

AUGUST 2021

Tangled Wires: Preparing India's Power Sector for the Clean Energy Transition

Jonathan Kay

Tangled Wires: Preparing India's Power Sector for the Clean Energy Transition

Jonathan Kay

The Carnegie Endowment is grateful to the UK Foreign, Commonwealth and Development Office for research funding that helped make the writing of this paper possible. The views contained herein are those of the author alone.

© 2021 Carnegie Endowment for International Peace. All rights reserved.

Carnegie does not take institutional positions on public policy issues; the views represented herein are those of the author(s) and do not necessarily reflect the views of Carnegie, its staff, or its trustees.

No part of this publication may be reproduced or transmitted in any form or by any means without permission in writing from the Carnegie Endowment for International Peace. Please direct inquiries to:

Carnegie Endowment for International Peace
Publications Department
1779 Massachusetts Avenue NW
Washington, DC 20036
P: + 1 202 483 7600
F: + 1 202 483 1840
CarnegieEndowment.org

This publication can be downloaded at no cost at CarnegieEndowment.org.

Contents

Summary	1
Introduction	3
A New Era of Intermittent Energy	5
Addressing Variability Through Regional Coordination	7
Distribution Dysfunction	10
Breaking the Cycle	13
Conclusion	17
About the Author	21
Acknowledgments	21
Notes	23
Carnegie Endowment for International Peace	31

Summary

Almost none of the world's largest polluters have enacted policies compatible with the Paris Agreement's target of limiting global warming to within 2 degrees Celsius, a threshold past which climate disruption is projected to become even more frequent, severe, and unpredictable.

Fortunately, despite the absence of adequate government support, renewable energy has grown at an astonishing pace in recent years thanks to its plummeting cost. India, for example, has more than doubled its stock of wind and solar power in the last five years, driven less by sustainability concerns than by clean energy's potential for cost-effectively meeting citizens' pressing development needs.

However, the low prices of wind and solar projects disguise the structural costs renewable energy poses for grids when deployed at larger scales. The intermittent, unpredictable nature of the electricity generated by such technologies—in contrast to the stable, on-demand flow of power from traditional fossil fuel generation—requires fundamental changes to how countries invest in and operate their grids.

For India, one of the most important steps for coping with the variability of these new sources of energy will be better coordination of the flow of power between the country's disparate state-run grids. By increasing the volume of energy traded between state utilities, periods of surplus power in one region can compensate for deficits in others, making for a more stable and reliable supply of renewable energy—one that can better displace expensive and polluting fossil fuels.

Yet, while such reforms would be difficult under the best of circumstances, they will be particularly challenging given the unique dysfunctions of India's power sector. With its politically compromised, perennially loss-making electricity distribution companies already struggling to keep the lights on, bolder change appears unlikely. Deeper reforms to India's power sector are therefore prerequisites to adopting solutions like regional coordination that can ensure the continued growth of renewable energy.

The good news is that Prime Minister Narendra Modi's national popularity and the dominance of his Bharatiya Janata Party (BJP) at the state level offer the country's leaders an opportunity to reform the power sector where others have failed. But to take advantage of this opening, Modi must go beyond his modus operandi by investing in incremental institutional solutions rather than one-and-done technical fixes and by serving as a coordinator for India's states rather than legislating by central fiat.

Deeper reforms enabling India to maintain its rapid expansion of renewable energy not only would provide clean, low-cost power to its people but also would help the world offset the failings of more laggard countries, perhaps even putting back within reach the Paris Agreement's more aggressive target of keeping global warming to within 1.5 degrees Celsius. But the hardest part of this ambitious task lies ahead—in ending the vicious cycles that have plagued India's power sector for decades.

Introduction

India's spectacular embrace of renewable energy is a rare reason for optimism in the fight against climate change. The world's third-largest carbon emitter has more than doubled its stock of wind and solar power in the last five years, making it one of the only countries in the world whose policies appear compatible with the Paris Agreement's target of limiting global warming to within 2 degrees Celsius—a threshold past which climate disruption is projected to become even more frequent, severe, and unpredictable.¹

Yet the hardest part is still to come. Fossil fuels like coal, which currently accounts for a majority of India's power-generating capacity, produce a stable and predictable stream of on-demand power. By contrast, power generation from wind and solar energy is more variable and unpredictable: wind turbines only generate electricity when the wind is blowing, and solar panels only generate electricity when the sun is shining. As a result, grid operators may not be able to fully rely on these forms of variable renewable energy, forcing them to turn back to fossil fuel generation. This challenge increases emissions and costs in the short term and slows the buildout of renewable energy in the long term.

Coping with variable renewable energy like wind and solar will therefore require deeper changes to how India manages its grid. One of the most important solutions will also be one of the most difficult: the integration of the country's disparate state-run electricity grids into a more coordinated system capable of using periods of surplus power in one region to compensate for deficits in another. In this way, variable renewable energy can more efficiently service larger geographic areas and more reliably displace expensive and polluting fossil fuels.

However, while such reforms would be difficult under the best of circumstances, they will be particularly challenging given the unique dysfunctions of India's power sector. A long history of politicians manipulating power distribution companies for the sake of short-term electoral objectives has compromised utilities' finances and the independence they need to undertake structural reform. Without addressing these more fundamental problems, clean energy-enabling solutions like regional coordination are unlikely to succeed.

Fortunately, Prime Minister Narendra Modi's national popularity and the dominance of his Bharatiya Janata Party (BJP) at the state level offers the country's ruling coalition an opportunity to reform the power sector where others have failed. To take advantage of this opening, however, Modi must go beyond his modus operandi, investing in incremental institutional solutions rather than one-and-done technical fixes and serving as a coordinator for India's states rather than legislating by central fiat.

One potential solution would be to organize a mutually reinforcing package of state-level power sector reforms undertaken by a coalition of the willing formed around a core of BJP-led state governments where Modi can use his personal influence to ensure follow-through. Such a reform package would include the narrower task of encouraging increased regional coordination of energy exchange as well as a broader, complementary set of reforms focused on the pathologies of the distribution companies themselves.

Modi and the BJP have strong incentives to invest in such overdue changes. Enabling India's clean energy transition through comprehensive power sector reform would complement other components of the BJP's agenda, including support for India's domestic manufacturing sector and the electrification of rural households. Perhaps most importantly, while India's adoption of renewable energy to date has been primarily motivated by development concerns rather than sustainability, that might change as the impacts of climate change grow more severe—particularly given the country's heightened vulnerability to climate change due to its reliance on agriculture, proximity to rising sea levels, and high levels of poverty.

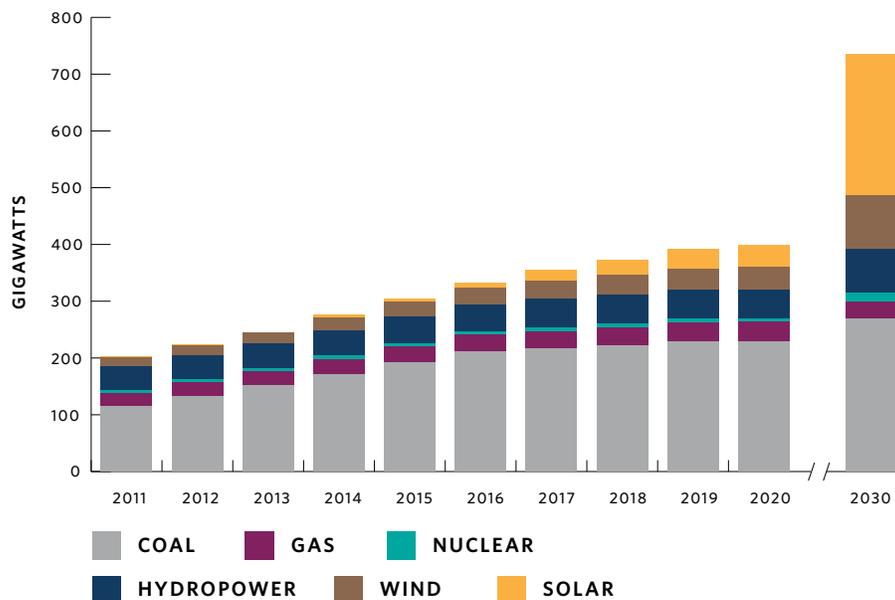
Deeper reforms enabling India to maintain its rapid expansion of renewable energy not only would provide clean, low-cost power to its people but also would help the world offset the failings of more laggard countries, perhaps even putting back within reach the Paris Agreement's more aggressive target of keeping global warming to within 1.5 degrees Celsius. But the hardest part of this ambitious task lies ahead—in ending the vicious cycles that have plagued India's power sector for decades.

