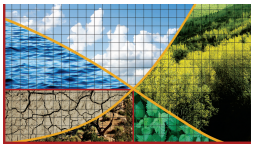

Harvard Environmental Economics Program

DEVELOPING INNOVATIVE ANSWERS TO TODAY'S COMPLEX ENVIRONMENTAL CHALLENGES

May 2013
Discussion Paper 13-46

Lighting the Way: Unlocking Performance Gains in Electricity Distribution and Retailing in India*

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*This paper won the Harvard Environmental Economics Program's 2013 Christopher P. Kaneb Prize for the Best Paper by a Masters Student.

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Acknowledgements

The Enel Endowment for Environmental Economics at Harvard University provides major support for HEEP. The Endowment was established in February 2007 by a generous capital gift from Enel SpA, a progressive Italian corporation involved in energy production worldwide. HEEP receives additional support from the affiliated Enel Foundation.

HEEP also receives support from the Alfred P. Sloan Foundation, the James M. and Cathleen D. Stone Foundation, Bank of America, Chevron Services Company, Duke Energy Corporation, and Shell. HEEP enjoys an institutional home in and support from the Mossavar-Rahmani Center for Business and Government at the Harvard Kennedy School. HEEP collaborates closely with the Harvard University Center for the Environment (HUCE). The Center has provided generous material support, and a number of HUCE's Environmental Fellows and Visiting Scholars have made intellectual contributions to HEEP. HEEP and the closely-affiliated Harvard Project on Climate Agreements are grateful for additional support from the Belfer Center for Science and International Affairs at the Harvard Kennedy School, ClimateWorks Foundation, the Qatar National Food Security Programme, and Christopher P. Kaneb (Harvard AB 1990).

Citation Information

Talbott, Will. "Lighting the Way: Unlocking Performance Gains in Electricity Distribution and Retailing in India." Discussion Paper 2013-46. Cambridge, Mass.: Harvard Environmental Economics Program, May 2013.

LIGHTING THE WAY:

UNLOCKING PERFORMANCE GAINS IN ELECTRICITY DISTRIBUTION AND RETAILING IN INDIA

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March 2013

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Written in fulfillment of the requirements for the degree of Master of Public Administration in International Development at the John F. Kennedy School of Government, Harvard University

ACKNOWLEDGEMENTS

I would like to thank Professor William Hogan and Professor Ishac Diwan, who provided helpful guidance and feedback throughout the process of preparing this report. Bernard Neenan also generously shared his time and expertise. Nick Bayard and Ning Fu offered valuable comments on an initial draft.

The findings, interpretations, and conclusions in this paper are those of the author and should not be attributed in any way to the Harvard Kennedy School.

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EXECUTIVE SUMMARY

The financial problems of electricity distributors in India have undermined the soundness of the entire power sector, resulting in chronic shortages. Unreliable power imposes costs on the entire economy that translate into lower economic growth. Recurring annual losses by the distribution sector can be traced to distorted tariffs and high levels of technical and commercial losses. However, rather than trying to correct these problems directly through mandated tariff hikes or infrastructure investments, the Ministry of Power should create an enabling environment for market incentives and competition to lead to efficient outcomes.

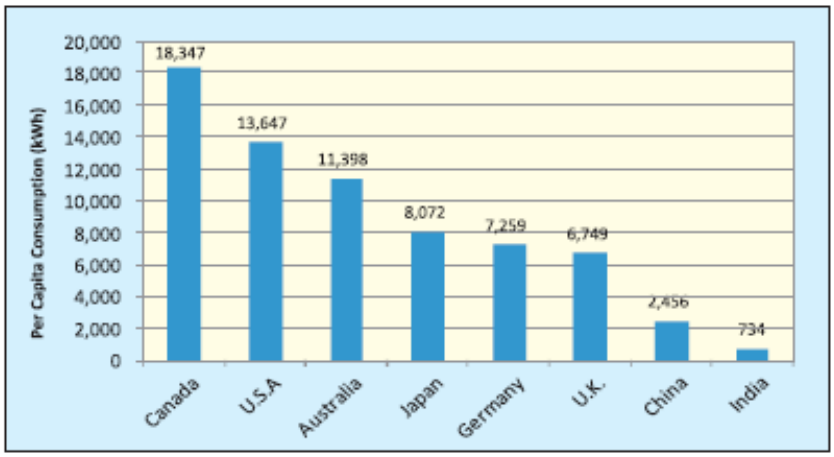
First, the retailing function, which is not a natural monopoly, should be unbundled from the distribution function, which is a natural monopoly, and opened to competition. The problems in retailing are "complex." Patronage-based relationships between end users and politicians have fostered environments in which electricity is demanded at subsidized rates or simply stolen with little fear of penalties. By depriving distributors of revenues, these norms ensure low-quality service. Liberalized retailers can create value by offering differentiated service plans allowing customers to match the reliability of their service with their willingness to pay and by lowering the transaction costs associated with maintaining paid connections. Both advances should increase revenues flowing into the power sector.

Second, the distribution function should be further commercialized. The problems in distribution are "complicated." Despite efforts by the national government to fund new investments in distribution infrastructure, effective execution of such projects has proven elusive and technical losses remain high. Based on international experience, expanding the scope of private sector participation should increase operational efficiency and reduce technical losses, provided that incentives are well designed. Reforms on the retailing side can be expected to ameliorate the political opposition often associated with privatizations of electricity distribution.

1. INTRODUCTION TO THE POLICY QUESTION

In July of 2012 India experienced the largest blackout in world history, with over 600 million people unexpectedly losing power.[1] The episode served as a dramatic reminder of the underdevelopment of India's electricity infrastructure. Figure 1 illustrates the low levels of electricity consumption in India relative to other countries.

Figure 1, Annual per capita electricity consumption, 2009



Source: Planning Commission (Power & Energy Division) of Government of India, 2011, p55 (in PDF)

In 2009 per capita electric power consumption in India averaged 734 kWh, compared to 2,456 kWh in China and 13,647 kWh in the United States. While such low levels of electrification pose challenges on their own, it is the shortfall of supply relative to demand that creates the more pernicious risk of outages. While the July 2012 blackout was striking in its scale, power outages in India are a chronic problem. In the year ending February 2012, power shortages during peak demand conditions averaged 11% of demand across India's regions.[2] The outages that inevitably result from these shortages create costly uncertainty, with consequences ranging from inconvenience to

[1] Yardley, 2012
[2] IndiaStat, "Region/Month-wise Status of Power Shortage (Energy and Peak) in India (April 2009 to February 2012)"

foregone investment in the country to purchases of diesel generators that drive up costs and pollution per unit of electricity.

Modern infrastructure, including roads, airports, seaports, water and sanitation services, and telecommunications and electricity systems, serves as an important input to most economic activities. Indeed, anecdotal arguments about India's crumbling infrastructure dampening growth are corroborated by academic research on the subject. Empirically establishing the contributions to growth from infrastructure can be challenging given that growing output could increase demand for infrastructure just as plausibly as a growing stock of infrastructure could increase output. However, studies accounting for this endogeneity still find a substantial positive impact of infrastructure investment on GDP growth.[3] Similar positive causal relationships hold for electricity infrastructure in particular, both in cross-country analyses[4] and in the case of India.[5] This academic research corroborates the intuitively sensible argument that a more robust power sector will support India's economic growth and development.

Each step along the electricity "supply chain" in India offers opportunities for improvement. But after early reform efforts focused on restructuring the generation segment, in recent years a consensus has emerged that distribution represents the weak link in the country's power sector.[6] Each year the revenues of distributors fall far short of their costs. Annual losses for the four years ending in 2011 swelled from roughly $3B to $8.5B, after accounting for payments from the government to cover subsidized tariff rates.[7] A functional distribution segment must collect enough in revenue, net of public support, to cover its costs, including the cost of electricity purchased, which represents the income that generators must receive to make their operations viable. Indian distributors' current losses discourage investment in additional generation production,

[3] Esfahani and Ramirez, 2003, p470
[4] Estache, 2004, p4
[5] Asafu-Adjaye, 2000, p621
[6] Shunglu Committee, 2011, p6 (in PDF) and Dossani, 2004, p1278
[7] Planning Commission (Power & Energy Division), 2011, p169 (in PDF) and Power Finance Corporation, 2012, p96 (in PDF)

which generators may never be able to sell to bankrupt distributors, and may eventually threaten the health of banks that finance the debt of distributors.

The Ministry of Power of India should therefore focus its policy reform efforts on improving the financial performance of distributors. It is worth reiterating that this goal represents a means to the end of more reliable and available electricity. Examples abound of infrastructure reform efforts losing sight of the forest (higher quality service provision) for the trees (strictly following a rigid reform agenda of liberalization or privatization based on a set of best practices).[8] To avoid this risk, reform strategies must account for local contexts and remain mindful of the linkages between distribution and the rest of the power sector.

This paper will proceed with a brief primer on the electrical supply chain, a review of India's historical power sector reform efforts, an assessment of the current conditions of distributors, an analysis of the relationships between drivers of financial underperformance, a discussion of available policy options, recommendations for policy implementation, and concluding remarks.

2. BRIEF PRIMER ON THE ELECTRICAL SUPPLY CHAIN

An effective electrical supply chain is characterized both by the features of the constituent activities, namely generation, transmission, distribution, and retailing and the nature of the linkages between activities. Since the activities differ in the extent to which they exhibit characteristics of natural monopolies, they differ in their optimal market structure.[9] Generation of electricity exhibits economies of scale, but only up to a point. It entails large initial capital costs, but ongoing variable costs are not negligible. As a result, with sufficient market demand, multiple firms can effectively compete in producing electricity. Transmission, on the other hand, like many network services, exhibits enormous economies of scale and a massive ratio of initial capital costs to

[8] Kessides, 2005, p85
[9] Hunt, 2002

ongoing variable costs. As a result, relative to running a single transmission network, it would be inefficient and unnecessarily costly to run multiple transmission networks in parallel, meeting a common formal definition of natural monopoly.[10] Apart from operating at lower voltages, distribution networks differ from transmission networks in other important operational ways that affect the optimal regulatory scheme for each activity. For example, whereas management of transmission networks consists of making a limited number of very large investments, managers of distribution networks make a large number of small investments. However, the fundamental network features of transmission also apply to distribution, making it a natural monopoly as well. Within a given geographical area, competition between multiple distributors is not productive. As with transmission, competition in distribution is likely unsustainable due to the difficulty of new entrants recuperating initial capital costs.

