CHAPTER 4

DISCUSSION AND ANALYSIS

4.1 INTRODUCTION

The analysis to find answers to the research questions, using the methodology highlighted in the previous chapter, is presented here. A detailed cost-of-supply model has been developed. The model is utilised to address some of the research questions. A solution to the issue of supporting the lifeline consumers in a reformed environment is also presented here.

4.2 EVALUATION OF THE AVAILABLE APPROACHES ON CROSS-SUBSIDY MEASUREMENT: OBJECTIVE 1

4.2.1 Discussion on legal position on cross-subsidy and cost of supply

Indian policy instruments and judicial reviews require cross-subsidy reduction and progression towards cost of supply. The Electricity Act, 2003 [30] recognised cross-subsidy as an issue and originally set the target of achievement of "cost of supply" for all categories of consumers through progressive reduction and eventual elimination of cross-subsidy. While this position was somewhat diluted through subsequent statutory policies (the National Electricity Policy and the Tariff Policy) as well as amendments of the 2003 Act and the revised Tariff Policy, the current legal position through the Apex Court judgment stands that the ultimate tariff objective under the 2003 Act is to arrive at cost of supply based on voltage of supply.

[30] The Electricity Act, 2003 (36 of 2003) notified on June 10, 2003.

a. Indian policy instruments require cross-subsidy reduction and progression towards cost of supply

It is observed from Indian policy documents that while cross-subsidy was (and continues to be) rampant in the power sector, particularly from the latter half of the 20th century, the word "cross-subsidy" did not make a formal entry into the statute books in the last century. However, even without its formal legal recognition, its presence was reflected and recognised through judicial processes. Under the regime of the Indian Electricity Act, 1910[31] and the Electricity (Supply) Act, 1948,[32] cross-subsidy featured in a number of cases moving right up to the Apex Court and was legitimised through legal sanctification. By late 1990's, the problem became fairly acute.

The Statement of Objects and Reasons to the Electricity Regulatory Commissions Act, 1998 states "*that as the problems of the power sector deepen, reform becomes increasingly difficult underscoring the need to act decisively and without delay. It is essential that the Government implement significant reforms by focussing on the fundamental issues facing the power sector, namely the* ***lack of rational retail tariffs, the high level of cross-subsidies****....*"[33]

In 2002, the Supreme Court recognised cross-subsidy as an issue.[34] It also interpreted the Electricity Regulatory Commissions Act, 1998 to state that "***the consumers should be charged only on the basis of average cost of supply of energy*** *and tariff should be determined by the State Commission without showing any undue preference to any consumer. The* ***statute also obligates the State Government to bear any subsidy which if it requires to be given to any consumer or any class of consumers****, should be only on such*

[31] The Indian Electricity Act, 1910 (9 of 1910) notified on March 18, 1910.
[32] The Electricity (Supply) Act, 1948 (54 of 1948) notified on September 10, 1948.
[33] The Statement of Objects and Reasons of The Electricity Regulatory Commissions Act, 1998 (14 of 1998) notified on July 2, 1998.
[34] Paragraph 91 of West Bengal Electricity Regulatory Commission Vs CESC Limited (2002) 8 SCC 715, available at. https://indiankanoon.org/doc/1885523/, last accessed on February 4, 2017.

condition that the Commission may fix and ***such burden should be borne by the Government.*** *"*

In 2003, the new Electricity Act (the Electricity Act, 2003) was promulgated, which repealed all other prevailing electricity statutes (namely, the Indian Electricity Act, 1910, the Electricity (Supply) Act, 1948 and the Electricity Regulatory Commissions Act, 1998). Cross-subsidy was recognised as a problem and its total elimination was advocated over a period of time, thereby also moving away from the Supreme Court judgment, which had prescribed immediate abolition of cross-subsidy and direct subsidy by the Government for the consumers, if necessary. The 2003 Act also set the target of achievement of "**cost of supply**" for all categories of consumers through progressive reduction and eventual elimination of cross-subsidy. While this position was somewhat diluted through subsequent statutory policies (the National Electricity Policy and the Tariff Policy) mainly on the basis of objections raised by the States as well as subsequent amendment of the 2003 Act,[35] it is indisputable that the problem was accorded due recognition by the 2003 Act and brought into the statute books for the first time.

Cross-subsidy is not defined in the 2003 Act. **Cross-subsidy** "**elimination**" (later amended to "**reduction**") is dealt with under Sections 38, 39, 49 and 42 of the 2003 Act and the requirement of tariff to progressively reflect cost of supply is available in Section 61.[36] The National Electricity Policy is a policy issued under Section 3 of the 2003 Act. The State Commissions are to be guided by the National Electricity Policy when framing tariff regulations. This Policy deals with cross-subsidy at length and states that there is an urgent need to correct this imbalance.[37] The Tariff Policy is also a policy issued under

[35] The Electricity Amendment Act, 2007 (26 of 2007) dated May 28, 2007.
[36] Sections 38(2)(d), 39(2)(d), 40(d) 42(2), 61(g) of the Electricity Act, 2003 (36 of 2003) notified on June 10, 2003 read with amendments made through the Electricity (Amendment) Act, 2007 (26 of 2007 dated May 29, 2007.
[37] National Electricity Policy, February 12, 2005 issued by the Ministry of Power, Government of India under Section 3 of The Electricity Act, 2003 in Clause 5.5.3 states that *"Over the last few decades cross-subsidies have increased to unsustainable levels. Cross-subsidies hide inefficiencies and losses in operations. There is urgent need to correct this imbalance without giving tariff shock to consumers. The existing cross-subsidies for other*

Section 3 of the 2003 Act and the State Commissions are likewise to be guided by the Tariff Policy when framing tariff regulations. The dilatory approach and lack of concerted policy direction is best exhibited by the two Tariff Policies issued by the Union Government. While the erstwhile Tariff Policy envisaged **bringing tariff for each consumer category latest by 2010-11 within the band of ±20% of the average cost-of-supply following roadmaps to be set by the State Electricity Regulatory Commissions within six months of announcement of the Tariff Policy**,[38] five years after lapse of the target date for correction of this distortion, the deadline has presently been removed from the current Tariff Policy,[39] issued in 2016, which itself draws attention to the magnitude of the problem. The Tariff Policy also states that direct subsidy under Section 65 of the 2003 Act is a better way to support poor consumers than by subsidising tariff across the board. State Government may raise resources through electricity duty and give direct subsidies to needy consumers. This is a substitution of cross-subsidy and a more effective way.[40]

Under the statutes, open access to transmission lines is immediately available.[41] For wires of a distribution licensee, it is available in phases, to be specified by the respective State Electricity Regulatory Commissions.[42] In

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categories of consumers would need to be reduced progressively and gradually." (Ministry of Power, Government of India, 2005).

[38] Tariff Policy, January 6, 2006 issued by the Ministry of Power, Government of India under Section 3 of The Electricity Act, 2003 in Clause 8.3, Item 2 states that *"For achieving the objective that the tariff progressively reflects the cost of supply of electricity, the SERC would notify roadmap within six months with a target that latest by the end of year 2010-11 tariffs are within ± 20% of the average cost of supply. The road map would also have intermediate milestones, based on the approach of a gradual reduction in cross subsidy."* (Ministry of Power, Government of India, 2006).

