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Rebalancing subsidies in market-based energy sectors: Synergies and obstacles in developing and transition economies

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ADB Working Paper Series

**REBALANCING SUBSIDIES IN
MARKET-BASED ENERGY SECTORS:
SYNERGIES AND OBSTACLES IN
DEVELOPING AND TRANSITION ECONOMIES**

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Abstract

Governments have faced increasing pressure for energy policy to converge around efficiency, sustainability, affordability, and access in recent years. However, separate “silos” rather than an integrated policy framework have addressed these objectives, widening the policy trade-offs. The emergence of market-based reforms and renewable energy technologies has created potential synergies to achieve the objectives. In this paper, we develop a simple analytical framework based on economic efficiency and welfare arguments for the purposeful reallocation of subsidies from fossil fuels to renewable energy. The need to remove poorly targeted fossil fuel subsidies, which generate greater environmental costs, also facilitates this reallocation. Our focus is on utilizing the synergies between market-based reforms and renewables as the electricity sector lies at the confluence of these multiple objectives. We illustrate our framework using experiences from four emerging economies, drawing lessons for policy makers pursuing supply diversification through renewables.

Keywords: electricity reform, renewables, emerging economies, subsidies

JEL Classifications: Q41, Q42, Q48, D61

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1. INTRODUCTION

In recent years, governments have focused increasingly on shaping energy policy around the objectives of improving the efficiency of energy use, achieving equity in energy consumption across households, and securing sustainability in energy supply (Chang and Fang 2017). They have largely addressed these objectives in separate “silos” rather than within an integrated policy framework. Nevertheless, these objectives have direct and indirect links through pricing and, by extension, through subsidy policies. Despite the debates about the measurement of subsidies (Kojima and Koplou 2015), there is a consensus that energy subsidies, particularly subsidies for the prices of fossil fuels, limit the efficiency of energy markets by distorting the resource allocation and causing negative environmental externalities, for instance through inefficient consumption (McKittrick 2017).

The resolution of the “trilemma” of energy policy objectives (efficiency, equity, and sustainability) has risen to the top of policy agendas in the recent context of climate change mitigation through the development and deployment of renewable energy. In most developed countries, renewables have received subsidies of some kind to scale up their penetration, the costs (also referred to as the “policy cost”) of which have either fallen on government budgets or increased consumer bills (Robinson 2020). However, for developing countries that already subsidize fossil fuels for a large proportion of their populations, these options are difficult to implement; firstly, the subsidization of renewable energy adds an additional layer of fiscal costs to already-pressured budgets; and, secondly, they severely constrain consumers’ ability to pay for energy.

In 2014, the International Energy Agency (IEA) estimated global fossil fuel subsidies to be \$548 billion and renewable subsidies to be \$121 billion, supporting a reallocation of subsidies toward renewables.¹ However, by 2019, the estimate of global fossil fuel subsidies was \$372 billion, although this was partially a result of lower international oil and gas prices (Bridle et al. 2019). In contrast, renewables received \$100 billion. Coady et al. (2015) argued that, if global fossil fuel subsidy calculations were also to reflect the negative environmental externalities of higher energy consumption, they would amount to \$5.3 trillion or 6.5% of global GDP. This implies that, apart from the fiscal costs of fossil fuel subsidies, significant adverse effects on *economic welfare* are associated with subsidies. Further, Bridle et al. (2019) argued that, while fossil fuel subsidies have declined and investments in renewables’ electricity generation capacity have exceeded those in fossil fuel generation capacity (coal, oil, and gas) every year since 2008, fossil fuels still meet the majority of the energy demand growth (70% in developing countries), implying that governments need to act further if they aim to bring about a rapid transition to renewable energy.

In this paper, we propose a simple, policy-relevant economic framework based on the welfare arguments for the reallocation of subsidies from fossil fuels to renewable energy. We accomplish this through the lens of the electricity sector, which lies at the confluence of the efficiency, equity, and sustainability objectives, and estimates have shown that it accounts for a third of direct pre-tax global energy subsidies (International Monetary Fund (IMF) 2013). We illustrate this framework using four developing and transition economies (Nicaragua, South Africa, India, and the People’s Republic of China [PRC]), representing distinct institutional contexts in which fossil fuel subsidies have been environmentally harmful, fiscally draining, and socially inequitable (Nepal

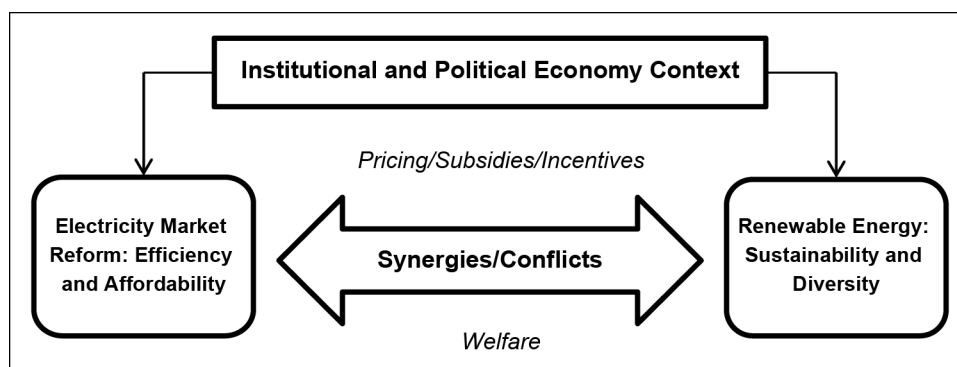
¹ The IEA (2014) defined an energy subsidy as “any government action directed primarily at the energy sector that lowers the cost of production, raises the price received by producers, or lowers the price paid by end-users. It can be applied to fossil and non-fossil energy in the same way.”

and Jamasb 2016). Our framework is in line with policy arguments for so-called “subsidy swaps,” which advocate bringing subsidy policy in line with social, economic, and environmental priorities and promote a transition to clean energy systems (Bridle et al. 2019).

Figure 1 shows that liberalized markets for conventional (fossil fuel) and renewable electricity are linked through pricing signals and economic incentives. As we argue later in this paper, while a key *conflict* between the two relates to pricing and subsidies and by extension to incentives for investment,² a key *synergy* relates to their impact on social welfare for consumers in either market. Policy measures to reconcile the two should therefore focus on the maximization of overall social welfare. Further, in emerging economies, subtle and visible political economy factors and the institutional context within which they operate strongly influence both conventional and renewable sources, albeit in different ways.³

The main research questions that this paper explores are the following. What are the synergies and conflicts between the adoption of renewables and electricity market reforms in these economies? Can renewables be part of an integrated approach and solution to energy affordability, access, diversification, and sustainability in emerging economies?

Figure 1: Synergies and Conflicts between Electricity Market Reform and the Adoption of Renewable Energy



Source: The authors.

The remainder of the paper proceeds as follows. Section 2 develops, in three progressive steps, an analytical framework to explore the economic link between renewable and fossil fuel subsidies through the lens of the electricity sector as the main channel through which the energy sector introduces and scales up renewables. It achieves this first by reviewing evidence on the welfare impacts of renewable and fossil fuel subsidies; second by introducing the context of electricity markets and efficiency outcomes in relation to the integration of renewables; and third by describing a simple analytical framework based on existing microeconomic theory to show the welfare gains from the reallocation of subsidies from fossil fuels to renewables. Section 3 utilizes a comparative review of energy subsidy reforms in four developing economies at different stages of the transition to renewables in the context of the framework, making observations on whether the reform policies have resulted in increased welfare through reallocation, either by mitigating the “misallocation effect” or

² See International Institute for Sustainable Development (IISD) (2014).

