

EXECUTIVE SUMMARY

Overview and Context Setting

The development of the Indian electricity sector plays a pivotal role in the blueprint for development of the Indian economy. For more than 20 years, this sector is undergoing changes and reforms, with opening up of the sector and progression towards a competitive environment, as experienced in many other countries of the world. In spite of these developments, Indian power sector has a staggering loss of Rs.3.8 trillion. India also has the highest number of poor population in the world, which generally stretches infrastructure and public services, and specifically strains provision of electricity services to the multitude. Both the number of consumers (actual and potential), as well as the number of poor people, with low capacity to pay, combine to make Indian electricity sector reform initiative a challenging task.

In spite of reform developments, Indian power sector is beset with many problems, of which, high and sustained levels of subsidy / cross-subsidy existing in the final customer tariff and the inability of the sector to move towards a cost-to-serve model, have been identified as major issues by industry experts. The maladies attributed to cross-subsidy include high industrial tariff, leading to Indian industry losing its competitive edge and resulting in its inevitable sickness, proliferation of captive plants, which are not necessarily cost-effective, practice of using artificially low agricultural tariff as an inducement to influence the vote bank, free and below-the-cost power leading to misuse, over-use and wastage, to name a few.

Cross-subsidy means subsidy across segments - where a section of customers, ostensibly with higher capacity to pay, are paying higher tariffs to subsidise low tariffs for some other poorer segments. On this aspect, there are conflicting views from the customers' side. The larger customers advocate sharp reduction, if not elimination, of cross-subsidy, while the small consumers need its continuity. There is also a pressure for introducing competition in retail power sector. Upon fruition of this objective, large customers shall probably discontinue taking power from the distribution licensees, with the likely fallout of sharp reduction in the available amount of cross-subsidy. Retail tariff for small consumers would inevitably increase in such a situation, which may be difficult to be offset by

grants (subsidy) from the State Governments. Therefore, the distribution licensees are putting up barriers to competition to retain their creamy layer of consumers. While tariff reform mandates progression towards cost-to-serve through legal pronouncements and policy instruments as well, the extent of implementation and effectiveness of these aspects of policy initiatives are not chartered.

Business Problem

Electricity distribution licensees in India are in financial distress due to a host of sector inefficiencies such as the issues of exiting prime customers, need to provide welfare tariff to large swathes of poorer segments, overall tariff inadequacy, technical / commercial incompetence etc. Policy objectives / implementation are not conducive towards bringing the sector back to financial solvency and meeting the declared goal of reform of the electricity sector.

Literature Review

It became necessary to review existing literature to assess the requirement and significance of progression towards cost-to-serve in a reformed electricity environment, and its influence on the tariff of the vulnerable segments.

In case the literature suggested application of a cost-to-serve model in a reformed / competitive environment, a necessity emerges for discovering whether international experience suggests rendering of any protection to any segment of consumers in this competitive, cost-to-serve model, particularly to the poor consumers and the path chalked out to deal with this protection need. Focussed literature review of five countries in different stages of reform was undertaken to elucidate issues on subsidy as well as protection needs for vulnerable consumers. Literature was also explored to understand the subsidy regime in the Indian context. Extensive review of tariff and related aspects were undertaken through study of legal and judicial processes, as also study of 55 distribution licensees in India and their 22 regulating authorities. Finally, literature was reviewed to gain some understanding on the theory and practice of cost-to-serve calculations. Thus, the broad themes of review include basic tenets of reform and reform expectations, cross-subsidy in electricity tariff, reform impact on small consumers, contextual global understanding by studying relevant electricity reform initiatives in Chile, Argentina, the Philippines, Nigeria and the United

Kingdom (U.K.), the Indian scenario, valuation of cross-subsidy, pertinent aspects of reform, cost-of-supply principles and studies in the Indian context.

Literature revealed requirement of cost alignment as the first step of reform in a standard reform model and limited scope of charging above-market costs in a competitive structure. Discouragement of cross-subsidy in electricity tariff was exhibited in the international scenario, with only specifically approved cross-subsidies allowed through the tariff structure to fulfil socio-political obligations, with minimal distortion of electricity prices for productive activities. Industrial tariff was found inevitably lower than residential tariff in developed countries, with commercial tariff divulging mixed signals vis-à-vis residential tariff. Social policy objectives were not found implementable directly through competitive electricity pricing. Requirement of legislative intent and a non-avoidable levy to meet welfare needs were observed. Reform expectations included erosion of cross-subsidy with political and welfare implications including need for support to low-income consumers. Overall, regulation need for protection of small consumers was observed together with progression of price regulation mechanism from marginal costing to social welfare maximisation. Protection of vulnerable consumers was found to be at a developed level in the U.K., social objectives were endeavoured to be met in Argentina and Chile, the Philippines came out with an ingenious solution of universal charge to address cross-subsidy / lifeline consumer issues, whereas Nigeria exhibited extensive cross-subsidy and an impoverished electricity sector.