Despite the fact that distribution and retailing are often bundled together, they should be thought of as distinct functions, with distribution referring to the management of distribution infrastructure ("the wires") and retailing referring to the sale of electricity to customers (and concomitant acquisition of electricity, either from vertically-integrated generation or wholesale markets). These functions should be thought of as distinct because they exhibit different fundamental characteristics; in particular, retailing is not a network-based activity prone to natural monopoly. In fact, bundling retailing with distribution prevents the application of competitive pressures that would be possible under liberalized retailing. Some have posited that retail competition in electricity contributes little value to customers[11] and that electricity is such an inherently homogenous product that Bertrand-style competition on price will make profitable market entry impossible.[12] Others, however, have argued in defense of retail liberalization, pointing out that the inability of regulators to conceive of innovations that would justify liberalized retailing says little about the market's ability

[10] Baumol, 1977, p809
[11] Joskow, 2000, p10 (in PDF)
[12] Batlle, 2012, p19

to devise and deliver such innovation.[13] This topic will be addressed in the Indian context in greater detail below.

3. HISTORY OF INDIAN POWER SECTOR REFORM

The history of India's power sector can be divided by a series of major legislative markers: the Electricity Act of 1948, the Electricity Act of 1991, the Electricity Act of 1998, and the Electricity Act of 2003, each of which made significant changes to the structure of the Indian power sector. Conceptually, these phases can be thought of as corresponding to the following models diagrammed in Figure 19: vertical integration, unbundled generation with a single buyer, a transition period, and finally, wholesale competition with multiple producers and multiple buyers.

Electricity Act of 1948

As in many other countries, both developed and developing, India's early electrical power sector was characterized by public ownership and vertical integration. Following India's independence in 1947, the Electricity Act of 1948 led to the establishment of State Electricity Boards (SEBs), operating vertically-integrated generation, transmission, distribution, and retailing activities. The national and state governments shared control of the power sector, with SEBs exercising significant autonomy, but relying on the national government in the form of technical advice from the Central Electricity Authority (CEA) and financial support from the Power Finance Corporation (PFC). With no competition in any segment, the state represented the only producer and buyer of electricity (on behalf of end consumers). Since SEBs were financed publicly and operated as extensions of state ministries of power, operational decisions such as tariff levels came under political pressure. The decision to heavily subsidize electricity for rural constituents, compounded by the selection of managers on the basis of political considerations rather than merit, led to revenue shortfalls and

[13] Littlechild, 2000, p15

electricity shortages.[14] By the 1970s blackouts were widespread and by the end of the 1980s SEBs represented the single largest drain on state finances.[15]

Electricity Act of 1991

In 1991 a financial crisis brought on by high levels of indebtedness at all levels of government triggered wide-ranging reforms of much of the economy, including the power sector. In large part these reforms sought to avoid future balance of payments crises by opening the country to foreign investment. Consistent with this overall thrust, the Electricity Act of 1991 opened the former state monopoly on generation to competition from private firms. The Act sought to ease the fiscal burden the power sector had become through tapping private capital and relying on competition to bring down production costs. Under the new rules private generators known as independent power producers (IPPs) could sell electricity directly to SEBs under power purchase agreement (PPA) contracts, which ensured attractive rates of return and were guaranteed by the national government.[16] The government had hoped that moving to a model of multiple sellers with a single buyer would restore the fiscal health of the SEBs. However, because underlying problems in distribution had not been addressed, SEBs continued to face financial strains.

Electricity Act of 1998

As the failings of the Electricity Act of 1991 and its focus on generation became clear, attention began to shift towards reforming distribution. In particular, momentum grew in support of the idea that depoliticizing SEBs and encouraging them to act according to more commercial principles would improve their performance. The Electricity Act of 1998 and its accompanying guidelines introduced several important reforms.[17] First, they established the Central Electricity Regulatory Commission

[14] Dubash and Rajan, 2002, p68 (in PDF)
[15] Tongia, 2003, p7 (in PDF)
[16] Besant-Jones, 2006, p118 (in PDF)
[17] Dossani, 2004, p5 (in PDF)

(CERC) and encouraged states to establish State Electricity Regulatory Commissions (SERCs) as independent regulators. SERCs were charged with setting tariffs at levels that would enable cost recovery. Second, they required states to unbundle SEBs into separate generation, transmission, and distribution agencies (with the retail function embedded in distribution). Third, they directed states to open transmission activities to the private sector and encouraged states to "corporatize" distributors, meaning to operate according to more commercial principles but not necessarily invite the participation of the private sector. This ambiguity reflected the national government's lack of clear vision over whether or not distribution should be privatized.[18]

States have shown considerable variation in the timing and extent to which they have followed these guidelines. Figure 2 shows the years in which different states unbundled their SEBs and established SERCs.

Figure 2, Years of SERC establishment and SEB unbundling across states

State	SERC operational	SEB unbundled
Andhra Pradesh	1999	1998
Assam	2001	2004
Bihar	2005	[a]
Delhi	1999	2002
Gujarat	1998	2006
Haryana	1998	1998
Karnataka	1999	1999
Madhya Pradesh	1998	2002
Maharashtra	1999	2005
Orissa	1995	1996
Punjab	1999	2010
Rajasthan	2000	2000
Tamil Nadu	1999	2010
Uttar Pradesh	1999	1999
West Bengal	1999	2007
Chhattisgarh	2000	2008
Jharkhand	2003	[a]

[a] Reform not implemented by 2010.

Source: Cropper, 2012, p27

[18] Tongia, 2003, p38 (in PDF)

Orissa, Andra Pradesh, and Delhi offer particularly illuminating examples of local experiences, which will be explored in greater detail below.

Electricity Act of 2003

Whereas the Electricity Act of 1998 implicitly endorsed state-level experimentation with different approaches to "corporatizing" and regulating distribution, the Electricity Act of 2003 sought to move towards a nationally-integrated competitive wholesale market for electricity.[19] The Act of 2003 includes several provisions designed to facilitate this transition, including non-discriminatory open access and a recognition of power trading as a distinct activity. Prior to 2003, producers did not face a market of competing buyers for their electricity. By allowing for trading and transmission of electricity across states these provisions enabled the transition to a model of multiple producers and multiple sellers.[20]

It should be noted that in addition to providing for competitive wholesale markets, the Electricity Act of 2003 actually began to pave the way towards competitive retail markets. Competitive wholesale markets generally entail distributors buying electricity from competitive producers that they then sell on to captive end customers. Competitive retail markets, on the other hand, entail end customers choosing between retailers competing for their business, which then purchase electricity in wholesale markets on behalf of those end customers. The Act of 2003 provides for this by mandating open access not only in transmission, but also in distribution.[21]

Weak de facto implementation of strong de jure rules

Over time the Indian power sector has trended towards the conditions required for competitive and efficient wholesale electricity markets, which can be precursors to competitive retail markets. These conditions include a spot market (into which sellers

[19] Singh, 2010, p2 (in PDF)
[20] Singh, 2006, p6 (in PDF)
[21] Singh, 2010, p11 (in PDF)

and buyers submit bids to arrive at market-clearing prices), an independent system operator (ISO, responsible for coordinating the dispatch of electricity over network wires), open access to network wires (so that geographically disparate buyers and sellers can be connected using infrastructure belonging to third parties), and appropriate calculation and application of location-specific transmission charges (so that costs associated with transmission losses and intensified congestion can be applied to consumption in a particular location).[22] However, the de facto implementation of these rules in India has not always followed their de jure adoption.

For example, regarding system operators, each of India's five regions (Northern, Western, Eastern, Northeastern, and Southern) has a Regional Load Dispatch Center (RLDC) that coordinates with State Load Dispatch Centers (SLDCs) within the states comprising each region. SLDCs are sometimes operated by independent State Transmission Utilities (STUs), but often times by legacies of SEBs, calling into question their ability to operate independently.[23] While management of bid-based spot markets is often rolled into the responsibilities of ISOs, the government has promoted electricity trading on power exchanges associated with prominent securities exchanges, with RLDCs and SLDCs (ostensibly acting as ISOs) managing the interface between the physical system and the trading platform.[24]

One key challenge in managing this interface is apportioning the transmission and distribution capacity required to execute trades submitted to the exchanges. Robust rules for open and non-discriminatory access in transmission and distribution are necessary for these exchanges to optimally match generation capacity with load demand. Yet adoption and implementation of these rules have been incomplete, with open and non-discriminatory access in distribution lagging particularly far behind the de jure provisions in the Electricity Act of 2003 mandating its adoption.[25]

[22] Hogan, 1998, p1
[23] Pandey, 2007, p2
[24] Ibid, p5
[25] Planning Commission (Secretariat for Infrastructure) of Government of India, 2012, p5

Arrangements granting transmission access are currently more supportive of long-term contracts and less conducive to short-term transactions, creating a chilling effect on precisely the kind of trades that spot markets exist to facilitate.[26] Moreover, these access rights are not allocated through an efficient process, such as an auction, that awards them to those who value them most highly.[27]

In fact, in pursuing a model that separates managing the market for electricity (power exchanges) from managing the physical operations of the power grid (grid operators), India is subscribing to an idea known as the "separation fallacy."[28] The fallacy arises from the fact that managing the physical constraints to operating an electrical grid is inseparable from assigning costs to the activities of grid users that make those constraints binding. By including market management, in addition to grid management, in the responsibilities of ISOs, these inextricably-linked issues can be handled more efficiently.