³ An example is the failure to implement cost-reflective pricing following market reforms.

by enabling the “output effect,” which we discuss in Section 2. Section 4 summarizes the policy implications. Finally, Section 5 presents the conclusions and offers policy recommendations.

2. ELECTRICITY SECTOR REFORM, SUBSIDIES, AND RENEWABLES

2.1 Allocation and Redistribution Effects

Energy subsidies⁴ have come under criticism regarding their efficiency as an instrument for income redistribution, poverty alleviation, and the maximization of social welfare in countries that are large energy importers/consumers. The Organisation for Economic Co-operation and Development (OECD) (2010) identified various channels for the provision of explicit and implicit subsidies: the direct transfer of funds (e.g., grants, loans, and equity infusion), including contingent direct transfers of liabilities (e.g. loan guarantees); government revenue foregone (e.g., fiscal incentives including tax credits); and government-provided goods or services other than general infrastructure. However, subsidies that producers and consumers receive through the pricing system are arguably the most widespread in emerging economies (Nepal and Jamasb 2016).

Consumer subsidies (which net energy-importing economies commonly define as the difference between consumer prices and international prices)⁵ are arguably less efficient than producer subsidies (the difference between the cost of production and the price that the producer receives) as the former are *poorly targeted* given their much wider scope. Consumer subsidies tend to benefit high-income households disproportionately. The IMF (2013) found that the richest 20% of households in low- and middle-income countries, rather than the intended poor, received 43% of total fossil fuel subsidies. A substantial literature and evidence support this argument:

- In India, the richest 10% of households received seven times the benefit from fuel subsidies that the poorest 20% received (Anand et al. 2013).
- In the PRC, the poorest 22% of the population received 10% of electricity subsidies relative to the richest 27%, which received 45% (Lin et al. 2009, 2011).
- In Ghana, the wealthiest quintile received 78% of the benefits from fuel subsidies, whereas the poorest quintile received 3% (Cooke et al. 2014).
- Similar evidence exists for other countries, including Thailand (IISD 2013), Viet Nam (IISD 2013), and the Seychelles (Alleyne and Hussain 2013).

Another argument against subsidies as distributive instruments is their *distortionary impact on the pricing systems* of emerging economies and the ensuing fiscal cost. State-owned utilities cannot (largely for political reasons; Victor 2009) charge cost-reflective tariffs, citing the need for subsidized provision of electricity for the poor.

⁴ “Energy subsidies” refers to fossil fuel subsidies except when specifying renewables.

⁵ For internationally traded commodities, a suggested benchmark is the international market price adjusted for transportation and distribution costs. In the absence of an international price, a suggested benchmark is the cost recovery price including a normal return on capital.

Consequently, utilities incur heavy losses, constraining investment⁶ and thus defeating the purpose of expanding access. In India, the annual losses of electricity distributors in 2011 amounted to \$8 billion or 1% of the GDP (Pargal and Ghosh-Banerjee 2014). In Pakistan, the size of “circular debt” increased from \$1 billion in 2006 to \$9 billion in 2012 (Kessides 2013). In sub-Saharan Africa (Angola, Malawi, South Africa, Zambia, and Zimbabwe), despite highly subsidized retail tariffs, the average tariff is double that in other developing-world regions (Eberhard et al. 2011).⁷

The pricing distortions have become entrenched in emerging economies, creating *strong vested interests* and a sense of entitlement among beneficiaries (Nepal and Jamasb 2016). *Institutional contexts* play a central role in the perpetuation (or elimination) of subsidies (Nepal and Jamasb 2012a, 2012b). Notably, much of the resistance to subsidy reforms emanates from the higher-income groups that benefit the most from them (Nepal and Jamasb 2016). “Price gap” comparisons often understate the amount of consumer subsidies due to leakages (theft and bill collection) and similarly producer subsidies (due to the loss of economic value from diverting resources from productive to less productive investment) (Nepal and Jamasb 2016). This has resulted in the *opportunity cost* argument on the inefficiency of subsidies. The IMF (2011) estimated that, of \$480 billion of global direct energy subsidies, coal received the lowest proportion (1%), despite constituting the second-largest (30%)⁸ global primary energy user by fuel.⁹ This reflects the insufficient internalization of *environmental externalities* from coal combustion, amounting to an implicit subsidy.

Following from this is the argument that consumer (and, to some extent, producer)¹⁰ fossil fuel subsidies have historically reduced the efficiency of energy use, increasing greenhouse gas emissions and worsening air quality, thereby increasing the costs of (negative) *environmental externalities* (Pershing and Mackenzie 2004). This intuitively supports a reallocation of fossil fuel subsidies to renewables. Whilst consumer subsidies for renewables do not carry the negative environmental externalities associated with fossil fuels, they are susceptible to similar redistributive inefficiencies in developing/emerging economies. Further, positive externalities (e.g., emission reductions) demonstrate long-term gains whilst redistributive inefficiencies and their impacts on social welfare are visible in the short term. In some developing countries, estimations of the value of local air pollution’s externalities have been lower than those of the externalities of higher-priced fossil fuels. Zhang et al. (2007) found that the externalities from SO₂, NO_x, and particulates in the PRC were substantially smaller than the externality of pricing CO₂ at US\$50/tonne.¹¹

Conversely, renewable subsidies can target poorer rural consumers more effectively through the use of decentralized systems; however, this depends on the effectiveness of the enabling institutions in differing country contexts (Urmee, Harries, and Schlepfer 2009). Decentralized systems do not automatically improve livelihoods through income-generating activities, implying that subsidies for renewables may yield limited returns

⁶ This relates to “circular debt,” wherein the lack of cost-reflective pricing among distribution utilities leads to delays in payments to generators.

⁷ This is partly due to investment constraints and partly due to small-scale high-cost electricity systems and fuel price fluctuations.

⁸ BP (2015). The largest proportion is oil (33%), then coal, natural gas (24%), hydro (7%), nuclear (4%), and renewables (2%).

⁹ Coal forms the largest absolute share of the total primary energy consumption in Asia, which estimations have also shown to contain the highest concentration of people living below the poverty line.

¹⁰ Producers may arguably be less prone to inefficiency assuming their incentive to minimize costs.

¹¹ Note that this does not undermine the case for renewables per se but questions the effectiveness of subsidies as an efficient instrument for facilitating renewables.

(e.g., Mala, Schlepfer, and Pryor 2009) provided evidence supporting this from decentralized solar installations in remote atoll communities in Kiribati).

The empirical literature has thus presented mixed arguments on the welfare impacts of subsidies for fossil fuel and renewables measured using separate metrics (such as the price gap, opportunity cost, and externalities approaches). In the sections below, we attempt to present these in a coherent economic framework.

2.2 Electricity Market Reform, Efficiency, and Renewables

A significant body of the economic literature postulates electricity market reforms as a solution to the problems associated with electricity provision in developing countries.¹² Previously, governments used regulated public monopoly for income redistribution and universal service goals. However, this often resulted in regulatory capture from political interest groups (Victor and Heller 2007). Technological progress allowed more competition in the electricity market by facilitating the unbundling of the sector and reducing the minimum efficient scale of generation (Steiner 2000; Sen and Jamasb 2012; Jamasb, Nepal, and Timilsina 2017; Sen, Nepal, and Jamasb 2018). Moreover, markets have regarded competition as being more effective in improving efficiency than regulation (Newbery 1996). Armstrong and Sappington (2006) stated that the gains from competition are largest when the industry scale economies are small in relation to the demand; the regulator does not have sufficient information, resources, and instruments; the regulator has limited power to commit; and subsidies are possible through other means than distortions in supplier prices (Sen, Nepal, and Jamasb 2018).

