SOUTH ASIA DEVELOPMENT FORUM

OVERVIEW

In the Dark

How Much Do Power Sector Distortions Cost South Asia?

Fan Zhang

WORLD BANK GROUP

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Overview

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This booklet contains the overview, as well as a list of contents, from *In the Dark: How Much Do Power Sector Distortions Cost South Asia?* (doi: 10.1596/978-1-4648-1154-8). A PDF of the final, full-length book, once published, will be available at https://openknowledge.worldbank.org/ and print copies can be ordered at http://Amazon.com. Please use the final version of the book for citation, reproduction, and adaptation purposes.

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South Asia Development Forum

Home to a fifth of mankind, and to almost half of the people living in poverty, South Asia is also a region of marked contrasts: from conflict-affected areas to vibrant democracies, from demographic bulges to aging societies, from energy crises to global companies. This series explores the challenges faced by a region whose fate is critical to the success of global development in the early 21st century, and that can also make a difference for global peace. The volumes in it organize in an accessible way findings from recent research and lessons of experience, across a range of development topics. The series is intended to present new ideas and to stimulate debate among practitioners, researchers, and all those interested in public policies. In doing so, it exposes the options faced by decision makers in the region and highlights the enormous potential of this fast-changing part of the world.

Contents of *In the Dark: How Much Do Power Sector Distortions Cost South Asia?*

Foreword

The countries of South Asia still need to expand electricity access and ensure electricity reliability. Looking forward, they will also have to satisfy the electricity demand of their fast-growing economies. More than 250 million people in the region still live without access to electricity—roughly a quarter of the global unserved population. Several of the countries in South Asia also face electricity shortages, leading to frequent power shedding. On average, per capita electricity consumption in the region is less than a quarter of the world average. As South Asia continues its growth trajectory and more people are connected to the grid, demand for electricity is set to increase rapidly over the coming decades. India alone is expected to account for 30 percent of growth in global energy demand between now and 2040.

Expanding and improving electricity services is imperative for economic growth and poverty alleviation in South Asia. The World Bank is helping countries in South Asia to meet their energy needs through direct investments, technical assistance and budget support. Total lending commitment to the region for energy projects reached US$8.6 billion at the end of fiscal 2018. The focus has been on providing low-carbon options for energy access, such as increasing the use of renewable energy and encouraging more efficient use of energy. The World Bank also supports individual countries' reform agendas, particularly those focused on enabling the creation of markets and improving sector governance. In addition, it encourages and facilitates regional efforts to promote greater cross-border trade of electricity.

Although large investments are urgently needed to plug energy gaps, reforms that address policy distortions in the energy sector could play a big part in making the best use of existing facilities, avoiding waste, attracting private investment, and promoting the shift toward a cleaner energy mix.

In support of a greater prioritization of reforms, the report presents an integrative analysis of energy sector distortions at different stages of electricity supply in the three largest countries in South Asia: Bangladesh, India, and Pakistan. Using a rigorous

analytical framework and new microeconomic data, the analysis estimates how various types of distortions affect economies and social outcomes. The range of distortions considered is broad, encompassing the misallocation of fuel supply, inefficiencies in generation, high losses in distribution, and inadequate pricing of emissions from fossil fuel–based electricity generation.

New insights are gained by relying on two important methodological innovations. First, the analysis goes beyond looking at just fiscal costs, evaluating the impact of distortions from a welfare perspective. Rather than the cost of subsidies, the report assesses the loss of consumer welfare and producer surpluses, as well as the environmental and social costs. Second, the report adopts a broad definition of the power sector. Instead of focusing exclusively on generation, transmission and distribution, the analysis covers the entire supply chain of power supply, from upstream fuel supply to downstream access and reliability.

The report finds that the full cost of distortions in the power sector is far greater than previously estimated based on fiscal costs alone. The estimated total economic cost is 4–7 percent of GDP in Bangladesh, India, and Pakistan. Some of the largest costs are upstream and downstream.

The report also shows that countries in South Asia can reap huge economic gains from energy sector reforms, and along the way offers important insights on the implementation of these reforms. For example, a narrow focus on liberalizing the price of electricity should be avoided because, in the absence of other reforms, the market equilibrium is highly inefficient. It also appears that, without fundamental changes in incentives, corporatizing power utilities does not guarantee substantial improvements in their operation. And ensuring universal access to electricity without ensuring a reliable power supply amounts to a missed opportunity, because the benefits from electrification crucially depend on households and firms getting a sufficient level of services.

Through policy reforms, institutional development and infrastructure investments, South Asia can address energy supply challenges and cement a path to sustainable development. The World Bank stands ready to support the countries in South Asia in these efforts.

Hartwig Schafer
Vice President
South Asia Region
The World Bank

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Abbreviations

GDP	gross domestic product
GW	gigawatts
kWh	kilowatt-hour
LNG	liquefied natural gas
OECD	Organisation for Economic Co-operation and Development
$PM_{2.5}$	fine particulate matter 2.5 micrometers in diameter or smaller

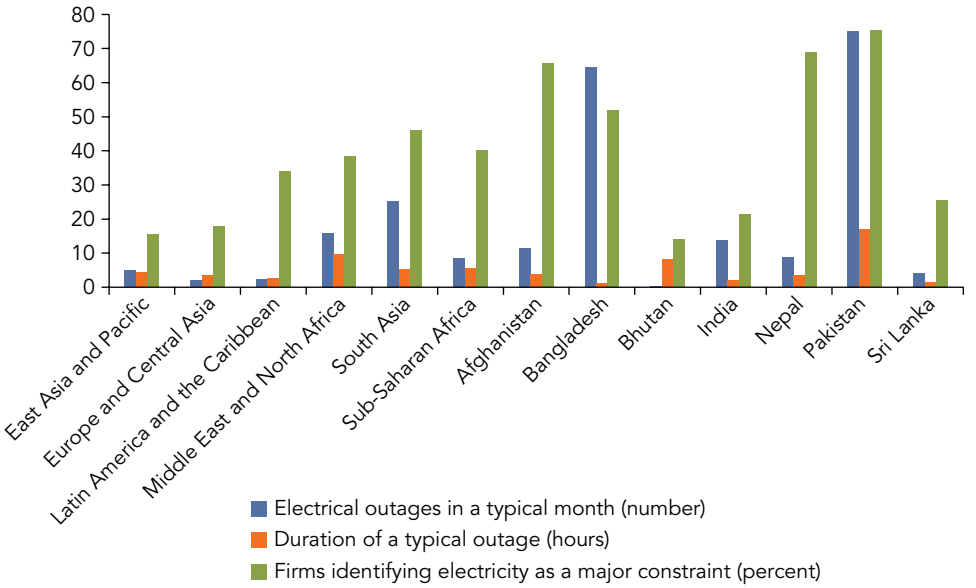
Overview

In the summer of 2012, India suffered the largest electrical blackout in history. Almost 700 million people—roughly equivalent to the entire population of Europe—lost power for two days. The power failure started when three of the country's five state-owned electricity grids failed. First to fail, on July 30, was India's northern grid. Revived after 14 hours of repair, it collapsed again the next day, quickly followed by the eastern and then the northeastern grids. The blackout stretched across roughly 2,000 miles, from India's western border with Pakistan to its eastern border with Myanmar. Trains were stranded on tracks; miners were trapped underground; traffic lights were extinguished, causing havoc on the roads; and millions of people were left without electric fans or air conditioners during the scorching heat of summer.

This power failure epitomizes the vulnerability of India's electricity sector. But India is not alone in struggling to keep the lights on. According to the most recent business surveys, conducted in 2011–15, South Asia had more frequent power outages than any other world region (Figure 1). Many of its countries rely on scheduled blackouts ("load shedding") to cope with the systemic shortages that occur as the supply of electricity continually falls short of the rapidly increasing demand. Firms reported almost daily blackouts, typically lasting more than five hours. Households had it even worse, reporting daily outages up to 10 hours in Bangladesh and up to 20 in some parts of Pakistan before 2014. The 2018 *Global Competitiveness Report*, which ranks 137 economies on the reliability of electricity supply, places Bangladesh at 101th, India at 80th, and Pakistan at 115th (Schwab 2018).

But power cuts are not the only concern. A bigger challenge is the large number of people forced to live without electricity 24/7. Among world regions, South Asia has the second-largest population living off the grid—255 million people in 2016, more than a quarter of all the people in the world living without access to electricity. Only Sub-Saharan Africa has more people not connected to the grid. As a result of low access rates and the low quality of supply, per capita electricity consumption in South Asia is

FIGURE 1 South Asia has the most unreliable power supply in the world



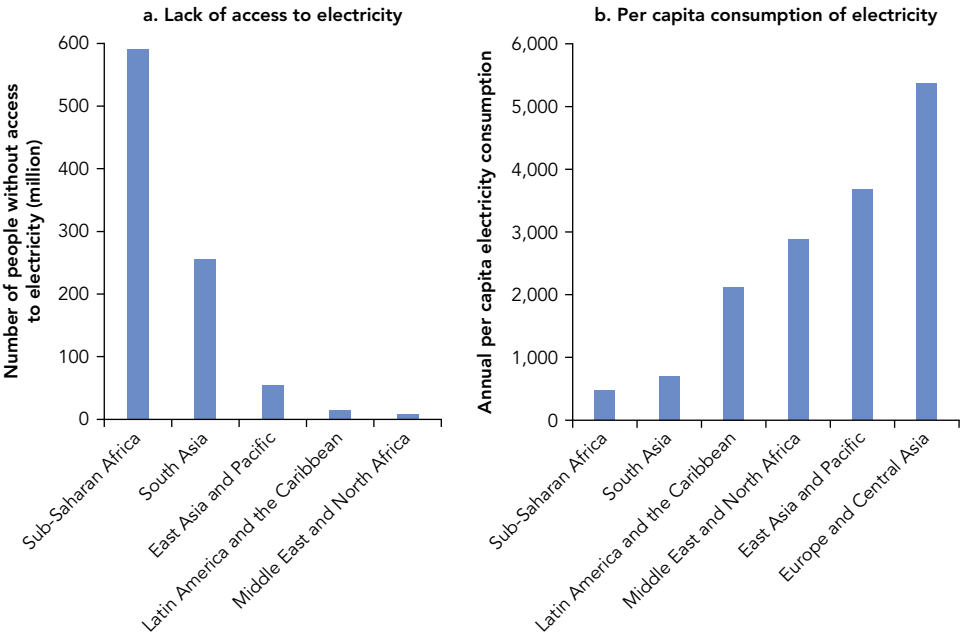
Source: World Bank Enterprise Surveys in Afghanistan (2014), Bangladesh (2013), Bhutan (2015), India (2014), Nepal (2013), Pakistan (2013), and Sri Lanka (2011).

the second-lowest in the world (after Sub-Saharan Africa). At 707 kilowatt hours (kWh) a year in 2014, it is less than a quarter of the world average (Figure 2).