A New Era of Intermittent Energy

India has long refused in international negotiations on climate change to adopt specific commitments to reduce its carbon emissions, arguing that it and other developing countries should not have to respond as rapidly as wealthy industrialized nations given the former's pressing development needs and low share of historical emissions.²

Yet despite Western countries' fears that India would become a "spoiler" for international cooperation on climate change, New Delhi's development-first stance has proved compatible with a rapid shift toward decarbonizing its energy sector, which constitutes the single largest source of its carbon emissions.³ Installation of new generating capacity for renewable energy in India has outpaced that of fossil fuels in recent years, making the country home to the fifth-largest supply of renewable energy in the world.⁴ New Delhi recently set its sights on further expanding its supply of renewable energy to 450 gigawatts by 2030 (see figure 1)—a number that would constitute a majority of its total energy capacity and be roughly equal to the current combined renewable energy resources of the United States, Japan, and France.⁵

Figure 1. India's Energy Capacity, Past and Projected



Source: IRENA (2021), IEA (2021), Global Energy Monitor (2021), MOSPI (2021)

Consistent with its international rhetoric, India's embrace of clean energy has been motivated more by developmental concerns than by sustainability per se; climate change ranks low among Indian voters' priorities.⁶ The plummeting cost of solar and wind energy have made renewables cheaper than fossil fuels in most states, offering the chance to simultaneously improve citizens' electricity access, throw a lifeline to India's bankrupt public utilities, and slow the growth of India's carbon emissions.

However, India's current approach to managing its grid means that this synergy may not last. The more wind and solar power that the country installs, the harder and more expensive such energy will be to use, threatening to put the brakes on the nation's transition to clean energy.

Solar and wind energy pose a problem that traditional forms of fossil fuel generation do not: intermittency. Whereas coal or natural gas power produce a stable, continuous flow of electricity, solar panels only generate power when the sun is shining, and wind turbines only generate power when the wind is blowing. Wind and solar generators therefore are expected to stay idle for portions of the day and year. However, while much of this variation obeys certain trends—solar energy generates the most power when the sun nears its zenith, for example, while India's wind output peaks during monsoon season—the precise scale of such variation is unpredictable.

When a cloud bank passes above a solar farm or a dying wind makes the turbines go still, grid operators must find a replacement source of energy. The typical solution is to turn to more reliable forms of power generation like fossil fuels that can produce power on demand. Yet because such power plants cannot be brought online or off-line instantly or without cost, grid operators prefer to keep a stream of stable fossil fuel generation on and running for hours or days at a time as a backstop to the vicissitudes of variable renewable energy (VRE).

The downside of this strategy is that, when wind and solar energy hits their peaks, the grid may already be getting all the energy it needs from the fossil fuel backstop. When this happens, VRE generators are consequently curtailed, prevented from selling their energy to the grid.

The immediate environmental cost of curtailment is obvious: clean VRE that could be displacing polluting fossil fuels is prevented from doing so. Furthermore, in the long term, the losses from such curtailment to solar and wind operators' profits may prevent them from constructing more generation capacity going forward. Curtailment also raises the price of energy for consumers since, unlike coal or natural gas, the fuel for VRE—sunlight and wind—is free. Therefore, every additional megawatt of power generated at these facilities is produced at an extremely low marginal cost.⁷ Finally, during periods when VRE *can* meet a majority of energy demand, the fossil fuel plants stabilizing the grid decrease their output by running at lower factor capacities, which usually makes them even more inefficient, expensive, and polluting to operate than usual.⁸

Without measures to adapt, these problems will only worsen as India grows the share of VRE capacity on its grid from 18 percent today to a target of over 40 percent by 2030 (according to International Energy Agency projections).⁹ While the total generating capacity available to the country's grid at peak solar and wind output—say, on a gusty spring day with clear skies—might increase, the floor of fossil fuel generation needed to fill in the gap when VRE approaches nil remains largely the same. This means that increasing amounts of VRE are competing to meet the same energy demand left over after the fossil fuel backstop takes its share—unless the fossil fuel backstop itself can be reduced.

Addressing Variability Through Regional Coordination

While some amount of curtailment is unavoidable at higher levels of VRE, there are several strategies to minimize it. One solution is to ensure that the grid enjoys a more stable and reliable supply of renewable energy in the first place by coordinating energy supply over as wide a geographic area as possible.

Transmission lines connect the whole of India into a single national grid. Responsibility for the electricity that passes through that grid, however, largely rests with the states, most of whom give responsibility for procuring and distributing electricity to state-owned power distribution companies, or discoms.¹⁰ Discoms typically purchase the bulk of their power through one-on-one, long-term contracts with particular generating facilities within their own state.

One problem with this approach is that, at the level of a single state, the weather conditions that affect VRE output change rapidly, meaning that supplies of wind or solar energy can peak or fall dramatically in a matter of minutes or seconds. These rapid fluctuations force each state's grid operators to maintain a larger cushion of fossil fuel generation to cope with unexpected drops in VRE output.

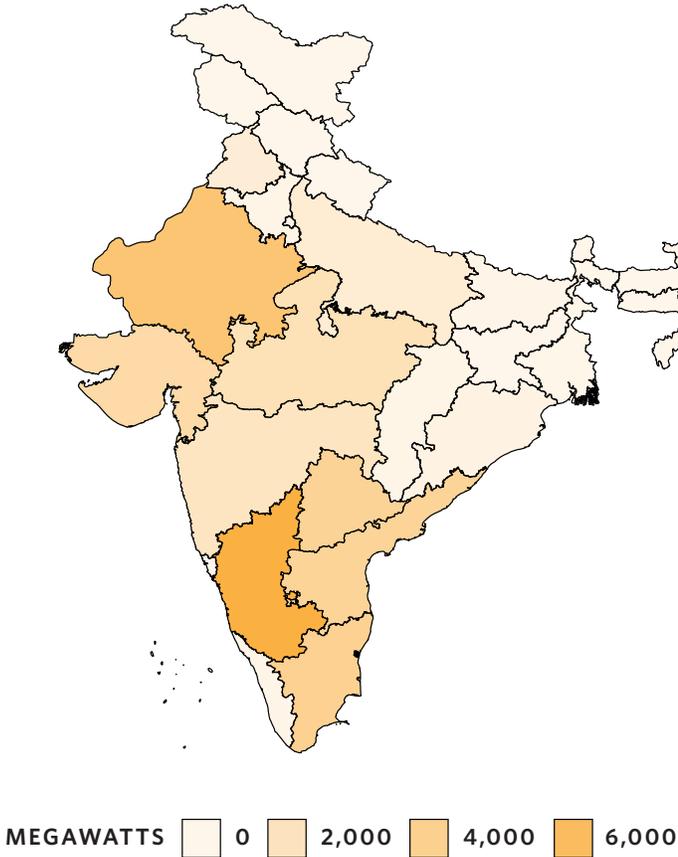
However, the average meteorological conditions experienced across several states are more predictable, with momentary troughs in one area typically balanced by momentary peaks in another. If grid operators were to coordinate to efficiently source and dispatch generation capacity across a larger geographic area, they would be able to draw from a larger and more stable pool of VRE—and thus turn off some of their fossil fuel plants.

Regional coordination also helps diversify the kinds of renewable energy in the grid by allowing the strengths of some states to complement the weaknesses of others. Some states may enjoy plentiful supplies of solar energy but little in the way of wind power, for example,

The benefits of regional coordination are obvious, and several studies have found such coordination to be one of the most important steps in the next decade for reducing India’s curtailment of VRE.¹³ Nevertheless, despite a proliferation in recent years of forums for trading energy across state lines, states continue to procure the vast majority of their energy from in-state generators.¹⁴ For example, as things stand now, if Tamil Nadu were to find itself curtailing a surplus of wind energy in the same moment that adjacent Karnataka were ramping up coal production to meet an energy deficit, the two states likely wouldn’t exchange power. As a result, Karnataka would pay for expensive and polluting coal power, and wind farm operators in Tamil Nadu would shut off their clean energy rather than making a profit. Each state would lose money and pollute more.

One possible obstacle to regional coordination is cost: accommodating an increased flow of electricity between states and regions without congestion requires significant investments in transmission infrastructure.¹⁵ However, this investment would likely be more than offset by the more efficient use of generation capacity—and greater use of cheap renewable energy—that increased energy exchange between states would enable.¹⁶

Figure 2b. India’s Installed Solar Capacity by State



Source: MNRE (2021)

The deeper obstacle to regional coordination is precisely that, however much money such coordination might save in the long run, state utilities have even stronger incentives to prioritize shorter-term interests—including by maintaining personalized control over energy dispatch rather than committing themselves to a more independent and centralized system. The reasons for this disconnect lie in a decades-long history of political capture and financial disarray that has left India's power companies tools of politics first and effective utilities second.

