to be an important use of the receipts, and other socially valuable items, such as increased spending on health and education, would also have claims on those receipts. In such a context, there is a chance that items needed for a just transition may be accorded a low priority.

THREE

Follow-up Literature Review, 2020–21

As noted, the original literature review focused on a five-year period from January 2015 to December 2019, and out of that body of work, key pieces were reviewed through early 2020, with main themes summarized in chapter 2.[9]

A follow-up review of a relatively more limited scope was carried out in mid-2022 to broaden the understanding of whether any new trends or emerging approaches had surfaced since the conclusion of the initial literature review completed in 2020.

The main purpose of the follow-up review was to determine whether new trends emerged in the more recent years, or whether the topics addressed in 2020–21 were largely aligned with those of the previous five years, or even earlier, in the academic study of energy subsidies. Because the follow-up review drew from a more limited set of journals and publications compared with the original review, it is presented separately in this brief chapter. The findings of the follow-up review may not be representative of the wider set of publications covered in the original review.

3.1. Overview of Findings

The review of papers on energy subsidies published in the period 2020–21 focuses on 22 studies[10] based on a search of the three main sources that were found to contain the majority of the articles in the period 2015–19, namely *Energy Policy, World Bank Policy Research Working Papers, and Energy Economics*. Appendix C presents a summary of the key literature identified in the follow-up review focusing on these sources.

The rate of publication observed through the limited sampling suggests unflagging interest in the topic. Nine studies (about 41 percent) relate to countries in the Middle East, and five (about 23 percent) to China. The focus on the Middle East is no surprise, given the significant size of both its oil sector and its energy subsidies. Neither is the focus on China, given its economic importance. But the lessons to be derived from these particular studies are unlikely to be novel or applicable to lower-income countries. Several groups of papers emerge.

- **Price impact models.** Ten studies, referred to using the shorthand "price impact models" as in table C.2, model the quantitative impact of subsidy reduction on prices and household welfare. This group of studies is subdivided into two categories: The first category comprises those concerned with the impact on the economy as a whole, using CGE models—the "CGE approach." The CGE modeling that had been so surprisingly dominant in the earlier period appears to be converging to a standard approach by the time of the second review. The second category includes those using the "price shifting approach" developed by the IMF and the World Bank, focusing on the direct and indirect

9. The original literature review summarized in chapter 2 was used to inform the scope of subsequent analyses and topical papers that were commissioned by ESMAP through 2021 and 2022, including those related to CGE modeling, poverty and distributional analysis of subsidy reform impacts, the use of cash transfers in the context of energy subsidy reform, the impact of energy subsidy reforms on firms, and political economy analysis.
10. A few of the studies were from early 2022, therefore not strictly within the period indicated, but were deemed highly relevant, and hence are included in the review given their potential interest for practitioners.

effects on prices and household welfare. This second group of 10 studies (45 percent of the total set) is comparable to the large group in the 2015–19 literature review (59 percent) focused on modeling the impacts of a cost increase (subsidy reduction). The value of these papers is mainly for those studying the individual economies concerned, while innovations in methodology appear to be relatively limited.

- **New approaches.** The several studies that tackle a new topic or show evidence of a methodological improvement, in that they provide insights beyond those applicable to one country, are discussed in more detail below.
- **Institution-centered approaches.** Studies in this third group analyze institutional factors using a descriptive approach to the topic selected. **Guénette (2020)** is concerned with the impacts and problems of imposing price controls; no formal model is deployed that might be extended to subsidy reduction. **Taiebnia and Barkhordari (2022)** apply a "policy dismantling" approach to break down policies related to subsidies, and discuss interaction of political economy, policy design, institutional constraints, and external factors in determining sector outcomes. Given the unique constraints facing Iran's energy sector, the ability to use this paper to draw lessons for other countries is difficult.
- **Sector reform focus.** Four studies are concerned with power sector reform and touch upon subsidies amid a broader discussion of sector reform. **Rana and Khanna (2020)** offer a straightforward extension of the work of Komives et al. (2005) on reform. The methodology follows that used in other country studies. **Huenteler et al. (2020)** take the 15 country case studies used by Komives et al. (2005) and relate the quasi-fiscal deficits (measured by a standard approach) to various policies followed. Given that subsidies are only one component determining improvement of the quasi-fiscal deficit, the contribution of this study to subsidy removal is limited. **Poudineh, Sen, and Fattouh (2020)** explore the suggestion that countries in the Middle East and North Africa region extend power sector reform in a way that takes account of links between the economies. This largely descriptive study could have relevance to other country blocs and does not contain extensive analytical content. The study by **Tsai and Mezher (2020)**, which focuses on the impact of different sector reform policies on Gulf Cooperation Council (GCC) countries, is mainly of interest to those studying GCC energy subsidy policies.

The papers studied are summarized in table C.1 in Appendix C by country or economy, the focus of the study, and key findings, while table C.2 organizes them by topic.

3.2. Studies of Particular Interest

As part of the review, several studies of particular interest were identified. Of the 2020–21 set of studies, six cover a wide range of topics and use methods that have previously been given little or no role in the general investigation of the impact of subsidy removal. These are explored in greater detail in these paragraphs.