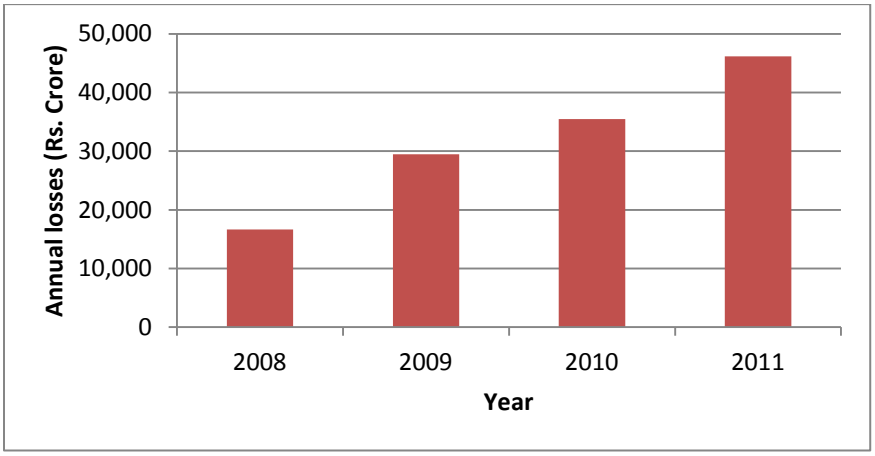
For India to move towards true implementation of non-discrimination and open access, it should follow the ISO model. Power exchanges are still in their nascence and account for only 11% of power sold in India, with the balance being transacted through direct bilateral contracting. [29] This suggests that the technical switching costs of this change would still be relatively low. However, both legislative changes and significant capacity building within RLDCs and SLDCs would be required. A detailed analysis of these steps lies outside the scope of this report, though such a restructuring would reinforce the gains from the reforms at hand.

[26] Singh, 2010, p6 (in PDF)
[27] National Load Dispatch Center, 2009, p6 (in PDF)
[28] Hogan, 2002, p3
[29] Central Electricity Regulatory Commission, 2012, p13

4. CURRENT CONDITION OF DISTRIBUTORS

The financial records of distributors in India are notorious for being poorly kept.[30] In addition to simple tardiness in compiling and publishing records, distinguishing between revenue that has been booked in theory and revenue that can actually be collected is a recurring challenge. Furthermore, when integrated SEBs were ordered in the Electricity Act of 1998 to unbundle, many administrative functions such as accounting were slow to adapt. In some cases, when SEBs were unbundled, the new generation, transmission, and distribution entities were given fresh balance sheets, with the accumulated losses of the old SEBs simply written off and subsumed into state budgets for that year.[31] As a result, information about the financial health of distributors is not always consistent across, or even within, data sources. Triangulation can help but not entirely solve this problem. Figure 3 shows annual losses for distributors (after accounting for government payments to cover subsidized tariffs) growing at 29% for the four years leading to 2011, when they reached $8.5B.[32]

Figure 3, Commercial losses for all distributors, 2008-11



Source: Planning Commission (Power & Energy Division) of Government of India, 2011, p169 (in PDF) and Power Finance Corporation, 2012, p96 (in PDF)

[30] Shunglu Committee, 2011, p7

[31] For example, when Tamil Nadu unbundled between the 2010 and 2011 fiscal years, $5B worth of accumulated losses were wiped clean from the balance sheets of the newly unbundled entities

[32] One crore equals 10M and an exchange rate of Rs. 54 / USD is used throughout this report

The 2011 loss of Rs. 46,132 crore took place against total expenditures of Rs. 286,046, representing a troublingly high negative margin. Yet despite these enormous annual losses, distributors still report positive net worth values, as Figure 4 illustrates.

Figure 4, Net worth for all distributors, by region, 2011 (Rs. Crore)

Region	Equity	Reserve	Accumulated Profit/Loss	Net Worth
Eastern Total	1,106	453	(14,858)	1,559
North Eastern Total	1,118	205	(6,201)	(4,999)
Northern Total	96,232	2,600	(72,900)	25,651
Southern Total	15,160	4,322	(8,144)	11,211
Western Total	29,478	8,244	(14,231)	23,218
Grand Total	151,242	16,713	(116,334)	50,719

Source: Power Finance Corporation, 2012, p142 (in PDF)

Distributors are able to overcome annual losses in excess of $8B to preserve their solvency, at least on paper, through infusions of outside capital. Figure 5 illustrates the range of sources of these funds. Given the long history of deep public sector involvement in SEBs it is clear that even in the case of "corporatized" distributors, "investments" of public funds do not carry the standard expectations of market returns. Moreover, many of the banks financing distributors are explicitly or implicitly directed by the government to lend with lenience.[33]

Figure 5, Total capital employed for all distributors, by region, 2011 (Rs. Crore)

Region	Net Worth	State Govt. Loans	Loan from FIs/ Banks/ Bonds	Other Loans	Grants towards Capital Assets	Consumer Contribution	Total Capital Employed
Eastern Total	(4,362)	29,072	17,730	917	4,149	1,910	49,415
North Eastern Total	(4,999)	1,490	1,934	197	4,244	225	3,093
Northern Total	25,651	8,950	151,849	2,453	5,758	7,956	202,617
Southern Total	11,211	780	74,682	13	2,320	8,136	97,142
Western Total	23,218	6,004	67,086	39	5,319	5,673	107,338
Grand Total	50,719	46,295	313,281	3,620	21,789	23,900	459,604

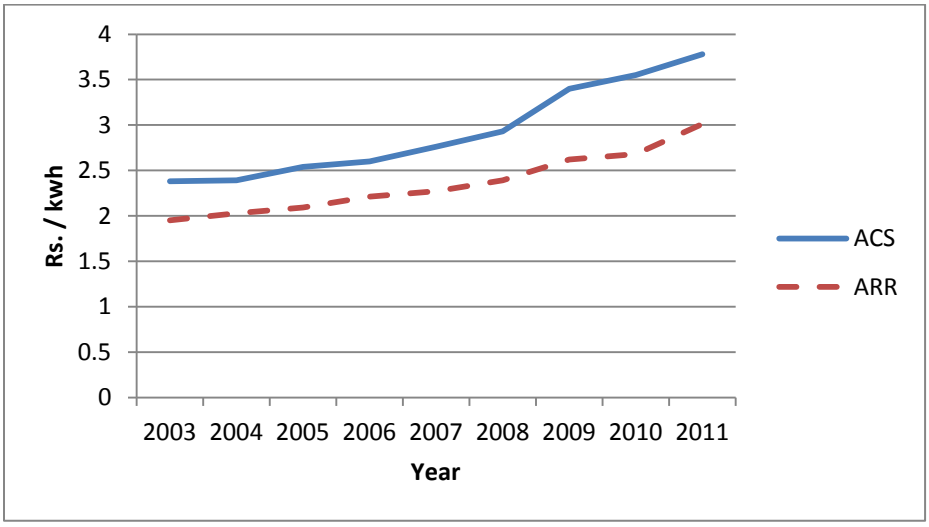
Source: Power Finance Corporation, 2012, p148 (in PDF)

[33] Economist, 2012

The existence of public support of distributors is perhaps unsurprising, given their recurring losses. After all, the government has an interest in keeping the lights on. Moreover, subsidizing electricity is not necessarily a poor use of public resources, though the figures presented above suggest that distributors could bankrupt state budgets. More immediately problematic is extensive lending to distributors by banks. Compared to the government, banks find it much more painful to write off delinquent loans. This suggests that banks with large exposures to distributors could eventually either bear major losses or seek significant public support themselves.

Developing a strategy for pulling distributors out of these financial straits requires digging deeper into the patterns of distributors' losses. Specific factors to explore include distorted tariffs, theft of power, technical losses, and generally weak management, each of which is addressed in greater detail below. Figure 6 shows the average cost of supply (ACS) and average revenue realized (ARR) for distributors. ACS is defined as total expenditures divided by total quantity of energy purchased. ARR is defined as total revenues (on a pre-subsidy basis) divided by total energy purchased.

Figure 6, Average cost of supply and revenue realized for all distributors, 2003-11



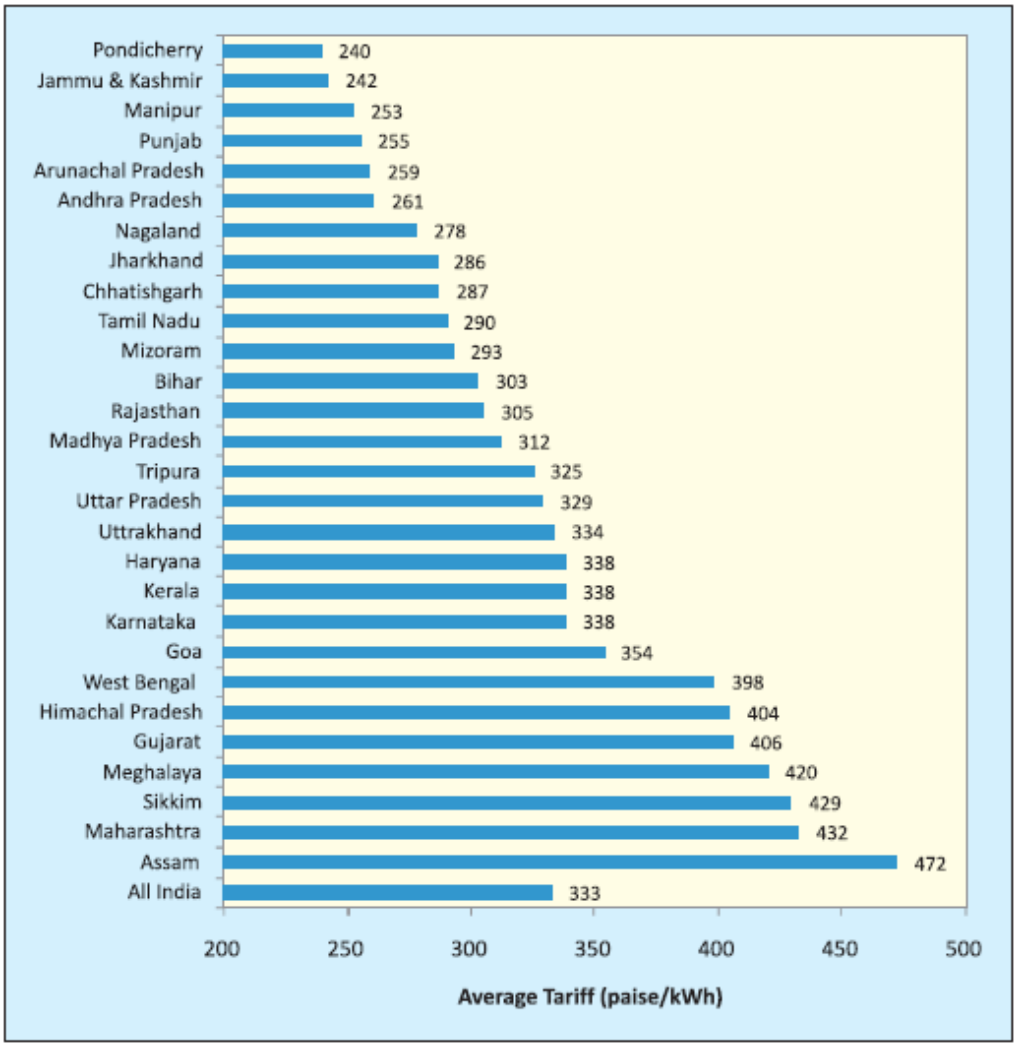
Source: Infrastructure Finance Development Company, 2012, p340 (in PDF) and Power Finance Corporation, 2012, p59 (in PDF)