Distribution Dysfunction

One of the state's foremost priorities in India's early years as an independent country was the provision of electricity to its citizens through the expansion of its grid and investment in new generation capacity.

Fortunately, in many states, cheap coal and hydropower were plentiful. Yet the combination of this natural abundance and the importance of electricity to India's citizens created a huge temptation for states to give out electricity for free to shore up voters' support. The power sector quickly became an instrument of mass patronage.¹⁷

Before long, as India's electricity demand grew, states could no longer afford to offer steep electricity subsidies while still paying to lay down new transmission lines and build new power plants. Yet voters had grown used to receiving these subsidies, and politicians had grown used to giving them out to win support from key constituencies. Consequently, rather than raise prices, most states turned to a system called cross-subsidization: charging industrial consumers like factories more for their power and using the profits to maintain subsidies for key voting blocs like farmers.

Yet this strategy, too, soon ran into problems. For one thing, some industrial consumers disconnected from the grid entirely, generating their own electricity from on-location power plants, which meant they were no longer financing consumer subsidies.¹⁸ Additionally, by raising the cost of doing business, the cross-subsidy regime likely depressed the growth of the country's industrial sector itself, and thus its ability to pay inflated electricity bills.¹⁹

Commandeered by politicians and severed from the accountability of market forces, the discoms' operating losses have mounted over the years, forcing them to cut back on investments in generation, the grid, and consumer billing infrastructure. This state of affairs has only led to further losses: even after years of attempted reforms, more than one-fifth of the power sent to Indian consumers today is either lost en route due to poor distribution infrastructure or never billed at all, roughly twice the share in other South Asian countries like Bangladesh

or Sri Lanka and four times that in the United States or China.²⁰ Inadequate investment has also led to chronic power shortages, which themselves have in some cases been triaged in favor of key electoral constituencies.²¹

In principle, both politicians and consumers have incentives to reform the system. Massive losses in the power sector strain India's public finances, cut into funding for other programs, and ultimately depress economic growth. Meanwhile, consumers may get subsidized electricity, but only in exchange for frequent blackouts. However, apart from a few success stories—including in Gujarat under the leadership of then chief minister Modi—reforms have proved elusive, and a vicious cycle of discom debt and low-quality power has endured.²²

One problem is credibility. Investing in power infrastructure often requires immediate increases in prices but may take years to yield any results, so consumers have to believe that governments will actually deliver on their promises of higher quality power in the future. Yet governments often either lack the discipline to think on this kind of time horizon or simply worry that the voters will fail to remain committed to such an arrangement.²³ Indeed, many would-be reformers have been ejected from office before their work could be completed, only to see the next ruling party return to the old cross-subsidies system.²⁴ As a result, the condition of most states' power sectors has remained largely unchanged for decades.

The most comprehensive study to date of the state politics of energy distribution in India, *Mapping Power*, concluded that there is no single solution to these vicious cycles, or even necessary conditions for success.²⁵ When states enjoy the financial cushion of cheap power or plentiful revenue from industrial consumers, for example, they may be better able to invest in new infrastructure without immediately increasing the prices consumers pay for electricity, but they may also feel less pressure to reform in the first place.²⁶ The electoral landscape also matters: the presence of substantial numbers of urban or industrial customers willing to pay more for high-quality electricity or the absence of well-organized farmers' movements with incentives to retain subsidies may both be conducive to reform.²⁷ However, states without these conditions have sometimes succeeded in reforming where states enjoying both conditions have failed.²⁸ Meanwhile, states with stable political leadership may be more likely to reform than those experiencing frequent changes between ruling parties, where politicians have less latitude to think beyond the next election.²⁹ Nevertheless, parties in power for several successive administrations can still fail to move the needle.³⁰

The enduring dysfunction of India's discoms is perhaps one of the most important barriers to the country's economic development today, with poor-quality power acting as a drag on economic development while the power sector's disastrous finances soak up public funds that could be used for more targeted investments or welfare initiatives.³¹ Furthermore, so long as discoms remain financially insolvent, politically compromised, and insulated from the pressure to turn a profit, they will also pose an obstacle to India meeting its renewable energy goals—starting with regional coordination.

One general problem is that even if investments in the transmission infrastructure necessary to engage in regional coordination would be offset by savings over time, discoms often neglect long-term planning in favor of a short-term fixation on stopping the bleeding of revenue losses.³² Whether from a lack of foresight or a simple lack of funds, they might opt for solutions with lower upfront costs that are ultimately more expensive over their lifespan, such as building more coal plants than necessary, for example, rather than making the structural changes necessary to take full advantage of potential new renewable energy capacity. In such cases, solutions like regional coordination that require significant costs and efforts up front but pay for themselves over multiple administrations may never be seriously considered.

Discoms also have more specific motivations to resist regional coordination and the increase in interstate energy trade it would entail. Remaining in exclusive relationships with in-state power generators, for example, allows discoms to more easily delay or even default on their payments, a common practice for coping with their frequent revenue shortfalls.³³ By contrast, most arrangements for regional coordination would require a timelier settlement of payments—within days rather than months—a prospect that, in turn, would require that discoms maintain more cash on hand than is currently standard practice.³⁴

Similarly, while more centralized and coordinated systems of dispatch would typically require that discoms commit to projecting their energy demand in advance, doing so might make it more challenging for them to use another favored tool of financial triage: simply deciding not to provide electricity when it gets too expensive, and then in some cases choosing to win voters' support by making special efforts to purchase and dispatch power to certain areas in the lead-up to elections.³⁵

Finally, with few funds to spare, discoms' tolerance for experimentation may be marginal. Investments in transmission, for instance, may take longer to pay for themselves than anticipated, further straining discoms' balance sheets in the short term. Discoms also might run afoul of approaches to regional coordination that would require them to pay fines for differences between their projected and actual energy use. And some coordination arrangements might force discoms to pool their reserve generating capacity, potentially requiring states to maintain more robust generating reserves than is common practice in India or risk having other states' lack of generating reserves prevent them from averting a blackout.³⁶ Although arrangements can generally be designed to limit risk, decisionmakers may nevertheless fear punishment if their efforts at innovation result in conspicuous short-term failures.

More to the point, they may believe that they have little to gain even if the risk were to pay off. This is perhaps the single most important obstacle to reforming the pathologies mentioned above: despite New Delhi's regular clarion calls for reform, discoms face limited pressure to turn a profit.

The obvious candidates to pressure discoms to improve their operational performance, including through innovations like regional coordination, would be the state electricity regulatory commissions (SERCs). However, many SERCs have seen their institutional capacity, independence, and legitimacy compromised by state governments determined to protect the cross-subsidy regime from being challenged (as one of the SERCs' primary functions is to set electricity prices), limiting their ability to push discoms to undertake any reforms.³⁷ Consumers, for their part, often see little relationship between the cost of electricity and the subsidized price they pay, which makes them less likely to push politicians to cut the discoms' supply-side operating losses.³⁸ Finally, while the central government can attempt to create incentives for improved discom performance, it has limited leverage: unless New Delhi is willing to allow the wholesale collapse of a state's power sector, it must continue bailing out distribution companies regardless of whether the states themselves are to blame for their problems.³⁹ Commentators have noted that past efforts have fallen short by “providing a carrot but not much by way of a stick.”⁴⁰

In the next stage of its transition to clean energy, India needs efficiently run utilities that are capable and motivated enough to take on risks for the sake of their consumers, not discoms that are tools of patronage first and power companies second. But if states can barely survive under the status quo, more disruptive and structural reforms like regional coordination are unlikely to materialize. Business as usual and reactive policy will likely remain the safest option for individual state politicians and bureaucrats unless the will to reform can be built elsewhere.