At first glance it may appear that these studies have little in common, but in fact two of the studies, namely, **Natalini, Bravo, and Newman (2020)** and **Rentschler and Hosoe (2022)**, have a shared emphasis. They focus not on the direct impacts on demand at the household or industry level, but on further effects such as the propensity to join a riot (a public type of "bad" action) or increase smuggling or tax evasion (a private behavior). Natalini, Bravo, and Newman's (2020) study of riots linked to energy price increases driven by subsidy reduction provides increased evidence of the reaction the government can expect using a cross-section linking identified episodes of rioting to subsidies (and other factors). Rentschler and Hosoe (2022) explore ways in which subsidies provide incentives for tax evasion and smuggling, focusing on an important issue, and use data from Nigeria, with its large oil sector, to analyze these dimensions.[11] Using a CGE model that accounts for informality, tax evasion, and fuel smuggling, the study explores the impact of fuel subsidy reform on consumption, tax incidence, and fiscal efficiency. This analysis could be interesting for replication elsewhere, but the reliability of the data would need to be verified. The modeling and lessons do not apply to illegal activities related to the sale and purchase of electricity, which is not tradeable and movable in the same way as oil. *A systematic search of the literature to explore in greater detail examples of the less commonly discussed side effects of energy subsidies could be interesting.*

Other recent papers highlighted here explore various energy sources and dimensions of subsidies. **Chen, Huang, and Mirzabaev (2022)** investigate China's use of subsidies to encourage agricultural households to use LPG and to discourage the use of biomass with its damaging indoor and outdoor pollution. A detailed model of agricultural household behavior is constructed to explain how the substitution might take place. **Wang et al. (2021)** evaluate the impact of policy changes on household behavior using the "difference-in-differences" method, a well-established tool in economics and the social sciences. They use this approach to evaluate coal-to-gas subsidies introduced in China in 2017 to encourage households to switch from coal to natural gas for residential heating. This study assesses the impacts of such subsidies on fiscal and household nonenergy expenditure. **Balarama et al. (2020)** explore the complete structure of household electricity price formation in Indonesia. Differences between marginal and average prices (reflecting increasing block tariffs) as well as various fixed charges lead to differences in household expenditure that can be exploited to provide estimates of demand response to price changes. This is clearly an important approach when prices are not purely linear. Pu et al. (2020) consider the issue of cross-subsidies, whether between industry and households, or between different industries. Little work is available to guide policy makers on the relative value of energy subsidies to the different agents. This study defines a "reasonable" cross-subsidy and shows how to calculate it and compare it with the actual cross-subsidy. This approach may be applicable beyond China.

11. Although outside the period covered by the review, a 2022 report by the UN offers an in-depth exploration of the issue of fuel smuggling in the Sahel region in Africa, including illustrative calculations of profits that stand to be made by smugglers by buying fuel in a subsidizing country and selling it in the neighboring country (UNODC 2022).

FOUR

Conclusion: Trends, Omissions, and Noteworthy Approaches

The analysis of the 114 studies reviewed as part of this exercise leads to several conclusions as well as comments on individual studies. Observations and insights on emerging topics and approaches are summarized below, along with areas that could benefit from further exploration and research (presented in italics).

On the measurement of the magnitude of subsidies, much of the related literature from the full review period (2015–21) consists of reviews of previous analyses or updates of earlier work. Questions of definition and measurement had already been well answered before the study period. In particular, the IMF produced a number of studies linked to the definition and the measurement of subsidies in a large number of countries, along with the yearly data sets and aggregate subsidy estimates that are published by the OECD and IEA. A key study in the development of this literature on the definition and magnitude of global energy subsidies is Coady et al. (2006).

A substantial body of work is devoted to lessons learned, and, in the more recent period, notable approaches to systematically tracking actual subsidy policy and reform implementation in developing countries were initiated. Before the study period, substantive collections of country cases had been analyzed and lessons drawn by Vagliasindi (2013) and Clements et al. (2013). The studies considered for this review mainly stay focused on established arguments adapted to the countries under analysis. With regard to tracking real world developments, a critical paper in this period is **Kojima (2016)**, which, against a background of a large drop in world oil prices, followed up on the 2013 effort to document developing-country experiences. Several years' more experience of government policies toward fossil fuel subsidies are now available. *Further analyses tracking the performance of implementation reform in developing countries and drawing lessons learned could offer a longer perspective, provide important checks on the stability of energy subsidy reform across a range of developing countries, and render useful lessons from experience.*[12]

There is a pronounced focus on understanding and measuring impacts on households. The principal topic of interest in the body of literature reviewed is understanding the impacts of subsidy removal on key segments of the economy, and in particular, on households. Indeed, in aggregate, two-thirds of the 2015–19 studies relate to subsidy reform impacts on households. Earlier works express some interest in the quantification of the impacts on households, but not at the scale seen in this review. *Two important economic variables—the price elasticity of demand and the importance of indirect relative to direct price effects—would be worth studying across a wide range of countries and circumstances to provide a solid foundation for future studies.*

On the other hand, the impact of subsidy reform on sectors affected by price increases has attracted relatively limited attention. The few studies concerned with this issue provide some important insights into how firms can cope with an increase in costs arising from an increase in energy prices. The removal of consumer subsidies and the indirect effects of energy price increases affect not only households but also firms in the chain of production;

12. The World Bank's Energy and Extractives Global Practice is currently working on a report that examines recently implemented price mechanisms and subsidies for liquid fuels, accompanied by two new global databases. The report and the data sets are expected be made publicly available in late 2024.