Inadequate access to electricity has important implications for economic development. In responding to World Bank Enterprise Surveys, almost half of business managers in South Asia identified lack of reliable electricity as a major constraint to their firm's operation and growth (see Figure 1). Indeed, they ranked blackouts as far more important than other barriers, including regulations and taxes, corruption, and human capital. Frequent blackouts force businesses to rely on generators, which produce electricity at a much higher cost than the grid. They force households to rely on kerosene lamps, a dirtier and costlier source of light. Lack of reliable electricity is also a major barrier to the economic advancement of underserved households, adversely affecting income, health, children's educational attainment, and gender equality (Samad and Zhang 2016, 2017, 2018).

Conventional wisdom suggests that inadequate investment in power infrastructure is the main cause of power shortages in South Asia. But a closer look at the data reveals a different picture. Over the decade ending in 2016, Bangladesh and India more than doubled their power-generation capacity, with average annual growth in capacity outstripping annual growth in gross domestic product (GDP). But in Bangladesh less than 80 percent of available capacity was operational most of the time (BPDB 2015, 2016);

FIGURE 2 South Asia has a quarter of the world's people without electricity—and the world's second-lowest regional per capita electricity consumption



Source: World Development Indicators database.
Note: Data on access to electricity are for 2016. Data on per capita consumption are for 2014.

in India power shortages reached 5 percent of estimated demand in 2014, but up to 15 percent of coal power plants were left idle (CERC 2015). In fiscal 2018, when total installed capacity was more than twice the amount of peak demand, peak demand shortage still registered 2.1 percent in India (CEA 2018). Even in Pakistan, where capacity growth lags GDP growth, only 80 percent of available capacity was operational in fiscal 2014 (World Bank 2015a). Losses in transmission and distribution add to the shortages: India and Pakistan lose about a quarter of electricity in the network for both technical and commercial reasons, well above the 10 percent international norm.

South Asia thus faces an efficiency gap. Inefficiencies originating in every link of the electricity supply chain have resulted in upstream fuel shortages, poorly performing state utilities, and wasteful consumption downstream. Although there are multiple inefficiencies, most are attributable to three types of distortions: institutional distortions caused by state ownership and weak governance; regulatory distortions resulting from price regulation, subsidies, and cross-subsidies; and social distortions related to the negative externalities (such as emissions and associated health damage) of energy production and consumption.

Using microeconomic data from utilities, households, and firms, this report quantifies the economic cost of each type of distortion at each stage of power supply. The results

show that the overall economic cost of distortions—ranging from 4 to 7 percent of GDP—is far greater than previously thought on the basis of analysis considering only the fiscal implications of distortions. Going beyond the traditionally defined power sector (generation, transmission, and distribution), the report suggests that some of the costliest distortions occur in upstream fuel supply and downstream access and reliability.

The report focuses on South Asia's three largest economies. Bangladesh, India, and Pakistan have a combined population of 1.6 billion, including almost 300 million people living in extreme poverty (subsisting on less than $1.90 a day) and 245 million lacking access to electricity. The three countries account for 98 percent of South Asia's electricity supply.

South Asia has made impressive progress in promoting the development of renewable energy in recent years. Bangladesh is a hotspot of the global off-grid solar power market. India now ranks fourth in the world in terms of installed wind energy capacity and sixth in solar-based capacity (Press Information Bureau 2017). Fossil fuel still plays a dominant role in power generation in South Asia, however. Bangladesh, India, and Pakistan together emitted 1.15 billion tons of carbon dioxide for power generation in 2015, almost as much as the power sectors of all the Organisation for Economic Co-operation and Development (OECD) countries in Europe. Both Bangladesh and Pakistan have also set ambitious targets for expanding the use of coal.

As a development imperative, improving the supply of electricity should be a first-order concern. But considering the role of power sector distortions is also important. Comprehensive sector reform that addresses inefficiencies at different stages of power supply could not only play a big part in increasing the supply of electricity but also in limiting the reliance on fossil fuel.

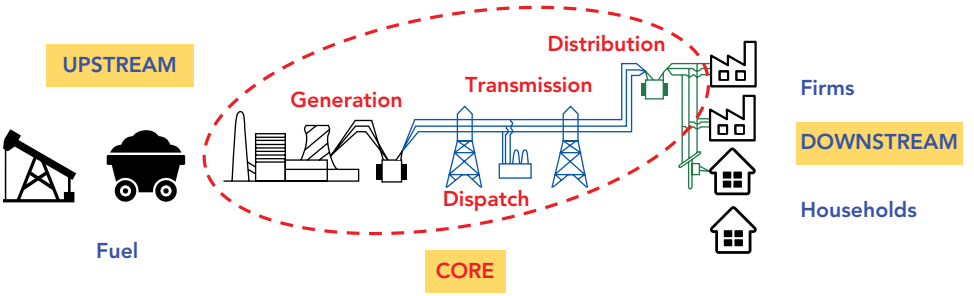
What This Study Adds

Many studies have examined the cost of power sector distortions in South Asia. They typically consider a narrow definition of the power sector—one that includes generation, transmission, and distribution and often omits upstream fuel supply and downstream access to electricity and reliability of supply. Most studies also focus on fiscal costs, ignoring the fact that, although there is no fiscal cost to a rural household lacking access to electricity or the atmosphere being polluted by coal-fueled generating plants, the economic costs are huge.

This report introduces two innovations. First, it goes beyond fiscal costs, evaluating the impact of distortions from a welfare perspective by measuring the economic cost of distortions through their impact on consumer wellbeing, producer surplus, and environmental costs. Second, it adopts a broader definition of the sector, one that covers the entire supply chain of power supply, including upstream fuel supply and downstream access and reliability (Figure 3).

Using a common analytical framework and covering all stages of power supply, this report provides what we believe to be the most comprehensive analysis to date of how

FIGURE 3 The report analyzes power sector distortions along the entire supply chain of electricity



Source: Schematic of the core sector is from United States Department of Energy. Icons outside the core defined by the dashed line are from the Noun Project, by the following artists: Oil well by Jason Dilworth, coal wagon by Georgiana Ionescu, factory by pictohaven, and house by Adrien Coquet.

policy-induced distortions and externalities have affected social welfare in Bangladesh, India, and Pakistan.

BEYOND FISCAL COSTS

Subsidies are often recognized as the main distortion in the power sector. Most studies emphasize their fiscal implications. For example, on the basis of the difference between regulated and market prices, the International Energy Agency estimates that subsidies in India's power sector amount to 0.36 percent of GDP (IEA 2013). Accounting for direct budgetary support by the government, the OECD estimates that subsidies in India's coal sector represent less than 0.001 percent of GDP (OECD 2015). Although subsidies create fiscal burdens, they also have redistributive effects. But, more important, subsidies contribute to energy shortages by distorting consumption and production and undermining the performance of utilities. This report argues that the correct measure of the economic cost of subsidies is thus not the fiscal costs but the loss in net output and consumer welfare.

Going beyond subsidies, the report also considers costs stemming from institutional and social distortions: efficiency losses caused by state ownership and weak governance, welfare losses resulting from lack of reliable access to electricity, and external (health and environmental) costs from excessive fossil fuel–based energy production and consumption. Institutional and social distortions do not result in direct fiscal costs, but they lead to economic losses that are often much larger than the losses from subsidies, because the efficiency losses from high production costs, poor service quality, and environmental and health damage lead to first-order efficiency losses whereas pricing inefficiencies are likely to be second-order effects (Joskow 2008).

The study uses microeconomic data to estimate key parameters in each country. It then uses these parameters to estimate the cost of institutional, regulatory, and social distortions. The results suggest that the costs of institutional and social distortions are several orders of magnitude higher than the fiscal costs of distortions.

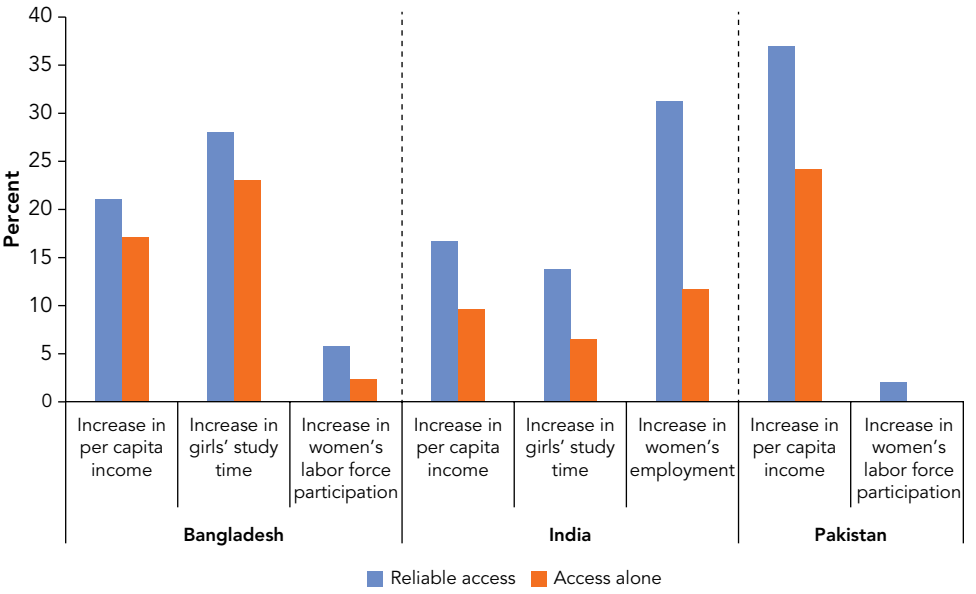
BEYOND THE CORE: UPSTREAM AND DOWNSTREAM

Going beyond the core electricity sector of generation, transmission, and distribution, the study covers issues upstream (coal and gas) and downstream (households and firms). Inefficiencies upstream and downstream often contribute most to the total cost of distortions.