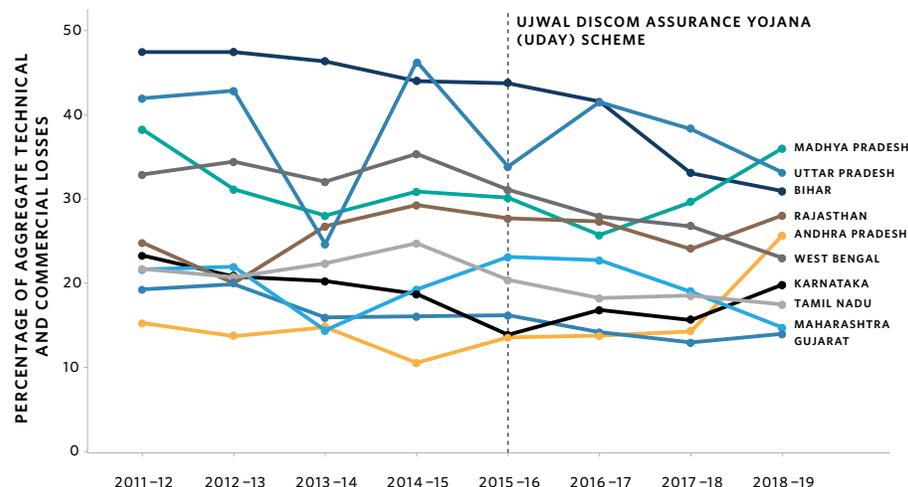
Breaking the Cycle

Vicious cycles rarely end of their own accord. In most Indian states, the fundamental problems with the power sector have changed little in the two decades since the major reforms of the 1990s and early 2000s, and they will likely remain trapped in the same pattern of dysfunction unless they are disrupted by an external intervention.

The obvious candidate for such an intervention is the central government. Yet past efforts—like the country's 2003 Electricity Act, for example, or the 2015 Ujwal DISCOM Assurance Yojana (UDAY) scheme—have typically done little to address the power sector's core political problems, instead focusing on more technical or bureaucratic reforms like establishing new regulatory agencies or restructuring utilities' debts.⁴¹ Such limited efforts have had

Figure 3. Discom Losses in India's Most Populous States

India's ten most populous states



Source: PFC (2015, 2017, 2020)

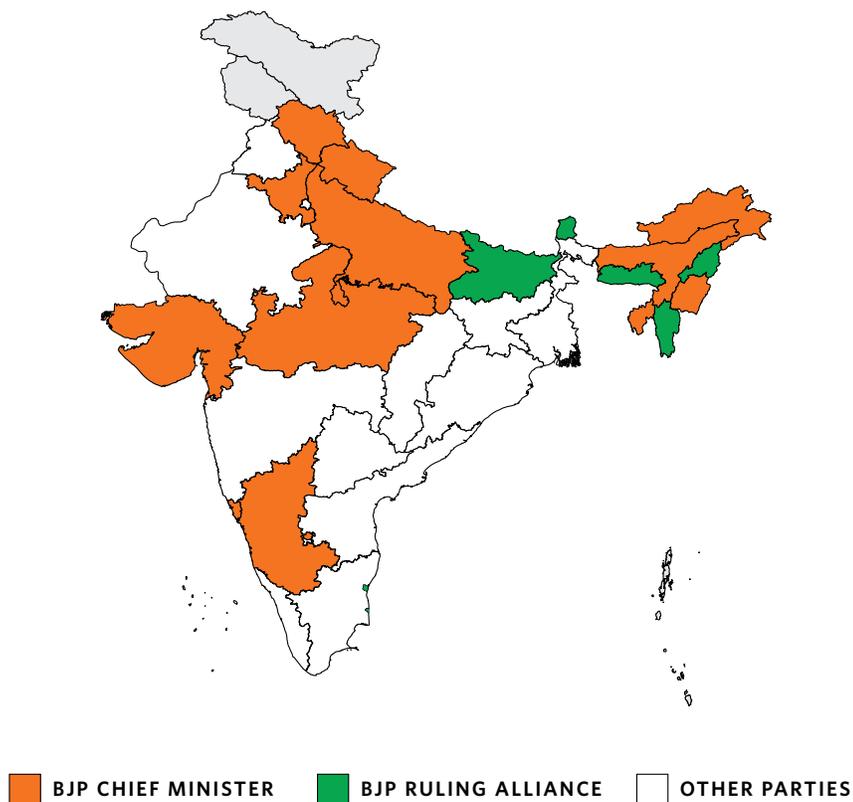
limited results. UDAY, for example, the most recent major initiative, has had no discernable effect on a key metric of discom performance: the proportion of energy sent to customers for which no revenue is collected, a figure known as aggregate technical and commercial losses (see figure 3).⁴²

Therefore, an alternative approach is necessary, one that begins with state-level rather than federal legislation and that sees the building of political will as a prerequisite to undertaking technical reforms.

The ideal solution might follow in the footsteps of the 2017 Goods and Services Tax, a rare instance in which India's central government and the states came together to implement a sweeping overhaul of a contentious economic issue over which both groups had jurisdiction.⁴³ However, the tax overhaul was in some ways far more straightforward to negotiate than a reform of the states' power sectors, which would likely require more nuanced efforts to tailor technical proposals and political strategies to the idiosyncrasies of particular state contexts.⁴⁴ Furthermore, the central government might have ruined any chance at repeating its success by recently renegeing on its commitments to compensate the states for their losses under the new fiscal scheme, an outcome that may have created lasting distrust between the two sides.⁴⁵

Another solution would begin not with all of India but instead with lower-hanging fruit: a coalition of willing, reform-minded states. The primary candidates would be those ruled by members of Modi's own party, the BJP—a plurality of states accounting for 38 percent of India's GDP and 40 percent of its population (see figure 4).⁴⁶ Modi's unparalleled national popularity and unrivaled dominance within the ranks of the party give him substantial

Figure 4. BJP Control of Indian State Assemblies



formal and informal influence over state BJP leaders, which could be used to convince them to adopt a more penetrating set of reforms to their power sectors with a degree of political will that past efforts lacked.⁴⁷

First, Modi could focus on the narrower task of encouraging—or, in the case of BJP-led states, actively pressuring—state governments to step up their engagement with interstate energy markets. These transitions could entail a vast range of possible governance options, from schemes largely retaining state primacy over energy dispatch to more market-based and centralized systems.⁴⁸ For example, at first, states might choose to continue managing much of their scheduling and dispatch unilaterally, offering only a smaller share of their total fleet of generators up for coordination with other states. Eventually, as states build trust in and capacity for the system and see the benefits of increased cooperation, they might gradually move to a more centralized and market-based system in which state authorities play less of a role.⁴⁹ This proposal would likely be an easier sell than a direct shift to a national, purely market-based system of power dispatch, as India’s Central Energy Regulatory Commission has recently proposed.⁵⁰

However, an explicit attempt at regional coordination would, for all the reasons discussed above, be best complemented by a second level of reform focused on fixing the distribution companies themselves. Several policies have proven promising for unraveling the cross-subsidy regime. Participating states might upgrade their feeders, for example, so as to better monitor and curb the energy use of those receiving subsidized electricity, an effort the central government has offered to help fund through its most recent scheme for discom reform.⁵¹ They might also replace electricity subsidies with direct cash transfers so that welfare to key constituencies no longer directly prevents the price of electricity from reflecting the cost of supply, a policy that has already proved itself successful in India for reforming subsidies for liquefied petroleum gas canisters.⁵² The reform package could even eschew specific policies in favor of broader objectives, such as maintaining an independent energy regulatory commission, the routes to which could then be worked out within particular states.⁵³ Yet whatever the precise design, if these reforms were undertaken, as power distribution gradually began to develop a degree of financial stability and independence from individual politicians' priorities, innovations like regional coordination would grow more attainable.

Why would this approach succeed where past efforts have failed? For one thing, linking a coordinated agenda for state discom reform to a high-profile, ruling coalition-sponsored national initiative would go a long way toward addressing states' credibility problem, leveraging Modi's formidable reputation to convince voters that improvements in quality would actually accompany changes in the prices they pay. Additionally, a more comprehensive, mutually reinforcing package of reforms—including the encouragement of regional coordination, which would by necessity foster a certain amount of discipline and independence if successful—may have more staying power than any one policy in isolation.⁵⁴

As important as the legislation itself would be, a change of mindset is perhaps most important. This would entail having the Prime Minister's Office display adequate resolve to use Modi's prominence both nationally and, more specifically, within the halls of power in BJP-ruled states to ensure that state governments actually implement their reforms—and that state leaders believe they have more to gain from a functional but independent power sector than a captured but broken one.

Of course, such an approach would likely require that Modi set his sights lower than a comprehensive national initiative and instead begin only with a few states, such as those with strong BJP majorities where he wields the greatest influence or renewables-intensive states like Tamil Nadu that would have the most to gain from regional coordination arrangements enabling them to sell their electricity surplus.