The average cost for each unit of energy purchased by distributors clearly exceeds the revenue attributable to selling it. This problem can be broken down into two issues: the price at which electricity is sold by distributors and the percentage of electricity purchased by distributors that they are ultimately able to sell.

Distorted tariffs

The first problem is that the average tariffs charged by distributors, shown in Figure 7, are too low.

Figure 7, Average tariffs charged by all distributors, by state, 2010



Source: Planning Commission (Power & Energy Division) of Government of India, 2011, p130

Note that the 2010 average tariff of Rs. 3.3 per kWh falls short of the ACS of Rs. 3.5 per kWh in that year. This means that even if distributors eliminated theft and technical losses and sold every unit of electricity they purchased, the average cost per unit would exceed the average price, suggesting that tariffs are too low on average.

However, this would not necessarily be a problem if more expensively-priced electricity represented a greater share of sales by volume than cheaply-priced electricity. This is indeed the case, as explained below, but Figure 6 clearly illustrates that the skew is not sufficient to push distributors into profitability. Variation in tariff levels exists not only across states but also across customer types within states. Distributors charge higher rates for industrial customers in an attempt to cross subsidize the large discounts given to agricultural customers, which date back to India's Green Revolution and have since been used by politicians to cultivate farmers as a voting bloc.[34] For example, in 2011, agricultural customers represented 22% of sales by volume but represented only 7% of sales by value; industrial customers, on the other hand, represented 34% of sales by volume, but 46% of sales by value.[35] Power service to agricultural customers is also problematic because meters in rural areas tend to be poorly maintained, making it difficult to track how much electricity has actually been consumed.

Aggregate Technical and Commercial Losses

Power losses can be technical or commercial in nature. The sum of both is referred to as aggregate technical and commercial (ATC) losses and represents the total energy that distributors purchase as inputs to the power system but do not ultimate sell for revenue. Technical losses are the natural result of power dissipating as it moves through transmission and distribution wires and other equipment. Although every power system experiences some degree of technical losses, they are generally exacerbated by aging infrastructure. Commercial losses refer euphemistically to energy lost due to theft, which takes place most commonly either through directly connecting

[34] Dubash and Rajan, 2002, p53
[35] Author's calculations based on Power Finance Corporation, 2012, p214 and 220 (in PDF)

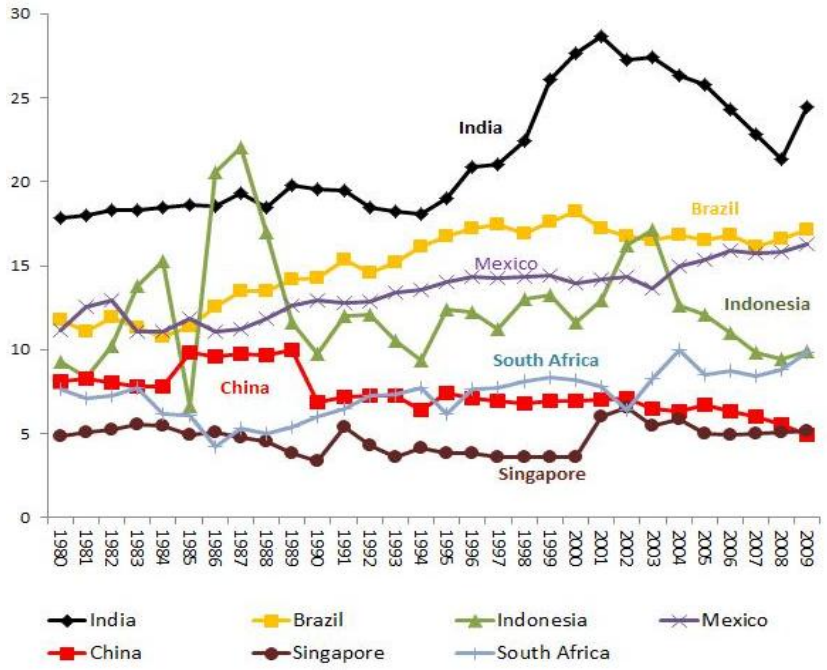
to distribution wires illegally or through tampering with meters so that they underreport power consumed. Particularly in older power systems without modern sensors and monitoring equipment, it can be difficult to distinguish whether a loss at a specific location is due to technical problems or theft. Figures 8 and Figure 9 report data on ATC losses in India and on historical technical losses across several countries.

Figure 8, ATC losses for all distributors, by region, 2011

Region	Net Input Energy (Mkwh)	Net Energy Sold (Mkwh)	Collection Efficiency (%)	Energy Realised (Mkwh)	AT&C Losses (%)
Eastern Total	49,283	33,534	96	32,178	35
North Eastern Total	6,241	4,504	91	4,083	35
Northern Total	215,329	168,072	94	157,599	27
Southern Total	116,500	99,491	94	93,341	20
Western Total	191,231	153,219	94	144,169	25
Grand Total	578,585	458,819	94	431,370	25

Source: Power Finance Corporation, 2012, p201 (in PDF)

Figure 9, Technical transmission and distribution losses, 1980-2009 (%)



Source: Plumer, 2012

Although the past decade has seen positive trends in India, its rate of technical losses continues to exceed that of other developing countries. Since this represents electricity that distributors have to pay to purchase, but cannot sell to end customers, it translates directly into higher financial losses.

Inefficient management practices

Finally, generally poor management practices present obstacles to more efficient operation and improved financial performance by distributors. For example, low levels of computerization and inadequate IT systems make it difficult to track sales and collection rates, pinpoint sources of ATC losses, and integrate this information into an understanding of commercial performance.[36]

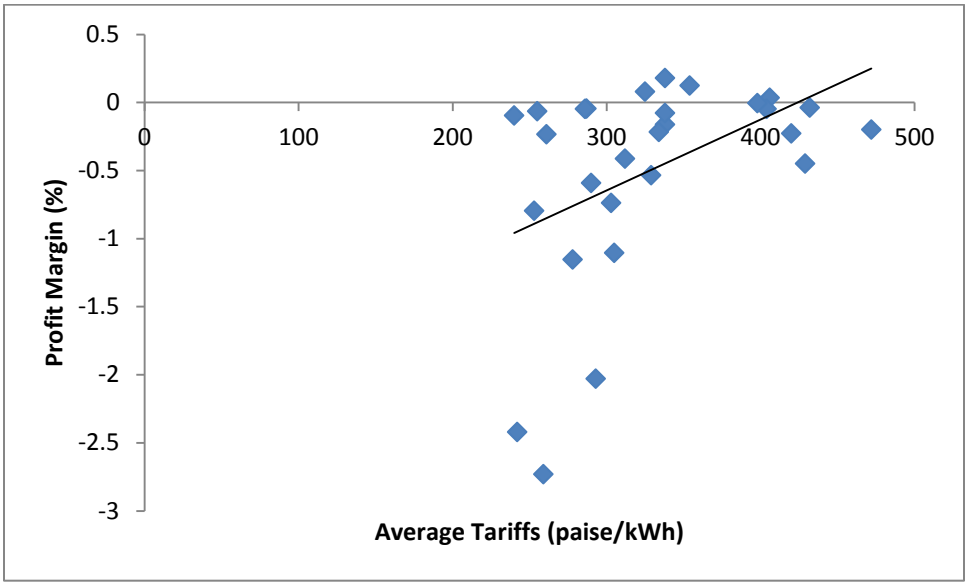
5. ANALYSIS OF DRIVERS OF FINANCIAL PROBLEMS

It is helpful to think of distributors' problems as falling into two categories: "complicated" and "complex" problems.[37] In this dichotomy complicated problems have been described as those for which "it is possible to identify and model the relationships between the parts" and for which "the relationships among the parts can be reduced to clear, predictable interactions."[38] Complex problems, on the other hand, "need to be seen as a set of activities and relationships that constitute a social system that reciprocates, adapts and reproduces over time."[39] In the present context, technical losses and inefficient management practices can be considered complicated problems. Expectations for subsidized power, the prevalence of theft, and non-payment of bills can be considered complex problems. These problems reflect norms and implicit social contracts between people and the government, in which politicians condone these patterns of behavior in exchange for political support.

[36] Ministry of Power of Government of India, 2012, p221 (in PDF)
[37] The following description of this dichotomy follows Kamensky, 2011
[38] Ibid, p66
[39] Ibid, p67

It is also helpful to examine the patterns between these categories of problems, as the following scatter plots do, taking the state as the unit of analysis. For states that unbundled SEBs into multiple distributors, data are aggregated across entities. It is instructive to examine the correlations between the drivers described above and financial performance, as well as the correlations between the drivers themselves. High correlations between the drivers themselves could suggest that historical factors specific to individual states lie at the root of these problems, rather than overarching institutional problems addressable by the Ministry of Power at the national level. Data for this section comes from Power Finance Corporation, 2012 and Planning Commission (Power & Energy Division), 2011.[40] Data for the year 2010 is used.