A need for tailored solutions for differently placed countries arose from the finding that electricity consumption, level of income and specific attributes of the country, are important factors behind margins and extent of cross-subsidy in electricity pricing. Indian cross-subsidy situation was reviewed with its inability to charge actual costs to consumers. Criticism of the policy of encouragement of consumer flight without addressing the cross-subsidy issue was noted. Finally, definition and measurement of cross-subsidy based on cost allocation was studied in detail, with the underpinning theories.

Research Need, Gap, Problems, Objectives and Methodology

The business problem of financial distress with issues of exiting prime customers and need to provide welfare tariff to large swathes of poorer segments pointed

towards the need for realistic determination of cross-subsidy. The crucial gap which was identified through literature survey was the absence of reliable data on actual cost-to-serve the consumers. While this knowledge should form the basis of any pricing decision-making, as well as choices pertaining to subsidy / cross-subsidy, this logical study was found missing in the Indian context. Important steps like introduction of competition, exit of large customers through open access, continuity of cross-subsidy to the detriment of industrial customers, proposal to separate the wire business (carriage) and the retail business (content), subsidy provision for large chunks of consumers, introduction of renewable power in a substantial scale, are all being undertaken with imperfect understanding of the cost to serve the various segments. **Cross-subsidy assessment based on the cost of supply of the customer segment, together with understanding on the protection issue of vulnerable consumers to fulfil welfare objectives, were found to be the major gaps in research, leading to the research problem:**

Determination of cross-subsidy based on cost of supply of the consumer segment is necessary – together with the need for understanding the protection issue of vulnerable consumers to fulfil welfare objectives.

The research problem led to framing of the following research questions.

1. What is the suitable approach to determination of cross-subsidy, with special focus on electricity tariff in India?
2. What has been the experience of progression of category-wise electricity tariff prevailing for Indian regulated tariff frameworks, towards average cost-of-supply, to achieve the mandated objective of cross-subsidy reduction?
3. What approach should be adopted to determine cross-subsidy based on a cost-of-supply model, while also addressing the welfare issues of serving the vulnerable segments?

The following research objectives were framed.

1. Arriving at a suitable approach on determination of cross-subsidy, with special focus on electricity tariff in India.

2. Assessment of the experience of progression of category-wise electricity tariff prevailing for Indian regulated tariff frameworks, towards average cost-of-supply, to achieve the mandated objective of cross-subsidy reduction.
3. Development of a suggestive approach on cross-subsidy determination based on cost-of-supply along with a suggestive approach on addressing the welfare issues of serving the vulnerable segments.

The research methodology and the research design framework were established step-wise for each of the objectives. Apart from reviewed literature, policy initiatives of the Indian Government, statutes, legal and regulatory pronouncements were *inter alia* studied in detail, including analysis covering 55 distribution licensees, (they contribute to 97% of supply met in India by volume of sales). Subsequent choice of 25 licensees for detailed study was made based on the identified variables. Focus segments of these licensees were studied across three reference years, to assess fulfilment of mandated objectives through governmental policy initiatives. Descriptive statistics and indexed numbers were used for the analysis. For assessment, relevant legal pronouncements have been reviewed, as detailed in **Exhibit 1**. Assessment of cost-of-supply data availability for the 55 distribution licensees is detailed in **Exhibit 2**. Pertinent worksheets in Excel for this part of the study with reference to achievement against milestones, are placed in **Exhibit 3**.

A licensee was chosen for fulfilment of the final objective and a cost-to-serve model (CoS Model) based on real life data of the utility was developed in Excel worksheet format, based on comprehensive independent load curves for all important tariff categories (**Exhibit 4**). The Excel model is replicative and has been validated by experts in the field (**Exhibit 5**). The CoS Model can accommodate both a different set of parameters and different choice of allocators to derive cost-of-supply, which gives it the necessary flexibility to adapt to any given situation. This model is an important product of this study.

Discussion and Analysis

Through evaluation of the available approaches on cross-subsidy measurement in fulfilment of the first objective, legal position on cross-subsidy and cost-of-supply was reviewed, with the finding that Indian policy instruments require cross-subsidy reduction and progression towards cost-of-supply, with some protection

for vulnerable consumers. Indian judicial pronouncements exhibited similar views on cross-subsidy reduction and attainment of cost-of-supply. Lessons could be culled out from global experience on requirement of well-articulated strategies, protection need of vulnerable segments and measures of protection for such consumers. Understanding of the theoretical underpinning of a cost-to-serve model was formalised at this stage. Based on the studies undertaken, cross-subsidy assessment through a cost-to-serve model for a regulated entity, based on recent historical cost incidence captured / allocated voltage-wise through a detailed study, with in-depth peak load assessment and voltage level-wise technical and commercial loss assessment, and segment-wise / consumption level-wise cost allocation (traversing beyond nature of supply) was predicated as appropriate.