Fuel supply is a crucial part of power generation. According to plant-level data, at even highly subsidized prices, fuel costs represent roughly 47 percent of the short-run marginal costs of gas power plants in Bangladesh and 63 percent in Pakistan, and they account for 15–64 percent of the variable costs of coal power plants in India (CEA 2004, 2015). Shortfalls in coal and gas have led to idled generation capacity and increased the need for more expensive and/or dirtier alternative fuel. Upstream inefficiencies can therefore quickly trickle down to consumers in the form of power cuts, costly electricity, and pollution. As this report shows, social distortions from coal use in India and the underpricing and inefficient allocation of gas in Bangladesh and Pakistan are among the largest sources of the overall economic cost of power sector distortions in those countries.

For the downstream population, power shortages represent a barrier to social and economic development. Lack of reliable access to electricity is associated with lower income, higher poverty, poorer health and education, and less gender equality (Figure 4).

FIGURE 4 Access to electricity is associated with higher income and better social outcomes in Bangladesh, India, and Pakistan—and the results are much stronger if the electricity is reliable



Source: Estimation based on household surveys in Bangladesh, India, and Pakistan. See also Samad and Zhang (2016, 2017, 2018).
Note: The effects of electrification on girls' study time and the effects of power outages on women's labor force participation in Pakistan are not estimated because data are not available.

Unreliable power supply also adversely affects the operation and growth of firms. Large businesses try to cope by investing in captive generators; small and medium-size businesses are usually unable to do so (Grainger and Zhang 2017). In manufacturing and services combined, the total losses in annual output attributable to power shortages amounted to $1.1 billion and $22.7 billion in Bangladesh and India, respectively, in fiscal 2016, and $8.4 billion in Pakistan in fiscal 2015.

Massive Electricity Shortages

Over the past few decades, countries in South Asia have substantially expanded electricity supply, improved access, and promoted market-oriented reforms. The combined generation capacity in Bangladesh, India, and Pakistan grew from 198 gigawatts (GW) in 2007 to 376 GW in 2017; the share of households with access to electricity in the three countries rose from less than 70 percent in 2007 to an officially estimated 86 percent in 2016, according to the latest World Development Indicators. All three countries have launched power sector reforms to encourage private investment since the 1990s.

Despite this progress, South Asia continues to face electricity shortages in terms of both access and quality of supply. On a per capita basis, total installed electricity-generating capacity still falls behind the world average: One-quarter of the world's people live in South Asia, but the region has just 5 percent of global electricity-generating capacity. In addition, heavy reliance on fossil fuel for power generation poses a daunting challenge as the region struggles to balance the need for energy with its environmental consequences.

LOW ACCESS AND LOW QUALITY OF SUPPLY

South Asia has the world's second-lowest rate of access to electricity, after Sub-Saharan Africa. The 255 million people in South Asia who lack an electricity connection represent roughly 14 percent of the region's population.

The lowest access rate in South Asia is in Bangladesh, where 24 percent of the population lived off the grid in 2016 (31 percent in rural areas) (Table 1). India achieved 100 percent village electrification in 2018. But at the household level, its rural access rate, at 81 percent in 2017, is still the third-lowest in South Asia. In Pakistan 99 percent of the population has access to grid electricity, according to official statistics, but estimates based on census data and the number of connections reported by utilities suggest that access to grid electricity was only about 74 percent in 2016 (IEA 2017). A household survey carried out by the International Finance Corporation in 2014 even suggests that up to 35 percent of the population in Pakistan may still live off the grid (IFC 2015).

For people nominally connected to the grid, access to electricity can be uneven and unreliable, characterized by frequent, long-lasting power outages. Outages often occur because of technical failures. In South Asia they also reflect the efforts of utilities to

TABLE 1 South Asia has low rates of access to electricity, especially in rural areas

Country	Total (percent of population)	Rural areas (percent of population)
Afghanistan	84.1	79.0
Bangladesh	75.9	68.9
Bhutan	100.0	100.0
India	86.1	81.0
Maldives	100.0	100.0
Nepal	90.7	85.2
Pakistan	99.1	98.8
Sri Lanka	95.6	94.6

Source: World Development Indicators database. Indian data are from the Indian rural electrification program's (Saubhagya) dashboard, updated as of October 2017.
Note: Data are for 2016 except for India.

cope with power shortages through scheduled power cuts (load shedding). In World Bank Enterprise Surveys conducted in 2011–15, business managers in the region reported that power cuts occur almost every day, with an average duration of 5.3 hours. By comparison, managers in East Asia reported one outage every nine days, and managers in Sub-Saharan Africa reported one outage every four days. To deal with power disruptions, almost half of firms in South Asia own or share a generator.

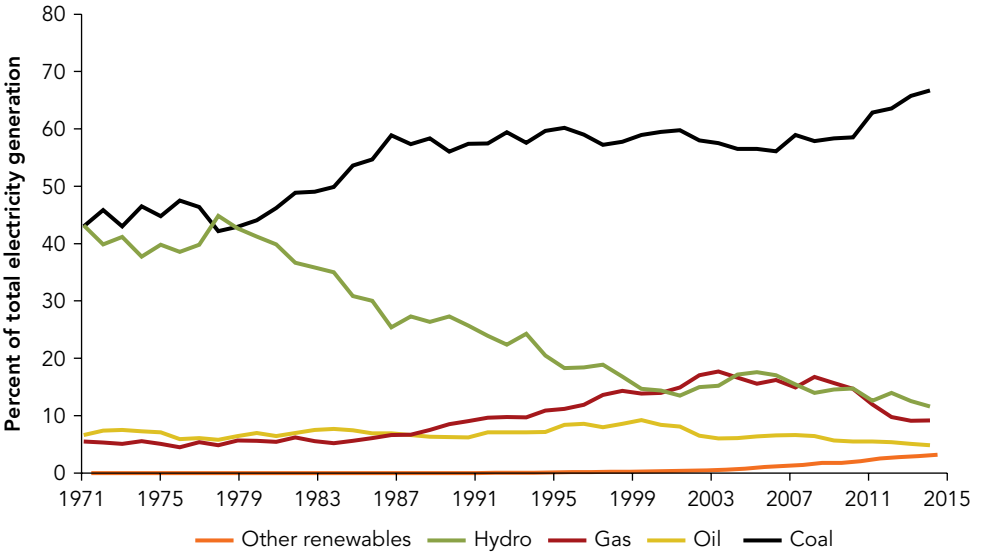
Within South Asia, Bangladesh and Pakistan had the most severe power shortages. In both countries, electricity demand routinely exceeded supply, triggering crippling blackouts nationwide.

The officially reported power shortages in Bangladesh, India, and Pakistan have all declined in recent years, thanks to new capacity addition, the decline in global oil price until recently, and, in India, lower than expected growth in demand. But these official figures almost certainly underestimate the true power deficit: because electricity demand is often defined as the amount of electricity distribution utilities buy, it does not account for demand by people who remain unserved or underserved. Lack of reliable access to electricity stymies the growth of businesses and disrupt people's daily lives, periodically prompting protests that sometimes turn violent (The Guardian 2012).

DIRE ENVIRONMENTAL AND HEALTH CONCERNS

As South Asia has expanded its electricity supply, the region has become increasingly dependent on fossil fuel for both grid electricity and captive power generation (Figure 5). This dependence has helped create some of the most polluted cities in the world. Fossil fuel–based power generation is the largest source of carbon dioxide emissions in the region.

FIGURE 5 South Asia has become increasingly dependent on fossil fuel for power generation



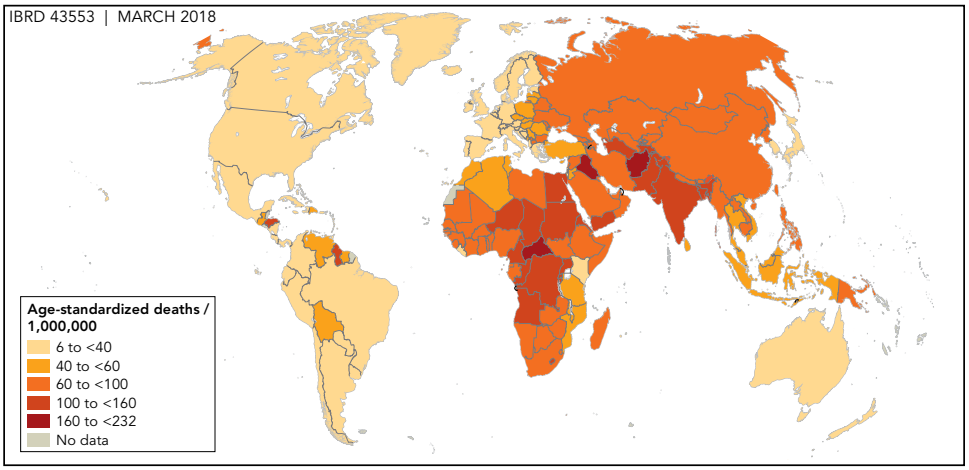
Source: World Energy Statistics and Balances database (IEA 2018).
Note: Figure shows the fuel mix for both grid electricity and captive power generation.