In the 1990s, developing/emerging economies adopted the transition to liberalized markets that the “OECD model” propagated, consisting of: independent power producers in generation; the corporatization and commercialization of state-owned utilities; independent regulation; the unbundling of competitive activities, that is, generation and retail, from natural monopolies’ activities, that is, transmission and distribution networks; and the privatization of generation and retail. Not all elements of electricity reforms are prevalent, even in countries with fully liberalized markets (Sen 2014). Privatization is not inherently necessary for competition. For example, Norway introduced competition under state and municipal ownership (Sen, Nepal, and Jamasb 2018). Some instruments, such as the auctioning of franchises, could increase the competition in the market when “full” competition is not viable (Sen, Nepal, and Jamasb 2018).

Most emerging economies set pre-reform prices below costs to subsidize poor consumers (i.e. the average costs were below the marginal costs). It is possible to view the removal of subsidies as having the same effect as a tax. Liberalization requires prices to rise above costs initially, potentially leaving poorer consumers worse off (Sen, Nepal, and Jamasb 2018). However, liberalization could be welfare enhancing in combination with direct transfers to consumers who become worse-off consumers (Armstrong and Sappington 2006). The literature has shown that reform policies need to take into account the context in which countries implement them (Sen, Nepal, and Jamasb 2018). This includes:

- Institutional capacity (Gratwick and Eberhard 2008);
- Initial resource endowments (Weinmann and Bunn 2005);

¹² See Sen et al. (2018).

- The size of the electricity systems (Nepal and Jamasb 2012b); and
- The interaction of political economy with sector reform (Victor and Heller 2007).

Liberalized wholesale energy-only electricity markets set the system price as the short-run marginal cost of the most expensive plant dispatched (Sen 2014).¹³ Generators will compete on the basis of their costs, and those with lower short-run marginal costs than the system marginal cost will gain (Sen 2014). Market price signals transmit the incentives for new investments in generation capacity. The price sensitivity of the demand for an additional MWh attenuates spikes in energy prices resulting from plant scarcity (Keay, Rhys, and Robinson 2013a, 2013b; Sen 2014; Sen and Jamasb 2013).

In contrast, renewables have high capital costs but a very low marginal cost of operation (i.e., in a liberalized market, $P = SRMC = 0$). The renewable energy supply is generally intermittent. While, during periods of abundance, the supply (e.g. wind) can meet the demand, in the absence of storage, intermittency requires some “backup” capacity that can quickly adjust to the demand. This backup capacity normally comes from fossil fuels (Sen 2014).

In order to encourage investments in renewables, governments offer feed-in tariffs (FiTs) or other subsidies. These instruments can, however, affect the competitive price setting in the market in the short run and the motivation for investments in the long run. Further, the intermittency of renewables implies that market prices will either equal zero marginal costs (during periods of abundant supply) or reach high levels when the supply is insufficient to allow backup generators to recover their capital costs (Keay, Rhys, and Robinson 2013a, 2013b; Sen 2014). This implies shorter periods with zero or low prices and longer periods with high prices (Keay, Rhys, and Robinson 2013a, 2013b).

It is difficult to justify market price volatility to low-income consumers as the promotion of electricity reforms occurred on the basis of the benefits of competitive prices (Sen 2014).¹⁴ More importantly, if countries integrate renewable sources without extra-market payments and subsidies, they will not be able to recover their fixed costs because, when these plants run, the market prices will be low or zero (e.g., Robinson 2013).

2.3 Subsidy Reform—A One-Sector, Two-Market Framework

The conflicts between reforming electricity and increasing the share of renewables with a view to diversification are apparent, as are the benefits. Reforms aim to provide efficient price signals for investment and incentives to compete on marginal costs. Renewables, if scaled up, can improve sustainability and supply diversification. These differing characteristics imply that a policy maker has the incentive to discriminate on price between a fossil fuel-based electricity market and a market for renewable electricity. Countries widely subsidize conventional electricity, but this is also a source of substantial negative externalities; consequently, goods and services that generate negative externalities are overproduced in the economy.

¹³ See Keay (2009); Keay, Rhys, and Robinson (2013a, 2013b); Rhys (2013); Robinson (2013); and Buchan and Keay (2014) for more details.

¹⁴ Note that competitive prices do not necessarily equate to lower prices if, as in many emerging economies, the prices at the outset are below the costs. However, the broad expectation was that privatization and restructuring would improve operational efficiencies and market competition would pass the gains on to consumers.

Renewables, on the other hand, generate relative positive externalities (e.g. environmental and security of supply impacts) but are underproduced.¹⁵ As the marginal cost of externalities *increases*, subsidizing conventional (fossil fuel) electricity compounds the environmental costs and welfare loss. A strong policy argument is therefore for the reallocation of subsidies from conventional (fossil fuel) to renewable electricity markets *to increase the overall social welfare*.¹⁶

Figure 2 elaborates the interplay between the systems for conventional (fossil fuel) power and renewables within a simple framework based on the welfare effects of price alteration—we applied the arguments of Aguirre (2012). In this framework, a producer can charge consumers different prices for a homogeneous product (e.g. electrons) in different sub-markets.¹⁷ Price alteration causes a misallocation of goods (it does not distribute the output efficiently to the highest-value end) and affects the total output. Since price alteration is an inefficient way of distributing a given quantity of output between different consumers or markets, a necessary condition for it to increase social welfare is that it should increase the total output—that is, the positive output effect should offset the negative effect of distributional inefficiency (Aguirre 2012).

We based our simple analytical framework, which Figure 2 presents, on the following assumptions:¹⁸

- Market 1 represents a conventional market for electricity from fossil fuels. Market 2 represents a market for renewable electricity. As conventional electricity is entrenched in developing economies,¹⁹ we characterized it as the lower price elasticity market. Conversely, as renewables have not gained an equivalent “anchor” consumer base in these economies, we characterized this market as the higher price elasticity market (relative to the conventional market). Higher price elasticity in the renewable market can, for instance, be the result of renewable obligation policies.
- Non-linear demand (curvatures) in both markets, as an output increase is necessary to increase social welfare (the total output will remain constant if the demand is linear).²⁰
- The social valuation of an increase in output (consumer surplus) in Market 2 exceeds the marginal social cost.
- We do not incorporate the impact of negative externalities arising from fossil fuel consumption in our analytical framework.

¹⁵ The literature on net externalities from renewables is mixed. Some studies have argued that renewable energy generates positive externalities (Cedrick and Long 2017), and others have posited that renewable energy leads to negative externalities, either from the supply chain or due to ambient effects (Droes and Koster 2014; Krekel and Zerrahn 2017).

¹⁶ An alternative is to impose a tax and utilize the revenues collected to finance clean energy through the government budget; however, in the short run, this decreases the welfare of poorer consumers who have low price elasticity of demand for fossil-fuel electricity.

¹⁷ For instance, differing by geography, time of purchase, or end use (Aguirre 2012).

¹⁸ Based on Ippolito (1980), Schmalensee (1981), and Aguirre (2012).

¹⁹ Due to widespread availability and the low price elasticity of demand from low-income consumers.

