India's electricity future: change is inevitable – how much, how fast?

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Background: moving towards markets but with a social contract

In India as in many other nations, electricity regulation and policies have often stemmed from a view that it was a vital public good, and perhaps a natural monopoly; government control was therefore not only important, but helpful. Even as commercial viability gained importance, most regulation was based on costs-plus (rate of return), instead of unfettered market systems.

Implicit, if not explicit, in Indian policies have been steps towards universal access and pricing that makes electricity affordable for the poor. Other social contract aspects, such as environmental concerns, have also been important, especially for mining (coal) and, more recently, carbon.

Historically, the utilities were integrated government monopolies (State Electricity Boards, or SEBs); these were jokingly referred to by then Prime Minister Rajiv Gandhi as State Employment Boards. While not necessarily bloated they are still, for the most part, government bodies, despite the unbundling of generation, transmission, and distribution into separate companies. Generation is predominantly coal-based, for which India has significant reserves. Coal represented 60 per cent of the 255 GW capacity on 31 December 2014, and has a greater share in terms of generation. However, due to mining difficulties, transport (railways) bottlenecks (with coal concentrated in a few areas, mainly the east), and issues of quality (high ash content, often 30 per cent), imported coal is on the rise, especially for coastal power plants.

Utilities, especially distribution companies (DisComs), have had limited success with maintaining their social contract or viability as enterprises. They lose significant money for every unit (kilowatt-hour) they sell (on average) and cannot meet demand; this results in regular outages (feeder-level load-shedding). Rather than procuring peak power, they treat load-shedding as a regrettable but viable balancing option. While this lowers the average cost of supply on paper (!) it passes on costs to consumers – both from the outage and from the need to secure back-up power or lighting (roughly US$1 billion is spent on kerosene annually).

The fundamental problem today has resulted from a system of compromises. Shortfalls in supply are distributed neither equitably nor efficiently, and prices have become (for decades) a highly political issue. Selected consumers (especially commercial and industrial) pay far more than cost, cross-subsidizing other consumers. Theft is a major concern, estimated at over 10–15 per cent of consumption. One major issue is the measurement of 'theft', since agriculture has special status (for irrigation pump-sets which consume about a quarter of the nation's electricity). Not only are agricultural tariffs extremely low (ostensibly to keep food prices down), but most pump-sets are unmetered, so no one knows exactly how much they consume. This results in assumptions-based accounting for agriculture consumption, technical losses, and 'commercial losses' a.k.a. 'leakage'.

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On the demand side, we have additional drivers for change. The population is young (median age being about 25 years), and while urbanization is growing rapidly, 60 per cent of the population is still in the villages (predominantly in farming, even though agriculture's GDP share is some 14 per cent and falling). A population with roughly one mobile phone per adult (and amongst the

lowest tariffs in the world), with strong competition in such areas as airlines, cars, and telephones, could become impatient. Indeed, there is likely a willingness to pay for better quality power. This is already evident in the money spent on back-up power and lighting.

Changes, big and small – past, present, and future

Restructuring, a.k.a. 'reforms'

Post-independence, electricity was part of Nehru's 'commanding heights' of the public sector, and remained predominantly under government control for decades. In 1991, facing a balance-of-payment crisis, the Indian Government opened up electricity to the private sector – especially generation, where foreign capital was sought for adding capacity. Over the next decade or so, most SEBs were unbundled into separate generation, transmission, and distribution functions. For the most part, distribution utilities remained government companies (except Odisha and Delhi, which are privatized), but they now had to procure power from separate generators, both public and private. States also set up Electricity Regulatory Commissions to handle tariffs. The 2003 Electricity Act aimed to usher in more private participation and better operational performance, however, there were only limited signature breakthroughs in the Act (especially its implementation).

'… ELECTRICITY WAS PART OF NEHRU'S "COMMANDING HEIGHTS" OF THE PUBLIC SECTOR …'

In general, there is a push towards more competition and private participation, but few states have pushed to privatize their DisComs. What we do find are cities on the anvil for privatization, as well as a model of franchisees, which take over operations to help improve efficiencies, but the licence still remains with the incumbent.

Open Access, a.k.a. 'retail competition'

The government recently tabled proposed amendments to the 2003 Act; these aim to transform how utilities operate, through 'Open Access' or structural separation. As in the UK, in parts of the USA, and in some other countries, electricity *retail* would separate from ownership of the common distribution *wires*, ushering in retail competition and private participation.