Burning coal and diesel also releases numerous toxic pollutants. The most harmful is fine particulate matter 2.5 micrometers in diameter or smaller, known as $PM_{2.5}$. These particles, less than 1/30th the width of a human hair, can be inhaled deep into the lungs, causing illness and premature death.

The population in South Asia is exposed to some of the world's highest combustion-related concentrations of $PM_{2.5}$ (Health Effects Institute 2017). At 89 micrograms per cubic meter in Bangladesh, 74 in India, and 65 in Pakistan, the annual population-weighted average concentrations are many times the World Health Organization's safe limit of 10 micrograms per cubic meter. The trend is also worrisome: Between 2010 and 2015, Bangladesh and India experienced the steepest increases in $PM_{2.5}$ concentration among the world's 10 most populous countries.

With worsening air quality, the three countries also have some of the highest mortality rates attributable to ambient air pollution (Map 1). Between 1990 and 2015, the annual number of deaths attributable to $PM_{2.5}$ exposure increased by 64 percent in Pakistan, 51 percent in Bangladesh, and 48 percent in India. In the three countries combined, the annual number of deaths attributable to $PM_{2.5}$ rose by 50 percent over the period, from 900,900 in 1990 to 1,347,900 in 2015 (Health Effects Institute 2017).

MAP 1 South Asia has some of the world's highest mortality rates associated with exposure to fine particulate matter



Source: Health Effects Institute 2017.

Three Types of Distortions

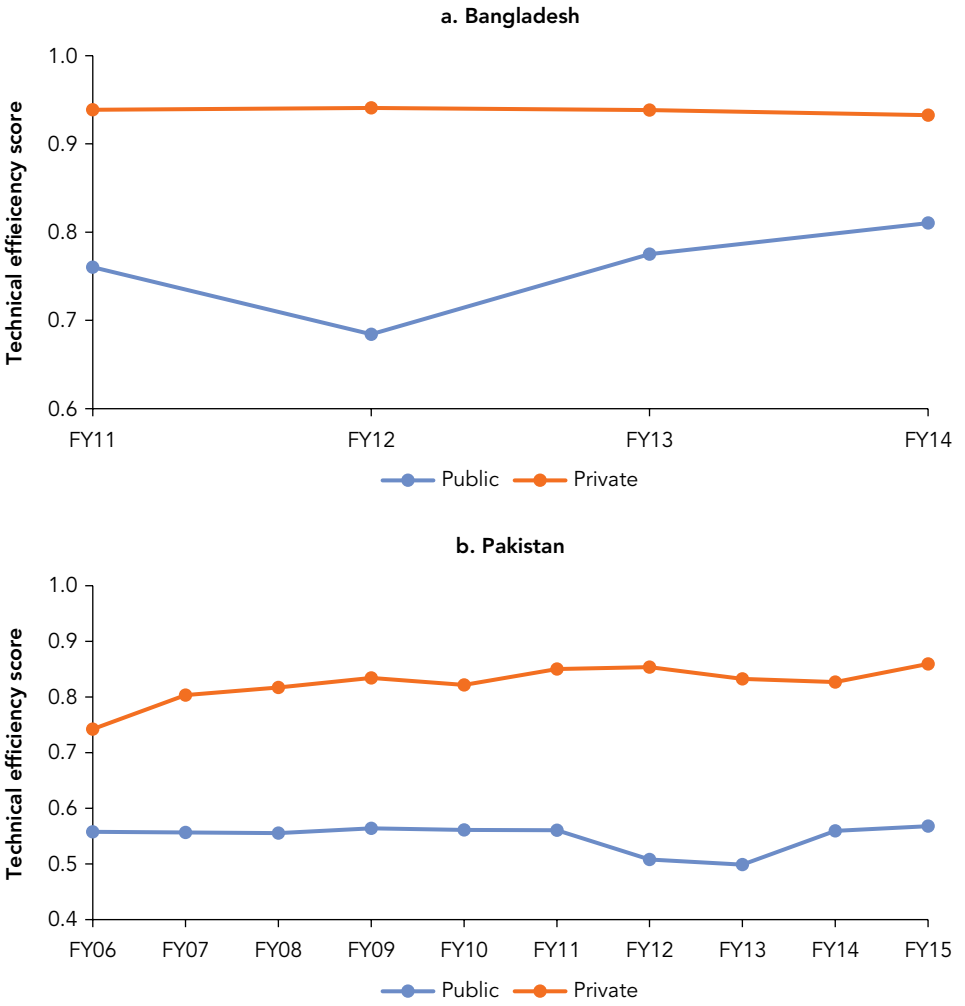
Multiple distortions have contributed to the power crisis in South Asia. They can be grouped into three categories.

INSTITUTIONAL: NO MARKET

Institutional distortions in the energy sector stem from the dominance of government ownership, the lack of competition, and soft budget constraints, under which governments have repeatedly bailed out heavily indebted utilities. Despite recent reforms, state-owned enterprises continue to dominate the sector. Government planners, not the market, allocate fuel supplies and set prices. Because the market plays a limited role in penalizing underperformance and rewarding efficiency, energy suppliers, especially public ones, face little pressure to control costs and maximize outputs.

The inefficiency of state-owned enterprises is exemplified by their performance in power generation. Using multiyear data at the level of thermal power plants, this report finds an astonishingly wide gap in efficiency between public and private plants (Figure 6). The conclusion holds even after controlling for differences in the age, capacity, location, technological, and operational characteristics of power plants. All else equal, a public plant uses substantially more fuel than a private one to produce the same amount of electricity—on average, up to 29 percent more in Bangladesh, 16 percent more in India, and 20 percent more in Pakistan. Some of this difference may be explained by the type of power purchase agreements signed by private plants, which allows them to be

FIGURE 6 Public power plants are substantially less efficient than private ones: Bangladesh and Pakistan as examples

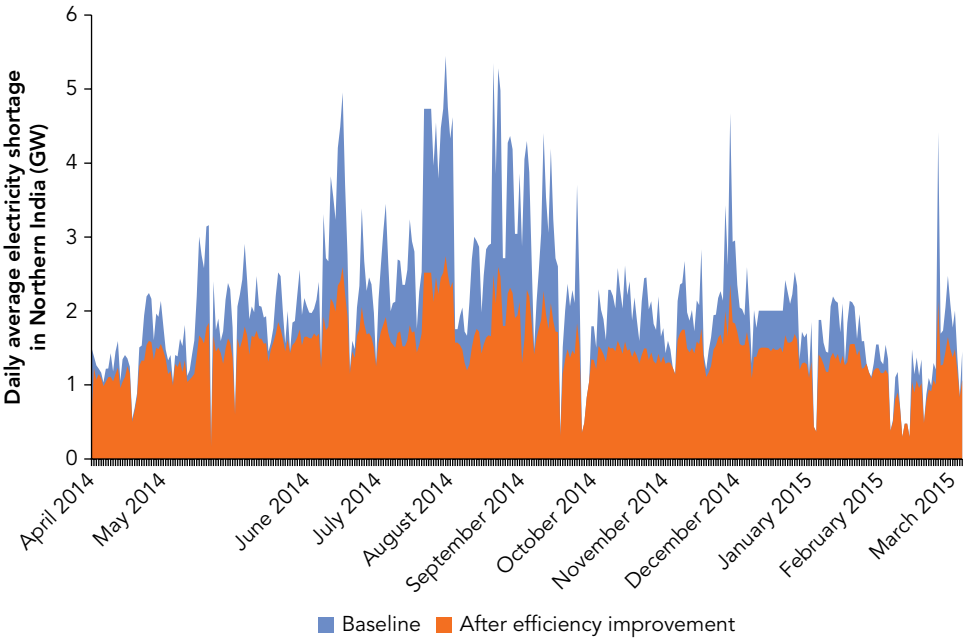


Source: Estimation based on plant-level data from Bangladesh Power Development Board (BPDB) annual reports (2011–14) and the Pakistan National Electric Power Regulatory Authority's (NEPRA) State of Industry Report (2006–15).
Note: Technical efficiency score measures the ratio of actual output to maximum feasible output. Private plants refer to independent power producers but not rental power plants in Bangladesh. FY = fiscal year.

dispatched at optimal load factors. But the efficiency gap could also reflect differences in managerial behavior across ownership types.

The inefficiency in generation imposes substantial opportunity costs, especially given the coal and gas shortages in all three countries. Simulation analysis shows that if public power plants eliminated their operational inefficiency, Bangladesh and India could reduce about 50 percent and Pakistan roughly 25 percent of their unserved energy demand with no new investment in generation capacity (Figure 7).

FIGURE 7 Institutional distortions in power generation exacerbate electricity shortages: India as an example

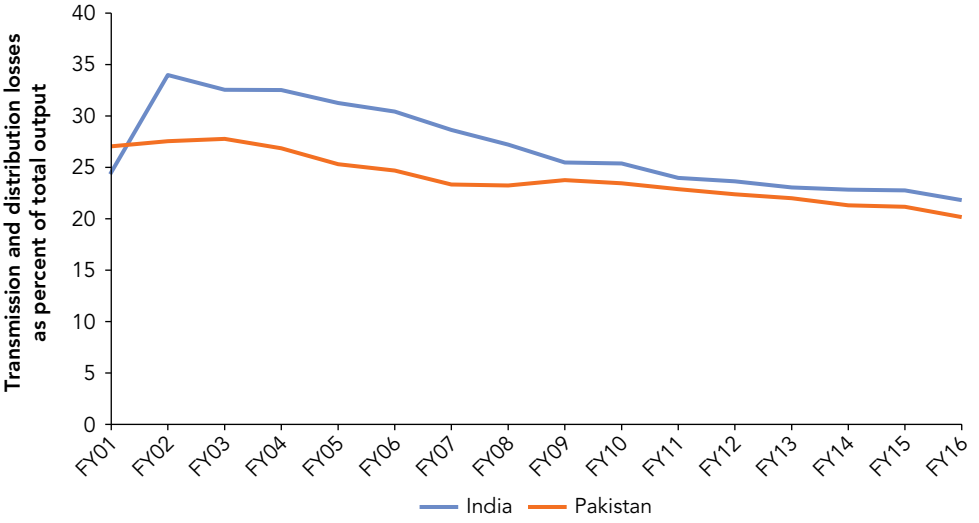


Source: Simulation based on Indian Central Electricity Authority (2000–12) and daily reports by the Northern Regional Load Dispatch Center.
Note: GW = gigawatt.