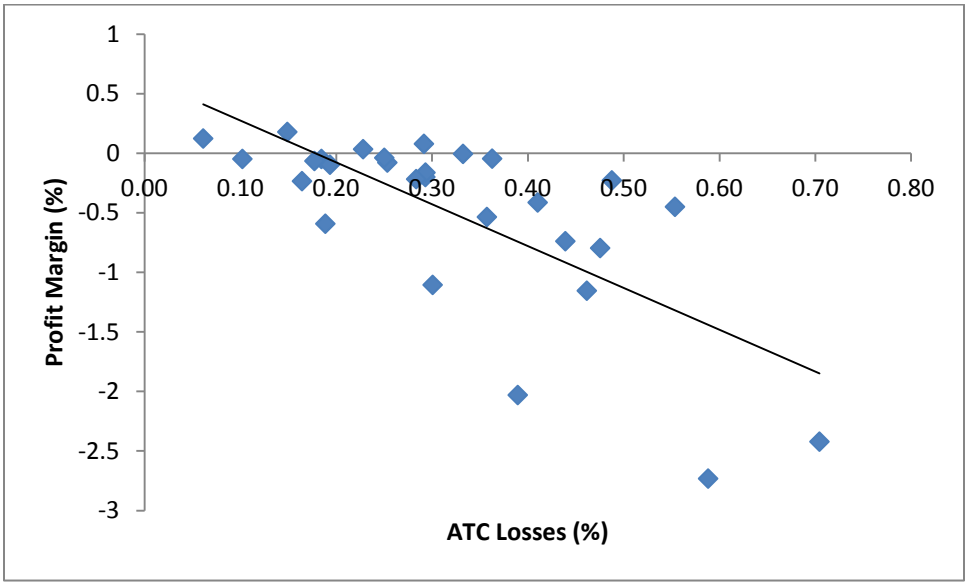
Figure 10, Relationship between profit margins and average tariffs



As expected, average tariffs and profit margins are positively correlated. On an aggregate basis, states with distributors charging higher tariffs tend to have distributors with higher profit margins.

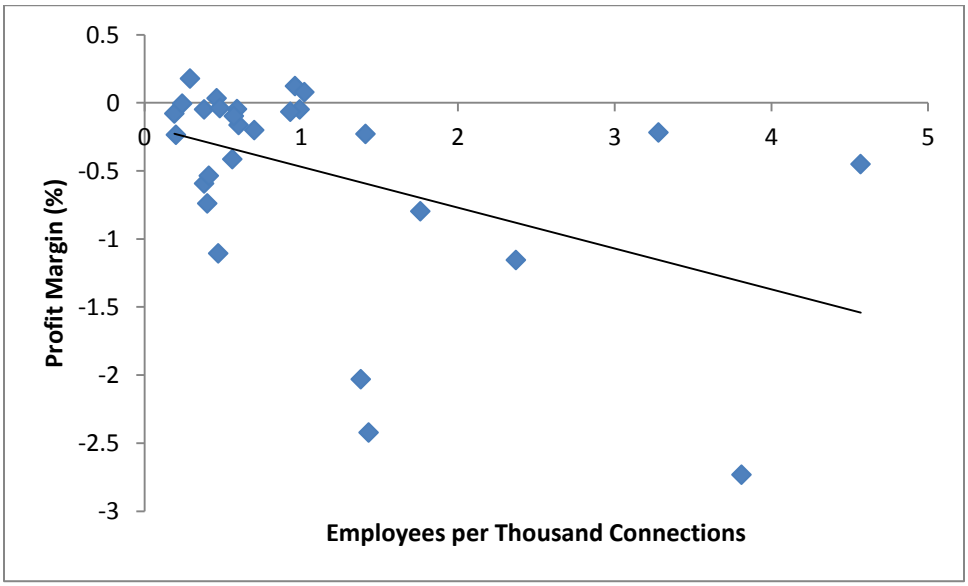
[40] Financial performance is measured as margin of profit/loss after accounting for subsidies against total revenue before subsidies; financial performance data is from Power Finance Corporation, 2012, p85 (in PDF); average tariff data is from Planning Commission (Power & Energy Division) of Government of India, 2011, p130 (in PDF); ATC losses data is from Power Finance Corporation, 2012, p204 (in PDF); data on employment is from Planning Commission (Power & Energy Division) of Government of India, 2011, p159 (in PDF)

Figure 11, Relationship between financial performance and ATC losses



As expected, ATC losses and profit margins are negatively correlated. On an aggregate basis, states with distributors with higher ATC losses tend to have distributors with lower profit margins.

Figure 12, Relationship between financial performance and operational inefficiency



As expected, operational inefficiency (proxied by the number of employees per thousand connections) and profit margins are negatively correlated.

Regression analysis shows that average tariff levels, ATC losses, and employees per thousand connections explain 65% of variation in financial performance. Of course there is no exogenous variation in this data so it is not possible to assign any causal interpretation to these results, but they still shed light on the magnitudes of variation in the data. A one percentage point improvement (reduction) in ATC losses is associated with an improvement of three percentage points in profit margins. An increase of Rs. 10 in average tariffs is associated with an improvement of four percentage points in profit margins. Both of these relationships are statistically significant at the 1% level. Detailed regression results are presented in Figure 17 in the Appendix.

Figures 13 and 14 examine whether or not the drivers themselves are correlated.

Figure 13, Relationship between operational inefficiency and ATC losses

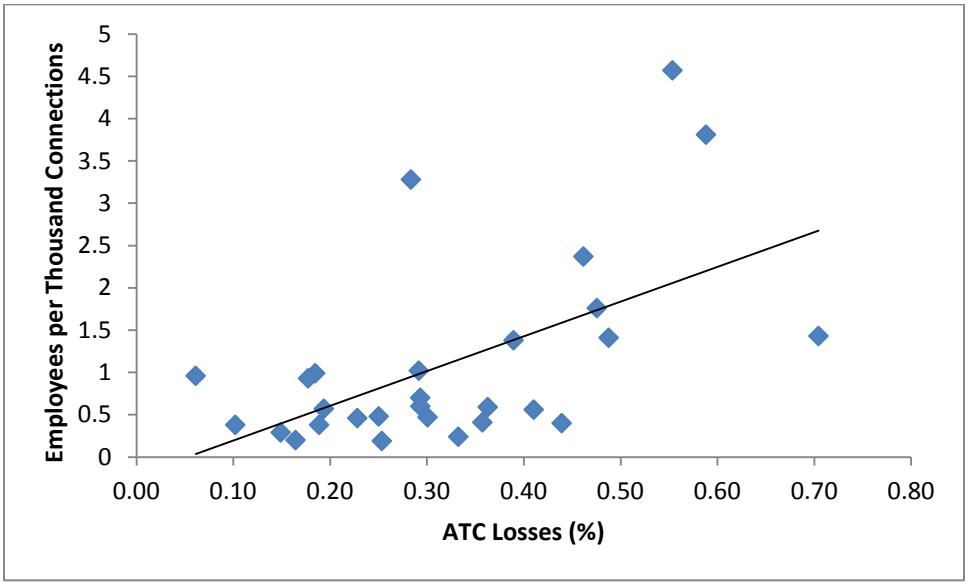
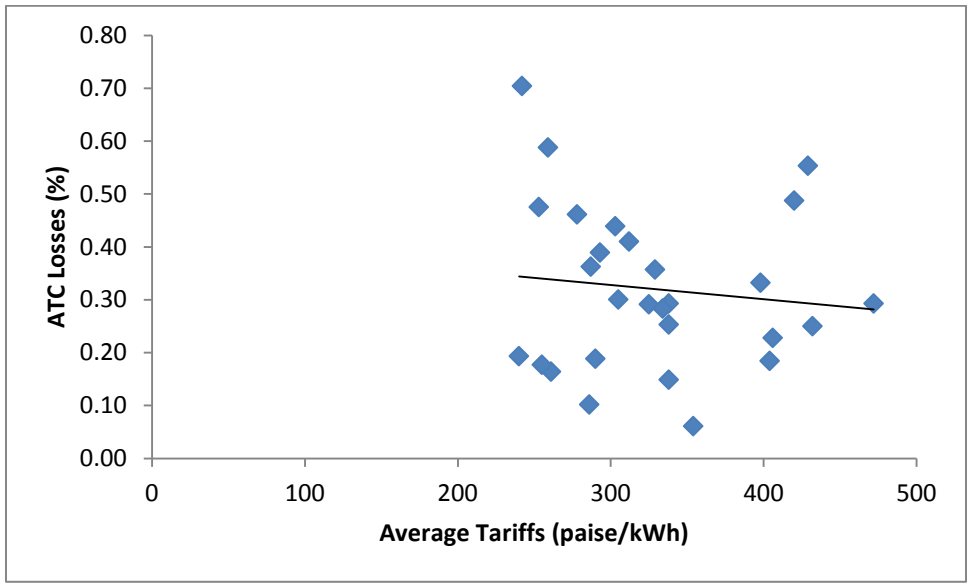


Figure 13 shows a positive correlation between ATC losses and operational inefficiencies. On an aggregate basis, states with distributors with higher ATC losses tend to have distributors with higher operational inefficiencies. This may provide suggestive evidence that there are "good" states and "bad" states and that targeting reforms to solve different kinds of complicated versus complex problems may provide less traction than targeting reforms to address state-specific problems. However, since

it is not possible given available data to distinguish between technical and commercial losses, Figure 13 is likely showing a positive relationship between technical losses and operational inefficiency, which one would expect, given that they both fall into the bucket of complicated problems.

Figure 14, Relationship between ATC losses and average tariffs



Moreover, Figure 14 shows little correlation between ATC losses and average tariffs. This further muddies any potential typology of states where either complicated or complex problems dominate. Rather, these findings support the approach recommended for the Ministry of Power: focusing on nation-wide structural reforms.

6. ANALYSIS OF POLICY OPTIONS

It is logical that higher tariffs and lower rates of ATC losses would reduce distributors' financial losses. But it would be a mistake to directly focus reform strategies on those measures, largely because that approach has already been tried, without much success.