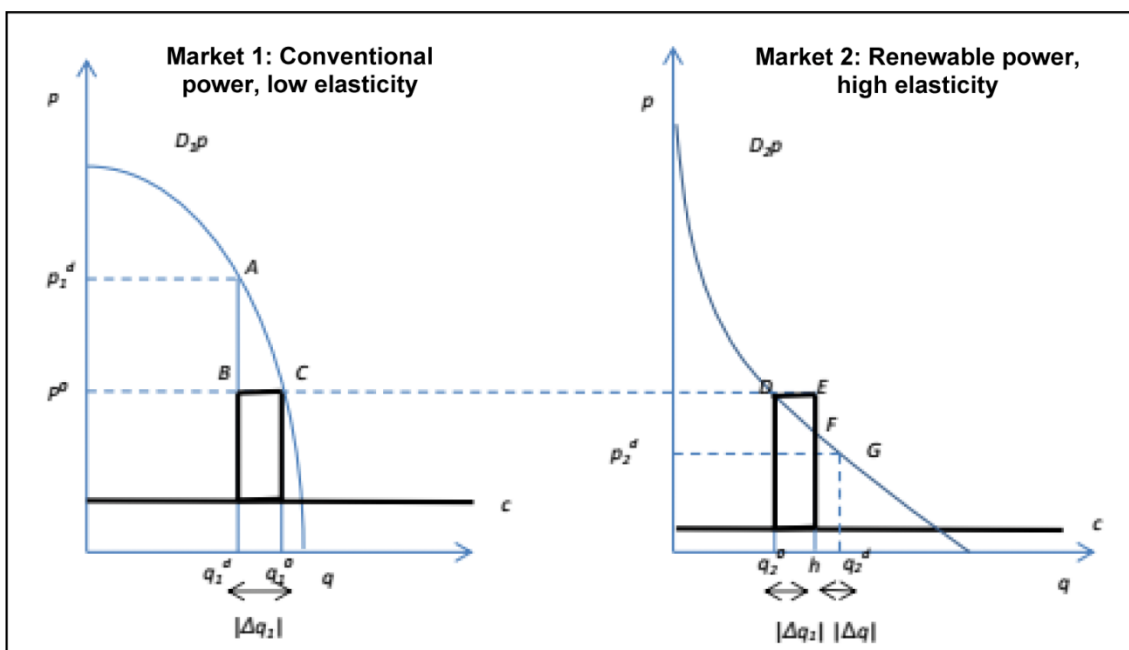
²⁰ If the demand in the low-elasticity market is strictly concave (strictly convex) and the demand in the higher-elasticity market is strictly convex (strictly concave), then the total output increases (decreases) with price discrimination (when all the demands are linear, the output remains unchanged) (Aguirre 2012).

Under a subsidy reallocation argument, a decision maker overseeing the sector would, in our framework, want to reduce the subsidies and increase the price in Market 1 (to p_1^d) and reduce the price in Market 2 (to p_2^d). A price increase removes the subsidy and thus the overproduction of fossil fuel-based electricity in Market 1. Consequently, the reallocation of the subsidy decreases the price in Market 2 as the output decreases in Market 1 and increases in Market 2. It is possible to show the effect on social welfare as the sum of two effects: a misallocation effect and an output effect (Aguirre 2012):

$$\Delta W = ME + OE \tag{1}$$

The misallocation effect results from the market not allocating output to its highest-value use (area $ABC + DEF$). ABC is the reduction in surplus in Market 1, whereas DEF is the misallocation effect or deadweight loss in Market 2. The output effect (OE or the effect of additional output on social welfare) is the incremental output gain from the lower price in Market 2.

Figure 2: Analytical Framework—Graphical Representation



Source: The authors; adapted from Aguirre (2012).

We assume that $\Delta q \geq 0$ and, since the change in the total output is:

$$\Delta q = \Delta q_1 + \Delta q_2 \tag{2}$$

the change in the output in Market 2 is:

$$\Delta q_2 = \Delta q - \Delta q_1 = \Delta q + |\Delta q_1| \geq 0 \tag{3}$$

As ME is always non-positive, OE should be positive for the overall social welfare to increase (Aguirre 2012).

We identified the output effect as $Fhq_2^d G$.²¹ We assumed that the long-run cost c is constant but higher in the conventional power market and lower in the renewable power market. The price in Market 1 cannot fall below c as it is necessary to cover the marginal costs. A lower c (or indeed a negligible c as renewables have very low or zero marginal costs) in Market 2 implies that the positive impact on social welfare (the total surplus) from price discrimination (or the reallocation of subsidies) is greater in Market 2 (renewables) than the negative welfare impact (reduction in surplus) of subsidy removal in Market 1.

In cases in which price discrimination serves to *open new markets* (e.g. if Market 2 only receives a service under price discrimination), $p_1^d = p^0 > p_2^d$ and therefore $\Delta q_1 = 0$ and $\Delta q_2 = q_2^d > 0$. In this case, price discrimination not only increases the social welfare but also implies a Pareto improvement as the misallocation effect will be zero and the output effect will be positive because the total output will increase (Aguirre 2012).²²

Market 1 closely represents the conditions in developing economies; the use of fossil fuel electricity is entrenched, and governments rely on it as a means of cheap electrification. With low per capita incomes, income elasticity is higher than price elasticity, and a rise in prices is unlikely to induce a proportionate fall in demand. Further, poorer households spend a larger proportion of their budgets on energy and are likely to suffer the largest impact from a price increase (Nepal and Jamasb 2016). Where a subsidy is available for an extended period, its removal is equivalent to imposing a tax on an entitlement and causes a welfare loss (Nepal and Jamasb 2016).²³

An important implication from our economic framework is that a policy that focuses on resolving the “trilemma” of efficiency, equity, and sustainability through renewables, aiming to maximize social welfare, should comprise instruments that in the short run mitigate the welfare reduction or misallocation effect in Market 1 (fossil fuels) or alternatively promote an expansion of the total output in Market 2 (renewables). While the mitigation of welfare reduction in the low-elasticity market is desirable in the short run, the expansion of the incremental output in the high-elasticity market (and therefore of the total output) is desirable as a long-run objective (e.g. arguably, the lack of alternatives to conventional fossil fuel electricity reduces consumers’ price elasticity of demand for it—therefore, increasing renewables’ output mitigates the welfare loss of consumers in Market 1).

²¹ In terms of surplus, this would exclude the cost c .

²² It is notable that the limitation of our framework is that it is a partial equilibrium approach, but it serves to illustrate a specific problem that a policy maker in a developing economy faces.

²³ Arze Del Granado et al. (2012) estimated that, on average, a \$0.25 per liter decrease in fossil fuel prices results in a 5% decrease in income in a sample of developing countries, where the top income quintile typically captures six times more in subsidies than the bottom quintile in absolute terms. The estimate for the average welfare impact of a \$0.25 increase was the highest for the Middle East and Central Asia, followed by Africa, Asia and the Pacific, and South and Central America. Nepal and Jamasb (2016) reviewed the negative welfare consequences of subsidy removal for low-income consumer groups in developing economies.