Soft budget constraints often exacerbate the inefficiency inherent in state ownership, as most evident in the power distribution sector. In India and Pakistan, hefty losses of electricity in distribution, along with poor recovery of overdue electricity bills, have given rise to alarming levels of debt in the sector and prompted repeated government bailouts. India's central government launched rescue operations to bail out loss-making distribution companies three times since fiscal 2001. In Pakistan the government periodically pays down the "circular debt" resulting from the combined losses in transmission and distribution—a debt that reached a staggering $9 billion by the end of fiscal 2012 (USAID 2013). These government rescues have not helped eliminate debt or electricity losses over the long term (Figure 8).

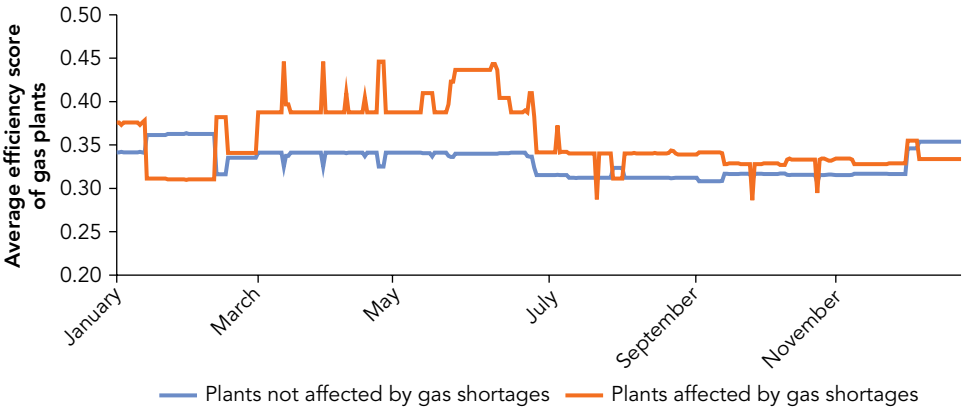
Institutional distortions also reduce allocative efficiency. In India the allocation of coal blocks (leases) favors government-owned power utilities. In Pakistan natural gas is routinely diverted from power generation to other sectors, even though gas is estimated to have the greatest economic benefit in the medium term when used in power generation (USAID 2011). In Bangladesh not only do less efficient power plants receive privileged access to gas (Figure 9) but they also are often brought into production before other generators, despite being two to three times as costly to operate (World Bank 2015b). Inefficient allocation of inputs and outputs in the electricity sector exacerbates power shortages. In Bangladesh and Pakistan,

FIGURE 8 Distribution utilities in India and Pakistan incur high electricity losses



Source: Indian Central Electricity Authority (2017) and Pakistan National Transmission and Dispatch Company (2016).
Note: FY = fiscal year.

FIGURE 9 Less efficient power plants receive privileged access to gas in Bangladesh



Source: Based on daily reports by the Bangladesh Power Development Board (January 1–December 31, 2014).
Note: Efficiency score is the ratio of electricity output to gas input in calorific value. Average efficiency is weighted by capacity.

it also increases the need for oil-based power generation, contributing to heavier emissions.

REGULATORY: MARKET BUT DISTORTED

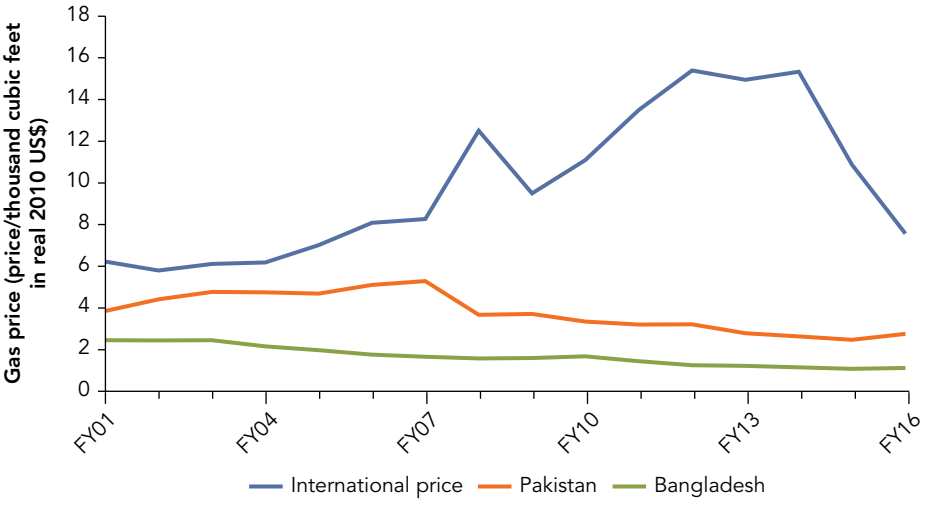
Regulatory distortions arise from subsidies and the mispricing of coal, gas, and electricity. Energy subsidies are widespread in South Asia. In addition to creating fiscal

burdens, they distort incentives for production and consumption and undermine the performance of utilities.

In the upstream fuel sector, coal and gas are priced substantially below their opportunity cost, even without factoring in their external costs to the environment. In Bangladesh the international benchmark price of natural gas is almost 11 times the domestic price for power generation. In India the price of coal for the power sector (along with the fertilizer and defense sectors) was 17 percent lower than the price charged to other sectors (CIL 2018); it was a third lower than the spot market price. Pakistan has a two-tier gas market. Imported liquified natural gas (LNG) is broadly charged at the full cost to consumers, but domestic gas was priced at roughly 36 percent of the international benchmark in fiscal 2016 (Figure 10).

Underpricing coal and gas contributes to fuel shortages, not only because it encourages wasteful energy consumption but also because it reduces suppliers' interest in upstream exploration and production. In Bangladesh and Pakistan, several large gas development projects have been abandoned because of the government's unwillingness to raise tariffs to allow cost recovery with reasonable returns. Because of the dependence on coal or gas for power generation, upstream fuel shortfalls have quickly cascaded into idled capacity downstream. Fuel shortages left an average 10 percent of gas capacity in Bangladesh and 15 percent of coal capacity in India stranded in 2014. In Pakistan shortages of gas for power generation were made up through expensive imported oil, increasing both electricity costs and trade bills.

FIGURE 10 The price of domestic natural gas is much lower than the international price in Bangladesh and Pakistan



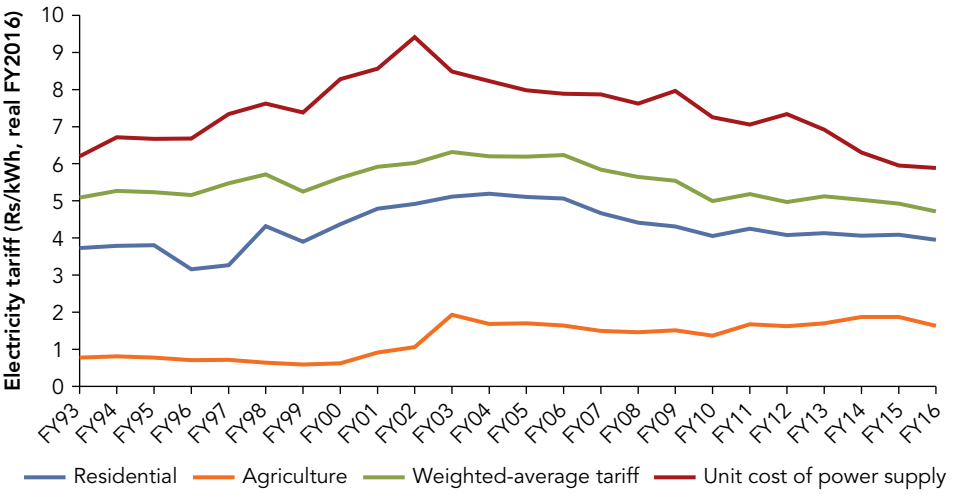
Source: Petrobangla Annual Report (2016); Hydrocarbon Development Institute of Pakistan (2001, 2007, 2014, 2016); Pakistan Ministry of Finance (2017); and the World Bank Global Economic Monitor Commodities database.
Note: FY = fiscal year.

The core electricity sector also underprices. For households and farmers, electricity is priced lower than the cost for utilities to buy it—25 percent lower in Bangladesh, and 22 percent lower in India in fiscal 2016, and 7 percent lower in Pakistan in fiscal 2015 (Figure 11). In addition, irregularities in billing and rampant theft of electricity constitute a de facto implicit subsidy. Distorted tariffs combined with unpaid subsidies have contributed to the deteriorating financial situation of distribution utilities. It not only compromises investment and maintenance (Pargal and Banerjee 2014) but also creates perverse incentives for utilities to underserve loss-making customers, especially in rural areas, where the cost of service is high.

In India, for example, analysis for this report using nighttime satellite images for 2013 shows that areas adjacent to newly electrified villages subsequently experienced worse power outages after the villages were connected to the grid. As more low-paying consumers joined the grid, distribution utilities may have been either unable or unwilling to invest in maintaining and upgrading infrastructure to expand the power supply.