The role of subsidized tariffs in driving distributors' losses is well understood. From a technical perspective it is straightforward that the price of electricity should

reflect its cost. But there are strong political pressures to maintain tariff subsidies. Indeed, one of the main motivators for establishing SERCs was to try to insulate distributors from these political pressures. But they have been slow to act and politicians have been averse to endorsing higher prices in the name of more reliable power for fear of alienating the powerful voting contingency that farmers represent. Indeed, politicians who do endorse higher tariffs, more comprehensive metering, or improved collection rates tend to perform poorly in subsequent elections.[41]

Policymakers have also focused on reducing ATC loss rates through investments in new infrastructure. This strategy is particularly appealing because it holds the potential to improve service quality *and* financial performance of distributors. Moreover, the magnitude of potential gains is large. Analysis has suggested that reducing technical losses is far more cost-effective than building additional generating capacity in closing the gap between supply and demand for electricity.[42] For these reasons the national government in 2001 established the Accelerated Power Development Program (APDP), in order to help distributors fund power infrastructure improvement projects through a combination of loans and grants. After disappointing initial results in 2003 the program was reformed to expand its scope to also target investments in IT infrastructure required for identifying needed investments in physical infrastructure.[43] Since the program was re-established in 2003, with a budget of Rs. crore 51,000, only Rs. crore 5,500 had been distributed to fund projects as of 2012.[44] Problems may lie in the administration of the program or a lack of incentives and capacity on the part of distributors. In any event, a disbursement rate of roughly 10% after almost ten years points to a dearth of investments actually being made.

One interpretation of the problems encountered by these approaches of tariff reform and infrastructure financing is that they target too granular a level of decision

[41] Joseph, 2009, p4
[42] Ruet, 2006, p124
[43] Power Finance Corporation, 2012, p26 (in PDF)
[44] Author's calculations based on disbursement amounts across program components reported in Power Finance Corporation, 2012, p27 (in PDF)

making, without paying sufficient attention to the context of these decisions. Reforms should acknowledge the incentives guiding stakeholders' decisions and seek to align those incentives with desired outcomes. Moreover, reforms should not target overly-specific outcomes, but rather create a sound market structure that allows for contextually appropriate outcomes to emerge.

Given these criteria, two appropriate levers for the Ministry of Power to consider adjusting are introducing competition to the retailing function and further commercializing the distribution function. Each of these levers represents a high-level choice about overall market structure and rules. Considerable variation exists in the specific forms these market structures can take. Figure 15, which summarizes the potential combinations of these levers, therefore presents a typology of market structures that should serve as a starting point in building strategies for improving the performance of distributors.

Figure 15, Summary of policy levers

		Commercializing distribution	
		No	Yes
Unbundling retailing	No	1. Status quo semi-public distribution with bundled retailing	2. More private distribution with bundled retailing
	Yes	4. Status-quo semi-public distribution with unbundled competitive retailing	3. More private distribution with unbundled competitive retailing

Source: Author

These options are explored in greater detail below and evaluated on the basis of the extent to which they are technically correct, politically supportable, and administratively feasible. As mentioned above, different states in India have followed unique paths in interpreting and implementing the guidelines in the Electricity Act of 1998 regarding unbundling and "corporatizing" of SEBs. Where possible, lessons from

the experiences of specific states are drawn to build an understanding of which reform strategies are most likely to succeed.

Option 1: Status Quo

In their current condition electricity distributors provide unreliable electricity at great cost to India's public finances. This is certainly not a technically correct solution. The persistence of the current arrangement over many years establishes its administrative feasibility and political supportability, to date. However, the growing strain that distributors' losses place on states' budgets is likely to eventually undermine political support and fuel calls for reform.

Option 2: Commercialized distribution with bundled retailing services

Increasing the private sector's role in distribution while maintaining a structure of bundled retailing would leverage the private sector's technical expertise and its drive to increase profits by reducing inefficiencies. These strengths are well suited for delivering solutions to the "complicated" problems of operational efficiency such as technical losses and labor productivity. Indeed, a recent survey by the World Bank analyzed a sample of 250 electric utilities across 71 developing countries and found that relative to complete state ownership and operation, private sector participation in electricity distribution is associated with a 32% increase in electricity sold per worker, a 54% increase in capital expenditures per worker and an 11% reduction in technical losses.[45] The report attributes these gains to the stronger incentives for efficiency facing the private sector and argues that greater degrees of privatization are associated with larger improvements in productivity and service quality.[46] In the Indian context, shortly after Delhi's distributor entered into a joint venture with a private firm, the newly formed North Delhi Power Limited entity installed state-of-the-art infrastructure

[45] Public-Private Infrastructure Advisory Facility, 2009, p34 (in PDF)
[46] Ibid, p47

equipment and information technology tools. These investments reduced ATC losses from nearly 50% in 2002 to 15% in 2009.[47]

However, expanding the scope of private sector participation in electricity distribution can face serious political problems. These disputes sometimes arise over failures on the part of either governments or private firms to abide by regulatory obligations or contractual agreements. Changes in government administrations following elections or perceptions by governments of changed mandates can amplify the lack of predictability in political environments without robust regulatory institutions. But more often, the catalyst of these problems is efforts by private distributors to raise tariffs. Orissa, the first Indian state to embrace privatization of its distribution sector, faced both of these problems. Working in conjunction with the World Bank, Orissa chose to fully divest the distribution service of its former SEB. The new private operators, however, found themselves unable to collect sufficient revenue to finance loss-reducing investments in new equipment. Not only did consumers and politicians successfully pressure the Orissa SERC into more modest tariff increases than private operators expected, but the state government also declined to pay the share of tariffs subsidized by public funds.[48]

There were major flaws in the manner in which the Orissa privatization was carried out. In preparing materials soliciting bids from private operators, the state government understated the distribution system's level of technical losses, leading private operators to believe the system was closer to profitable operation than it was in reality.[49] When the true levels of losses were discovered, the relationship between the private operator and the government suffered. But even if one sets this incident aside, the political obstacles that private operators faced are somewhat unsurprising. This is because the technical capabilities of the private sector are not necessarily well-suited to navigating the "complex" problems of public expectations of subsidized power and the

[47] Antmann, 2009, p13
[48] Tongia, 2003, p41
[49] Ibid, p41

political patronage that capitalizes on these expectations. Indeed, these same dynamics have played out in other developing countries pursuing traditional privatization of electricity utilities. The Dominican Republic and Georgia stand out as examples in which private investors ultimately withdrew because of an inability to raise tariffs to the level required for cost recovery.[50]

From an administrative feasibility perspective the key feature of privatization is the specific form that it takes. There is a range of degrees to which private sector participation can be increased, ranging from management and lease contracts to concessions through to partial and full divestitures. Each approach presents unique risks and challenges to administrative feasibility. In a full divestiture, the demands placed on the government are in arriving at a fair sale price and then after the actual transition maintaining an effective regulatory framework in which the private monopolist operates. As one moves closer to a management contract, because transactions become more iterative, the stakes of any single decision by the government probably fall but the overall level of engagement by the government must increase. The commercialization of the Delhi distribution utility mentioned above illustrates the administrative feasibility of crafting a concession contract that creates effective incentives for a private firm in order to achieve specific performance targets. The government of Delhi solicited bids from private operators on the basis of the level of ATC loss reductions that bidders would commit to deliver, with the agreement that operators would be entitled to a share of the savings if targets were exceeded and that operators would bear the costs of ATC losses if targets were not met.[51] This approach also has the benefit of allowing learning by doing rather than a one-time divestiture transaction for which the government may not be sufficiently prepared to avoid the risk of manipulation by private counterparts.

[50] Besant-Jones, 2006, p48
[51] Infrastructure Development Finance Company, 2012, p315 (in PDF)

Option 3: Commercialized distribution with liberalized competitive retailing

From a technical perspective, the arguments for unbundling and liberalizing retailing in the Indian context differ from the arguments supporting this policy reform in more developed countries, where most examples of competitive retailing can be found, such as the United States and the European Union, along with New Zealand and Australia. Electricity is generally considered a commodity, making it difficult for retailers of electricity to differentiate their offerings from those of their competitors. One possible avenue for differentiation is pricing mechanisms, ranging from real-time wholesale prices to long-term contracts, which essentially shift the allocation of price risk between suppliers and buyers of electricity, as well as create opportunities for buyers to save through management of their consumption. Some have also argued that retailers can introduce innovations in customer service, but there is debate over whether or not reductions in already relatively low transaction costs in developed countries can justify the margins required to recoup retailers' costs.[52] In a sense the commoditization of electricity in developed countries reflects the success of electricity markets in those countries: standardized electricity is conveniently available on demand at the flip of a switch. In India electricity is a different kind of good. Specifically, electricity from the grid is not ubiquitously available on demand. Moreover, the transaction costs associated with signing up for and paying bills on an electricity connection are higher than they are in developed countries. This creates opportunities for providers of electricity to differentiate their offerings along two important dimensions: reliability and convenience.

Although tariff rates currently vary across customer categories (e.g. industrial, residential, agricultural, etc.), customers do not have choices about their electricity service within categories. They pay the same tariff rate and receive the same quality of service. However, there is likely significant variation in the value that customers place on reliable electricity and their willingness to pay for that reliability. By offering

[52] Joskow, 2000 and Littlechild, 2000 present the two viewpoints in this debate

customers an array of service options corresponding to different levels of reliability and prices, with higher reliability plans carrying higher prices, retailers could unlock both additional revenue flowing into the power sector from end users and a higher level of welfare for those users.[53]

One could argue that the introduction of this array of service options is not dependent on unbundling and liberalizing retailing. Indian distributors in their current form may be unlikely to introduce this kind of innovation, but what about more commercially-oriented distributors? While this would indeed be possible, a model of unbundled retailing would offer the advantage of competition. Another useful characterization of complex problems is that they are best solved through iterative and adaptive experimentation.[54] Given how new this type of service offering would be in the Indian context, multiple competing retailers could arguably generate more learning, more quickly, about the kinds of plans that match customer demand, relative to the efforts of a single bundled distributor with less strong incentives to experiment.