3. COUNTRY CASE STUDIES—SELECTED DEVELOPING AND TRANSITION ECONOMIES

The motivations for subsidy reforms are varied, and governments of emerging economies have adopted various instruments for economic, regulatory, and policy support in their power sectors, reflecting aspects of our framework (Commander 2012). India, the PRC, and Nigeria redirected revenues from higher prices (or reduced subsidies) toward social safety net programs targeting the poor; this is, in effect, a means of mitigating the misallocation effect.²⁴

The reinvestment of revenues (savings) in general infrastructure has, however, been less effective due to poor targeting.²⁵ However, the success of measures such as direct cash transfers is dependent on effective institutions and communication with the public (IMF 2013).²⁶ Similarly, governments have utilized various instruments in attempts to open or scale up the market for renewables (output effect), including subsidies (through FiTs, feed-in premiums, and production tax credits) and fiscal incentives for investors (investment credits and tax holidays) (Poudineh et al. 2018).

We examined a diverse set of four developing and transition country experiences to illustrate our analytical framework, which we chose to reflect the heterogeneity of institutions, political economy, system size, and resource endowments of these countries. Table 1 summarizes our four country experiences alongside the measures for characterizing the heterogeneity among them. We used (i) the Transparency (Corruption Perceptions) Index as a proxy for the strength of institutions, (ii) the total installed generation capacity for the system size, (iii) the Freedom House index for the dynamism of the political processes, and (iv) the share of coal in primary energy reserves for resource endowments.

The selected countries represent different world regions experiencing “waves” of reforms.²⁷ India and the PRC represent the world’s largest emerging economies and net energy consumers, with a primary energy demand from 2013 to 2040 that is likely to increase by 33% and 146%, respectively (IEA 2015).

The four selected countries have all implemented varying levels of energy subsidy reforms. The IMF (2015) estimated comparative energy subsidies by product on a per capita basis for the four countries over the period 2013–15 (Table 2). The PRC accounted for the largest absolute per capita share and percentage of GDP, with coal accounting for the most (which increased from 2013–15) and then petroleum. In contrast, the energy subsidies of Nicaragua accounted for the smallest share of the GDP, which it allocated to petroleum and electricity. Notably, the total subsidies in Nicaragua remained largely constant between 2013 and 2015, implying a *reallocation* rather than an absolute increase. India exhibited a similar trend (with coal and then petroleum accounting for the largest shares), while the subsidies in South Africa, which it allocated mainly to coal, increased.

²⁴ See Liu et al. (2011) and Siddig et al. (2014).

²⁵ Yemen (Breisinger et al. 2011) and the PRC (Lin and Ouyang 2014).

²⁶ Programs in Nigeria and Bolivia failed due to these factors, whereas they succeeded in Ghana and Indonesia.

²⁷ Latin America experienced the earliest “wave,” followed by South and Southeast Asia and Africa.

Table 1: Selected Country-Specific Experience

	System Size	Political Economy	Resource Endowments
	System Size (GW)	Freedom Index, (2015)**	Share of Coal in Primary Reserves (2014)
India	303 (2016)	2.5	91%
PRC	320 (2015)	6.5	86%
South Africa	47 (2012)	2	99%
Nicaragua	1.41 (2012)	3.5	Negligible
	Institutional	Power Sector Reform	Subsidies
	Corruption Perception Index (CPI), 2015*	Description/Status	Policy
India	38	Reforms in the 1990s: IPPs in generation; state electricity boards unbundled; state-owned T; D privatized in 2 of 29 states; federal and state independent regulators; power trading classified as a separate business; power exchanges for short-term trading alongside PPAs; open/third-party access in 19 states.	Diesel subsidies eliminated in 2014; tax of \$6/tonne on coal with revenues channeled to the Clean Energy Fund, but coal prices controlled; electricity subsidies at the state level; distribution utilities' losses estimated at \$65 billion in 2016.
PRC	37	Regulations issued by the State Council in the 1980s/90s; electricity regulator SERC created in 2002—regulatory framework extended to all energy-related sectors (2010); IPPs (linked to state); state-owned SPCC (created in 1997) unbundled in 2002 into five generating companies, two grid companies, and four service companies; D&T integrated; grid ownership and dispatch integrated; grid companies act as single buyers. New sector reform announced by the State Council and NDRC in 2015—local authorities to have more control over T&D prices; plans to deregulate industrial commercial users; plans to integrate renewables through price reform.	Subsidies for coal larger than subsidies for renewables. Subsidy estimates (IISD 2015): renewables—\$7–\$16 billion; producer—\$6 billion; consumer—\$1–\$26 billion; GHG emissions—\$167–\$667 billion; air pollution—\$31–\$367 billion.
South Africa	44	Vertically integrated state-owned monopoly Eskom controls 96% of generation, T and half of D; private IPPs in G; municipal D companies (supply half of D); regulator NERSA established in 2004; sector overseen by Department of Public Enterprises and Department of Energy. Little progress on electricity reforms.	Eskom bears the cost of electricity (renewable and fossil fuel) subsidies, estimated to cost 0.5% of the GDP excluding externalities (Eberhard et al. 2015). Eskom's credit rating downgraded to "junk" status.
Nicaragua	27	1998: wholesale market based on spot price (system marginal cost); contracts market with G, D, and large users, which hedges against currency fluctuations; regulated end-user market served by distributors at regulated prices. 1995: state-owned monopoly INE separated into operations company ENEL and T/dispatch company ENATREL. ENEL's thermal and geothermal assets separated for privatization and D assets formed into two new companies and privatized. New state entity CNE created to oversee planning, policy, electrification, and legislation.	Subsidies driven by oil price spikes in 2000s with losses concentrated in distribution. Tariff reforms after new government in 2006; difference between costs and tariffs went from a 12.4% shortfall at end-2005 to a 7.9% surplus at end-2006. Electricity subsidies fell from 3% to 1% of the GDP over 2011–13. Fossil fuel subsidies reallocated to renewables; transition financed with external aid. Direct subsidies for low-income consumers in 2014 est. at \$66 million in 2014; total electricity subsidy \$108 million.

continued on next page

Table 1 *continued*

	Instruments		
	Economic Instruments	Regulatory Instruments	Policy Support
India	FiTs, net metering, fiscal incentives for capacity investments, generation-based incentives, favorable access to capital markets, solar IPP auctions, renewables purchase obligation (distribution and generation); Rural Electrification Program, 2014.	Tariff policy Renewable energy certificates	National Action Plan on Climate Change (NAPCC), 2010 National Renewable Energy Law (draft, 2016) Twelfth Five-Year Plan, 2012–17
PRC	FiTs, renewable electricity surcharge, tax incentives for producers/investors; incentives for small-scale distributed generation; net metering.	The Twelfth Five-Year Plan for Renewable Energy Wind Power Technology Development 12th Five-Year Special Plan State Council Document 9 (2015)	Renewable Energy Law 2005 National Climate Change Program China Energy White Paper 2012
South Africa	Renewable energy FiTs (REFiTs); Renewable Energy Independent Power Producer Program (REIPP); sovereign guarantees (to facilitate IPP investments).	Integrated Resource Electricity Plan 2010–2030	Constitution and Bill of Rights (1996) (guarantees environmentally sustainable development) White Paper on Renewable Energy (2003) National Climate Change Response Policy White Paper (2011)
Nicaragua	Tax incentives for producers/investors, Currency hedging, auctions, FiTs, quotas, Renewable procurement auctions.	National Sustainable Electrification and Renewable Energy Program (PNESER); Grid access: preferential dispatch; other grid benefits; Renewable energy in rural access programs; Renewable energy cook-stove program	Renewable energy law/strategy; solar heating, wind power, geothermal, biomass, biofuel law/programs; Rural Electrification Policy of Nicaragua Action Plan for the Electricity and Mining Sector, 2010–17

T = transmission, D = distribution.