[39] Tariff Policy, January 28, 2016 issued by the Ministry of Power, Government of India under Section 3 of the Electricity Act, 2003 in Clause 8.3, Item 2 states that *"For achieving the objective that the tariff progressively reflects the cost of supply of electricity, the SERC would notify a roadmap such that tariffs are brought within ± 20% of the average cost of supply. The road map would also have intermediate milestones, based on the approach of a gradual reduction in cross subsidy."* (Ministry of Power, Government of India, 2016). **Absence of timeline is noteworthy**.

[40] Clause 8.3 of the Tariff Policy, ibid.

[41] Sections 38 (2) (d), 39 (2) (d) and 40 (c) of the Electricity Act, 2003 (36 of 2003) notified on June 10, 2003.

[42] Sections 42 of the Electricity Act, Ibid.

specifying the extent of open access in successive phases, all relevant factors including cross-subsidies are to be considered. Open access is to be allowed on payment of a surcharge, which is to be used to meet current level of cross-subsidy. Surcharge and cross-subsidies are to be progressively reduced. Regulations should be framed such that tariff progressively reflects the cost of supply of electricity and cross-subsidies are reduced in the manner specified by the Electricity Regulatory Commissions.[43]

Notably, the Ministry of Power, Government of India, came out with a Notification stating that *"all 1 MW and above consumers are deemed to be open access consumers and that the regulator has no jurisdiction over fixing energy charges for them"*, and buttressed this pronouncement through a direction of Public Policy (Ministry of Power, Government of India, 2012) issued under the Electricity Act, 2003.[44] A number of State Regulatory Commissions (notably Rajasthan, Gujarat, Madhya Pradesh, Punjab, Maharashtra) immediately came out with orders making this pronouncement ineffective within their jurisdiction or side-stepped the issue, making the provisions nugatory (the State Commissions are empowered by the federal structure of the Constitution of India, which positions electricity as a subject with concurrent jurisdiction, as well as through specific provisions of the 2003 Act, which precludes the Central Government from giving policy directions to the State Commissions[45]). This reinforces the ambivalence in the sector as well as the issue of above-cost paying, cross-subsidising consumers, who are

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Section 42 (3) states that *"Where any person, whose premises are situated within the area of supply of a distribution licensee, (not being a local authority engaged in the business of distribution of electricity before the appointed date) requires a supply of electricity from a generating company or any licensee other than such distribution licensee, such person may, by notice, require the distribution licensee for wheeling such electricity in accordance with regulations made by the State Commission and the duties of the distribution licensee with respect to such supply shall be of a common carrier providing non-discriminatory open access."*

[43] Sections 61 (g) of the Electricity Act, Ibid and the Electricity Amendment Act, 2007 (26 of 2007) dated May 28, 2007.

[44] Notification No. 23/1/2008-R&R(Vol-IV) dated November 30, 2011 (Ministry of Power, Government of India, 2011) and un-numbered dated April 23, 2012 (Ministry of Power, Government of India, 2012) issued by the Ministry of Power, Government of India.

[45] Sections 107 and 108 of the Electricity Act, 2003, notified on June 10, 2003.

contributing through payments to the distribution licensees at rates way above their cost of supply.

b. Indian judicial pronouncements on cross-subsidy reduction and progression towards cost of supply

Judgments of the Appellate Tribunal for Electricity on the subject have been definitive. Starting with pronouncements on gradual and progressive reduction of cross-subsidy (including requirement of cross-subsidy to be brought down by bringing tariff within ±20% band of average cost-of-supply by 2010-11 following the path set by the Tariff Policy),[46] the Tribunal has issued notable rulings where it has categorically stated that tariff determination should be on the basis of cost-of-supply and not average cost-of-supply,[47] marginal cost of power cannot be allocated to specific consumer categories; average pooled power purchase cost should be used,[48] policy direction cannot be issued by the State Government to frustrate cross subsidy reduction by allocating cheaper power to specific consumer categories,[49] cross-subsidy surcharge is

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[46] Judgments of the Appellate Tribunal for Electricity, available at http://aptel.gov.in/judgementnew.html, last accessed on March 8, 2013, in
- Appeal No. 79 of 2005 dated March 2, 2006;
- Appeal No. 3 of 2005 dated March 14, 2006;
- Appeal No. 131 of 2005 dated March 31, 2006;
- Appeal No. 130 of 2005 dated July 10, 2006;
- Appeal No. 154 of 2005 dated July 24, 2006;
- Appeal No. 224 of 2006 dated January 22, 2007;
- Appeal No. 269 of 2006 and Appeal No. 12 of 2007 dated May 23, 2007;
- Appeal No. 146 of 2007 dated December 19, 2007;
- Appeal No. 16 of 2008 dated February 18, 2008;
- Appeal Nos. 29, 30, 31, 32 and 33 of 2008 dated April 1, 2008;
- Appeal No. 85 of 2008 dated October 6, 2009;
- Appeal No. 8 of 2008 dated November 8, 2010.

[47] Judgments of the Appellate Tribunal for Electricity, available at http://aptel.gov.in/judgementnew.html, last accessed on March 8, 2013, in
- Appeal Nos. 14, 26 and 27 of 2011 dated May 10, 2012;
- Appeal Nos. 13 and 198 of 2010 and 42 of 2011 dated July 26, 2012.

[48] Judgment of the Appellate Tribunal for Electricity in Appeal Nos. 124, 125, 177 of 2005 & 18 of 2006 dated June 2, 2006 available at http://aptel.gov.in/judgements2.html, last accessed on May 22, 2016.

[49] Judgment of the Appellate Tribunal for Electricity in Appeal Nos. 41, 42 and 43 of 2010 dated January 31, 2011 available at http://aptel.gov.in/judgementnew.html, last accessed on March 8, 2013.

payable even when dedicated transmission lines are used,[50] etc. The opinion of the Tribunal culminates in the view that the ultimate objective is to arrive at **cost of supply based on voltage of supply**.

The authoritative judgment in the matter came from the Apex Court in 2015,[51] wherein it has been clarified that *"determination of voltage cost of supply will not run counter to the legislative intent to continue cross subsidies. Such subsidies, consistent with executive policy, can always be reflected in the tariff except that* ***determination of cost of supply on voltage basis would provide a more accurate barometer for identification of the extent of cross subsidies, continuance of which but reduction of the quantum thereof is the avowed legislative policy****, at least for the present. Viewed from the aforesaid perspective, we do not find any basic infirmity with the directions issued by the Appellate Tribunal requiring the Commission to gradually move away from the principle of average cost of supply to a determination of voltage cost of supply.*" The Apex Court, in the same judgment, also sanctified the Appellate Tribunal's view on gradual progression towards voltage-wise cost-of-supply.[52]

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[50] Judgments of the Appellate Tribunal for Electricity, available at http://aptel.gov.in/judgementnew.html, last accessed on March 8, 2013, in

- Appeal No. 28 of 2005 dated March 29, 2006;
- Appeal Nos. 20 and 77 of 2007 dated August 22, 2007;
- Appeal Nos. 139 and 140 of 2007 dated May 20, 2009;
- Appeal No. 20 of 2009 dated February 9, 2010;
- Appeal Nos. 119 and 125 of 2009 dated February 9, 2010;
- Appeal Nos. 32, 33 and 118 of 2009 dated April 28, 2010;
- Appeal No. 193 of 2011 dated October 3, 2012.

[51] Paragraph 12 of Punjab State Power Corporation Limited Vs Punjab State Electricity Regulatory Commission & Others in Civil Appeal No. 4510 of 2006 dated February 10, 2015 available at http://judis.nic.in/supremecourt/imgs1.aspx?filename=42362 last accessed on May 22, 2016.