For assessment of cross-subsidy with reference to average cost-of-supply, as prevailing for Indian regulated tariff frameworks, for fulfilment of the second objective, population of 55 licensees were initially chosen, 25 representative licensees selected therefrom and indexed tariff of specified consumer categories of these 25 licensees with reference to the band of $\pm 20\%$ of the average cost-of-supply (requirement available from earlier policy instruments, considered an interim milestone for assessment) was exhibited with reference to three years, being a) 2004-05 (before introduction of National Tariff Policy); b) 2008-09 (interim period); and c) the latest available year for which tariff has been determined (2015-16 or 2014-15, as available), post completion of the time period mandated by the erstwhile National Tariff Policy.

Slow progression towards intermediate milestone of achieving tariff within the $\pm 20\%$ band of the average cost across the subject licensees could be seen. Of the cross-subsidisers, average industrial tariff (high voltage) has just reached 120% of average tariff. Commercial tariff (high voltage), in spite of some lowering, is still above 120% of average tariff. Similarly, residential with 100 kWh monthly consumption is at a cross-subsidised tariff at 71% of average tariff. Residential with 300 kWh monthly consumption is at 88% of average tariff and has achieved the intermediate milestone. Analysis against international scenario was also attempted, with even less encouraging results.

Assessment of cost of supply through development of a model and estimation of realistic cross-subsidy, together with a suggestive approach on addressing the welfare issues of serving the vulnerable segments, is endeavoured through the final objective. The comprehensive category and segment (slab-wise) cost-of-supply model developed in Excel for the study, is based on actual data of a licensee. Independent load curves for all important tariff categories have been studied, demand corresponding to the highest peak load (system peak / coincident peak demand) recorded during the year has been duly factored in, due consideration is given to class peak (non-co-incident peak demand), both voltage-wise average losses and peak losses in the network have been considered, voltage-wise classification is based on metered data, allocation matrix has been adopted based on acceptable principles, detailed segregation has been made for various functional costs and consumer-specific costs have been duly allocated to segments.

The key learnings from the model and study are that co-occurrence with system peak is a major cost contributor – categories whose class peak is closer to system peak contribution has higher demand-related costs; reliable data on consumer load curves and reliable voltage level data are highly relevant for cost-of-supply study; cost of high voltage consumers is significantly lower, as they have lower network cost incidence (they are not using lower voltage networks and are not affected by lower voltage level costs / line losses) and consumer specific costs get distributed over large unit consumption and becomes insignificant; the cost-to-serve the weakest segment i.e. the lifeline segment is the highest primarily due to incidence of consumer specific costs (distributed over small unit consumption) and higher incidence of network related costs (being at the end of the distribution network, all network costs and line loss related costs, both technical and commercial, are aggregated at this level); the cost to serve low-end residential / commercial consumers is appreciably higher than the benchmark of average cost and the statutory mandate on progression towards cost of supply has serious welfare implications. Articulated policies are needed to prevent tariff shocks.

The data reveals that the cost to serve is higher than the average for all low and medium voltage segments. Where the tariff doesn't match the cost, these low and medium voltage segments become the cross-subsidised categories. The cost to serve the lifeline category is 193% of the average cost, whereas, in comparison,

the cost to serve high voltage 33 KV supply (non-traction) load is just 64% of the average cost of the utility and so on. In fact, for all high voltage categories, the cost-of-supply is lower than the average. While high voltage 33 KV supply (non-traction) load has the lowest cost, public water works and public utility category is close behind at 67% of average cost. These are the cross-subsidisers, with tariff detached from cost realities. Thus, the segment-wise CoS Model distinctly brought out the anomalies in tariff structure and the necessity of tariff rationalisation. An extract of the findings is given to elaborate the position.

Nature of Supply with Voltage Consideration	Monthly Consumption Slab (if applicable)	Cost-of-Supply as Percentage of Average Tariff
LT Residential Lifeline	Lifeline	193%
LT Residential	upto 60 kWh	129%
LT Commercial	Upto 60 kWh	160%
LT Industrial	Upto 500 kWh	110%
Overall LT		111%
HT 33 KV other than Traction		64%
HT Metro Railway		77%
HT Industrial below 33 KV		71%
HT Commercial below 33 KV		93%
HT Public Water Works and Public Utility		65%
Overall HT		77%

Welfare implications emerged as a serious issue with the finding that lifeline segment has 193% and residential category at monthly consumption of 60 kWh segment has 129% of the average as its cost. Various literature highlighted that special benefits for the poor are not available in a competitive model. In a structured situation, special dispensations for the vulnerable consumers are usually secured through legislative intent. Lessons culled out from global experience were validated in the context of a developing economy with a large poverty headcount.