Regulatory distortions also take the form of cross-subsidies between consumer groups. In the Indian rail system, for example, coal freight cross-subsidizes passenger service. This cross-subsidization leads to higher electricity prices for consumers and undermines efficiency and investment in freight rail. The resulting constraints in rail capacity have created bottlenecks in coal supply in India. Econometric analysis shows that every 1 percent increase in distance between coal mines and the power plants they serve increases the plants' coal shortage by 14 percent, reduces their utilization rate by 3 percentage points, and increases their output shortage by 10 percent on

FIGURE 11 Electricity tariffs in India illustrate the extent to which residential and agricultural consumers are subsidized



Source: Indian Power Finance Corporation (2003, 2007, 2017) and Indian Planning Commission (2000, 2001, 2002, 2012, 2014, 2015).
Note: Unit costs of power supply for fiscal 2015 and 2016 are based on annual plan projection. Domestic prices for fiscal 2002 and 2003 are interpolated because the original data files did not include them. FY = fiscal year; Rs/kWh = rupees per kilowatt-hour.

average (Figure 12). An additional 34 million tons of coal could be delivered each year if railway distortions were removed and coal shortages were no longer linked to the distance to coal mines.

In the core sector, industrial and commercial users of electricity are often overcharged to compensate for the lower rates for households and farmers (Figure 11). Although the higher electricity prices for these consumers help relieve the fiscal burden on the government, they lead to unintended consequences downstream. Because electricity is required as a primary input in nearly every sector, overcharging industrial and commercial consumers raises the prices of almost all goods and services. Meanwhile, high electricity tariffs for industry undermine export competitiveness, especially for energy-intensive producers (Figure 13). Removing the cross-subsidies could increase India's net manufacturing exports by 1–3 percent depending on the sector (Figure 13).

FIGURE 12 Distance to coal mines is correlated with worse coal shortages and lower power generation in India

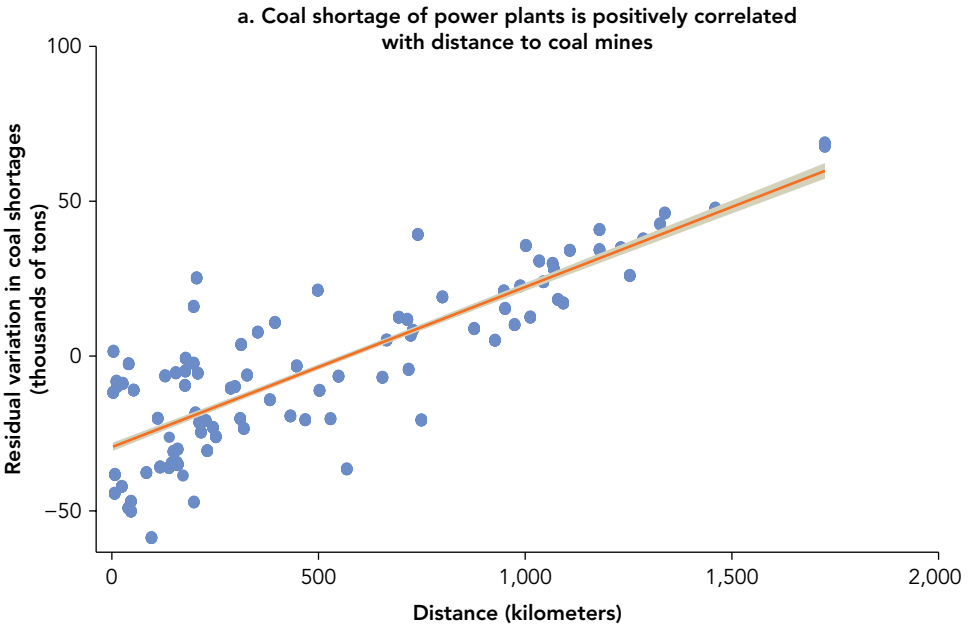


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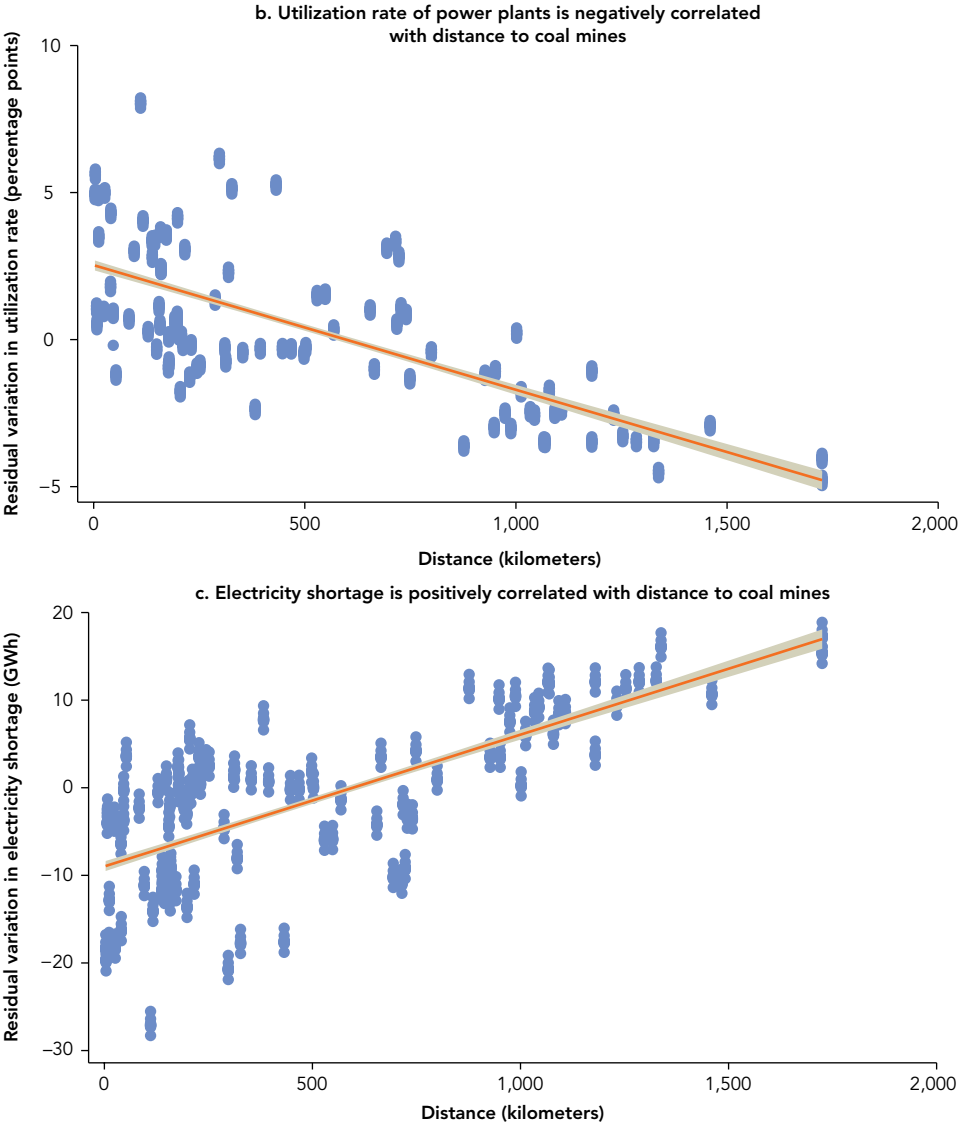
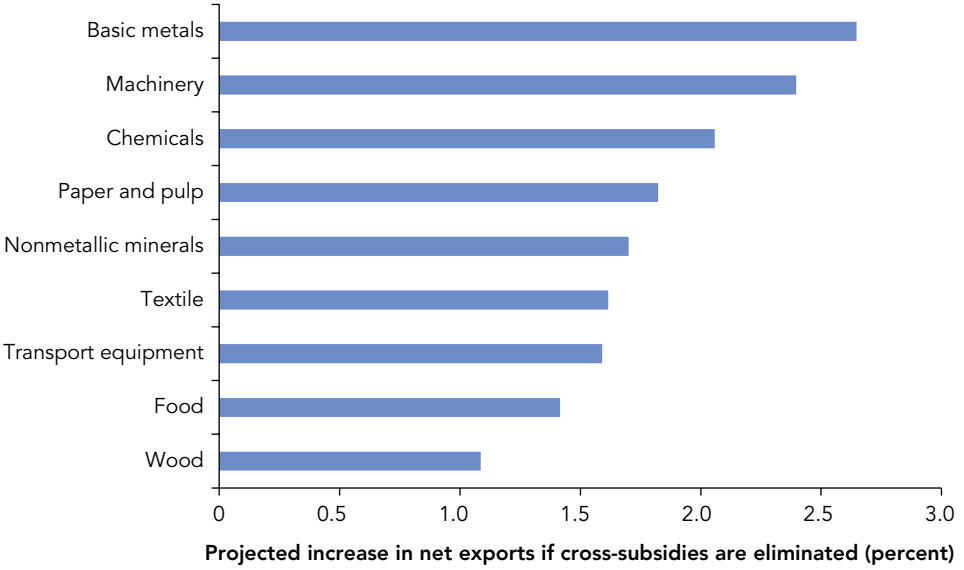
FIGURE 12 Distance to coal mines is correlated with worse coal shortages and lower power generation in India *(continued)*



Source: Coal linkage data are from the India National Thermal Power Corporation and the Central Board of Irrigation and Power. Daily actual and normative required coal stock data are from the Central Electricity Authority of India (2008–16). Data on monthly power generation of coal plants are from the Central Electricity Authority of India (2012–16).
Note: Coal shortages are daily average shortages, defined as the normative coal stock minus the actual coal stock. Electricity shortage is defined as a plant's targeted output minus its actual output. The vertical axis is the difference in residuals from regressions with and without controlling for distance between power plants and coal mines. Other independent variables in the regression include capacity, age, age squared, quality of coal, year, month, and region fixed effects. Gray shaded areas are 95 percent confidence intervals. See chapter 4 for details about the regression analysis. GWh = gigawatt-hour.