nonetheless, a much smaller group of studies focus on the effect of subsidy reforms or price increases on firms. A review of the papers on firm-level effects offers different perspectives and insights, informed by the different approaches they use. If the price-shifting model introduced by Coady et al. (2006) is adopted, then all costs are passed on to consumers, and firms experience no change. However, as emphasized by **Rentschler, Kornejew, and Bazilian (2017)**, firms may decide not to pass on all their cost increases, but to hold prices steady and use coping measures. They show that there is a significant positive relation between higher prices and higher productivity—implying less than a full pass-through of cost increases. A similar result is obtained by **Calì et al. (2019)**. These results are new and mark an important extension of the understanding of the impact of subsidy removal on consumer prices. The analysis of coping mechanisms adopted by firms in the context of higher energy costs may parallel the reactions of households. Coping mechanisms may help explain differences in the price elasticity of demand found in various circumstances. *The behavior of firms in a broad range of countries merits further investigation if suitable data can be made available. Further work in this area could provide insights into the degree to which price increases are passed through by various sectors of an economy.*

Analysis of the distribution of benefits from energy subsidies by income group (vertical distribution) continued to be an area of focus. Main approaches were well established before 2015, and studies such as Komives et al. (2005) provide a template for this topic. A few papers explore mathematical models for determining the level of subsidy according to selected welfare criteria. Although a novel approach, these do not appear to be the focus of further application outside a research environment. A possible further development of the analysis of household energy use, as suggested by **Pizer and Sexton (2019)**, may be to investigate the nature of the horizontal distribution of benefits and policies to alleviate inequalities that arise. **El-Hamidi (2016)** highlights differences due to the gender of the head of household. *A review of emerging approaches toward understanding the distributional impacts of energy subsidies and their reform, and discussion of suitability of approaches in varied contexts, can be useful.*[13] *Dimensions of vertical and horizontal distribution of benefits and impacts would be worth exploring.*

Evaluations of the impact of energy subsidy removal used a wide range of models. The studies related to energy subsidies published in 2020–21 indicate substantial interest in quantifying the effects of energy price increases (or subsidy reduction) using established models. It was not possible to discern any distinctive shift to a new approach, but some interesting studies concentrate on by-products of subsidy reform. A great variety of models are used, including those published in the World Bank Policy Research Working Papers series. Nonetheless, there appears to be relatively limited explanation of the modeling used in studies from the academic literature, and little analysis seems to have been undertaken to make direct comparisons between different modeling approaches. Assessment of the difference between the estimates that would be produced by applying each modeling approach in turn to the same set of data could render useful insights. For example, applying different models to the same data set could permit a more general assessment to be made of the importance of allowing for indirect effects on prices faced by consumers and

13. ESMAP has since published a report that builds on this recommendation. See Olivier, Matytsin, and Gencer (2023).

the effects of assuming that the price elasticity of demand is zero.[14] *A review of different modeling approaches and data requirements could be useful. Later on, comparison of the findings of different models in the same context and the performance of models compared with actual results could be another interesting exercise.*

CGE models are being increasingly used for assessing the impacts of subsidies and their reform. The widespread use of CGE models to evaluate energy subsidy reforms was a significant innovation and a somewhat unexpected development, especially when their use may be declining in other circumstances. It does not appear to be the case that possible new users of the technique are being offered easily accessible, useful, and relevant material on using CGE models for topics such as subsidy removal. This topic would benefit from a review of its value in the context of energy subsidy removal. *A survey of CGE modeling approaches that have been recently applied, and a guide to model selection, estimation, data requirements, and simulation that is geared for a nonspecialist audience, could be helpful.*[15]

Quantitative analyses of energy subsidy reform impacts also explored environmental aspects. Several papers that focused on quantitative impacts incorporated environmental impacts of energy subsidies and their reform. A focus on environmental aspects was observed across quantitative analyses focusing on impacts on households, firms, and the macroeconomy, but it was the latter where the discussion of environmental aspects appeared to be more systematically included, possibly reflecting the capabilities of the modeling tools.[16] *A review of the approaches to quantitative analysis of environmental impacts (both standalone and concurrent with other impacts) of energy subsidies and their reform could be of interest for practitioners.*

Quantitative approaches to estimating reform impacts are advancing, but there are still opportunities for further improvement. As noted in chapter 2, impacts on households at different income levels are estimated using increasingly complex models (e.g., four partial equilibrium approaches). A lack of econometric estimation or testing among so many studies devoted to evaluating the quantitative impacts of a policy change is striking and unexpected, while the parallel literature on the impacts of energy sector restructuring contain a substantial number of econometric studies that sought to test some of the hypotheses that drive sector reform. The introduction of dynamic models with which to investigate the impacts of subsidy reform on growth by **Breisinger et al. (2019)**; **Cockburn, Robichaud, and Tiberti (2018)**; and **Glomm and Jung (2015)** open new avenues for evaluating subsidy reforms. *CGE and other models could be used to simulate what would happen if subsidies were removed, and the results could be compared with actual outcomes and tested for significant differences.*

Qualitative approaches to assessing perceptions about reform impacts can complement quantitative methods to offer an improved understanding of potential support for reform.

14. For example, between 2015 and 2019, four CGE studies covered subsidy removal in Egypt. It would be helpful to undertake a detailed comparison of these four studies, the structure of their models, and the results. This exercise might help answer general questions as well.
15. Based on this recommendation, ESMAP prepared a technical report on approaches and practical uses of CGE modeling for energy subsidy reforms. See Njinkeu, Djiofack, Gencer, Beyene, and Alli (2023).
16. Recent papers outside of the period or outside of the journals covered in this review include quantitative analyses of the environmental impact of fossil fuel subsidy policies, such as Solarin (2020) and Arzaghi and Squalli (2023).