* Scale 0–100 (clean to very corrupt); ** scale 1–7 (most free to least free).

Source: Authors; IRENA (2015).

Table 2: Post-Tax Energy Subsidies by Product in US\$ per Capita (Nominal)

	Petroleum	Coal	Gas	Electricity	Total	Total (% of GDP)
2013						
India	76.19	124.80	7.55	7.60	216.13	14.32
Nicaragua	36.95	0.00	0.00	47.90	84.84	4.63
PRC	122.95	1,198.21	15.73	18.28	1,355.16	19.47
South Africa	305.39	405.44	7.16	80.63	798.62	12.10
2015						
India	56.56	153.44	7.28	0.00*	217.28	12.34
Nicaragua	40.17	0.00	0.00	44.92	85.09	4.37
PRC	81.26	1,551.87	19.21	0.00*	1,652.33	20.13
South Africa	319.31	440.07	7.90	78.10	845.37	13.16

Source: IMF (2015); * subject to data availability.

In Nicaragua, the early electricity market reforms in the 1990s/2000s failed to expand renewables, exposing the tariffs to oil price volatility. The rural electrification rates were the lowest in Latin America (36%, versus 94% for urban) (World Bank 2012). A new government in 2006 undertook three key measures:

- Two large fiscal transfers to distribution companies to compensate for their losses from subsidies.²⁸ The regulator, INE, simultaneously implemented tariff reforms over a period of a year until they began to cover the costs of supply by the end of 2006.
- A 2017 target for 94% of electricity from renewables, with legislation on increasing renewables in generation (2005), geothermal energy (2002; amended 2003–10), biomass, and biofuels (see Table 1). The 2010 National Sustainable Electrification and Renewable Energy Program repositioned renewables in the energy mix as a solution for rural electrification.
- During the transition to renewables, Nicaragua leveraged an existing bilateral aid package with Venezuela (the PetroCaribe Plan) to purchase oil on concessionary terms to bridge its electricity supply deficit as a short-term measure²⁹ (Di Bella et al. 2015). It then used a portion of the package to finance off-budget electricity subsidies.

The net electricity generation from renewables consequently doubled (to 41% of the total) between 2005 and 2012, and the installed capacity increased to 38%, including wind, geothermal, hydro, and biomass (Figure 3).³⁰ As Table 1 shows, the country reduced, but did not eliminate, electricity subsidies; the resources of PetroCaribe subsidize the difference between a “notional” and an “effective” tariff. The Electric Development Fund targets renewables subsidies for households with consumption levels of < 150 kWh/month. Some distribution companies continue to run arrears.

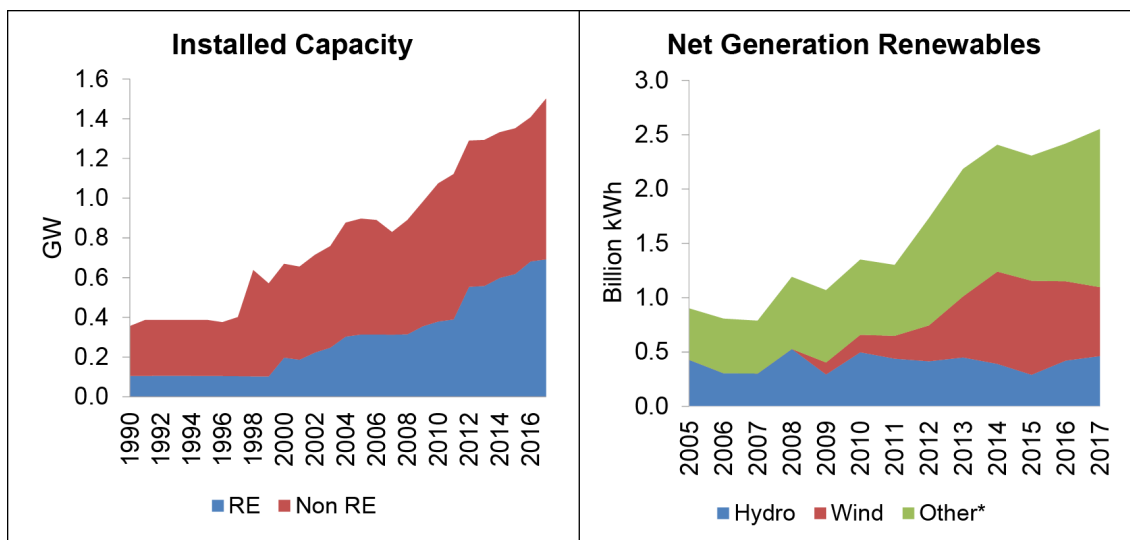
Nicaragua effectively mitigated the *misallocation effect* from reducing conventional power subsidies by leveraging PetroCaribe Financing. Further, it targeted the expansion of renewable outputs (Table 1). Auctions and quotas included renewables in the power procurement auctions. It limited the FiTs (from 2005) to wind power and run-of-the-river hydropower (IRENA 2015). It developed geothermal power through concessions, requiring financial guarantees from the developers. It similarly developed hydropower through project-specific legislation. Nicaragua provided direct financing or fiscal incentives for investment (e.g. tax exemptions) at different stages of renewable projects, from the Energy Investment Development Fund (general VAT receipts) (Di Bella et al. 2015). As the share of renewables rose, it reallocated larger amounts of the electricity subsidies to renewables.

²⁸ Followed by \$198 million from 2010 to 2013.

²⁹ Adding 15 MW of new diesel-fired generation capacity, with a potential 45 MW through a second round of Venezuelan financing.

³⁰ This rose to 52% in 2014.

Figure 3: Installed Capacity and Renewables in Net Generation—Nicaragua



Source: EIA (includes geothermal).

Although the country has “rationalized” electricity subsidies, it finances the difference between a “notional” tariff schedule and an “effective” tariff schedule with PetroCaribe resources. The Electric Development Fund’s subsidies for renewables directly target households with consumption levels below 150 kWh/month. Some distribution companies continue to run arrears with generation companies. Notably, as the share of renewables rises in generation relative to fossil fuels, the government allocates a larger amount of the available subsidy by default to renewables, with positive impacts on social welfare.

South Africa has not implemented a full electricity market reform, as Table 1 shows, and it subsidizes the electricity that Eskom produces. The White Paper on Renewable Energy (2003) and the Integrated Resources Plan (2010–30) were seminal policies recognizing the rights of citizens to a sustainable environment and diversification through renewables. The former set a renewables target of 10,000 GWh by 2013 (including biomass) and the latter 17.8 GW by 2030. Figure 4 shows the renewable energy progress for the 2005–17 period.