Yet even beginning with a smaller coalition would be enough. A critical mass of states proving the feasibility and benefits of reform would allow investors to vote with their feet and, in turn, would help voters to see the benefits of a better way, encouraging them to exert pressure on their own representatives. These regional arrangements could then gradually expand and deepen, eventually setting the stage for a truly national arrangement.⁵⁵

Alongside its role as coordinator for the states, the Indian central government—as well as foreign donors and investors—will also have a clear role to play in national projects that can help make both discom reform in general and regional coordination in particular more attractive for states.⁵⁶

One important area, particularly if energy trade between states increases, would be assisting with investment in transmission infrastructure, including the continued construction of “green energy corridors” capable of carrying large amounts of energy from one region to another.⁵⁷ The central government could also help enable discom reform and clean energy adoption by bailing out and shutting down inefficient and polluting coal generators early; renegotiating expensive, long-term power purchase agreements; and investing in the technology to help grid operators more accurately predict the supply of VRE and engage with the logistics of market-based, coordinated dispatch.⁵⁸

Yet while such initiatives—or the myriad regulatory changes necessary to adapt to a new, renewables-heavy energy landscape—are necessary, they are not sufficient absent reform to the discoms themselves.

Conclusion

While most of India’s actions to mitigate climate change so far have focused on development rather than sustainability concerns, this may change as the impacts of climate change grow more obvious. Mitigating climate change has often been described as a public good insofar as action by one country to curb its emissions benefits all countries.⁵⁹ However, these benefits (in essence, foregone harms) do not and will not accrue to all countries equally: staying within the threshold of 2 degrees Celsius in global temperature increases targeted by the international community would still translate into rises in temperature far beyond 2 degrees in some countries—including in much of India.

Different countries in turn will enjoy vastly different abilities to adapt to the climactic disruptions they do experience. Given the country’s high levels of poverty, reliance on agriculture (which depends in turn on the increasingly fragile monsoon season), and large tracts of land in areas susceptible to rising sea levels or drought, India is one of the countries in the world most vulnerable to climate change.⁶⁰ Therefore, as crop yields decline, sea levels rise, and diseases like malaria and dengue fever encroach on warmer climes, India may grow less willing to defer climate mitigation in exchange for short-term economic gains and an increased risk of catastrophe in the future.⁶¹ At this point, climate policy as an end in itself may assume a more prominent role on the national stage—thereby making the dysfunction of the discoms even more of a political liability.

Indeed, discoms' dysfunction will likely sabotage enablers of clean energy beyond regional coordination as well. The same obstacles to intelligent investment in transmission infrastructure posed by the lack of fiscal space and capacity for long-term planning will likely present challenges for even more complicated and context-dependent decisions about investment in energy storage, for example, or when to shut down, upgrade, or replace older coal plants.⁶² The political rewards of controlling power dispatch, meanwhile, are already creating incentives to prevent the buildout of small rooftop solar panels—a sector that the Indian government hopes will grow to 40 gigawatts by 2022—since such resources would typically sell their energy directly to other consumers, thereby bypassing the discoms' system of cross subsidies.⁶³ In other words, unless India reforms its discoms, regional coordination will only be the first of many casualties in its green transition.

The timing for reforming India's power sector is propitious. The BJP has several years before the next general election, and reform is typically best done well in advance of an election when time remains in an administration for the benefits to materialize.⁶⁴ Additionally, the country's recovery from the coronavirus pandemic presents a moment of crisis that the central government has already seized to enact painful reforms in other areas, such as privatization of public sector banks.⁶⁵

Of course, the more organic approach to reform described above would require that Modi depart from his usual governance style, which has been large-scale, top-down, and centralized.⁶⁶ Much of Modi's popularity rests on efforts like his sweeping flagship welfare projects, which could be relatively easily designed and deployed from the Prime Minister's Office without the need to gain wide buy-in from state governments or engage with the vagaries of institutional reform.⁶⁷ By contrast, a state-based approach to power sector reform—even one that began only with BJP compatriots—would require flexibility, patience, and a willingness to engage with the specifics of each state context.

Fortunately, Modi and the BJP have strong incentives to try. Indeed, Modi's prominent embrace of renewable energy and targeting of ambitious milestones is a sign of his faith that a buildout of renewables will translate into an electoral payoff nationally, just as his push for renewables as chief minister of Gujarat paid off for him there.

One incentive is that the power sector is a colossal strain on public finances and a drag on economic growth, which are important considerations for a ruling party whose popularity rests in large part on the promise of prosperity. Reforming discoms would also greatly increase the quality of electricity to India's households, which may be a natural extension of Modi's recent, largely successful campaign to electrify 100 percent of India's villages.⁶⁸ Energy security might be another motivation: reducing India's substantial reliance on coal and gas imports by developing a domestic renewable energy manufacturing industry would accord with Modi's push for *Atmanirbhar Bharat* ("self-reliant India").⁶⁹

This is to say nothing of issues that have not yet generated much electoral momentum but could be tapped into by a political entrepreneur as deft as Modi, such as the health benefits of clean energy. Pollution from coal plants is one of the primary drivers of India's dismal air quality, for instance, which is estimated to lead to a staggering 2.5 million premature deaths each year.⁷⁰

Contradictions between business as usual in India's power sector and its green energy aspirations will only become more obvious as the country's share of VRE generation capacity increases. Indeed, one study by the prominent Energy and Resources Institute found that, in the absence of flexibility-enabling changes such as regional coordination or battery storage, India's target of 450 gigawatts of renewable energy by 2030 would be entirely unrealistic.⁷¹

By contrast, reforming now—while there is still time and flexibility to plan for high shares of renewable energy rather than simply react to an imminent crisis of curtailment—would let India not just continue the meteoric growth of renewables but accelerate it.

About the Author

Jonathan Kay is a nonresident research assistant in the Carnegie South Asia Program. He was previously a James C. Gaither Junior Fellow.

Acknowledgments

The author is profoundly grateful to Milan Vaishnav, Rohit Chandra, Jessica Seddon, Kartikeya Singh, Megan DuBois, and Abigail Diebold for comments on earlier drafts of this paper. He also thanks Ryan DeVries and Amy Mellon for their design, editorial, and production assistance. Any errors are the author's own.

Notes

- 1 “Each Country’s Share of CO2 Emissions,” Union of Concerned Scientists, August 12, 2020, <https://www.ucsusa.org/resources/each-countrys-share-co2-emissions>; International Renewable Energy Agency, *Renewable Capacity Statistics 2021* (Abu Dhabi: International Renewable Energy Agency, 2021), 13, 20; and “India—Current Policy Projections,” Climate Action Tracker, September 22, 2020, <https://climateactiontracker.org/countries/india/current-policy-projections>.
- 2 Anil Agarwal and Sunita Narain, *Global Warming in an Unequal World: A Case of Environmental Colonialism* (New Delhi: Center for Science and Environment, 2000); Tejal Kanitkar and T. Jayaraman, “Equity in Long-Term Mitigation,” in *India in a Warming World: Integrating Climate Change and Development*, ed. Navroz K. Dubash (New Delhi: Oxford University Press, 2019), 92–113; and Sandeep Sengupta, “India’s Engagement in Global Climate Negotiations From Rio to Paris,” in *India in a Warming World*, 114–141.
- 3 Ashok Lavasa, “Reaching Agreement in Paris: A Negotiator’s Perspective,” in *India in a Warming World*, 169–186; Dhanasree Jayaram, “From ‘Spoiler’ to ‘Bridging Nation’: The Reshaping of India’s Climate Diplomacy,” *Revue Internationale et Stratégique* 109 (2018): 181–190; and *India: Third Biennial Update Report to The United Nations Framework Convention on Climate Change* (New Delhi: Ministry of Environment, Forest and Climate Change, 2021), 21.
- 4 Peter Zeniewski et al., *India Energy Outlook 2021* (Paris: International Energy Agency, 2021), 38; and International Renewable Energy Agency, *Renewable Capacity Statistics 2021*, 2–4.
- 5 PTI, “India to Have 60% Renewable Energy by 2030: Power Minister RK Singh,” *Financial Express*, July 21, 2020, <https://www.financialexpress.com/industry/india-to-have-60-renewable-energy-by-2030-power-minister-rk-singh/2031205>; and International Renewable Energy Agency, *Renewable Capacity Statistics 2021*, 2–4. The following sources were used for figure 1: International Renewable Energy Agency, *Renewable Capacity Statistics 2021*, 5, 13, 20; “Global Coal Plant Tracker,” Global Energy Monitor, January 2021, <https://globalenergymonitor.org/projects/global-coal-plant-tracker/dashboard>; and *Energy Statistics India 2021* (New Delhi: Ministry of Statistics and Programme Implementation, 2021), 22–23. Projections for 2030 draw from International Energy Agency estimates, which assume that India falls slightly short of current government targets; see Zeniewski et al., *India Energy Outlook 2021*, 114.