There are various factors which are affecting the policy processes, as revealed by literature. For instance, the pre-dominant view emerging from the literature survey is that there exists a lack of understanding of the selection process for the subsidised segment. Extensive survey of the tariff process of utilities across India was undertaken to discover the policies and processes for understanding vulnerability. Tariff and lifeline data for the 55 distribution licensees (**Exhibit 6**) and definition of lifeline category for the same 55 distribution licensees across

major Indian States (**Exhibit 7**) reveal that the attempts in this respect are motley and variegated, leading to a conclusion that there is no serious effort to give a coherent shape to the problem of identifying the vulnerable segments.

The study has recommended a framework which provides a satisfactory solution for all major stakeholders. Universal access charge has been quantified for lifeline consumers (“lifeline” is considered as defined in present policy documents). The study also suggests a re-look at the extant definition, with suggestions on modification (mandatorily building in, *inter alia*, the concept of “connected load” into the definition of lifeline) and bringing uniformity across India. A concept of “lifeline family” has also been mooted. Direct subsidy has been discussed, as the concept has some global acceptance, though the researcher finds the same to be a less elegant solution. The recommendations define the suggested framework and outlines the desirable policy and interventions at macro and micro levels.

Conclusion and Scope for Future Research

The crucial research gap was absence of understanding of actual cost of supply - a major constraint, which affects all pricing decisions of Indian electricity sector, as the same are being undertaken on the basis of imperfect knowledge. Decisions on eventual tariff, subsidy needs, necessity of cross-subsidisation, introduction of competition, tariff of the end-consumer (once large customers exit the system), cost implications of segregation of wire business and retail business (segregation of carriage from content, which is a part of the proposed amendments to the policy structure), proliferation of renewable generation through major initiatives, decisions on grid-connected or off-grid distributed generation, including solar sources - all need a logical working base on cost. The cost-to-serve modelling also needs to be sliced to the minimum possible strata or segment for appropriate policy interventions. Too broad-based a stratification on the basis of categories of supply, usually centred around the nature of supply (e.g. “residential”, “commercial”, “industrial” etc.), hides the inefficiencies and anomalies, and camouflages the real cost to serve the lowest consumer segments. This study fills that void, by providing a basic framework for understanding cost of supply and consequent cross-subsidy in the perspective of the Indian electricity sector. Final implementation is in the hands of the policy-makers for whom it will serve as a reference point.

The three critically affected stakeholders are the distribution utility, the cross-subsidisers and the cross-subsidised, apart from the government and the investors. Absence of an inter-connected strategy to deal with the three segments is a huge concern for the sector. Unless the payment of exit charge by the cross-subsidisers is adequately compensatory, the tariff of the cross-subsidised, who are left with the utility, inevitably moves up. Competition falters if the exit charge is set at a steep threshold, as the cross-subsidisers have no impetus to forsake the system. There is also an overarching need to protect the troubled distribution utilities, who are in considerable financial distress. Unless the issue of cost-of-supply based tariff is resolved satisfactorily, competition cannot be introduced with a modicum of success. It is in this context that a replicable cost-of-supply model is of some contribution, as it would be of help to the policy-makers and other stakeholders.

Achieving cost-of-supply based tariff without addressing the issue of the vulnerable section of the society may not yield the desired results. The present research contributes by way of presenting an approach to addressing the problems of tariff / subsidy of poor or vulnerable consumers in India. Economic aspect of protection for “lifeline customers” or “Below Poverty Line customers” (“BPL” customers) has been examined and the magnitude of support need for lifeline category is assessed. Some solutions to address the support quantum is proposed through this research.

However, the researcher feels that while all possible factors have been identified to understand the problem around lifeline or vulnerable consumers in India, the exact mechanism for identification of the lifeline segment has not been covered in detail due to limitations of scope of the present study. Further research is needed on allied aspects, including prevention of subsidy leakage and mechanism to identify the lifeline segment needing support. Lowering of industrial tariff, as proposed through the study, may also have significant long-term welfare implications, as there is scope of Indian industry becoming more competitive, with longer-lasting welfare potentials. The research also touches upon innovative tariff signalling, once cost-of-supply is achieved, including time-of-the-day tariff (fixed time-slots), time-of-use (real-time) tariff, interruptible tariff, only-variable-cost or only-fixed-cost tariffs and other bespoke tariff structures, as also promotion of green energy and DSM initiatives, through correct market signals. These aspects provide interesting scopes for future research.