[52] Paragraph 9 of Punjab State Power Corporation Limited Vs Punjab State Electricity Regulatory Commission & Others, Ibid.
The relevant extract is *"The Appellate Tribunal on an interpretation of Section 61(g) and 62(3) particularly in the absence of any prefix to the expression "cost of supply" in Section 61(g) took the view that* ***it is more reasonable to advance towards a regime of voltage cost of supply which would provide a more actual/realistic basis for dealing with the issue of cross subsidies****. However, as the progress to a regime of voltage cost of supply by reduction/elimination of cross-subsidies is to be gradual, the learned Appellate Tribunal held that no fault can be found with the determination of the average cost of supply made by the Commission for the financial years in question. However, keeping in view what the Tribunal understood to be the ultimate object of the Act it had directed that the relevant data with*

In another judgment, the Apex Court, while discussing upon the rationale of cross-subsidy surcharge, calls for judicious determination of such surcharge and pronounces upon the need for cross-subsidy surcharge to render protection to the vulnerable sections of the society.[53]

A detailed list of the reviewed judgments, with key findings, is provided in **Exhibit 1**.

4.2.2 Protection of vulnerable consumers in Indian policy instruments

Lifeline consumers have been defined in the policy instruments as those with consumption of 1 kWh per day. One of the objectives of the National Electricity Policy is to provide *"Minimum lifeline consumption of 1 unit/household/day as a merit good by year 2012."*[54]

The National Electricity Policy also requires that "*A minimum level of support may be required to make the electricity affordable for consumers of very poor category.* ***Consumers below poverty line who consume below a specified level, say 30 units per month, may receive special support in terms of tariff which are cross-subsidized.*** *Tariffs for such designated group of consumers will be at least 50 % of the average (overall) cost of supply. This provision*

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regard to voltage cost should be laid before the Commission and for the future the Commission would gradually proceed to determine the voltage cost of supply."

[53] Paragraph 27 of Sesa Sterlite Limited Vs Orissa Electricity Regulatory Commission & Others in Civil Appeal No. 5479 of 2013 dated April 25, 2014 available at http://judis.nic.in/supremecourt/imgs1.aspx?filename=41475 last accessed on January 21, 2017.

The relevant extract is *"The issue of open access surcharge is very crucial and implementation of the provision of open access depends on judicious determination of surcharge by the State Commissions. There are two aspects to the concept of surcharge – one, the cross-subsidy surcharge i.e. the surcharge meant to take care of the requirements of current levels of cross-subsidy, and the other, the additional surcharge to meet the fixed cost of the distribution licensee arising out of his obligation to supply. The presumption, normally is that* ***generally the bulk consumers would avail of open access, who also pay at relatively higher rates. As such, their exit would necessarily have adverse effect on the finances of the existing licensee, primarily on two counts – one, on its ability to cross-subsidise the vulnerable sections of society*** *and the other, in terms of recovery of the fixed cost such licensee might have incurred as part of his obligation to supply electricity to that consumer on demand (stranded costs). The mechanism of surcharge is meant to compensate the licensee for both these aspects."*

[54] Clause 2.0 of the National Electricity Policy, February 12, 2005 issued by the Ministry of Power, Government of India under Section 3 of the Electricity Act, 2003 in Clause 5.5.3.

will be further re-examined after five years."[55] The National Electricity Policy further states that "*Targetted expansion in access to electricity for rural households in the desired timeframe can be achieved if the distribution licensees recover at least the cost of electricity and related O&M expenses from consumers,* ***except for lifeline support to households below the poverty line who would need to be adequately subsidized. Subsidies should be properly targeted at the intended beneficiaries in the most efficient manner****. Government recognizes the need for providing necessary capital subsidy and soft long-term debt finances for investment in rural electrification as this would reduce the cost of supply in rural areas. Adequate funds would need to be made available for the same through the Plan process. Also commensurate organizational support would need to be created for timely implementation. The Central Government would assist the State Governments in achieving this."*[56]

The Tariff Policy also requires that *"Consumers below poverty line who consume below a specified level, as prescribed in the National Electricity Policy may receive a special support through cross subsidy. Tariffs for such designated group of consumers will be at least 50% of the average cost of supply."*[57]

A conjoint reading of the policy instruments results in some ambiguity. The National Electricity Policy defines "lifeline" or "Below Poverty Line" consumer as one consuming 1 kWh per day (also 30 kWh per month). Review of the definition of "lifeline", set to be done after five years from 2005, is yet to be accomplished. The protection afforded to such consumers could be through subsidy or cross-subsidy – the position is not clear in the National Electricity Policy. The Tariff Policy, however, encourages cross-subsidisation of this category of consumers. It is not clear which category / segment is expected to be the cross-subsidiser. There is also a current thought that cross

[55] Clause 5.5.2 of the National Electricity Policy, Ibid.
[56] Clause 5.1.52 of the National Electricity Policy, Ibid.
[57] Clause 8.3 of the Tariff Policy, January 28, 2016 issued by the Ministry of Power, Government of India under Section 3 of the Electricity Act, 2003.

subsidisation should be limited to the residential category (intra-segment, as opposed to both intra-segment and intra-category subsidisation at present) and industry should be spared from this burden (Ministry of Finance, Government of India, 2016). Forum of Regulators are inclined towards levy of a universal charge on all consumer categories to reduce cross subsidy (Forum of Regulators assisted by PricewaterhouseCoopers Private Limited, 2015), which is so far not reflected in any policy instrument. All in all, absence of concrete policies in this respect is abundantly clear.

4.2.3 Global learnings in the context of cost-of-supply attainment and protection of vulnerable consumers

Experience of power market reforms in selected countries around the world to assess relative successes and failures in the context of tariff, cost-of-supply and support given to the poor consumers to address societal needs, have been analysed. A co-relation is attempted in the Indian context to fully appreciate global issues in tandem with appreciation of country-specific contexts. A path forward for India and similar developing countries is attempted thereafter.

Reform model of electricity sector of Chile has been considered successful by experts. **Chile has a structured scheme of capital subsidy for rural electrification**. Projects are identified on the basis of both social and economic benefits. Capital cost is shared between the State, the companies and the users. **Competitive bidding with respect to the lowest subsidy requirement determines project allocation**. **Post project execution, running costs are expected to be paid by the users**. While the Chilean model requires a competitive environment for subsidy funding need, the fact remains that this model is successful and offers lessons to be learned.

Argentina had a mixed history of reform of the electricity sector – initial success, followed by a crisis in the sector, which is apparently limping back to an improvement trajectory. Lack of strategic vision is a criticism levelled upon the policy-makers. There is **subsidy in the Argentine system**, specifically **also for the urban poor**. **Unpaid bills** raised on the communities living in slums, are apparently **settled by the local government indicating subsidy**. **Cross-subsidy or social tariff is also envisaged**. Argentina's electricity sector is not particularly robust, even though the poverty headcount is fairly low at 1.8%.