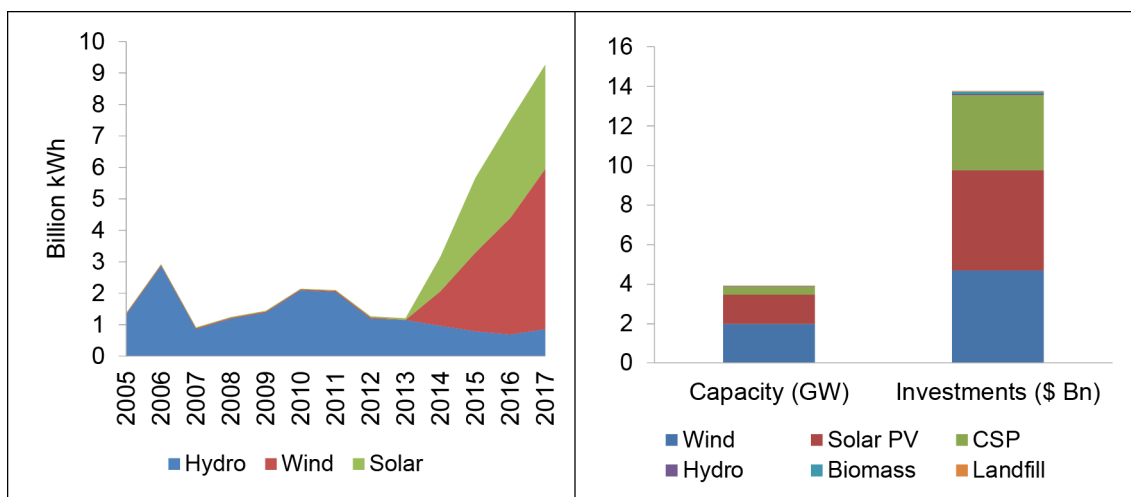
However, South Africa’s primary instrument—its 2009 Renewable Energy FiT (REFiT) program, covering generation costs plus a 17% after-tax return on equity indexed for inflation—failed to contract any capacity after political pressure to decrease REFITs. In 2011, the government replaced it with the REIPP program, which it based on competitive tariff bidding, sovereign guarantees to ensure Eskom’s offtake of electricity, pass-through of IPP costs to utilities’ tariffs, and a quasi-government entity (“IPP unit”) to oversee the process, preventing political interference. From 2011 to 2015, it contracted \$19 billion of private investments for 92 IPPs totaling 6.33 GW.³¹ The REIPP program allowed a critical mass of creditworthy projects to develop over three rounds, with the average solar PV and wind tariffs decreasing by 71% and 48%, respectively, in nominal terms (Eberhard et al. 2015). The program stipulated contributions to economic development.³²

³¹ The total capacity is 47 GW.

³² For wind, a minimum of 25% local content; 1% of project revenues for socioeconomic contributions; 17% of shares to citizen groups.

South Africa introduced renewables at cost-reflective tariffs, while it continues to subsidize coal. Despite the recent success in adding renewables, it has not updated its targets and plans, and renewables remain low vis-à-vis coal.³³ However, Eskom’s costs of coal subsidization have catalyzed a decline in new coal-fired capacity, implying a rebalancing in favor of renewables in the electricity mix, although this is likely to be a slower process in the absence of a subsidy reform. The negative externalities resulting from fossil fuel subsidies are likely to outweigh the “output effect” from the expansion of renewables.

Figure 4: Net Generation of Renewables (2005–17)—South Africa; and Cumulative REIPP Capacity and Investments (2011–14)—South Africa



Source: EIA; Eberhard et al. (2015).

The PRC’s electricity sector underwent structural changes up to the mid-2000s, but there was little modification in the way in which it traded or regulated electricity, with state entities holding different views on liberalization (Andrews-Speed 2013). The 2005 Renewable Energy Law catalyzed the renewables policy, converging on three areas: a mandatory market share (renewable portfolio standards) by sector and technology; tariff-based support mechanisms; and government financial support for renewable projects³⁴ (IRENA 2014). Competitive bidding initially took place for wind and solar power, which helped the government to determine the level of subsequent FiTs. However, the lack of competitiveness may have led to state-related entities bidding low tariffs. The PRC aims to procure 20% of its capacity from renewables by 2030—also the year of “peaking emissions.”

The literature has widely discussed the negative externalities of coal consumption in the PRC.³⁵ Although the wholesale coal prices align with the international prices, coal subsidies for electricity are prevalent. However, the country has restructured household tariffs into a three-tiered system, under which it subsidizes consumption <240 kWh/month and penalizes >4,400 kWh/month (considering negative externalities). As Table 1 shows, coal subsidies eclipse renewable subsidies, but

³³ In 2012, renewables accounted for 2% and 1% of the installed capacity and net generation, respectively. The former rose to 13% by 2015.

³⁴ \$290 billion in the 12th Five-Year Plan.

³⁵ Matus et al. (2012) estimated that ozone and PM concentrations resulted in a \$22–112 billion loss of welfare in the PRC’s economy from 1975 to 2005.

financial support for coal has moved toward greater efficiency and desulfurization of coal plants, contributing to a 14% fall in SO₂ emissions during the period 2000–10 (Andrews-Speed 2013).

Table 3: The PRC's Renewable Targets (GW)

	Status 2013	Target 2015	Status 2015	Target 2020
Biomass	6	13	8	30
Hydro	259	260	296	350
Solar	16	51	43	103
Onshore Wind	77	100	129	200
Offshore Wind		5		30
Total Capacity (Incl. Fossil Fuels)	1,265	–	1,516	1,850

Source: IRENA (2014); IEA (2020).

Producer subsidies for renewables include a 50% subsidy for solar PV and off-grid solar systems; non-renewable electricity tariffs incur a surcharge that funds renewables. Subsidies for equipment manufacturing for renewables (through tax exemptions and direct support) have improved the industry's economies of scale, lowering costs and subsequently tariffs (IRENA 2014). Export-oriented manufacturing ensures strong demand, supporting the industry's growth. Consequently, the share of renewables in electricity has increased (not substantially in absolute terms), accounting for the majority of the new capacity (68% in 2013), while the share of coal is decreasing (by 2% in 2014). While subsidies for "more efficient" coal plants will reduce (not eliminate) negative externalities in the conventional power market, the subsidization of coal *and* renewables raises the costs of delivering the targeted renewable energy output, constraining the transition and supporting the case for a reallocation of subsidies to renewables.

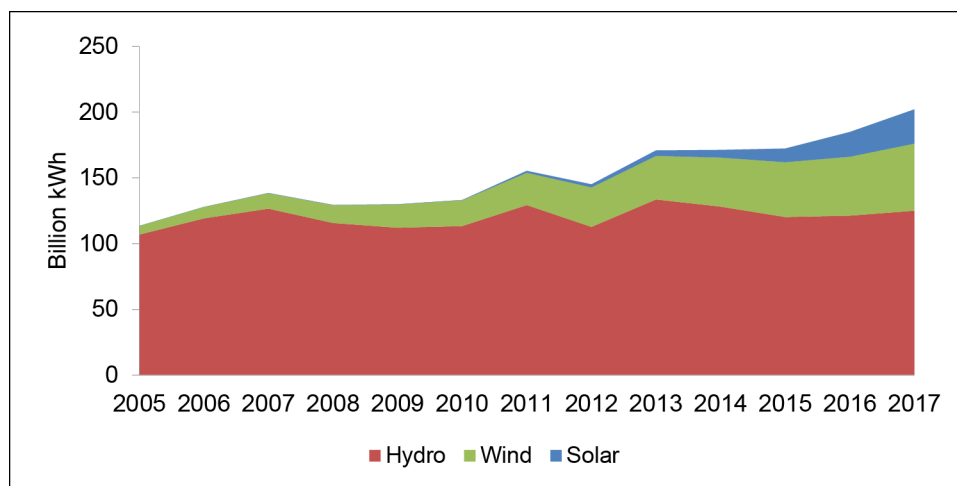
The experience in India has not been dissimilar from that in the PRC, as both countries are geographically complex and implement policies at the state level. Indian states have differed in their progress on market reforms as well as their integration of renewables (Sen et al. 2016). Figure 5 shows the increase in renewable energy for the 2005–17 period. India's National Action Plan on Climate Change (NAPCC) (2010) was seminal in catalyzing the shift toward renewables; it has committed to 40% installed capacity from non-fossil fuel sources by 2030 (from 30% at present) as part of the international climate agreement and has set an ambitious national target to achieve 100 GW solar, 60 GW wind, and 15 GW other renewables by 2022.³⁶ Although it eliminated diesel subsidies in 2014 alongside the oil price decline, coal and electricity subsidies are pervasive and concentrated in the distribution sector (Table 1), placing a constraint on new capacity as well as on the purchase of renewables.