Calvo-Gonzalez, Cunha, and Trezzi (2015), using opinion surveys before and after a subsidy reform, find that many people who actually benefited from the generous cash compensation were not in favor of the scheme and saw themselves as "losers." After implementation, surveys reveal a slow increase in support linked to changing beliefs. The finding that there are winners who perceive themselves as "losers" opens up new possibilities for explaining why reforms in some countries have not had wide-scale support and therefore have not succeeded. As for perceptions of firms and industries, **Moerenhout, Sharma, and Urpelainen (2019)** interview industrial and commercial consumers for their reactions to the presence of consumer subsidies on electricity and their possible removal, and their coping strategies. *Collection of survey data, and analysis of societal and sectoral perspectives on energy subsidy reform to get a sense of potential support, would be valuable. Approaches for building support for reform and trust in the government's ability to deliver in the context of energy subsidy reform could be an area for further exploration.*

Political economy continues to be an area of focus. The framework on the role of political economy developed in **Inchauste and Victor (2017)** is applied to four countries in a series of studies by different authors. Testing the framework on other country situations could offer additional insights. If doing so turns out to be straightforward, the application to other countries could be useful and help further refine the framework. *More in-depth exploration of approaches to the political economy of subsidy reform and practical examples of assessing and understanding stakeholder perspectives through various tools could be interesting.*[17]

17. Based on this recommendation, a forthcoming ESMAP technical report titled "Political Economy Analysis and Communications in the Context of Energy Subsidy Reforms: Approaches and Insights from Recent Experiences" explores this topic further.

Appendix A.
Journals Searched and Article Selection Process

The process of selecting from the large number of articles published in the journals considered[18] was carried out in four steps:

- First, the website of the journal was identified, and its search function was used to identify all articles published within the period considered. For example, in the journal *Energy Policy* a total of 3,371 articles were published in the period 2015–19.
- Second, to reduce these to a manageable number, a search for the word "subsidy" in either the title, the abstract, or among the keywords was performed. For those journals most focused on energy issues, this step identified many such articles. For example, in the period 2015–19, *Energy Policy* published 292 articles in which the word "subsidy" appeared in the title or abstract or among the keywords; *Renewable and Sustainable Energy Reviews* published 126; *Applied Energy*, 98; *Energy*, 93; and *Energy Economics*, 82.
- Third, the titles of the articles identified as part of the second step were read to gauge their potential relevance to some aspect of energy subsidy reform. Applying this method to each of the selected journals, as well as to articles and books from a direct internet search and cross-referencing process, produced a list of 100 articles that appeared relevant to the topic of energy subsidy reform.
- Fourth, a rapid review of the articles narrowed the focus of the in-depth review to 92 papers for 2015–19 and 22 for 2020–21.

The search method was intended to capture as many relevant studies as possible. While researching among the set of journals and outlets targeted, the point of departure was that any paper with a substantial focus on energy subsidy reform would certainly have included the word "subsidy" in either the title, abstract, or keywords. It is, nonetheless, possible that some papers may have been missed if the expression "subsidy" was not used in any of these categories. Although some relevant articles may have been overlooked, the array used for this study is an attempt to present a comprehensive picture of topics and trends in the literature on energy subsidy reform during 2015–19, with a snapshot also offered for 2020–21.

TABLE A.1

Journals Searched for the Review

Applied Energy	Energy Reviews
Economics of Transition	Journal of Development Economics
Energy	Journal of Economic Literature
Energy Economics	Journal of Economic Perspectives
Energy for Sustainable Development	Journal of Economic Surveys
Energy Policy	Renewable and Sustainable Energy Reviews
Energy Procedia	World Development

18. The growth in internet publishing has led some journals to greatly expand the number of papers published per year.

Appendix B. Models Used for Estimating the Impact of energy Subsidy Removal on Households

TABLE B.1

Models Used for Estimating the Impact of Energy Subsidy Removal on Households

Authors	Energy products included[a]	Country	Findings
Model 1: Direct price impacts and zero demand elasticity			
Araar, Chioueiri, and Verme 2015	Gasoline, diesel, LPG, kerosene, electricity	Libya	Complete removal of energy subsidies would lead to household expenditure loss of 19.9 percent (equivalent to 3.9 percent of government spending). The share under the poverty line would increase from 8.5 percent to 30.4 percent. The problem is finding gradual policies to eventually bridge the large gap.
El-Hamidi 2016	Gasoline, kerosene, diesel, electricity	Egypt, Arab Rep.	Calculated change in expenditure after subsidy reduction for electricity and transport fuels by male- and female-headed households. Main finding was that prior to the policy change, expenditure on electricity in female-headed households was greater than in male-headed households for all quintiles, while it was the reverse for transportation.
Younger 2016	Electricity	Ghana and Tanzania	Simulated effects of removing subsidies in Ghana and Tanzania; with no further adjustment poverty increases. The lifeline tariff had little impact on poverty largely because the poor (especially in Tanzania) were not connected.
Model 2: Direct and indirect impacts with zero price elasticities			
Coady, Flamini, and Sears 2015	Electricity, gasoline, diesel, kerosene, LPG, natural gas, coal	Global	Total direct and indirect impact on households of US$0.25 per liter increase in fuel prices is equivalent to 5.5 percent of household income, of which the direct effect is 2.5 percent. Based on data for 32 developing countries in 2014.
Feng et al. 2018	Gasoline and diesel, electricity	11 LAC countries	Across 11 LAC countries, an average 19 percent of gasoline, 21 percent of electricity, and 27 percent of natural gas and LPG proceeds from subsidy removal would be required to compensate the bottom two quintiles for direct and indirect effects of these price increases. Indirect effects would be greater than direct effects for gasoline and diesel but would be smaller for electricity.