In fact, the 2003 Electricity Act allowed 'Open Access' for large consumers (over 1 MW), and Mumbai allowed retail competition for all users. But realizing change is harder than drafting legislation. Will private players even want to take up 'unviable' areas? It is worth emphasizing that private participation is not the same as competition (and even market systems need regulation).

In Mumbai, retail competition saw cherry-picking (plus disputes), requiring regulatory intervention in transactions with poorer consumers. Even worse, states resisted meaningful open access (for large consumers) though various mechanisms; some of these were overt (including cross-subsidy surcharges) and some covert (such as invoking Section 11 of the Act, 'extraordinary circumstances', to prevent sale of surplus power outside the state, or treating consumers as temporary customers when they wanted power from the incumbents).

Most fundamentally, whenever we have a system with extreme pricing distortions, both within and across consumer segments (subsidies and cross-subsidies), what would new entrants want to do? Most likely, *cherry-pick the best consumers*, leaving someone else as a provider of last resort. There are other issues policy-makers must address including: lack of good wholesale markets, continuation of cross-subsidies, incorrect price signalling, and calculations based on average costs and book values – not reflecting such factors as time-of-day pricing or marginal costs. In addition, the way in which improved service on a per consumer level is operationalized (via new entrants and new retail offerings) is unclear, given that load-shedding and supply quality are determined at a distribution feeder level; this creates difficulties in providing a service to thousands of small consumers, at least until smart meters are deployed.

Green, clean, and smart

India has promoted Renewable Energy (RE) for decades – it even has a separate Ministry for New and Renewable Energy. But the question remains: how much more, if any, are consumers willing to pay for so-called green power, especially when they face shortfalls in supply?

In a move to augment clean energy, the Government recently announced ambitious plans to add 100 GW of solar power by 2022, increasing previous targets (under a Central National Solar Mission) fivefold. Ambitious, yes, but are there hidden costs or implications? Drawing insights, or even small portions verbatim, from chapters in a recent book (*Blowing Hard or Shining Bright? Making Renewable Power Sustainable in India, Brookings India*, 2015), we can see a few issues that are not adequately addressed in a more simplistic generation-oriented policy thrust.

Renewables in India are different from renewables deployed in places such as the USA and Europe; understanding these differences is key to viable policies. The triad of 'usual' challenges of renewables remains in India, such as:

- *intermittency/variability*,
- *location-specific potential* (sometimes concentrated in areas distant from consumers or the grid),
- *higher costs*.

In addition, India's grid is weak and unstable, and rather than having a reasonable reserve margin (typically

15–20 per cent in the west), there is a shortfall in the grid, officially in the range of 5 per cent or so, but actually much higher.

There are other technical reasons why the Indian grid is weak; these include a lack of ancillary services (systems designed to keep the grid stable, instead of just pricing kilowatt-hours), and even a lack of time-of-day pricing for bulk procurement of power. There are few peaking plants (which would operate only some 5–10 per cent of hours in a year), since there is insufficient incentive for these. Without incentives for plants that can ramp up (or down) quickly but which may not get used much, how will the grid handle 20 per cent renewables? Even worse, the types of plants capable of fast ramping are limited in near-term growth in India:

- *hydropower* (due to land and social/environmental challenges),
- *natural gas* (due to supply constraints).

Hydropower has an additional constraint when considering peaking or storage – its additional duty for irrigation limits when water can be stored versus released. Overall improvements in the grid, including better balancing without resorting to load-shedding, should be key areas of effort, which would facilitate increased RE penetration.

How much RE can the grid handle? There is seldom a technical limit (with storage, it could be 100 per cent) but it is more an issue of techno-economic optimization. Depending on what else is available (hydro is ideal, since it includes both storage and the ability to ramp up/down quickly), as well as the strength of the grid in terms of interconnections, a number of utilities in the world have found they can handle 20–25 per cent RE without major system upgrades. However, this is not India's initial bottleneck – shorter-term problems remain.

First, RE does not meet peak demand (India's peak is lighting-heavy, in the evening when the sun is down and wind is often reducing). This means that RE does not solve the capacity problem (kW), but instead addresses the energy problem (kWh).