Capital subsidies have been more successful than distribution subsidies in India. A "renewables purchase obligation" (RPO) for distributors (ranging from 1% to 3%), which a Renewable Energy Certificate (REC) trading program facilitated, failed to integrate renewables as distributors could not fulfil them—this led to low prices for RECs and a disincentive for new investment in renewables. In 2015, the RPO moved to generation, requiring investors in fossil fuel plants to invest 10% of their plant capacity in renewables, whilst the government introduced a debt restructuring program in distribution. Competitive auctions for solar IPPs have witnessed tariffs fall by

³⁶ In contrast, solar is currently 4 GW and wind 30 GW.

two-thirds over the last 4 years.³⁷ The government provided fiscal incentives (80% accelerated depreciation) to scale up renewables, which reduced (40%) after contracting a “critical mass” of projects. It propagates rooftop solar (60 GW of the 100 GW target) as a decentralized solution for rural electrification alongside local content requirements for solar power developers.

Figure 5: Net Renewables Generation (by Source)—India



Source: EIA.

Financing is accessible on the capital market through a “green bond” that the Indian Renewable Development Agency floated. A tax per tonne on coal (which increased from \$2–\$6 over the period 2014–16) aims at negative externalities and channels the revenues (amounting to over \$2 billion a year) into a clean energy fund. However, somewhat contradictorily, India plans to ramp up coal production from 500 million tonnes at present to 1 billion tonnes by 2020, primarily to meet the rising power demand. Like the PRC, it will channel subsidies into improving the quality and efficiency of Indian coal. However, these are unlikely to offset the negative externalities of coal-fired power.

4. POLICY LESSONS AND SUMMARY

Our analytical framework demonstrates that it is necessary to view fossil fuel subsidy reform (a key aspect of electricity market reform) and the introduction and scaling of renewables (a key aspect of diversification and sustainability) as a two-stage policy process rather than as isolated measures. Our framework shows that there is a logical argument for reducing fossil fuel electricity subsidies as well as reallocating them to renewable electricity for the larger development and deployment of renewable energy. As the marginal cost of externalities is increasing, subsidizing conventional electricity compounds the environmental costs and welfare loss. A strong policy argument therefore exists for the reallocation of subsidies from conventional electricity markets to the market for renewable electricity to increase the overall social welfare.

³⁷ The cost differential between a kWh of coal and a kWh of solar power reduced from 1:8 in 2011 to 1:1.8 in 2014.

In principal, a subsidy is a negative tax on goods with positive externalities. As discussed in this paper, fossil fuel subsidies can take the forms of (i) direct government subsidies; (ii) cross-subsidies among the consumer types and incomes; and (iii) cross-sector energy subsidies, for example from the transport sector to the electricity sector. Renewable support policies can take several forms—such as (i) direct financing, (ii) investment/fiscal incentives for producers, and (iii) subsidies targeting end-consumers. Although energy use has negative resource and environmental externalities, the justification for subsidies has come from the desire to protect low-income users and support domestic industry, albeit at a high economic cost. In the case of electrification, the provision of support schemes and subsidies should focus on the use of targeted capital subsidies for improving access to the energy system. As the consumption of energy has negative environmental externalities, the reduction or removal of subsidies or externalities can then target consumption.

The removal of subsidies in a revenue-neutral way, by replacing them with cash payments for all households, is in principal efficient and can help to alleviate general poverty among poor households by allowing them to allocate the extra income freely to the goods with the highest utility. However, these schemes face exposure to the fluctuations in government budgets, and effective targeting is necessary to mitigate the potential volatility. In this paper, we have not discussed the particular instruments for removing subsidies, incorporating externalities, and supporting renewables due to limitations of space.

The experience of the four case countries shows that we cannot assume away the transition to scaling up renewables in the electricity mix and that it varies within differing institutional and political conditions. The switching of subsidies from fossil fuels to renewables cannot take place simultaneously and will involve a time lag. Suitable bridging arrangements are required to catalyze the transition, as is apparent in the case of Nicaragua, which utilized external oil financing. In developing and transition economies, the simplicity of schemes should be a guiding principal due to the institutional and administrative constraints. These economies should rather aim to avoid the complexities that follow the implementation of multiple and accumulating instruments that has taken place over time in some developed economies (see Newbery 2015).

The case studies also show that it is possible to mitigate the “misallocation effect” of subsidies and enhance their “output effect” if countries integrate subsidy reforms and diversification through renewables into electrification (particularly rural) initiatives, as renewables provide small-scale decentralized solutions to problems associated with rural access. It follows that it is possible to target subsidies for renewables directly relative to fossil fuel subsidies. In emerging economies that subsidize both fossil fuels and renewables, such as India and the PRC, although they are increasingly channeling fossil fuel subsidies toward improving the efficiency of coal usage, these economies face an inevitable constraint as subsidizing coal increases the cost of delivering the target for renewables. This constraint, along with the positive externalities from renewables, supports the argument for a subsidy reallocation away from coal and toward renewables.

Finally, our findings imply the need to revisit the significance of system size as a determinant of the success of diversification through renewables in heavily subsidized emerging economies. Small systems may have limitations in diversification due to absence of economies of scale. Interconnections can then be an effective source of diversification, decarbonization, and competition in the sector. In Nicaragua, while an alternative to oil was pipeline gas from Colombia or LNG from Peru’s regasification terminal, Nicaragua’s small-sized power system proved to be a disadvantage when it

came to introducing gas as a new fuel source that required a significant size to be justified. The reallocation of subsidies from fossil fuels toward renewables should not undermine the implementation of energy efficiency improvement policies and increasing both the public and private sector energy investments as complementary policies to maximize the benefits of greater deployment of renewable energy sources.

5. CONCLUSIONS

The integration of renewables in the presence of subsidies can challenge the implementation of market-based reforms as the former often requires intervention and the efficiency of the latter requires cost-reflective price signals and competition. At the same time, they also offer opportunities for improving social welfare.

In this paper, we developed a simple analytical framework based on economic efficiency and social welfare arguments for a purposeful reallocation of subsidies from fossil fuels to renewable energy. We focused on the synergies between market-based electricity reforms and renewables as electricity lies at the confluence of multiple policy objectives, including efficiency, sustainability, affordability, and access.

The underlying message of our analytical framework is that policy makers carrying out electricity reforms with multiple goals need to achieve a balance of pricing and investment (i) to address inefficiency by correcting pricing distortions, (ii) to address environmental objectives by incentivizing renewables, and (iii) to ensure affordability and increase social welfare in the process. The experience of four emerging economies shows that the institutional constraints and political conditions that are unique to them characterize this policy problem. We conclude that, while the removal of fossil fuel subsidies should target consumption, it is more effective to deploy renewable subsidies toward capital subsidies to improve electricity access for the overall social welfare to improve. There is a need for future research on suitable instruments and schemes for maximizing the social welfare from realigning energy subsidies.

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