Authors	Energy products included[a]	Country	Findings
Jiang, Ouyang, and Huang 2015	Coal, transport fuels, electricity, natural gas, LPG	China	In China, transport subsidy removal would have the most progressive effect, coal the least progressive effect, and electricity a regressive effect. Petroleum product subsidy removal would have the greatest effect on households.
Maboshe, Kabechani, and Chelwa 2019	Electricity	Zambia	Electricity subsidies are highly regressive (Q5 receives 60 percent and Q1 < 1 percent). A simulation of a 75 percent electricity price increase shows that the poorest households would experience a three times greater loss in real expenditure compared with the richest households. Indirect effects would be much smaller than direct effects.
Schaffitzel et al. 2020	Gasoline, diesel, LPG, electricity	Ecuador	Removing subsidies for households without compensation would be regressive for diesel and LPG, progressive for gasoline, and neutral for electricity. Indirect effects would be very large for diesel, substantial for electricity and gasoline, and small for LPG. Increasing cash transfers to the poorest 40 percent by US$50/month would increase their real income by 10 percent and leave US$1.3 billion for the public budget.
Verme and El-Massnaoui 2015	Gasoline, diesel, electricity	Morocco	Direct effects of the 2014 subsidy reform increased the poverty level from 4.1 percent to 5.2 percent, while resulting in large savings (18.9 billion Moroccan dirhams) to the government. A uniform cash transfer that maintained prereform poverty levels would have cost 10.4 billion Moroccan dirhams. Indirect effects were estimated for some energy products—for electricity, the indirect effects would have been 36 percent of the total effect of subsidy reduction.
Model 3: Direct impacts with price elasticity of demand			
Acharya and Sadath 2017	Coal, gasoline, diesel, kerosene, LPG, electricity	India	Estimates price and income elasticities for several energy types, and applies them to simulated changes in subsidies, but does not relate these increases in expenditures to total expenditure or combine them to give a total household expenditure effect.
Araar and Verme 2016	Gasoline, diesel, LPG, electricity	Middle East and North Africa region	A 30 percent reduction in energy subsidies would provide governments in the region with more revenue than required to offset the change in the poverty gap (4–5 percent of household welfare for all energy products) resulting from reforms.
Atalla, Gasim, and Hunt 2018	Gasoline	Saudi Arabia	Estimated price elasticity of demand for gasoline and applied it to an announced price increase. The overall effect was split into a reduction of deadweight and a reduction in external costs—pollution, congestion, and accidents.
Burke and Kurniawati 2018	Electricity	Indonesia	Estimated electricity demand elasticity of 0.15 to 0.20, but much higher in the long run. Indonesia, by subsidy reforms, estimated to reduce household electricity demand by 7 percent relative to prereform projection.
Coady et al. 2015	Electricity, gasoline, diesel, kerosene, LPG, natural gas, coal	Global	Estimated global net economic welfare gains from eliminating posttax subsidies as benefits from reduced environmental damage and higher revenue less losses from consumers facing higher energy prices at 2 percent of global GDP in 2013, built from country-level data. Carried out sensitivity analysis. Consumer welfare gain is estimated by using a demand curve with constant price elasticity.
Coady et al. 2017	Electricity, gasoline, diesel, kerosene, LPG, natural gas, coal	Global	Same as Coady et al. (2015).
Coady et al. 2019	Electricity, gasoline, diesel, kerosene, LPG, natural gas, coal	Global	Updated version of Coady et al. (2015). Net welfare gain of eliminating posttax subsidies estimated at 1.7 percent of global GDP in 2015. Carried out sensitivity analysis and explained differences from previous estimates.
Khalid and Salman 2019	Electricity	Pakistan	Compared different shapes of pricing reform (uniform price increase, nonuniform price increase, selective price increase) via deadweight losses and consumer surplus for households. Targeted subsidy yields fiscal savings and improves welfare of the most vulnerable.
Moshiri 2015	Electricity, gasoline, natural gas	Iran, Islamic Rep.	For three energy goods price elasticities are small but income elasticities are near unity. Subsidy reform leads to weak effects on decreasing household energy consumption, whereas the compensation effect tends to increase its use. Efficiency improvements are needed to reduce energy consumption.