- 6 Pradip Swarnakar, “Climate Change, Civil Society, and Social Movement in India,” in *India in a Warming World*, 253–272; and Nives Dolsak and Aseem Prakash, “Are India’s Political Parties Ignoring Climate Change?” *Forbes*, April 13, 2019, <https://www.forbes.com/sites/prakashdolsak/2019/04/13/are-indias-political-parties-ignoring-climate-change/?sh=23f7978662e9>. In addition, a recent Pew Research Center survey found that, while 58 percent of Indians believed that “climate change is a very serious problem,” only 37 percent believed that their “national government is doing too little to reduce the effects of climate change.” A survey by the New Delhi–based Association for Democratic Reforms, meanwhile, found that only 12 percent of Indian voters rated water and air pollution among their five most important governance priorities; climate change as a phenomenon, including but not limited to such pollution, did not make the list of voters’ thirty-one most important issues at all. See, respectively, Cary Funk et al., “Concern Over Climate and the Environment Predominates Among These Publics,” Pew Research Center, September 29, 2020, <https://www.pewresearch.org/science/2020/09/29/concern-over-climate-and-the-environment-predominates-among-these-publics>; and Association for Democratic Reforms, *All India Survey on Governance Issues and Voting Behavior 2018* (New Delhi: Association for Democratic Reforms, 2019), 14.
- 7 While the marginal cost to the generator of an additional unit of VRE is essentially zero, grid operators usually still have to pay for each additional unit at a contracted price. This means that in some cases grid operators may have an incentive to use nonrenewable energy that, though more expensive to generate because of the cost of its fuel, is nevertheless available to them at a lower contracted price. One solution is to have VRE generators with surplus generation capacity pay traditional generators for the right to sell their energy, an approach that can allow maximal use of VRE while providing savings for all parties. For an example of both a market-based and a non-market-based approach, see Lakshmi Alagappan et al., *Regulatory Dimensions to Renewable Energy Forecasting, Scheduling, and Balancing in India: Regulatory Practices Analysis and Primer* (New Delhi: USAID, 2017), 37.
- 8 Rahul Tongia, Santosh Harish, and Rahul Walawalkar, “Integrating Renewable Energy Into India’s Grid—Harder Than It Looks,” Brookings India, 2018, 14–15, <https://www.brookings.edu/wp-content/uploads/2018/11/Complexities-of-Integrating-RE-into-Indias-grid.pdf>.
- 9 Zeniewski et al., *India Energy Outlook 2021*, 114; and Jesse D. Jenkins, Max Luke, and Samuel Thernstrom, “Getting to Zero Carbon Emissions in the Electric Power Sector,” *Joule* 2, no. 12 (2018): 2506–2508.
- 10 Under India’s constitution, the electricity sector is a shared responsibility of the states and the central government. However, while the central government plays important roles in the generation and transmission of electricity, distribution—the final step of providing electricity to consumers—has in practice come under the purview of state governments.
- 11 Thomas Spencer et al., *Renewable Power Pathways: Modelling the Integration of Wind and Solar in India by 2030* (New Delhi: Energy and Resources Institute, 2020), 30–34.
- 12 USAID, *Greening the Grid: Pathways to Integrate 175 Gigawatts of Renewable Energy Into India’s Electric Grid, Vol. 1—National Study* (New Delhi: USAID, 2017), 84–88; Spencer et al., *Renewable Power Pathways*, 21–23, 30–34; and Alagappan et al., *Regulatory Dimensions to Renewable Energy Forecasting, Scheduling, and Balancing in India*, 61.
- 13 *Greening the Grid*, 72; and Spencer et al., *Renewable Power Pathways*, xii–xiii.
- 14 Vibhuti Garg, “Deepening India’s Short-Term Power Market: New Financial Products Will Boost Trading of Renewable Energy,” Institute for Energy Economics and Financial Analysis, September 2020, https://ieefa.org/wp-content/uploads/2020/09/Deepening-India-Short-Term-Power-Market_September-2020.pdf.
- 15 *Greening the Grid*, 66–67; Tongia, Harish, and Walawalkar, *Integrating Renewable Energy Into India’s Grid*, 14–16; and T. Bruce Tsuchida, Stephanie Ross, and Adam Bigelow, “Unlocking the Queue with Grid-Enhancing Technologies: Case Study of the Southwest Power Pool,” Brattle Group, February 1, 2021, https://watt-transmission.org/wp-content/uploads/2021/02/Brattle__Unlocking-the-Queue-with-Grid-Enhancing-Technologies__Final-Report_Public-Version.pdf#90.
- 16 *Greening the Grid*, 73–84, 88–91; and Spencer et al., *Renewable Power Pathways*.
- 17 Sumir Lal, *Can Good Economics Ever Be Good Politics? Case Study of India’s Power Sector* (Washington, DC: World Bank, 2006); Sunila S. Kale, *Electrifying India: Regional Political Economies of Development* (Redwood City: Stanford University Press, 2014); Navroz K. Dubash, Sunila S. Kale, and Ranjit

- Bharvirkar, eds., *Mapping Power: The Political Economy of Electricity in India's States*, (New Delhi: Oxford University Press, 2018); and Navroz K. Dubash, Ashwini K. Swain, and Parth Bhatia, "The Disruptive Politics of Renewable Energy," *India Forum*, July 5, 2019, <https://www.theindiaforum.in/article/disruptive-politics-renewable-energy>.
- 18 Kale, *Electrifying India*, 53.
 - 19 Dubash, Swain, and Bhatia, "The Disruptive Politics of Renewable Energy."
 - 20 "UDAY National Dashboard," Indian Ministry of Power, accessed April 23, 2021, <https://www.uday.gov.in/home.php>; and International Energy Agency, *Electricity Information 2018* (Paris: International Energy Agency, 2018), <https://www.indexmundi.com/facts/indicators/EG.ELC.LOSS.ZS>.
 - 21 Brian Min and Miriam Golden, "Electoral Cycles in Electricity Losses in India," *Energy Policy* 65 (2014): 619–625.
 - 22 Namrata Chindarkar, "Beyond Power Politics: Evaluating the Policy Design Process of Rural Electrification in Gujarat, India," *Public Administration and Development* 37 (2017): 28–39; and Siddharth Sareen, "Gujarat's Success in Efficient Electricity Distribution: A Call for Proactive Governance to Further Gains," in *Mapping Power*, 93–113.
 - 23 Lal, *Can Good Economics Ever Be Good Politics?*, 5–8. See also Philip Keefer and Razvan Vlaicu, "Democracy, Credibility, and Clientelism," *Journal of Law, Economics, and Organization* 24, no. 2 (2007): 371–406.
 - 24 Elizabeth Chatterjee, "The Politics of Electricity Reform: Evidence From West Bengal, India," *World Development* 104 (2018): 128–139; and Ashwini K. Swain, "Transforming Reforms: Hype, Hostility, and Placation in Andhra Pradesh's Power Sector Reforms," in *Mapping Power*, 28–49.
 - 25 Navroz K. Dubash, Sunila S. Kale, and Ranjit Bharvirkar, "Conclusion," in *Mapping Power*, 342.
 - 26 Jonathan Balls, "Uttarakhand: The Golden Combination of Cheap Energy and a Large Industrial Base," in *Mapping Power*, 296–318; and Ashwini K. Swain, "Protecting Power: The Politics of Partial Reforms in Punjab," in *Mapping Power*, 216–236.
 - 27 Both conditions held in the case of Odisha, for example, while West Bengal may have benefited from the relative political weakness of the agricultural sector. Well-organized farmers' lobbies have proven serious obstacles to reform in states like Tamil Nadu and Maharashtra. See Mrigakshi Das and Mahaprajna Nayak, "Endless Restructuring of the Power Sector in Odisha: A Sisyphean Tale?" in *Mapping Power*, 193–214; Chatterjee, "The Politics of Electricity Reform," 135; Hema Ramakrishnan, "Tamil Nadu Power Sector: The Saga of the Subsidy Trap," in *Mapping Power*, 255–273; and Kalpana Dixit, "Paradoxes of Distribution Reforms in Maharashtra," in *Mapping Power*, 176–192.
 - 28 Chindarkar, "Beyond Power Politics"; and Sareen, "Gujarat's Success in Efficient Electricity Distribution."
 - 29 Chatterjee, "The Politics of Electricity Reform."
 - 30 Min and Golden, "Electoral Cycles in Electricity Losses in India," 622; and Das and Nayak, "Endless Restructuring of the Power Sector in Odisha."
 - 31 Ajai Nirula, "India's Power Distribution Sector: An Assessment of Financial and Operational Sustainability," Brookings India, October 22, 2019, <https://www.brookings.edu/wp-content/uploads/2019/10/India%E2%80%99s-Power-Distribution-Sector.pdf>; Tim Buckley and Vibhuti Garg, "India's Power Distribution Sector Needs Further Reform: More Accountability of State Governments to Address Discom Woes," Institute for Energy Economics and Financial Analysis, September 2020, https://ieefa.org/wp-content/uploads/2020/09/Indias-Power-Distribution-Sector-Needs-Further-Reform_September2020.pdf; and Abhishek Dangra, "The Missing Piece in India's Economic Growth Story: Robust Infrastructure," S&P Global, August 2, 2016, <https://www.spglobal.com/en/research-insights/articles/the-missing-piece-in-indias-economic-growth-story-robust-infrastructure>.
 - 32 For a discussion of discoms' challenges with long-term planning, see Daljit Singh and Ashwini K. Swain, *Fixated on Megawatts: Urgent Need to Improve Power Procurement and Resource Planning by Distribution Companies in India* (New Delhi: Center for Energy, Environment and Resources, 2018); and Rakesh Kumar Goyal et al., *Rethinking Discom Resource Planning—In Renewable Energy Rich Environment* (New Delhi: USAID, 2019), 19–22, 40–41.