The Philippines was one of the first countries of the region to try to make the sector self-sufficient through its endeavour to reach cost-of-supply. **The Philippines have a system of universal charge** to address under-recoveries on cross-subsidy **as well as lifeline rate subsidy and senior citizen subsidy** to address vulnerable consumer needs. The system of levy of universal charge has been proposed in the Indian context by the Forum of Regulators (Forum of Regulators assisted by PricewaterhouseCoopers Private Limited, 2015) though not accepted in subsequent policy documents like the Tariff Policy (Ministry of Power, Government of India, 2016), the Economic Survey of 2015-16 (Ministry of Finance, Government of India, 2016) etc. With 13.1% of its population under poverty headcount (12.8 million), the Philippines is a much smaller country than India with its poverty headcount of 272.5 million. Even so, the model merits consideration.

Nigeria is a poor country. 53.5% of Nigeria is under poverty headcount, much higher than India's 21.25%. Its electricity sector seems to be quite behind India. High non-technical losses through unmetered billing, estimated bills, thefts, connivance of the electricity personnel with the customers, are some of the issues faced by the Nigerian electricity sector. There is **significant cross-subsidy in the Nigerian tariff structure** and subsidy is promised by the government to rescue the sector. Indian policy makers and industry experts are aware of similar issues facing Indian electricity sector. The key learning from the Nigerian experience is that with a predominantly poor population and the history of both non-technical losses and a subsidy / cross-subsidy regime, it is difficult for the sector to reinvent itself at a smart pace. Moreover, immense circumspection is warranted when dealing with the delicate societal issue of supply to the poor.

U.K. has a clearly defined Consumer Vulnerability Strategy in place created by Ofgem. There is a **transparent bifurcation of the duty of the regulator and the government.** Understanding of vulnerability is extremely detailed and not only consumers with **low-income**, but also those who are

disabled, of **pensionable age** etc. comes under its ambit. There are different strategies to deal with different forms of vulnerability. The government provides subsidy to ensure warm houses for specific categories of vulnerable consumers. U.K. was one of the fore-runners of electricity sector reform and while there is inevitable criticism of the current policy of intervention, the fact stands out that a detailed strategy is very much in place to deal with vulnerability. U.K. has also experimented with a number of innovative tariff structures, which may be worth pursuing in suitable cases.

The key learnings from the selected countries are set out in Table 4.1. Application of such learnings in the Indian context is detailed through Chapter 5.

Table 4.1: Key Global Learnings

Country	Key learnings for developing economies	Comments
Chile	• Rural electrification projects are assessed on the basis of economic or social benefits as well as financial benefits. The maximum subsidy allowable is set just above the financial break-even point. Projects are competitively bid on the basis of lowest subsidy requirements. • Self-generating projects also qualify for subsidy. • Running costs are paid by the users.	• Social cost evaluation is an innovative and replicable model. • Competitively bid projects on the basis of lowest subsidy requirement bring in efficiency. • It will also lower net subsidy requirement of the government for rural electrification capital schemes. • Decisions on grid-connected or off-grid distributed generation can be taken through use of the Chilean model.
Argentina	• For non-payment of bills in slum areas, the government picks up the payment. • Payments are made from a special fund. Regularised customers contribute to the fund as well. • Introduction of social tariff was under consideration.	• Argentina's electricity sector is not in a robust state. Cross-subsidy continues. There is also significant subsidy in the system. • Social tariff may be an innovation; impacts are yet to be made clear.
Philippines	• Lifeline rates are offered at significant discounts (100% upto 20 kWh monthly consumption; 50% for 21 to 50 kWh monthly consumption; graded upto 100 kWh).	• Universal charge is a concept which can be implemented for cross-subsidy removal. • Lifeline discount solely on the basis of consumption is criticised. Secondary residences of wealthy

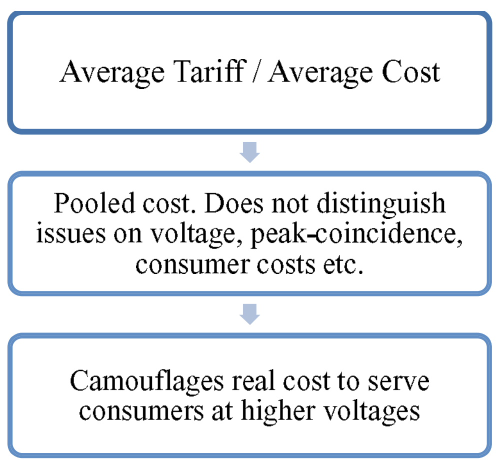
Country	Key learnings for developing economies	Comments
	• Subsidy is exclusively consumption based; secondary residences of wealthy users also enjoy subsidy. Poorer families with higher number of members fail to make the cut. • Universal charge is obligatory upon all non-lifeline electricity customers to cover expenditure ranging from cross-subsidy removal mitigation fund, indigenous renewable energy, stranded debt and costs, etc.	households also enjoy lifeline rates.
Nigeria	• Subsidy and cross-subsidy both exists, as also rampant theft and other non-technical losses. • With a predominantly poor population with history of both non-technical losses and a subsidy / cross-subsidy regime, it is difficult for the sector to reinvent itself.	• Nigeria is a poor country, with electricity sector in the cusp of reform developments. Learnings are yet to emerge. • Circumspection is warranted when dealing with the societal issue of supply to the poor.
U.K.	• U.K. has a clearly defined Consumer Vulnerability Strategy with areas of activity bifurcated between the regulator and the government. • With a focus on fuel poverty elimination, Warm Home Discount schemes are in place. • The regulator encourages introduction of tailored social tariff for vulnerable consumers. • Tariff innovations were encouraged – ranging from tariff structure with only fixed cost, as well as with only variable cost, to fit various energy needs.	• Well-articulated strategy to deal with vulnerable section (not restricted only to low-income consumers); their specific needs are addressed through adoption of a multi-prong approach. This is a valuable lesson for emerging economies. • Though innovative tariff seems to have been recently restricted, there are lessons for appropriate modification and adoption.

Source: Protection for the Poor in Electricity Pricing: Global Lessons for India (Chatterjea & Dwivedi, 2016).

4.2.4 Principles of cost-of-supply determination

As a concept, average cost-of-supply or average tariff is easy to comprehend and implement. The entire cost base of the utility is aggregated and divided by the number of units sold to derive average cost. Where the utility is allowed to pass through its cost stream in entirety to the customers, average tariff and average cost are equivalent. Revenue stream of the utility, divided by the number of units sold, provides the average tariff. In a simple concept, the difference between the tariff actually paid by a customer and average tariff, is considered to be the cross-subsidy borne by that customer. However, viewing cross-subsidy with reference to average tariff is a largely discarded concept (through literature, policy and judicial decisions). At best, it serves as a primary ready reckoner and is largely used as the first milestone to reach when there is a huge difference between cost-of-supply and customer tariff.

In India, while the professed policy is attainment of cost-of-supply, as an intermediate milestone, tariff of all customers were expected to be within the band of ±20% of the average cost-of-supply by 2010-11 (Ministry of Power, Government of India, 2006).



The concept that the cost to serve small customers is higher than the cost to serve the larger customers is well-established (Gilbert, Kahn, & Newberry, 1996). The relationship between average cost (average tariff), customer segment tariff and customer segment cost-of-supply is illustrated with some **hypothetical numbers** through Table 4.2 and Table 4.3. The hypothetical numbers are drawn from the concepts available through literature review and are used to accentuate the issue. Actual numbers for cost-of-supply are developed in paragraph 4.4.

Illustration of assessment of cross-subsidy with reference to average tariff / average cost is presented through Table 4.2, using notional numbers.