Authors	Energy products included[a]	Country	Findings
Moshiri and Santillan 2018	Electricity, natural gas	Mexico	A 20 percent increase in price of all energy would require a cash transfer of Mex$111 to poor households and Mex$267 for the rich to leave them indifferent to price change. Energy goods are weak substitutes.
Mundaca 2017	Gasoline, diesel	Middle East and North Africa region	Simulates country-level reduction of consumption of gasoline and diesel when price increased by US$0.20/liter using estimated elasticities of demand. Long-run price elasticities for fossil fuels are at least three times that of the short run, giving a proportionately larger reduction in consumption. Consumption is linked to CO_2 emissions.
Pacudan and Hamdan 2019	Electricity	Brunei Darussalam	Welfare losses are high for non-poor households under removal of power subsidies using an increasing block tariff scheme. Increases in energy expenditure as a percentage of income are lowest for the poorest households.
Peltovuori 2017	Gasoline, diesel, kerosene	Kiribati	Subsidy removal would have only a small impact on budgets of poor households and would increase total household expenditure by less than 0.5 percent for the poorest quintile.
Rentschler 2016	Electricity, gasoline, kerosene	Nigeria	Shows that in Nigeria uncompensated fossil fuel subsidy removal would increase national poverty rate by 3–4 percent, and that uniform cash compensation that appears effective at the national level fails to mitigate price shocks in 16 out of 37 states. Recommended varying cash compensation. Energy efficiency required to help reduce energy consumption by region.
Rentschler 2018 (chapter 3)	Electricity, gasoline, kerosene	Nigeria	Same as Rentschler (2016).
Model 4: Direct effects with price elasticity plus indirect effects with no elasticity of substitution			
Atamanov, Jellema, and Serajuddin 2015	Electricity, gasoline, diesel, kerosene, LPG	Jordan	The universal subsidies on fossil fuels and electricity are pro-rich, but poorer households do benefit. Diesel has a small direct but a large indirect impact on all groups (77 percent of total effect); the indirect impact for gasoline is much smaller (14 percent) and for electricity is about 40 percent.
Model 5: CGE models allowing for own price elasticities and for elasticities of substitution			
Authors	Energy sources	Countries	Model type Findings
Bhattacharyya and Ganguly 2017	Electricity	India	*Author-specified CGE model* Removal of electricity cross-subsidy to agriculture by industry would increase inflation and reduce household incomes. Other policy alternatives would result in an unbearable budget deficit. The only feasible option is a direct price subsidy to agriculture. With food prices being held down, there is a minimal effect on household income.
Breisinger et al. 2019	Electricity, gas, gasoline, diesel, kerosene, LPG, fuel oil	Egypt, Arab Rep.	*Author-developed dynamic CGE model* Early returns on reform package show improvements in current account balance, budget deficit, and growth, and the model shows that these are likely to increase if reform is sustained. Will take time for benefits to be felt by households, and gradual subsidy phaseout is preferable to immediate abolition.
Cockburn, Robichaud, and Tiberti 2018	Electricity, gasoline, diesel, kerosene, LPG, fuel oil	Egypt, Arab Rep.; Jordan	*Recursive dynamic structure based on the PEP 1-t standard model* Subsidy cuts generate fiscal savings, freeing savings for investment and growth. In Egypt, reform strongly increases prices, whereas in Jordan, falling aggregate demand more than offsets power price increases so that the consumer price index falls. In Egypt, the large share of subsidies going to households results in a moderate input cost increase, leading to more investment and growth with higher wages and household nominal incomes.
Delpiazzo, Parrado, and Standardi 2015	Electricity, coal, other fossil fuels	Global	*ICES-XPS CGE model* Simulates global phaseout of fossil fuel subsidies. Shows that GDP increases and emissions decrease relative to baseline calculation; asymmetry of response of energy exporters (lower GDP) and importers (higher GDP and emissions).

Authors	Energy sources	Countries	Model type Findings
Dennis 2016	Electricity, petroleum products, coal, natural gas	Multicountry	*GTAP model* Removal of petroleum subsidies yields the biggest gains where the share of the sector is largest though efficiency gains via reallocation of resources. In a few cases, private household welfare declines where resource reallocation benefits are small; hence, flexibility of factor markets is important. Governments may also compensate households while achieving fiscal savings.
Farajzadeh and Bakhshoodeh 2015	Electricity, gasoline, diesel, kerosene, LPG, fuel oil, natural gas	Iran, Islamic Rep.	*Author-modified CGE model* Simulated complete elimination of energy subsidies where (1) all revenue was returned to households, and (2) a portion of revenue was returned. First case caused a fall in GDP and a rise in prices with resulting loss in welfare, but large reduction in emissions. Second case produced increase in welfare and smaller reduction in emissions.
Gelan 2018a	Electricity, petroleum products, natural gas	Kuwait	*Modified IFPRI (Lofgren) static CGE model* Simulated 25 percent reduction in subsidy to natural gas, oil, and electricity. Resulted in large energy price increase, marginal GDP decrease. If cash transfers to energy users equivalent to their welfare loss were added in, the price increase was less, and GDP increased. Greater substitution between capital and energy improves results.
Gelan 2018b	Electricity	Kuwait	*IFPRI (Lofgren) static CGE model* Simulated 30 percent reduction in electricity subsidy, resulting in adverse economic effects but reduction in CO_2 emissions. The inclusion of cash transfers to compensate for user losses resulted in smaller reduction in emissions, but GDP increased.
Gharibnavaz and Waschik 2015	Electricity, gasoline, diesel, kerosene, fuel oil	Iran, Islamic Rep.	*Author-modified GTAP model* Simulated subsidy reforms as implemented in 2010. Results indicated that these reforms, accompanied by lump-sum payments to households, could result in aggregate welfare gains greater than 45 percent, with lowest income groups greater than 100 percent, and an increase in government revenue of 30 percent. The subsidy reform would have been responsible for some of the inflation experienced, but not for fiscal deficits.
Glomm and Jung 2015	Energy	Egypt, Arab Rep.	*Overlapping generations author-developed model* Simulated reductions in energy subsidies coupled with increases in taxes or increase in infrastructure investment. GDP tends to drop, while consumption rises and, with it, welfare. Largest gains in welfare when subsidy cuts fund additional infrastructure investment.
Griffin, Laursen, and Robertson 2016	Electricity, crude oil, natural gas, gasoline, diesel, fuel oil	Egypt, Arab Rep.	*Author-developed dynamic CGE model* In the short run, reforms lead to slightly lower consumption, strong investment, and a shift from energy to other sectors (construction). Impact on consumer prices is limited, and offsetting policies for the poor would not result in a large impact on the potential gains from reform. In the long run, GDP increases about 1 percentage point relative to baseline.
Jewell et al. 2018	Oil, gas, coal	Global	*CGE model* Simulated removal of fossil fuel subsidies. Resulted in only a small decrease in global energy demand and fall in CO_2 emissions. In some regions, emissions increase either because coal replaces oil, or natural gas use shifts from subsidizing, energy-exporting regions to nonsubsidizing, import regions. Only small effect on renewables by 2030.
Li, Shi, and Su 2017	Petroleum products, natural gas	Malaysia	*Author-developed model* Removing fossil fuel subsidy would reduce budget deficit, but households would be worse off. Compensation policy could protect lowest-income group without harm to the economy. Carbon emissions are reduced in a range of 2–6 percent in the various scenarios.