- 33 Nirula, “India’s Power Distribution Sector,” 7–8.
- 34 See, for example, discussions of this issue in the context of the Central Electricity Regulatory Commission’s recent proposal for a national system of market-based economic dispatch. World Bank, “Market-Based Economic Dispatch of Electricity—Redesigning Day-Ahead Market (DAM) in India: Comments and Suggestions,” Central Electricity Regulatory Commission, February 2019, http://www.cercind.gov.in/2019/Comments-MBED/14.%20World%20Bank_Comments_MBED.pdf; and RPG Power Trading Company Ltd., “Comments/Suggestions on CERC Discussion Paper on Market Based Economic Dispatch (MEBD) [sic],” Central Electricity Regulatory Commission, January 28, 2019, <http://www.cercind.gov.in/2019/Comments-MBED/RPTCL%20Comments-Suggestions%20on%20CERC-MBED.pdf>.
- 35 Mani Khurana and Sudeshna Ghosh Banerjee, *Beyond Crisis: The Financial Performance of India’s Power Sector* (Washington, DC: World Bank, 2015), 56; and Min and Golden, “Electoral Cycles in Electricity Losses in India.”
- 36 Alagappan et al., *Regulatory Dimensions to Renewable Energy Forecasting, Scheduling, and Balancing in India*, 66–67, 77–84.
- 37 Sheoli Pargal and Sudeshna Ghosh Banerjee, *More Power to India: The Challenge of Electricity Distribution* (Washington, DC: World Bank, 2014), 105–123; Navroz K. Dubash and D. Narashimha Rao, “Regulatory Practice and Politics: Lessons From Independent Regulation in Indian Electricity,” *Utilities Policy* 16 (2008): 321–331; and Khurana and Banerjee, *Beyond Crisis*, 51–56.
- 38 The gap between average cost of supply and average revenue realized, which represents the difference between the average cost of supply per unit of electricity and the average revenue collected, has remained high—0.5 rupees per kilowatt-hour at the time of writing—despite the Indian central government’s efforts to reduce it to zero by the end of the 2019 fiscal year. See “UDAY National Dashboard”; and Aggarwal et al., *Unpacking India’s Electricity Subsidies: Reporting, Transparency, and Efficacy* (Winnipeg: International Institute for Sustainable Development, 2020), 26–36.
- 39 Khurana and Banerjee, *Beyond Crisis*, 57–62.
- 40 Dubash, Kale, and Bharvirkar, “Conclusion,” 344. Rahul Tongia provides a representative account of one central government effort at state-level power reform in the early 2000s: “. . . the central government pledged to increase output from central power stations, upgrade inter-state transmission lines and to provide sundry other benefits including enhanced financing. The central government has promised to match (with funds) any savings that the states realized through the reduction of theft, which offers a substantial windfall that can offset the political cost of cracking down on nonpaying users. In addition to this carrot for reforms, the states face the stick of the ERCs [SERCs], that will set tariffs so that utilities that do not improve performance will suffer operating losses without the prospect of a financial bailout. (The credibility of this threat is unclear but probably low.)” See Rahul Tongia, “The Political Economy of Indian Power Sector Reforms,” in *The Political Economy of Power Sector Reform: The Experiences of Five Major Developing Countries*, ed. David G. Victor and Thomas C. Heller (Cambridge: Cambridge University Press, 2007).
- 41 Daljit Singh and Rahul Tongia, “Falling Short of Addressing the Real Challenges: Comments and Analysis on the Draft Electricity (Amendment) Bill 2020,” Brookings India, June 2020, <https://www.brookings.edu/research/comments-on-the-draft-electricity-amendment-bill-2020>; and Dubash, Kale, and Bharvirkar, “Conclusion.”
- 42 For a more comprehensive analysis of UDAY’s failures in improving discom performance, see Alagappan et al., *Unpacking India’s Electricity Subsidies*, 9–21. The following sources were used for figure 3: *Report on The Performance of State Power Utilities for the Years 2011-12 to 2013-14* (New Delhi: Power Finance Corporation, 2015), 118–119; *Report on The Performance of State Power Utilities for the Years 2013-14 to 2015-16* (New Delhi: Power Finance Corporation, 2017), 126–127; *Report on Performance of State Power Utilities 2017-2018* (New Delhi: Power Finance Corporation, 2020), xxxiii–xxxiv; and *Report on Performance of State Power Utilities 2018-19* (New Delhi: Power Finance Corporation, 2020), xxxiii–xxxiv.
- 43 Rohit Chandra, “Response to CERC Staff Paper on Market-Based Economic Dispatch,” Central Electricity Regulatory Commission, February 2019, http://www.cercind.gov.in/2019/Comments-MBED/22.%20Rohit%20Chandra_Comments_CERC%20MBED.pdf.

- 44 Dubash, Kale, and Bhavirkar, “Conclusion,” 342–343; Alagappan et al., *Regulatory Dimensions to Renewable Energy Forecasting, Scheduling, and Balancing in India*, 61–62; “Where the Energy Union Starts: Regions,” European Network of Transmission System Operators for Electricity, November 20, 2015, <http://vision.entsoe.eu/regions>; and Chandra, “Response to CERC Staff Paper on Market-Based Economic Dispatch,” 3–5.
- 45 G. Seetharaman, “The Pushback Over Delays in GST Transfers by the Centre Is the Latest Instance of States’ Growing Assertion on the Fiscal Front,” *Economic Times*, December 15, 2019, <https://economictimes.indiatimes.com/news/economy/finance/the-pushback-over-delays-in-gst-transfers-by-the-centre-is-the-latest-instance-of-states-growing-assertion-on-the-fiscal-front/articleshow/72623644.cms?from=mdr>.
- 46 *Handbook of Statistics on Indian States 2019–2020* (New Delhi: Reserve Bank of India, 2020), 3, 44.
- 47 Milan Vaishnav and Jonathan Kay, “For Reforms, Create a Coalition of the Willing,” *Hindustan Times*, March 7, 2021, <https://www.hindustantimes.com/opinion/for-reforms-create-a-coalition-of-the-willing-101615022346514.html>.
- 48 Chandra, “Response to CERC Paper on Market-Based Economic Dispatch”; and Alagappan et al., *Regulatory Dimensions to Renewable Energy Forecasting, Scheduling and Balancing in India*, 62.
- 49 Alagappan et al., *Regulatory Dimensions to Renewable Energy Forecasting, Scheduling and Balancing in India*, 62, 66–67.
- 50 Chandra, “Response to CERC Staff Paper on Market-Based Economic Dispatch,” 3–5; Alagappan et al., *Regulatory Dimensions to Renewable Energy Forecasting, Scheduling, and Balancing in India*, 61–62; and “Where the Energy Union Starts: Regions,” European Network of Transmission System Operators for Electricity.
- 51 “Cabinet Approves Revamped Distribution Sector Scheme: A Reforms Based and Results Linked Scheme,” Press Information Bureau, June 30, 2021, <https://pib.gov.in/PressReleasePage.aspx?PRID=1731473>.
- 52 For the (conditional) benefits of segregated feeders, see Chindarkar, “Beyond Power Politics”; and Ashish Khanna et al., *Lighting Rural India: Load Segregation Experience in Selected States* (Washington, DC: World Bank, 2014). On the potential utility of direct benefit transfers, see Neeraj Mittal, Anit Mukherjee, and Alan Gelb, “Fuel Subsidy Reform in Developing Countries: Direct Benefit Transfer of LPG Cooking Gas Subsidy in India,” Center for Global Development, December 2017, <https://www.cgdev.org/sites/default/files/fuel-subsidy-reform-developing-countries-india.pdf>; Ranajoy Bhattacharyya and Amrita Ganguly, “Cross Subsidy Removal in Electricity Pricing in India,” *Energy Policy* 100 (2017): 181–190; and Raghumatta Rao, “Direct Benefit Transfer: Fiscal Fix to End the Distribution Segment’s Subsidy Challenges,” *Powerline Magazine*, August 2017, <https://powerline.net.in/2017/08/30/direct-benefit-transfer>.
- 53 For one analysis of the importance of regulator independence, see Ajay Kumar Pandey and Manjushree Ghodke, “Barriers to Viability of Indian Power Distribution Companies,” *International Journal of Energy Sector Management* 13, no. 4 (2019): 916–934.
- 54 This is a point frequently made by researchers writing on the mixed success of segregated feeder reforms, for example. See Chindarkar, “Beyond Power Politics”; and Khanna et al., *Lighting Rural India*, xiv.
- 55 It helps that some of the states outside the BJP coalition in southern India have strong incentives to move to a more coordinated or market-based approach, as this would allow them to find buyers for their plentiful renewable energy capacity, which will soon run into issues of oversupply and curtailment. It is also, from one view, fortunate that some of the states most likely to be spoilers to cooperation—the coal-rich, mostly low-renewables states in northern India—are BJP-ruled. See Rahul Tongia and Samantha Gross, “Working to Turn Ambition Into Reality: The Politics and Economics of India’s Turn to Renewable Power,” Brookings Institution, September 2018, <https://www.brookings.edu/wp-content/uploads/2018/09/India-Renewable-Power-v10.pdf>, 13–14.
- 56 One of the most important external partners for such projects will be the United States, with whom cooperation on renewable energy could dovetail with a growing partnership in other areas (including the two countries’ engagement through the Quad). See Kartikeya Singh, “Meeting India’s Net-Zero Moment,” Center for Strategic and International Studies, March 24, 2021, <https://www.csis.org/analysis/meeting-indias-net-zero-moment>.