Table 4.2: Cross-Subsidy Assessment with reference to Average Tariff / Average Cost[58]

Consumer Category	Cross-Subsidising Consumer (Commercial receiving supply at 33 kV)	Cross-Subsidised Consumer (Lifeline)
Average Tariff / Average Cost	Rs.6 per kWh (same across consumers)	Rs.6 per kWh (same across consumers)
Category Tariff Charged	Rs.11 per kWh	Rs.2 per kWh
Cross-Subsidy Status	Is a cross-subsidiser (Giver)	Is cross-subsidised (Receiver)
Cross-Subsidy Quantum	Giving cross-subsidy (support) @ Rs.5 per kWh	Receiving cross-subsidy (support) @ Rs.4 per kWh

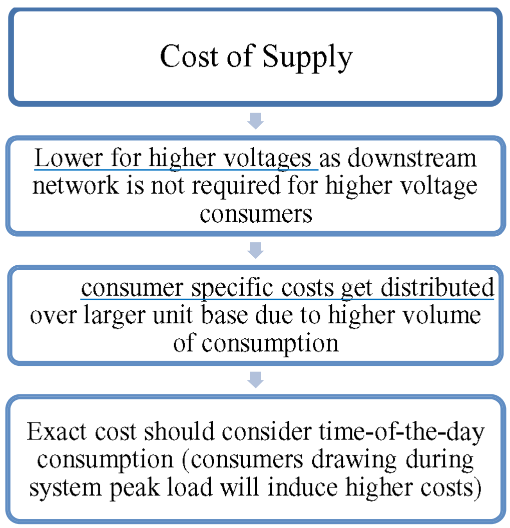
Derivation of cross-subsidy with reference to average tariff / average cost has been used as an intermediate assessment milestone for the purpose of this study for the explained reasons.

Cost-of-supply for certain categories of consumers is higher than other categories. On the basis of first principles, industrial prices are expected to be lower than commercial prices (Gilbert, Kahn, & Newberry, 1996) and commercial prices are likely to be lower than residential prices. Two primary cost factors determine these relations. The ranking of industrial, commercial and residential loads reflect a declining load factor. All other factors remaining constant, a high load factor load has a lower cost-to-serve than a low load factor load, as networks and other facilities are used more frequently in off-peak periods in the first instance. Second, cost of distribution facilities to serve industrial loads is lower compared to that of residential customers, as they typically take service at higher voltages, with lower losses and less need of

[58] Notional numbers for illustration.

step-down transformers and low voltage lines. Economics of distribution costs also favour commercial loads over residential loads for similar reasons.

The difference in cost incurred to serve each category of consumers, is primarily driven by of voltage of service,[59] period of consumption,[60] as well as total consumption units.[61]



Even within a category (same supply voltage), the cost-of-supply differs as, among others, consumer specific costs are distributed over a differential number of unit consumption viz. the cost-to-serve a residential consumer with 100 kWh monthly consumption is distinctly higher than a residential consumer with month consumption of 5000 kWh, all other factors remaining the same.

Table 4.3 exhibits cross-subsidy assessment with reference to actual cost-of-supply / cost-to-serve, using notional numbers.

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[59] Electricity network needed for a consumer is only upstream vis-à-vis supply voltage. Network cost to serve a consumer connected at 33 kV is cost of 33 kV and higher voltage networks. Network cost to serve a low voltage consumer encompasses the entire distribution network.

[60] Necessary to derive co-incidence with peak demand and corresponding network cost.

[61] Customer centric costs (e.g. cost of printing and delivering a bill) get spread over a larger number of units for a customer with higher consumption, as compared to a customer with lower consumption units, over a defined time period.

Table 4.3: Cross-Subsidy Assessment with reference to Actual Cost-of-Supply[62]

Consumer Category	Cross-Subsidising Consumer (Commercial receiving supply at 33 kV)	Cross-Subsidised Consumer (Lifeline)
Actual Cost-of-supply	Rs.4 per kWh (Lower)	Rs.12 per kWh (Much Higher)
Category Tariff Charged	Rs.11 per kWh	Rs.2 per kWh
Cross-Subsidy Status	Is a cross-subsidiser (Giver)	Is cross-subsidised (Receiver)
Cross-Subsidy Quantum	Giving cross-subsidy (Support) @ Rs.7 per kWh	Receiving cross-subsidy (support) @ Rs.10 per kWh

The magnitude differs considerably with assessment methodology as exhibited through the hypothetical numbers in Table 4.2 and Table 4.3.

Cost-of-supply is frequently modelled on the basis of actual cost incidence. In spite of its critics, most empirical studies initiate from cost allocation (Heald, 1996). Heald is also of the opinion that there are difficult issues of identification and measurement. Availability of acceptable data is a considerable problem faced by electricity utilities. Joskow & Marron comment that costs are often not accurately captured / allocated (Joskow & Marron, 1991). Particularly in the context of residential customers, real time pricing is not widely accepted even in developed countries or may not have adequate welfare implications (Allcott, 2011), (Joskow & Wolfram, 2012), (Ito, 2014). Viljainen is of the view that solutions which are practical, rather than optimal, forms the cornerstone of incentive regulation. Application of marginal cost pricing or Ramsey pricing, are not necessarily appropriate (Viljainen, 2005).

Thus the option selected for this study is primarily on the basis of historical cost following a pragmatic approach. This option is chosen from the context of suitability, for ease of data capturing from the management perspective with

[62] Notional numbers for illustration.

practical applicability. The option of real-time marginal cost pricing is not being used herein. It remains in the realms of future scope when the environment is more amenable to exploit use of real-time data.

Aspects of peak load pricing is captured to the extent of historical cost allocation of fixed costs[63] on the basis of peak co-incidence (system peak and class peak, as appropriate). It is relevant in the context that a number of judgments of the Appellate Tribunal for Electricity require variable cost[64] allocation on the basis of average pooled power purchase cost and have specific reservations on marginal cost allocation of the highest power purchase cost to a consumer category to shore up their cost-to-serve (and frustrate the purpose of reduction of cross-subsidy and achievement of cost-of-supply through ingenious methods).[65] It is pertinent to mention that the definitive judgment of the Apex Court requires gradual progression towards *"voltage cost of supply"* (and gradual moving away from the principle of average cost-of-supply).[66]

Table 4.4 exhibits cross-subsidy assessment with reference to various aspects of cost that have been studied.

Table 4.4: Cross-Subsidy Assessment with Reference to Various Aspects of Cost

Cost Aspects in the Context of Cross-subsidy Assessment	Comments
Capital vis-à-vis Revenue	• Both capital and revenue costs are amenable to

[63] Fixed costs indicate items of cost which are incurred irrespective of use (over a band / period of time) and remains constant (over that time period) at a specific capacity level.
[64] Variable costs imply those elements of cost which vary with usage / volume. This is as opposed to fixed costs. Typically, fuel costs and / or power purchase costs are the main components of variable costs.
[65] Judgment of the Appellate Tribunal for Electricity in Appeal Nos. 124, 125, 177 of 2005 & 18 of 2006 dated June 2, 2006 available at http://aptel.gov.in/judgements2.html,last accessed on May 22, 2016;
Judgments of the Appellate Tribunal for Electricity in Appeal No. 269 of 2006 and Appeal No. 12 of 2007 dated May 23, 2007, available at http://aptel.gov.in/judgementnew.html, last accessed on March 8, 2013.
[66] Paragraph 12 of Punjab State Power Corporation Limited Vs Punjab State Electricity Regulatory Commission & Others in Civil Appeal No. 4510 of 2006 dated February 10, 2015 available at http://judis.nic.in/supremecourt/imgs1.aspx?filename=42362, last accessed on May 22, 2016.