Authors	Energy sources	Countries	Model type Findings
Monasterolo and Raberto 2019	Fossil fuels, electricity, renewables	High income	*EIRIN model*
			Gradual phaseout of fossil fuel subsidies can, in a higher-income country, improve macroeconomic performance, decrease inequality, and open up fiscal space to support renewable energy policies.
Siddig et al. 2015	Petroleum products	Nigeria	*GTAP model*
			Simulated removal of subsidy on imported petroleum products. An increase in GDP would result, but there would be a detrimental effect on household income, especially for poor households. Targeted income transfers could alleviate the problem.
Timilsina et al. 2018	Electricity, natural gas	Bangladesh	*Author-developed CGE model*
			Simulated removal of electricity subsidies in power (and indirect subsidies to natural gas). GDP would increase as a result, but magnitude depends on how budgetary savings are spent. Funding investment helps most, followed by cuts in income tax. Compensating households through lump-sum transfers would be inferior to these other options but is superior from a distributional perspective.
Wang et al. 2016	Electricity	Abu Dhabi	*Modified Lofgren CGE model*
			Simulated power subsidy reduction in Abu Dhabi. Shows that GDP increases through expansion of high-value-added service sector, and emissions decrease through reduction of carbon-intensive industry and utility output. Private consumption declines with real wages.
Wesseh, Lin, and Atsagli 2016	Gasoline, diesel, kerosene fuel oil, LPG	Ghana	*GTAP model*
			Simulates removal of subsidies on oil products while ensuring all government revenue is spent. CO_2 emissions increase; there is an overall improvement in environmental quality; and welfare declines.
Yusoff and Bekhet 2016	Crude oil, natural gas, petroleum products, electricity	Malaysia	*Modified Lofgren CGE model*
			Simulates removal of fossil fuel subsidies and tax subsidies and shows that target energy savings of master plan can be achieved. Noted that there are tradeoffs with growth and socioeconomic and environmental effects, and that subsidy removal may be more beneficial for the rich than for the poor.

Source: Author's compilation.
Note: CGE = computable general equilibrium; CO_2 = carbon dioxide; GDP = gross domestic product; GTAP = Global Trade Analysis Project; CES-XPS = Inter-temporal Computable Equilibrium System–Extending the Public Sector; IFPRI = International Food Policy Research Institute; LAC = Latin America and the Caribbean; LPG = liquefied petroleum gas; PEP = Partnership for Economic Policy; Q1 = bottom income quintile; Q5 = top income quintile.
a. Some authors use the term petrol or petroleum for gasoline, and gasoil for diesel.

Appendix C. Summary of Studies in the Follow-up Review (2020–21)