The second way that competitive retailers could differentiate their offerings would be through reducing transaction costs for customers, which are currently high in interactions with distributors. In India seven separate administrative steps are required to obtain an electricity connection, compared with three in countries like Germany and Japan.[55] Once customers have a connection they must deal with inefficient bill collection systems that force them to either wait in line in person or navigate poorly-designed websites.[56] Liberalized retailers could compete for customers by improving the convenience of these transactions. This kind of value proposition creates two reinforcing gains: it attracts customers and then lowers the probability of those customers falling into delinquency. The case of the city of Bhiwandi in the state of Maharashtra highlights the gains possible from this kind of reform. A private operator

[53] This is consistent with the idea of "priority service" contracts as efficient tools for rationing developed in Wilson, 1989
[54] Andrews, 2012
[55] International Finance Corporation, 2010, p37 (in PDF)
[56] Author's personal experience

licensed by the SEB of Maharashtra was able to reduce the incidence of illegal connections from 10% of the city's population to 1% by allowing customers to register and pay for legal connections at new neighborhood-level stations staffed by employees with connections to those neighborhoods, rather than at traditional centralized office locations.[57]

More ambitiously, retailers could combine advanced meters with pre-paid accounts that customers could recharge at kiosks located throughout a city. Again, this strategy has the potential to yield the double benefit of improving customer satisfaction while also discouraging commercial losses. The largest pre-paid program in the US, the M-Power program in Phoenix, was initially designed to improve collection rates from customers at risk of falling into arrears but ended up growing in popularity with those customers because of its transparency.[58] Smart meter programs can also focus less on customer empowerment and more on improvements in system performance or reduction in commercial losses. When Enel, the dominant electric utility in Italy, rolled out a smart meter program covering 30 million customers, its primary motivation was reducing commercial losses.[59]

The examples above raise the question of why these strategies should be thought of as benefits associated with unbundled and liberalized retailing, since it would be possible for bundled distributors to implement these kinds of programs. But for these efforts to reduce commercial losses to succeed they need either high-level political sponsorship (as in the case of Enel, in which the government still holds a major stake), or a deep familiarity with and sensitivity to the local context (as in the case of the M-Power program, which was introduced by a utility co-operative). Even if a private distributor has the technical wherewithal to identify the sources of commercial losses, securing the political mandate to discontinue service to customers is more challenging. The lack of political leadership in India around reforming the power sector has been

[57] Tankha, 2010, p7 (in PDF)
[58] Neenan, 2010, p15 (in PDF)
[59] Tweed, 2011

clear. In the absence of this political leadership, progress on reducing commercial losses is better led by actors that can engage customers on a local level. The Maharashtra case mentioned above helps to make this point. The private operator in this case was actually acting with a distribution franchising license for a very small geographic area. The strategy worked because it was an intensely local effort. Splitting up distributors to neighborhood-level entities is likely to raise significant challenges in terms of planning, standardizing, and coordinating on investments in distribution infrastructure. Retailers, on the other hand, face neither these constraints nor the pronounced economies of scale of distributors. Together, these characteristics make them better suited to operate at very local scales.

An analysis of stakeholders' interests can shed some light on the likely political supportability of combining commercialization of distribution with liberalization of retailing, relative to commercialization of bundled retailers as in Option 2 above. First, industrial customers should be better off under any reform. These customers currently pay higher than average tariff rates to cross-subsidize other categories of customers. The combination of high tariffs and unreliable electricity service has pushed some industrial customers to forego the grid entirely, setting up their own on-site generation capabilities, known as captive generation.[60] Given the inefficiencies of on-site generation, these industrial firms can expect to benefit considerably from Option 2 and Option 3. Presumably in either case average tariffs would increase for currently subsidized customers, relieving the pressure to charge above-average tariffs for industrial customers.

Second, current managers of distributors and politicians closely involved in regulating distributors stand to lose from reforms such as Options 2 and 3 above. The status quo allows these stakeholders to seek and collect rents, essentially trading political patronage in the form of subsidized power in exchange for political support from voters benefiting from subsidized power. While many of these stakeholders are

[60] Hansen, 2008, p16 (in PDF)

likely to oppose reform efforts, the more far sighted among them may recognize that their leverage in the status quo depends on customers' willingness to accept that cheap power will also be low-quality power. These politicians could capture political gains through offering voters the opportunity to access higher-quality power, but should probably be expected to oppose reforms.

Third, the reaction of customers who, unlike the industrial customers described above, are recipients of subsidies can be broken into two categories. Those with a willingness to pay for electricity that is above their current subsidized rates should be better off under Option 3 than Option 2, since they can specify and capture the value they place on more reliable electricity. Those with a willingness to pay that is at or below the subsidized rate are likely to be worse off under Option 3 than Option 2, since the reliability gains of others will come at their own expense. While it is crucial that customers be denied higher reliability service options unless they pay for them (to preserve the incentives of paying higher prices) it would also enhance the political supportability of Option 3 to establish a floor below which reliability not be allowed to fall for the poorest customers. Ideally this floor would match the current level of reliability. However, the feasibility of this would depend on whether or not the net financial impacts of partially rationalized prices and improvements in collection rates create sufficient surplus to offer this level of reliability even for customers selecting the cheapest service plan available.

A final important group of stakeholders is current workers at distributors. These workers would likely oppose Option 2 based on concerns of job losses following streamlining of distribution operations by private firms. However, the introduction of a new class of retailing firms in Option 3 could create a natural employment transition opportunity for these workers and secure their political support. As seen in the Maharashtra case described above, field-level employees of distributors, such as those that go door to door installing the "last mile" of wires, are well suited to the task of engaging customers, particularly in converting them from illegal to paid connections.

Although on balance there are more stakeholders with something to gain from Option 3, this reform strategy is also more challenging in terms of administrative feasibility relative to Option 2. The biggest obstacle to competitive retailing is establishing truly non-discriminatory and open access to the distribution grid, as discussed above. SERCs and other regulators would also need to be vigilant in ensuring that unbundled distributors not use their position as infrastructure operators to privilege their incumbent retail customers in other ways, such as preferentially repairing the wires serving those customers. In general, regulators would need to carefully specify the rules governing interactions between retailers and distributors, such as formulas for apportioning transmission and distribution charges borne by retailers to the bills of retailers' customers. Finally, the performance of competitive retailers would depend on their ability to purchase electricity in wholesale markets. As mentioned above, the Electricity Act of 2003 took several important steps towards establishing wholesale markets in India, but transparent and liquid spot markets continue to be a work in progress.

Option 4: Liberalized competitive retailing without commercialization of distribution

In theory, independently liberalizing retailers without commercializing distribution could allow for many of the benefits from differentiation on reliability and transaction costs. This option could also avoid some of the political pitfalls associated with privatization. However, the administrative feasibility of liberalized retailers interacting with distributors at their current level of performance would be quite low. The administrative challenges associated with Option 3 above would be amplified considerably.

Figure 16 summarizes the strengths and weaknesses of the policy options described above in terms of their technical correctness, political supportability, and administrative feasibility.

Figure 16, Summary of strengths and weaknesses of policy options

Policy Option	Technically correct?	Politically supportable?	Administratively feasible?
Option 1: Status Quo	-	+ / -	+
Option 2: Traditional privatization	+	-	+ / -
Option 3: Liberalized retailing and privatized distribution	+	+	-
Option 4: Liberalized retailing without privatized distribution	+ / -	+	-

Source: Author

As argued above, the problems of distributors should be separated into two categories. Rationalizing tariffs and addressing commercial losses are complex problems that should be addressed by unbundling and liberalizing retailing. Technical losses and operational efficiency are complicated problems that should be addressed through commercializing distribution in order to mobilize the technical expertise and incentives of the private sector. Therefore, it is recommended that the Ministry of Power pursue Option 3, which combines both of these reforms.

7. IMPLEMENTATION RECOMMENDATIONS

The key recommendations of this report are for India to (1) unbundle and liberalize electricity retailing and (2) move towards greater commercialization of electricity distribution. More detailed implementation recommendations follow below.

The Ministry of Power should remain mindful of the foundation set by previous reforms of the power sector and build deliberately upon it. Specifically, the Electricity Act of 1998 encouraged states to commercialize the distribution arms of their SEBs and the Electricity Act of 2003 introduced the concept of non-discriminatory and open access, which is a precursor to retail competition.

Retail unbundling and liberalization

First, regarding unbundling and liberalization of retailing, non-discrimination and open access rules at the transmission and distribution levels should be adopted. SERCs should be charged with strictly enforcing these rules, monitoring the practices of transmission and distribution infrastructure operators, and applying stiff financial penalties in the case of violations. The Ministry of Power should also clarify that the Electricity Act of 2003's provision regarding electricity trading paves the way for the liberalization of retailing, with retailing established as a distinct activity overseen by SERCs. Given the inevitable time lag until the emergence of independent retailers, distributors should be allowed to continue to operate their incumbent retailing operations, provided they do not discriminate against new entrants.

The actual implementation by retailers of the service differentiation described above warrants a closer examination. It should be noted that there is a tradeoff between the technical capabilities of competitive retailers and the costs required to acquire those capabilities. Two key technical capabilities are first, the ability to curtail targeted non-priority customers in real-time during peak load conditions so that customers paying higher prices can receive more reliable service, and second, the ability to more permanently disconnect customers with accounts in arrears. The smallest geographical unit that can remotely be curtailed in real-time depends on the existing distribution infrastructure currently in place, but will be approximated here by a neighborhood. In other words, it is possible to temporarily disconnect an entire neighborhood from a remote control center, but not individual connections within that neighborhood. Curtailing individual connections would require physical visits by retailer employees to physically disconnect wires. Given that peak load conditions can vary by the day or hour, it would be impractical to maintain prioritized connections in this way. Maintaining prioritized connections in real time would require the installation of smart meters equipped with a remote disconnect feature. However, in the first stage of implementation retailers should hold off on making these investments.