Cost Aspects in the Context of Cross-subsidy Assessment	Comments
Costs	subsidy. Capital cost and subsidy deals with electricity being made available. Revenue cost and subsidy is more on the question of affordability / sustainability. • In India, the Government has schemes on capital cost; particularly rural electrification is happening extensively under capital schemes (present scheme is Deendayal Upadhyaya Gram Jyoti Yojana). • Most countries adopt tailored models for sustenance of electrification of remote areas; Chilean model is a sustainable capital model. • Indian concern is more on the revenue aspect i.e. affordable electricity for the poorer segments on a sustained basis.
Average Cost vis-à-vis Cost-of-supply	• Average cost is pooled cost; it is the average cost per unit of electricity sold. Where average cost equals average tariff, then it is average revenue per unit sold. • Cost-of-supply is the cost to serve a consumer or a consumer segment. It is the actual cost incidence of serving that consumer / segment. Since allocation principles are involved in cost identification, a number of formulae are available for the same. • In India, there are categories paying below average cost / tariff. The policies suggest achieving average cost / tariff as the first milestone.
Category-wise Cost-of-supply vis-à-vis Intra-Category wise Cost-of-supply or Segment-wise Cost-of-supply	• Category-wise cost stops at purpose of supply viz. residential, commercial, industrial. • Intra-category wise cost is segment-wise cost. It differentiates between, say a lifeline and a high-consuming residential, though they might both belong to the same residential category, from the viewpoint of nature of supply. Even under commercial, it differentiates between a local grocery shop and a shopping mall. It is the only cost which has a logical use from the policy perspective.
Historical / Embedded vis-à-vis Real-time cost	• Historical cost or embedded cost is the past incurred cost or accounting cost. Advantages of embedded cost are ease of availability, implementation, comprehension and alignment with overall utility cost. Criticism is departure from true economic cost.

Cost Aspects in the Context of Cross-subsidy Assessment	Comments
	• Real-time cost reflects real cost of that slice of time; requires elaborate data capturing mechanism. Literature suggests that real-time cost is yet to take off significantly even in developed countries like U.S.A. • For India, a workable model is under exploration here and historical cost appears more practical.
Regulated vis-à-vis Unregulated	• Where two segments exist under the same firm, there is a practice of loading costs of the unregulated segment on the regulated segment. This is also cross-subsidisation. • In India, with freeing up of generation, this phenomenon is expected to occur where both generation and retail are under the same umbrella.

Based on above study, cross-subsidy assessment through a cost-to-serve model for a regulated entity, based on recent historical cost incidence, captured / allocated voltage-wise, category and segment-wise through a detailed study, with in-depth peak load assessment and voltage level-wise technical and commercial loss assessment, is predicated.

4.3 ASSESSMENT OF CROSS-SUBSIDY WITH REFERENCE TO AVERAGE COST-OF-SUPPLY PREVAILING FOR INDIAN REGULATED TARIFF FRAMEWORKS: OBJECTIVE 2

The interim milestone of achieving tariff which is within ±20% band of the average cost-of-supply for all categories of consumers (excepting the lifeline segment, which is required to be at least 50% of the average cost-of-supply), is studied through Objective 2. The policy instruments have been adopted as a guiding principle for the purpose of fulfilling this objective. Incidentally, the relevant policy underwent a change in the recent period. While the erstwhile Tariff Policy (Ministry of Power, Government of India, 2006) required achievement of tariff within ±20% band of the average cost by 2010-11, the current Tariff Policy requires achievement of tariff within ±20% band of the average cost-of-supply, but refrains from specifying a timeline. It is clear from the policy that the milestone set earlier was not achieved, so the requirement was repeated, albeit without a specific time-line. Thus, while the intermediate policy initiative was a proposal to bring down tariff for each **consumer category latest by 2010-11 within ±20% band with respect to the average cost-of-supply following roadmaps to be set by the State Electricity Regulatory Commissions within six months of announcement of the Tariff Policy in 2006,**[67] **five years after lapse of the target date for correction of this distortion, the deadline has presently been removed from the current Tariff Policy**,[68] issued in 2016.

Population of 55 licensees have been chosen, covering over 97% of supply met in India by volume of sales, with subsequent choice of 25 licensees (the steps are detailed in paragraph 3.10.2).

Indexed tariff of specified consumer categories of 25 utilities with reference to the band of ±20% of the average cost-of-supply is exhibited.

- **2004-05 (before introduction of National Tariff Policy)**

Findings are available in Figure 4.1 and Table 4.5.[69]

- **2008-09 (interim period)**

Findings are available in Figure 4.2 and Table 4.6.

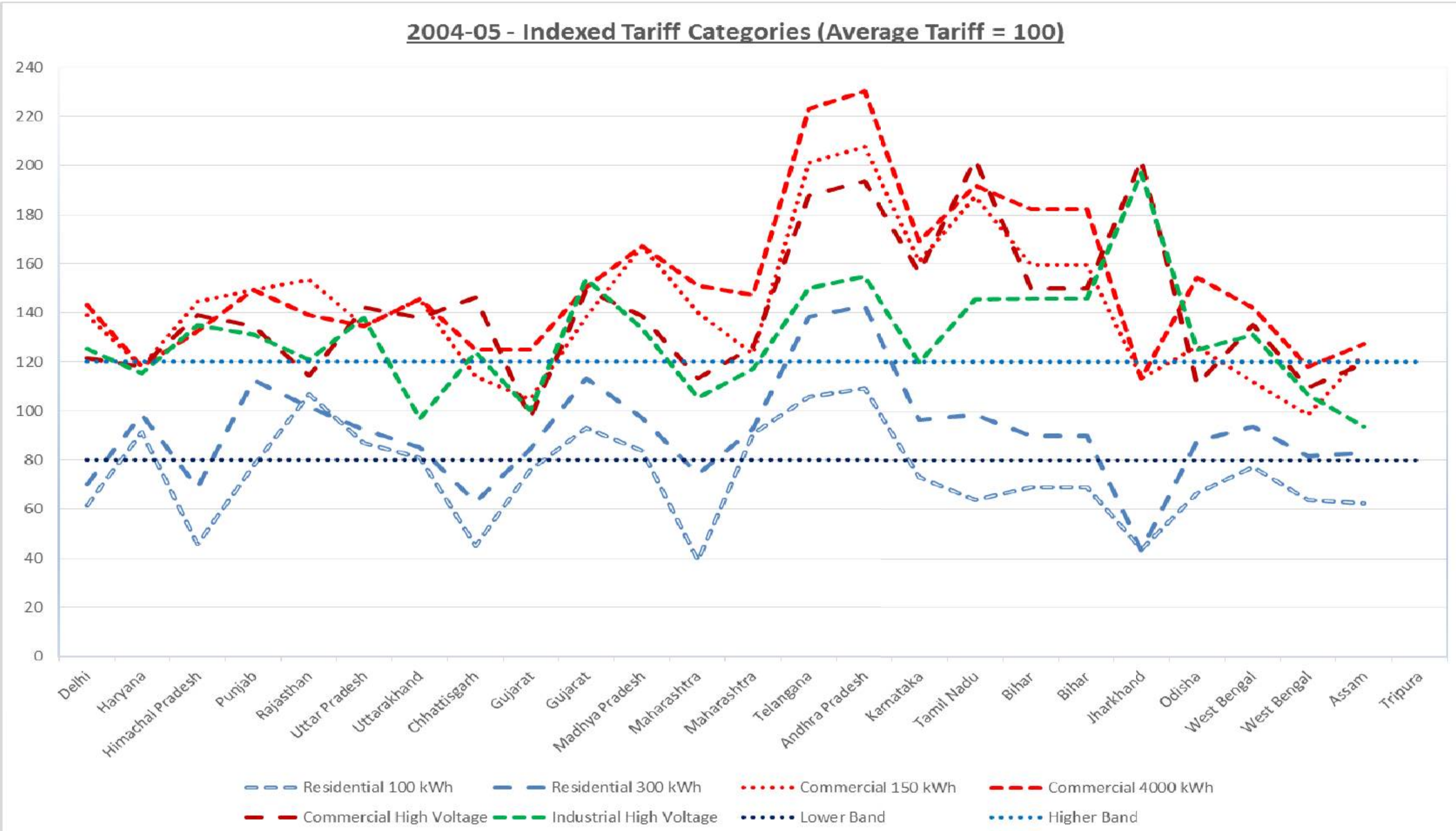
- **Latest available year for which tariff has been determined (2015-16 or 2014-15, as available) post completion of the time period mandated by the erstwhile National Tariff Policy.**