Second, we have a system of enormous price distortions. A number of so-called paying customers (larger users, or commercial and industrial) are faced with electricity rates higher than the cost of opportunistic (take-it-when-available, without a battery) solar energy – this encourages self-generation. The consumer still keeps the grid connection for parts of the day, and back-up. Current pricing schemes do not factor in this issue, where a consumer compares his/her generation cost versus retail costs (which are always higher even without any cross-subsidy surcharges, because of the cost of the distribution grid, which provides such services as balancing, stability, and back-up.).

Continued technological improvements (including storage) will make this issue even starker (solar has experienced a learning curve improvement of 20–40 per cent in recent years). In addition, 'traditional' electricity continues increasing in cost, even before factoring in any carbon tax or price. While RE started out as niche, not only is the scale no longer niche, its disproportional impact on the grid, finances, and consumer participation make this a topic demanding deeper and more holistic analysis.

One of the proposed improvements to the grid that will facilitate increased RE is the deployment of Smart Grids. What are Smart Grids? There is no single technology or design, but this is a general term for the transformation of the power grid using digital communications and control to enable functionalities such as increased monitoring, resiliency, flexibility, efficiency, and enhanced renewables integration. Definitions and functionalities abound, but for India, the killer apps are likely to be different. In the west, the drivers have been:

- labour costs for meter reading and connections/disconnections,
- pressures due to renewable energy and electric vehicles,
- concerns on handling the peak on aging infrastructure (especially in the USA).

'… THE SHORT-TERM NEEDS INCLUDE REDUCTION OF LOSSES (BOTH TECHNICAL AND FINANCIAL) AND KEEPING THE GRID IN BALANCE …'

In India, the short-term needs include reduction of losses (both technical and financial) and keeping the grid in balance (especially given shortfalls).

Smart Grids are an enabling infrastructure for broader reforms – there is no single solution, but they can be designed to enable a multitude of policy and operational changes. Retail time-of-day pricing is just a start. One could offer:

- *guaranteed lifeline supply* (in place of today's load-shedding),
- *demand response* (a dynamic form of demand-side load management) could be enabled, whereby rather than procuring additional peak power when there is an impending gap in supply–demand, the utility could incentivize consumers to reduce their load.

Big shifts are underway with Smart Grids; some have more focus worldwide (like demand response). In India, a Smart Grid can also help reduce theft, since the utility would inherently be able to measure and monitor power flows.

The challenges with Smart Grids are more than financial (with large up-front capital outlays), or even of technology and standards (which are a work-in-progress, if not a moving target). The fundamental challenge is likely to be one that impacts all change and transformation – one of changing mindsets. As long as utilities are free to load-shed, no peaking power or smart meter will be cost-effective.

Changes – from inside or outside? Big or small?

India's central government, like previous governments, is pursuing 'electricity for all'. More than just a wire to the village (or home), there is now a push towards the actual service of electricity (the end of load-shedding). In addition, there are major programmes underway for financial/operational reforms, Smart Grids, and other related areas. Most of these are being driven outside the DisComs. Even peak and time-of-day pricing is being considered. However, the biggest reforms – of unleashing full market forces, including privatization of utilities – have not taken central attention in recent years. While new entrants for retail may add in some private participation, true competition for private participation may take some time.

In addition to changes under the purview of the Ministry of Power, other factors could make a major difference to India's grid. In the short run, how coal is (or is not) available will have a profound impact, and the government is keen to increase private participation (and productivity) in coal mining.

Taking a broader perspective of electricity worldwide, unbundling and restructuring was a major shift in the industry in the 1990s, but this did not impact the flow of power significantly (apart from the power that often began to be procured from newer generators, changing transmission patterns). In contrast, the rise of renewables, storage, and Smart Grids, which can be 'game-changers', portend a 'Utility Death Spiral' where edge-based generation (plus storage and demand response) prompts consumers to reduce, if not eliminate, supply from the broader grid; this raises the utility's costs (as it still needs to serve 'expensive' customers and also keep the grid stable), which further prompts others to exit the grid, and so on.

India is not quite there yet, but existing distortions in pricing make RE disproportionately attractive to larger consumers, and the technology will only improve over time. Just as mobile phones began as an expensive niche product, before completely overwhelming landlines in India, so rooftop solar power, having begun in the same way, will inevitably grow in importance. While small changes are more palatable, both operationally and politically, it is difficult to address a subset of the issues (such as: time-of-day pricing, links to renewables, storage, supply fuels, and theft) alone, due to their interdependency. The fundamental question then becomes: to what extent will the change be a managed one?

All views are personal.