FIGURE 13 Cross-subsidies in electricity tariffs undermine the competitiveness of Indian industries



Source: Chan, Manderson, and Zhang 2017.

SOCIAL: MARKET BUT WITH EXTERNALITIES

Social distortions reflect the negative externalities of energy production and consumption, including the health costs of coal mining and combustion and the climate change effects from burning fossil fuel. In addition, in India the provision of heavily subsidized electricity to farmers for pumping water has encouraged water-intensive farming practices and triggered the depletion of groundwater.

Fossil fuels dominate the fuel mix for power generation in South Asia. In 2015 gas accounted for 81 percent of electricity generation in Bangladesh and coal for 75 percent in India. In Pakistan oil accounted for 37 percent and gas for 27 percent. In addition to contributing to climate change, emissions from fossil fuel–based power generation have well-documented adverse effects on health. In India the air pollution produced by coal-fired power plants is a leading risk factor for death, contributing to the loss of about 2.3 million years of healthy life (disability-adjusted life years) in 2015 (Global Burden of Disease MAPs Working Group 2018). Although gas is cleaner than coal, its combustion produces nitrogen oxides—precursors to ground-level ozone (urban smog) that can cause various respiratory diseases.

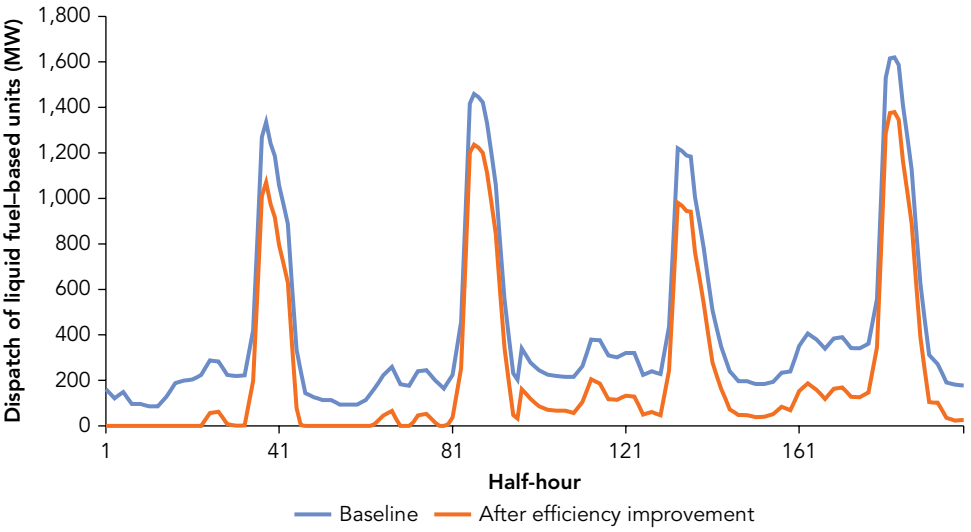
When pricing fails to account for these external costs of fossil fuel consumption, emissions are excessive. Imposing an environmental tax on emissions can be

a cost-effective way to reduce air pollution; it could also pave the way for a forceful turn toward the development of renewable energy. India is among the few countries that have introduced an environmental tax on coal consumption. But its Clean Environment Cess offsets less than 3 percent of the marginal environmental and health damage caused by coal-based power generation. Bangladesh and Pakistan have no such environmental tax.

The net social benefit from achieving full-cost pricing can be approached as the sum of avoided environmental and health damage, increased revenue from environmental taxation, and forgone consumer and producer surplus. This annual benefit is estimated at $345 million in Bangladesh, and $35.4 billion in India.

Improving the efficiency of gas allocation and use is another way to reduce pollution in Bangladesh and Pakistan. Waste in gas consumption has led to greater reliance on furnace oil and diesel for power generation. These liquid fuels are not only more expensive but they also out-pollute gas by 30–600 percent, depending on the type of emissions (IPCC 2006). Simulation analysis shows that improving fuel efficiency and channeling gas from less efficient to more efficient uses would reduce the consumption of liquid fuel and cut annual carbon dioxide emissions by 250,000 tons in Bangladesh and 1.8 million tons in Pakistan (Figure 14).

FIGURE 14 Improving the operating efficiency of gas units would reduce the use of oil: Evidence from Bangladesh



Source: Simulation based on daily reports by the Bangladesh Power Development Board, January 1–December 31, 2014.
Note: For illustration, this figure shows data for January 1–4, 2014. The pattern remains the same for the year as a whole. MW = megawatt.

Another social cost of power sector distortions comes from the heavy reliance on kerosene lighting and captive power generation in South Asia. Households and small businesses lacking reliable access to electricity turn to kerosene lamps to meet basic lighting needs, using an estimated 244 million lamps in the region (Tedsen 2013). Many studies report a strong association between kerosene lighting and tuberculosis risk and respiratory infections (WHO 2015). Analysis in this report shows that households without a connection to the grid consume 14–88 percent more kerosene than households with a connection, all else equal. In India access to electricity is associated with a 7.4 percent reduction in the number of days of illness. The health-related income loss from lack of access to electricity is estimated at at least $410 million a year (Samad and Zhang 2016).

Kerosene lamps also contribute to emissions of ambient black carbon, a major climate warmer in the atmosphere, second only to carbon dioxide. Black carbon remains in the atmosphere for only a few days, but during that time a single gram has several hundred times the global warming impact that the same amount of carbon dioxide has over 100 years (Jacobson and others 2013). Black carbon emissions also contribute to snow and ice melting in the Himalayas and increase the disruption of the South Asian monsoon patterns (Shindell and others 2012).

South Asia already experiences some of the greatest warming effects of black carbon emissions from residential kerosene lighting (Map 2). The annual environmental cost of black carbon emissions from kerosene lighting is estimated at $0.6 million in Bangladesh, $6.4 billion in India, and $2.1 million in Pakistan.

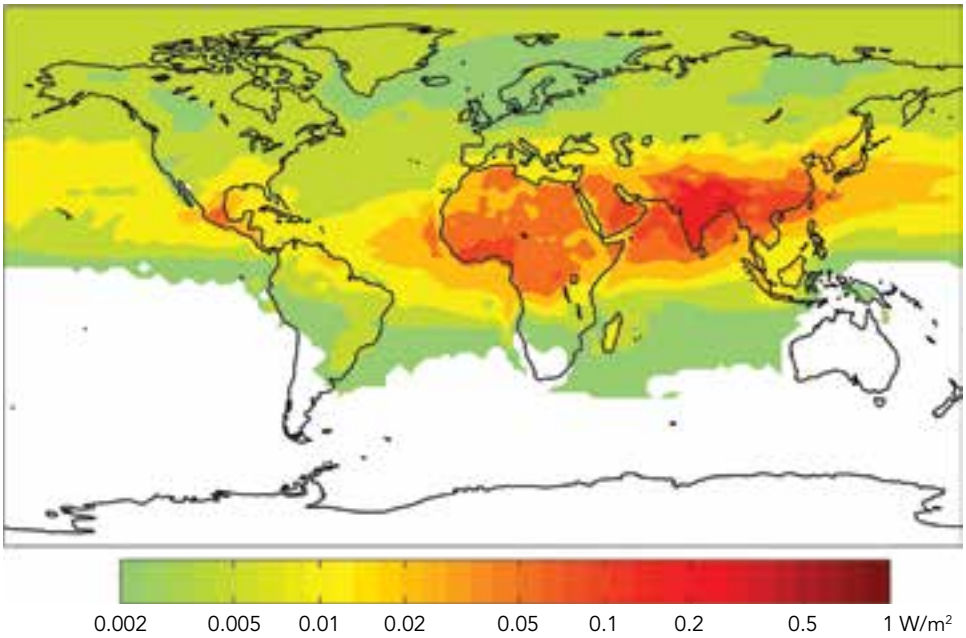
Another consequence of unreliable access to grid electricity is the increased use of fossil fuel–based captive generation, such as diesel generators. Captive generators are usually less efficient than utility-scale power plants. They are also located closer to population centers and at ground level (without high stacks of utility power plants). For all of these reasons, they are likely to have a greater environmental effect for a given amount of electricity produced.

Another social distortion stems from electricity subsidies for agriculture, which have contributed to the overexploitation of groundwater, particularly in India and parts of Pakistan (Figure 15). Electricity tariffs for the agricultural sector were estimated to be 70 percent lower than the average cost of electricity supply in India in fiscal 2016 (Indian Planning Commission 2015; Power Finance Corporation 2017).

Empirical evidence shows that farmers are price sensitive in their use of irrigation water (Veettil and others 2011). When the cost of water extraction is artificially low, farmers are less likely to adopt water-conserving irrigation technologies and more likely to shift to water-intensive crops such as rice. Many studies show a link between excessive agricultural electricity use and groundwater depletion (Badiani and Jessoe 2013).

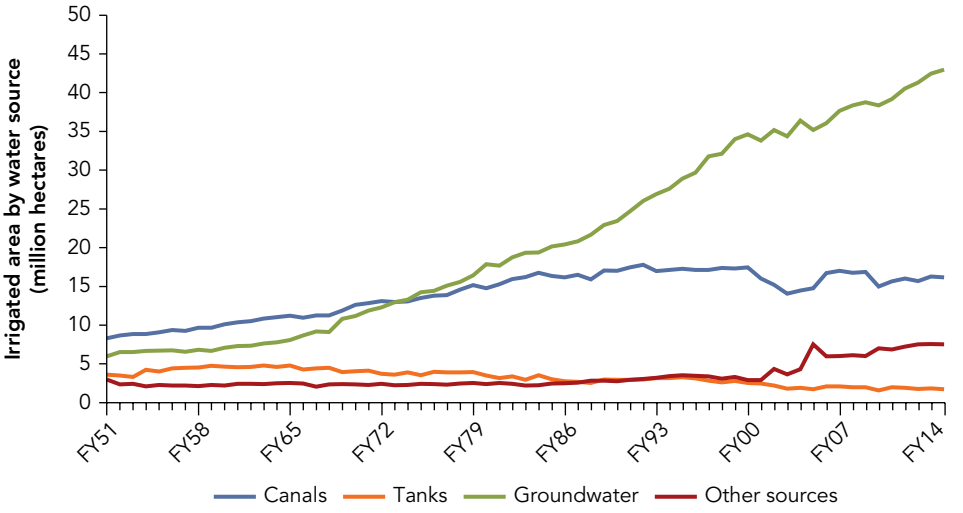
Satellite images reveal a strikingly high rate of groundwater extraction in India. Groundwater extraction in Rajasthan, Punjab, and Haryana (including Delhi) in

MAP 2 Warming effects of black carbon emitted by kerosene lamps are greatest in South Asia



Source: Lam and others 2012.
Note: W/m² = watts per square meter.