Findings are available in Figure 4.3 and Table 4.7.

Pertinent worksheets in Excel are placed in **Exhibit 3**.

[67] Tariff Policy, January 6, 2006 issued by the Ministry of Power, Government of India.
[68] Tariff Policy, January 28, 2016 issued by the Ministry of Power, Government of India
[69] Table 4.5, Table 4.6 and Table 4.7 provide shortened names of licensees commonly used; full names are furnished through the List of Abbreviations.

Figure 4.1: Indexed Tariff of specified consumer categories of 25 licensees in 2004-05 with reference to ±20% band of the average cost-of-supply



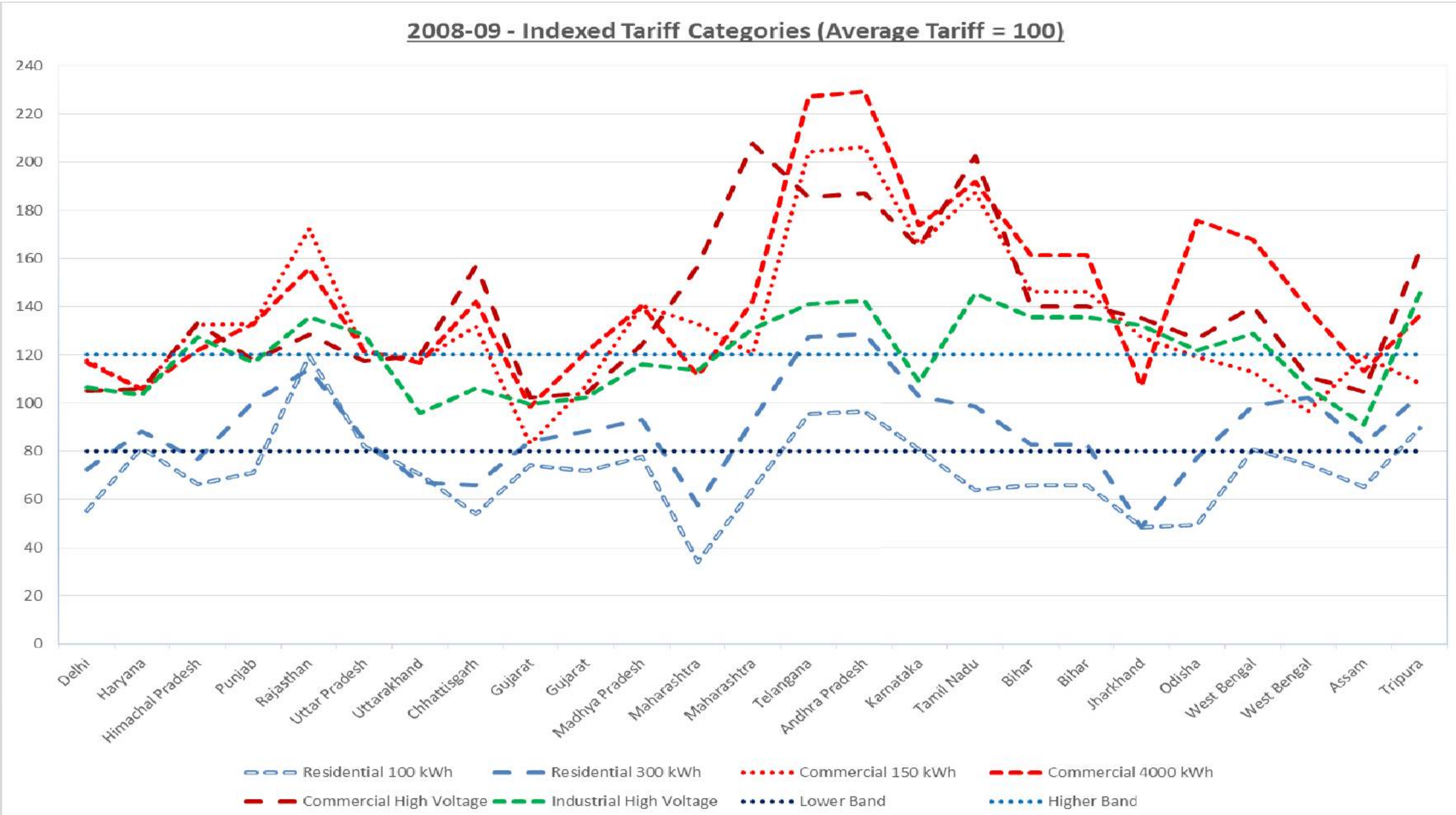
Source: Present study, details in Exhibit 3.

Table 4.5: Tariff Analysis of Focus Segments in Indexed Format for 2004-05

(Average Tariff = 100) for Three Reference Years				2004-05 Focus Customer Segments						
Sl.No.	Region	State	Licensee	Lifeline	Residential with 100 kWh monthly consump-tion	Residential 300 kWh monthly consump-tion	Commercial 150 kWh monthly consump-tion	Commercial 4000 kWh monthly consump-tion	Commercial High Voltage	Industrial High Voltage
1.	Northern Region	Delhi	BRPL	73	61	70	139	143	121	125
2.		Haryana	DHBVNL	74	91	99	118	118	118	115
3.		Himachal Pradesh	HPSEBL	43	46	69	145	133	139	135
4.		Punjab	PSPCL	104	78	112	149	149	134	131
5.		Rajasthan	JVVNL	100	107	101	154	139	114	121
6.		Uttar Pradesh	MVVNL	71	87	93	135	135	142	138
7.		Uttarakhand	UPCL	62	81	85	145	145	138	97
8.	Western Region	Chhattisgarh	CSPDCL	43	45	63	114	125	146	124
9.		Gujarat	TPL - Ahmedabad	74	76	85	105	125	97	100
10.			MGVCL	92	93	113	138	150	149	154
11.		Madhya Pradesh	Central Discom	61	84	97	167	167	139	133
12.		Maharashtra	RInfra	56	39	74	140	151	113	105
13.			MSEDCL	62	91	93	123	147	126	117
14.	Southern Region	Telangana	TSSPDCL	97	106	138	201	223	188	150
15.		Andhra Pradesh	APSPDCL	100	109	143	208	230	194	155
16.		Karnataka	BESCOM	54	73	96	161	169	157	120
17.		Tamil Nadu	TANGEDCO	38	64	98	188	192	202	145
18.	Eastern Region	Bihar	NBPDCL	44	69	90	160	182	150	146
19.			SBPDCL	44	69	90	160	182	150	146
20.		Jharkhand	JBVNL	25	44	43	113	113	203	197
21.		Odisha	CESU	35	67	88	126	154	111	125
22.		West Bengal	WBSEDCL	74	77	94	112	142	135	131
23.			CESC	51	64	82	98	118	110	107
24.	North-Eastern Region	Assam	APDCL	54	62	83	123	127	119	94
25.		Tripura	TSECL							

Source: Present study, details in Exhibit 3.