TABLE C.1

Studies on Energy Subsidies Published in 2020–21

Authors	Country studied, time period, focus	Study focus	Findings
Aldubayan and Gasim 2021	Saudi Arabia, 1985–2018, Gasoline prices	Econometrics of gasoline price impact on demand.	Valued environmental impacts of reducing gasoline subsidy.
Atamanov, Dehzooei, and Wai-Poi 2020	Iran, Islamic Rep., 2019–20, Gasoline prices	Between-deciles effect of reducing gasoline subsidy (using an assumed price elasticity of demand).	Appears similar to earlier World Bank work on Iran; valuable for updating the magnitude of the problem.
Bah and Saari 2020	Saudi Arabia, 2013, Fuel taxes	Attempts to quantify the impacts on households of a reduction in energy subsidies and hence an increase in energy prices on the cost-of-living budget based on 2013 survey.	Standard input-output model. Estimates direct and indirect effects. Useful again for Saudi Arabia, but not as an addition to general subsidy analysis.
Balarama et al. 2020	Bangladesh, 2017, Electricity prices	Uses nonlinear structure of electricity prices to estimate price elasticity from cross-section data.	New and interesting method of estimating demand response to change in structure of prices.
Chen, Huang, and Mirzabaev 2022	China, 2014, Price of commercial energy and consumption of traditional biomass for fuel	Builds a large theoretical model of agricultural household behavior to trace impacts of subsidies to clean fuels reducing consumption of biomass.	Predictions of model are tested with household data for 2014. Main interest is around new model; this would need very substantial and technical knowledge to evaluate fully.
Fathi and Bakhshoodeh 2021	Iran, Islamic Rep., 2015, Impact of energy subsidies on meat market	Based on integrated supply and demand framework, uses simple econometrics to evaluate government policies toward sector.	Narrow scope by concentrating on meat, but useful in that it models effect on supply sector.
Guénette 2020	Global, Current, Impacts and implementation problems of imposing price controls	Topic is only indirectly related to subsidies.	No relevance to issues of subsidy removal.
Guilano et al. 2020	Argentina, 2016–19, Distributional impact of reduced energy subsidy	Impacts related to possession of various household factors with decile dummy effect; regression model estimated from cross-section.	No new approaches, but insights for students of Argentina.
Huenteler et al. 2020	15 countries, 1987–2011/16, Relating power sector cost recovery to change in policies (such as subsidies)	Based on measurement of the quasi-fiscal deficit (hidden cost), the change in cost recovery is related to policies.	Valuable study extending analysis of cost recovery to policies using the experience of 15 countries. Limited contribution to subsidy analysis.
Ilyas et al. 2022	Pakistan, 2015–16, Distributional effects of phasing out power subsidies	Evaluates direct and indirect impact of electricity price increase using standard input-output.	Standard approach; valuable within Pakistan, but nothing new otherwise.
Lin and Kuang 2020	China, 2012, Effects of energy subsidy removal on various household groups (heterogeneity)	Calculates direct and indirect effects (allowing for different behavior as income varies) via standard input-output model.	No new approaches. More recent data for China may be available.

Authors	Country studied, time period, focus	Study focus	Findings
Natalini, Bravo, and Newman 2020	Global, 2005–16, Links existence of fuel "riots" to energy prices	Assembles new data on fuel riots worldwide and relates this data to a few variables, including energy prices, via regression.	A new topic but perhaps of limited interest. Argues that subsidy removal would increase the probability of riots.
Poudineh, Sen, and Fattouh 2020	Resource-rich Middle East and North Africa region countries, Current, Extension of standard energy sector reform model	Argues that reform needs to take account of links between sectors and allow for possible gains in efficiency.	Description of policy, no testing of theory. Does not have primary focus for work on subsidies, although there is a link. Interesting to link to the World Bank's work (Foster and Rana 2020) on sector reform.
Pu et al. 2020	China, 2018, Cross-subsidies between different classes of electricity use	Defines a "reasonable" cross-subsidy and how to calculate the theoretical value of this concept; compares with actual cross-subsidies.	An underresearched topic. Appears to make an important contribution. Most relevant to large economies with a wide range of power users.
Rana and Khanna 2020	Egypt, Arab Rep., Historical survey	Follows common approach of the 15 countries selected; standard material on magnitude of subsidies.	An important case to complement others in the series but main emphasis is on sector reform.
Rentschler and Hosoe 2022	Nigeria, 2011 data as reference year, A CGE model that integrates tax evasion and smuggling	A path-breaking study on a topic scarcely referred to in the literature.	Oil sector policies can be evaluated in view of links to illicit activities. Two questions arise: how good are data, given that, by nature it is unobservable? Do other economies suggest similar effects?
Shehabi 2020	Kuwait, 2013, A CGE model of effects on export diversification as a result of oil subsidy reform	For oil producers this is an important topic, and this CGE model is a good starting point.	Sector disaggregation is important if we are to pinpoint export diversification. This study treats exports as a single good, suggesting the need for further work on this topic.
Taiebnia and Barkhordari 2022	Iran, Islamic Rep., Historical exercise in explaining shifts in behavior	No modeling involved and only simple data series are used to describe the changes to reform program.	Topic very limited because of Iran's unique structure for economic decision-making.
Timilsina and Pargal 2020	Bangladesh, 2012, A CGE approach to evaluating subsidy reform	An extension of other work with parallel focus.	Part of a general move to a standard model to evaluate subsidy reduction (going beyond the simple sector models referred to in this paper).
Tsai and Mezher 2020	Gulf Cooperation Council, Evaluation of impacts of differences between members on energy reform	A largely descriptive account linked to institutional explanatory factors	Some general interest from parallel institutional analysis on other countries, but strong results unlikely.
Wang et al. 2021	China, 2017, Difference-in-differences model used to evaluate impact of change in subsidies at a city level; testing for heterogeneity included	An unusual approach to measuring "effects" of policy shift.	Interest in this study is in the value of this method of estimation of "effects."
Yau and Chen 2021	Taiwan, China, 1989–2012, CGE model with dynamic responses built in; used to evaluate different subsidy reduction schemes	Traces consumer and industrial pass-through of higher energy prices.	Interest focuses on the convergence of CGE approaches and value of extensions.

Source: Author's compilation.
Note: CGE = computable general equilibrium.

Apart from geographical concentration and topic, it is useful to categorize studies by their approach, as presented in table C.2.

TABLE C.2

Approaches of the 2020–21 Studies

Price impact models		New approach	Institutional-centered approach	Sector reform focus
CGE approach	Direct and indirect price-shifting approach			
Studies 17, 19, 22	Studies 1, 2, 3, 6, 8, 10, 11	Studies 4, 5, 12, 14, 16, 21	Studies 7, 18	Studies 9, 13, 15, 20

Source: Author's compilation.
Note: CGE = computable general equilibrium.

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