FIGURE 15 Groundwater extraction has surged in India



Source: Indian Ministry of Agriculture and Farmers Welfare, accessed through Indiastat.
Note: FY = fiscal year.

2002–08 was equivalent to a net loss of 109 cubic kilometers—twice the capacity of the country's largest surface-water reservoir (Rodell, Velicogna, and Famiglietti 2009). This rate of extraction is unsustainable. With about 60 percent of agriculture depending on groundwater for irrigation, and 85 percent of the rural population and 45 percent of the urban population relying on it for drinking water, the depletion of groundwater poses a significant risk to long-run food and water security in India (Sekhri 2013).

Conclusion

The full cost of distortions in the power sector is far greater than previously estimated on the basis of fiscal cost alone. Some of the largest costs are upstream or downstream, making the case for a stronger prioritization of power sector reform.

The total annual economic cost of power sector distortions is conservatively estimated at about $11.2 billion in Bangladesh (5.0 percent of GDP) in fiscal 2016, $86.1 billion (4.1 percent of GDP) in India in fiscal 2016, and $17.7 billion (6.5 percent of GDP) in Pakistan in fiscal 2015. In Bangladesh the underpricing of gas is the largest source of economic cost, responsible for an annual loss of $4.5 billion (2.0 percent of GDP). In India the environmental effects from excessive coal use are the largest source of cost, estimated at $35.4 billion a year (1.7 percent of GDP). In Pakistan the impact of the lack of reliable access to electricity on households and firms is the largest source, costing roughly $12.9 billion a year (4.8 percent of GDP).

These results suggest that the potential gains from power sector reform are huge. They include cost savings for utilities; income gains for households and firms; reductions in air pollution and health damage for the population; and lower subsidies to state-owned utilities, higher tax revenues, and lower public health spending for governments.

It is important to make power sector reform a top priority. Few other reforms could quickly yield economic gains of a similar magnitude. By expanding access to electricity and improving the quality of supply, power sector reform would also directly benefit poor households. A narrow focus on liberalizing the price of electricity should be avoided, however, because regulatory distortions in the core sector of electricity are often not the most important source of economic cost; and, in the absence of institutional reforms, inefficiencies of energy companies are passed onto consumers. The highest payoffs are likely to come from institutional reforms, the expansion of reliable access to electricity, and the appropriate pricing of carbon and emissions of local air pollutants.

POLICY RECOMMENDATIONS

The analysis points to several implications for the implementation of reforms.

Focus beyond the Core Sector

Achieving a reliable and sustainable electricity supply requires looking beyond the core power sector to address distortions in the upstream fuel sector. Doing so calls for measures to introduce effective competition in an otherwise monopolistic fuel market and to limit the government's political interference in operation and investment.

Pricing reform is also important. Fuel subsidies do not always have a large direct budgetary impact, but their opportunity cost is much greater than that of electricity subsidies in South Asia. Pricing that reflects the full economic cost of fuel would encourage production, curtail demand and emissions, and facilitate the efficient allocation of fuel across sectors. Diversifying the fuel portfolio to include different types and sources of fuel—by, for example, increasing regional energy cooperation and scaling up the development of previously untapped renewable resources—makes sense, because depending primarily on a single fuel raises reliability concerns.

Think beyond Investment

Although urgently needed in some segments of the power sector, investment alone is unlikely to solve the power crisis in South Asia. A big contributor to power shortages is inefficiency. Competition and private participation can improve operating efficiency. Competition can be promoted by ensuring nondiscriminatory access to fuel for public and private producers alike, by dispatching generation in merit order from lowest to highest cost, and by removing discriminatory charges on consumers buying electricity from the open market. In addition to outright privatization, other ways to tap private sector initiative include franchise arrangements in electricity distribution and contracts to outsource system operations and maintenance. In the absence of market competition, incentive-based regulation—such as price cap and yardstick competition mechanisms—can be used to reward more efficient operation. It is also important to prioritize investment to address electricity supply bottlenecks. With greater private sector participation and a more decentralized investment pattern, pricing mechanisms such as locational marginal pricing for transmission can provide signaling on where investment should be targeted.

Reform beyond Corporatization

Corporatization has been a key government strategy for power sector reform in South Asia. But, without fundamental changes in incentive structures, it is no guarantee of meaningful changes in performance. Because the government remains the controlling owner, corporatized utilities are still susceptible to political pressure. Moreover, the separation of management and control implies asymmetric information and agency costs. And, with or without corporatization, when firms believe that they will not be allowed to fail, they have little incentive to reduce losses. The effectiveness of corporatization thus depends on preventing inefficient political interference and soft budget constraints.

Floating newly corporatized companies on the stock market, which can play a unique role in monitoring and rewarding managerial efforts, has also been shown to help turn around firm performance.

Prioritize Quality, not Just Access

Achieving universal access to electricity brings a broad range of social and economic benefits and should remain high on governments' agenda. But merely ensuring connectivity is not enough. Unreliable supply of electricity discourages households and businesses from adopting electricity and limits the potential gains from electrification. As a result of regulatory and political imperfections, grid extension can undermine the quality of electricity service. Where electricity prices are too low to recover costs, adding new electricity connections inevitably puts greater strain on the grid because the system is forced to absorb more loss-making customers. Electoral incentives may create a bias favoring short-term, more visible investment in grid extension over long-term, hidden efforts in grid maintenance. In a budget-constrained environment, the drive toward quantity can come at the expense of quality for both existing and new customers.

To ensure the quality of electricity supply, it is important to remove electricity subsidies, so that utilities have the resources to invest in the long-term reliability of the grid. Cost-recovery tariffs also eliminate perverse incentives to underserve loss-making customers.

A powerful way to improve quality is to engage citizens in monitoring service delivery. Also critical is improving the collection and sharing of data on power outages. Understanding where and whose power gets cut improves accountability. Where utilities may underreport load shedding or resist sharing outage data, high-frequency satellite imagery of night lights data can provide an alternative means of monitoring power supply disruptions in close to real time.

Accompany Reforms with Compensation

Energy price reform requires large price increases. But price hikes can cause immediate economic distress, especially for the poor and vulnerable. Raising prices gradually while providing targeted social assistance can mitigate their impact. Phasing out subsidies following a preannounced schedule reduces policy uncertainty and allows consumers to smooth out adjustment costs over time. Scaling up existing social programs or implementing new ones can protect the poor from immediate price shocks. To offset price increases, efforts are also needed to improve efficiency on both the supply and demand side. Many countries have used energy-efficiency programs to ensure affordable energy for low-income households.

Putting a price on emissions would also prompt countries to move toward renewables and away from fossil fuel–powered electricity. Although new jobs and

opportunities are created during the process, workers in communities reliant on the fossil fuel industry could experience massive social and economic disruptions. Retraining programs and strategies for pursuing greater economic diversification in the local economy are needed to ensure a just transition of the workforce.

OUTLINE OF THE REPORT

The report is organized as follows:

Chapter 1 presents an overview of power sector distortions in South Asia. It discusses the mechanisms and consequences of the three types of distortions in the upstream, core, and downstream segments of the power sector in all three countries.

Chapter 2 presents the methodological framework and theoretical foundation and illustrates how distortions are measured in practice. It also describes the main data sets used and discusses the limitations of the analysis.

Chapters 3–5 present country-specific analysis. They provide institutional background, illustrate analytical approaches, and present detailed estimation results for each country.

Chapter 6 addresses interactions across distortions and offers policy implications for power sector reform.

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Electricity shortages are among the biggest barriers to South Asia's development. Some 255 million people—more than a quarter of the world's off-grid population—live in South Asia, and millions of households and firms that are connected experience frequent and long hours of blackouts.

Inefficiencies originating in every link of the electricity supply chain contribute significantly to the power deficit. Three types of distortions lead to most of the inefficiencies: institutional distortions caused by state ownership and weak governance; regulatory distortions resulting from price regulation, subsidies, and cross-subsidies; and social distortions (externalities) causing excessive environmental and health damages from energy use.

Using a common analytical framework and covering all stages of power supply, *In the Dark* identifies and estimates how policy-induced distortions have affected South Asian economies. The book introduces two innovations. First, it goes beyond fiscal costs, evaluating the impact of distortions from a welfare perspective by measuring the impact on consumer wellbeing, producer surplus, and environmental costs. And second, the book adopts a broader definition of the sector that covers the entire power supply chain, including upstream fuel supply and downstream access and reliability.

The book finds that the full cost of distortions in the power sector is far greater than previously estimated based on fiscal cost alone: The estimated total economic cost is 4–7 percent of the gross domestic product in Bangladesh, India, and Pakistan. Some of the largest costs are upstream and downstream.

Few other reforms could quickly yield the huge economic gains that power sector reform would produce. By expanding access to electricity and improving the quality of supply, power sector reform would also directly benefit poor households. The highest payoffs are likely to come from institutional reforms, expansion of reliable access, and the appropriate pricing of carbon and local air pollution emissions.

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