Rather, retailers should initially contract with the smallest "curtailable" unit. Neighborhoods would collectively choose a specific reliability option from a specific retailer (among multiple retailers, each offering multiple plans). With regards to the first technical capability above, each neighborhood would pay a particular rate and would be curtailed collectively under particular peak load conditions, with variation across neighborhoods. It would not be possible to curtail individual connections. This would somewhat dull the incentives of households to pay power bills promptly and in full, since real-time curtailment would not be exclusively linked to households' willingness to pay. However, since fulfillment of the neighborhood-level contract (and receipt of the specified level of reliability) would require all households to pay, there would be strong incentives for local monitoring of households by one another. The second capability described above is easier to execute on without smart meters; a sufficiently delinquent connection would be reported by local monitors and eventually visited by a retailer employee for manual disconnecting.

The efficacy of this approach depends on the homogeneity of neighborhoods. Less homogeneous neighborhoods will find it more difficult to reach agreement on a neighborhood-wide service plan. There will also be greater welfare losses under a neighborhood-wide plan as homogeneity decreases. Moreover, less homogeneous neighborhoods will presumably also have weaker social connections, which may impair the local monitoring mechanism. In these contexts of lower levels of homogeneity, with demand for reliability differentiation across households, there would be a strong basis for retailers to install smart meters and offer household-level service plans.

Smart meters significantly enhance the first capability described above for retailers, as they make it possible to curtail individual connections remotely in real time. They also make more permanent disconnections trivial through the same remote control functionality. Despite the functionality of smart meters there are two arguments for taking a staged and geographically targeted approach to their rollout. First, the initial stage described above gives retailers time to build local presences and learn about

the preferences of prospective customers. During this period retailers can also develop the capacity to engage in and track transactions of buying and selling electricity that they will carry out on behalf of customers. Second, the cost of smart meters should only be incurred where they will create significant value.

Smart meters that can remotely manage the low-voltage connections of non-industrial customers are available at a price of roughly $50.[61] Installation and ongoing maintenance would undoubtedly increase the total cost. But against this cost would be balanced benefits accruing from reductions in commercial losses and increased revenues associated with customers signing up for higher reliability service plans. Smart meters also benefit grid operators by collecting information about system performance and allowing for more rapid detection of service outages. Finally, smart meters can generate significant, but hard to quantify, "social" benefits, such as facilitating a shift to real-time pricing that encourages electricity to be conserved when it is most expensive to produce. Setting aside these broader benefits, a back of the envelope calculation suggests that the investment can be justified where there is scope for reductions to commercial losses. It would be harder to meet this condition in more homogeneous areas since the local monitoring described above would curb commercial losses, but in less homogenous neighborhoods this mechanism would be less effective, strengthening the case for smart meters. Assuming average annual electricity consumption of 734 kWh[62], initial technical and commercial losses of 13% and 12%[63], an average tariff rate of Rs 3.3/kWh[64], an exchange rate of Rs 50/$ and a meter lifespan of 15 years[65], each smart meter can be expected to yield incremental revenues of nearly $60.[66] See Figure 18 for calculations. This is clearly a very rough estimation that is sensitive to the assumptions made above, many of which represent midpoints of wide

[61] Antmann, 2009, p28
[62] See Figure 1
[63] See Figure 8 and assume roughly even balance between technical and commercial losses and a reduction in commercial losses to one third of the initial value based on the experience of Delhi
[64] See Figure 7
[65] Country Energy, 2007, p1
[66] This figure does not account for discounting of future periods

ranges, such as average electricity consumption and average tariffs. However, this estimate suggests that when a comprehensive list of benefits is accounted for, the sum is likely to exceed meter costs. Moreover, given that smart meters can be expected to benefit the overall quality of distribution infrastructure, retailers should seek financing through the APDP program.

Distribution commercialization

The Ministry of Power should redouble its efforts to commercialize distribution, moving from its policy in the Electricity Act of 1998 of encouraging states to "corporatize" distribution to an explicit target of significant private sector participation in distribution. As discussed above, there are many forms that private sector participation can take, ranging from management contracts through full divestitures. Beginning with management contracts and gradually expanding the scope of private sector participation would decrease the risk of making costly missteps, instead preserving space to adapt and change course over time. Whereas penalties for violating open access rules are appropriate for compelling implementation of retail unbundling, rewards for reaching targets may be a more appropriate compliance mechanism for commercializing distribution. This is because optimal arrangements will show some variation across states; whereas there is certainly a "wrong" way to charge retailers for use of the distribution grid, there are multiple "right" ways to involve the private sector in distribution. Targets should focus on both structural reform indicators, such as the percentage of distribution assets operated by the private sector, and performance outcomes, such as reductions in technical losses. States reaching these targets should be rewarded with public funds for investing in the power sector, with targets ratcheting up over time to incentive continued improvement.

8. CONCLUSION

Escalating financial losses by distributors have precipitated a crisis in India's power sector. Access and reliability are poor, investment in generation capacity is

discouraged, and mounting losses are putting pressure on the finances of states and the banks that lend to distributors. The key factors driving distributors' financial underperformance are excessively low tariffs, high technical and commercial losses, and operational inefficiencies.

Rather than seeking to solve these problems directly the Ministry of Power should pursue structural reforms that create incentives and space for efficient solutions to emerge. Identifying the proper reforms requires understanding the nature of distributors' problems. Technical losses and operational inefficiencies are best understood as complicated problems than can be solved through the application of well-incentivized technical expertise. Low tariffs and commercial losses are best understood as complex problems that can be solved through experimentation and innovation at the local level.

The reforms pursued by the Ministry of Power should be appropriately matched the problems they are meant to solve. In order to solve the complex problems distributors are currently facing, retailing should be unbundled from distribution and liberalized. Independent retailers can add value through differentiated service options as well as lower transaction costs. Depending on the level of homogeneity in communities, service plans can be offered at the level of neighborhoods or individual connections. In order to solve the complicated problems distributors are currently facing, distribution should be further commercialized. Private sector participation should begin with management contracts and expand in scope over time.

Together these reforms can set off a virtuous cycle, in which more customers make more complete payments for more reliable power, enabling more investment in infrastructure and capacity, creating a more robust foundation for India's growth.

9. APPENDIX

Figure 17, Regression results for determinants of financial losses

Regression Statistics				
Multiple R	0.807			
R Square	0.651			
Adjusted R Square	0.607			
Standard Error	0.474			
Observations	28			
ANOVA				
	df	*SS*	*MS*	*F*
Regression	3	10.067	3.356	14.909
Residual	24	5.402	0.225	
Total	27	15.468		
	Coefficients	*Standard Error*	*t Stat*	*P-value*
Intercept	-0.903	0.534	-1.689	0.104
ATC Losses	-3.004	0.726	-4.139	0.000
Average Tariff	0.004	0.001	3.093	0.005
Employees per thousand customers	-0.072	0.099	-0.728	0.474

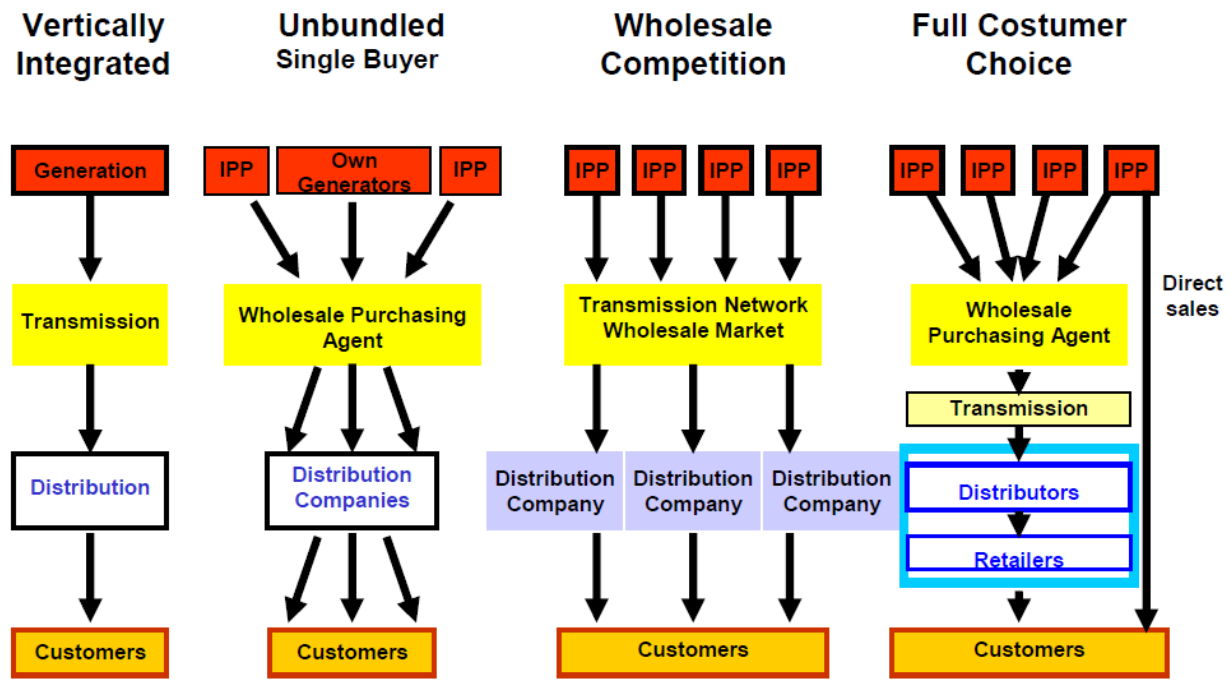
Source: Author's calculations based on data described in footnote 37

Figure 18, Calculation of incremental revenues from smart meters

	Before AMI	After AMI
Electricity consumed (kWh)	734	734
ATC losses (%)	25	17
Technical losses (%)	13	13
Commercial losses (%)	12	4
Billed electricity (kWh)	551	609
Average tariff (Rs/kWh)	3	3
Revenue (Rs)	1,817	2,010
Incremental revenue (Rs)		194
Years		15
Lifetime incremental revenue (USD)		58

Source: See footnotes 59 through 63

Figure 19, Diagrams of different market structures



Source: Hansen, 2008, p7 (in PDF)

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