- 57 *Transmission Plan for Envisaged Renewable Capacity* (Gurgaon: Power Grid Corporation of India Ltd., 2012); and “Green Energy Corridors,” Indian Ministry of New and Renewable Energy, December 31, 2019, <https://mnre.gov.in/green-energy-corridor>.
- 58 Singh and Tongia, “Need for an Integrated Approach for Coal Power Plants”; Ashish Fernandes and Harshit Sharma, *The 3Rs of DISCOM Recovery: Retirement, Renewables and Rationalisation* (Bangalore: Climate Risk Horizons, 2020); Francisco Boshell and Arina Anisie, *Advanced Forecasting of Variable Renewable Power Generation: Innovation Landscape Brief* (Abu Dhabi: International Renewable Energy Agency, 2020); and Alagappan et al., *Regulatory Dimensions to Renewable Energy Forecasting, Scheduling and Balancing in India*, 62–63.
- 59 See, for example, William Nordhaus, “Paul Samuelson and Global Public Goods,” Yale University, May 5, 2005, <http://www.econ.yale.edu/~nordhaus/homepage/homepage/PASandGPG.pdf>.
- 60 Antoinette L. Brenkert and Elizabeth L. Malone, “Modeling Vulnerability and Resilience to Climate Change: A Case Study of India and Indian States,” *Climate Change* 72 (2005): 57–102; J. Srinivasan, “Impact of Climate Change on India,” in *India in a Warming World*, 31–44; Yasuaki Hijioka, “Asia,” in *Climate Change 2014: Impacts, Adaptation, and Vulnerability* (New York: Intergovernmental Panel on Climate Change, 2014), 1327–1370; and “Country Index: Vulnerability,” Notre Dame Global Adaptation Initiative, July 2020, <https://gain.nd.edu/our-work/country-index/>.
- 61 For an example of the importance of participants’ vulnerability for their willingness to cooperate around climate change, see Jon Hovi et al., “The Club Approach: A Gateway to Effective Climate Co-operation?” *British Journal of Political Science* 49 (2017): 1071–1096.
- 62 Akshay Srivastava et al., *Energy Storage System Roadmap for India: 2019–2032* (New Delhi: India Smart Grid Forum, 2019); Tongia, Harish, and Walawalkar, *Integrating Renewable Energy Into India’s Grid*, 31–32; and Singh and Tongia, “Need for an Integrated Approach for Coal Power Plants.” For a related discussion of the importance of utility procurement practices for long-term planning of clean energy adoption in the United States, see Megan Anderson et al., *How to Build Clean Energy Portfolios* (Basalt, CO: Rocky Mountain Institute, 2020).
- 63 “Govt Aims to Produce 40 GW Power Through Rooftop Solar in Next 1.5 Years,” *Economic Times Energy World*, February 18, 2021, <https://energy.economicstimes.indiatimes.com/news/renewable/govt-aims-to-produce-40-gw-power-through-rooftop-solar-in-next-1-5-years-pm-modi/81094331>; Daljit Singh, “Newer Challenges for Open Access in Electricity: Need for Refinements in the Regulations,” *Brookings India*, April 2017, https://www.brookings.edu/wp-content/uploads/2017/04/open-access_ds_042017.pdf; and Dubash, Swain, and Bhatia, “The Disruptive Politics of Renewable Energy.”
- 64 *Discussion Paper on Market Based Economic Dispatch of Electricity: Re-Designing of Day-ahead Market (DAM) in India* (New Delhi: Central Electricity Regulatory Commission, 2018).
- 65 Milan Vaishnav and Sukumar Ranganathan, “Sukumar Ranganathan on India’s Budget Breakthrough,” February 2, 2021, in *Grand Tamasha*, produced by Jonathan Kay, Tim Martin, and Maya Krishna-Rogers, podcast, audio, <https://grand-tamasha.simplecast.com/episodes/sukumar-ranganathan-on-indias-budget-breakthrough>; and Sadanand Dhume, “India Breaks the Privatization Taboo,” *Wall Street Journal*, March 4, 2021, <https://www.wsj.com/articles/india-breaks-the-privatization-taboo-11614880693>.
- 66 K.K. Kailash, “‘One Nation,’ New India and the Hollowing Out of the Federal Idea,” *India Forum*, February 19, 2021, <https://www.theindiaforum.in/article/one-nation-new-india-and-hollowing-out-federal-idea>; and Neelanjan Sircar, “The Politics of Vishwas: Political Mobilization in the 2019 National Election,” *Contemporary South Asia* 28 (2020): 178–194.
- 67 Abhishek Anand, Vikas Dimble, and Arvind Subramanian, “New Welfarism of Modi Govt Represents Distinctive Approach to Redistribution and Inclusion,” *Indian Express*, December 22, 2020, <https://indian-express.com/article/opinion/columns/national-family-health-survey-new-welfarism-of-indias-right-7114104>.
- 68 “Saubhagya Dashboard,” Ministry of Power, accessed April 4, 2021, <https://saubhagya.gov.in>.
- 69 Alyssa Ayres, “India’s New Self-Reliance: What Does Modi Mean?,” *Council on Foreign Relations, Asia Unbound* (blog), May 12, 2020, <https://www.cfr.org/blog/indias-new-self-reliance-what-does-modi-mean>.

- 70 Karn Vohra et al., “Global Mortality From Outdoor Fine Particle Pollution Generated by Fossil Fuel Combustion: Results From GEOS-Chem,” *Environmental Research* 195 (2021): 4.
- 71 Spencer et al., *Renewable Power Pathways*, xi.

Carnegie Endowment for International Peace

The Carnegie Endowment for International Peace is a unique global network of policy research centers in Russia, China, Europe, the Middle East, India, and the United States. Our mission, dating back more than a century, is to advance peace through analysis and development of fresh policy ideas and direct engagement and collaboration with decision-makers in government, business, and civil society. Working together, our centers bring the inestimable benefit of multiple national viewpoints to bilateral, regional, and global issues.

South Asia

The Carnegie South Asia Program informs policy debates relating to the region's security, economy, and political development. From the war in Afghanistan to Pakistan's internal dynamics to U.S. engagement with India, the program's renowned team of experts offer in-depth analysis derived from their unique access to the people and places defining South Asia's most critical challenges.



 **CARNEGIE**
ENDOWMENT FOR
INTERNATIONAL PEACE

CarnegieEndowment.org