Figure 4.2: Indexed Tariff of specified consumer categories of 25 licensees in 2008-09 with reference to ±20% band of the average cost-of-supply



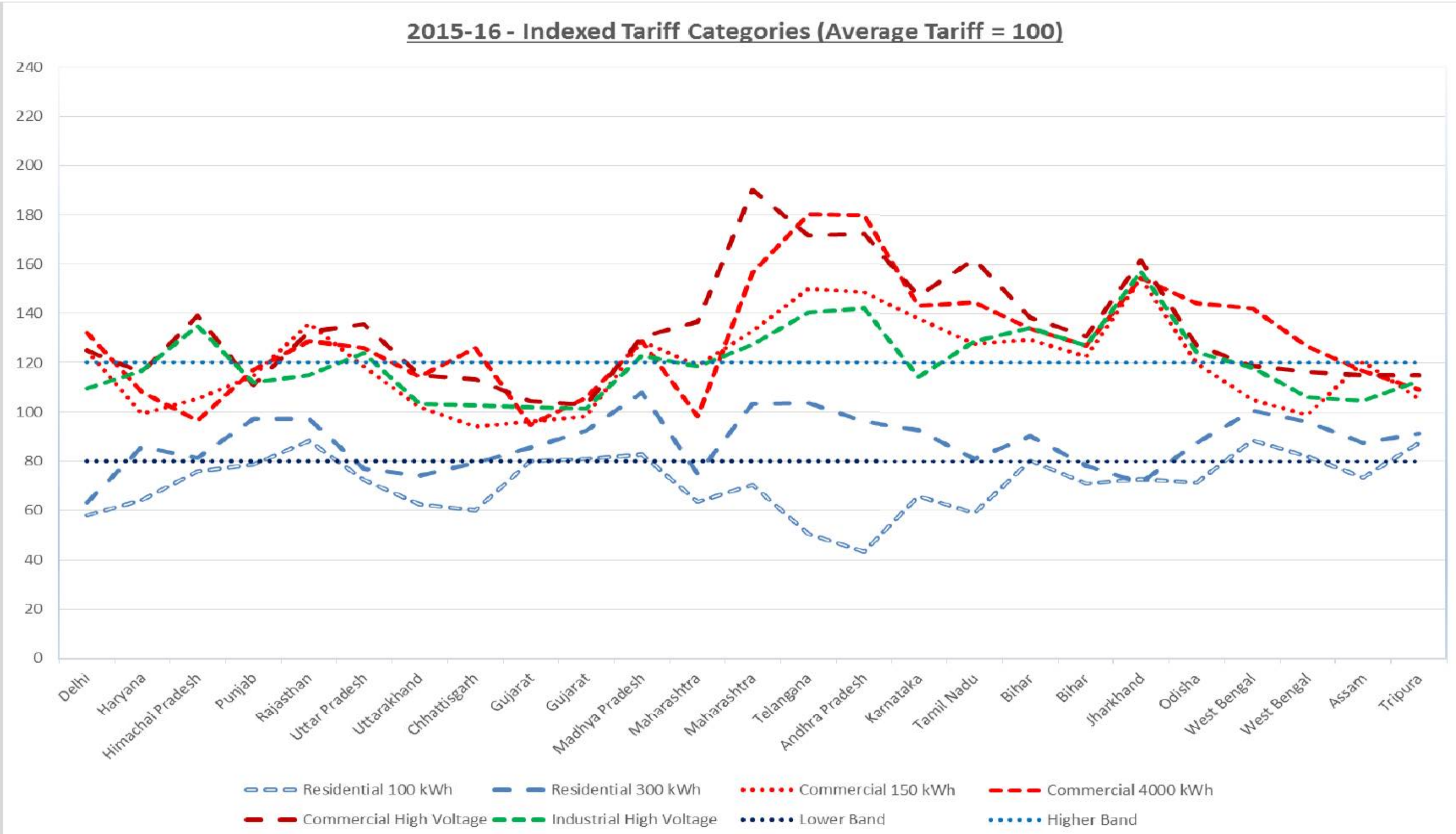
Source: Present study, details in Exhibit 3.

Table 4.6: Tariff Analysis of Focus Segments in Indexed Format for 2008-09

(Average Tariff = 100) for Three Reference Years				2008-09 Focus Customer Segments						
Sl.No.	Region	State	Licensee	Lifeline	Residential with 100 kWh monthly consump-tion	Residential 300 kWh monthly consump-tion	Commercial 150 kWh monthly consump-tion	Commercial 4000 kWh monthly consump-tion	Commercial High Voltage	Industrial High Voltage
1.	Northern Region	Delhi	BRPL	67	55	73	118	117	105	106
2.		Haryana	DHBVNL	66	81	88	106	106	106	103
3.		Himachal Pradesh	HPSEBL	52	66	76	133	122	133	127
4.		Punjab	PSPCL	93	71	101	133	133	118	117
5.		Rajasthan	JVVNL	113	120	114	172	156	128	136
6.		Uttar Pradesh	MVVNL	66	82	85	122	122	117	128
7.		Uttarakhand	UPCL	49	70	67	118	117	120	96
8.	Western Region	Chhattisgarh	CSPDCL	51	54	66	132	142	157	106
9.		Gujarat	TPL - Ahmedabad	72	74	84	83	98	102	100
10.			MGVCL	37	72	88	107	121	104	102
11.		Madhya Pradesh	Central Discom	69	77	93	141	141	124	116
12.		Maharashtra	RInfra	8	34	58	133	111	157	114
13.			MSEDCL	14	64	93	120	142	208	131
14.	Southern Region	Telangana	TSSPDCL	89	95	127	204	227	185	141
15.		Andhra Pradesh	APSPDCL	90	96	129	206	229	187	143
16.		Karnataka	BESCOM	59	81	103	166	174	165	109
17.		Tamil Nadu	TANGEDCO	38	64	98	188	192	202	145
18.	Eastern Region	Bihar	NBPDCL	40	66	83	146	161	140	136
19.			SBPDCL	40	66	83	146	161	140	136
20.		Jharkhand	JBVNL	31	49	49	127	107	135	132
21.		Odisha	CESU	55	49	77	119	176	127	122
22.		West Bengal	WBSEDCL	63	81	99	113	168	140	129
23.			CESC	53	75	102	97	139	111	106
24.	North-Eastern Region	Assam	APDCL	64	65	83	119	113	105	91
25.		Tripura	TSECL	64	90	103	108	136	163	146

Source: Present study, details in Exhibit 3.

Figure 4.3: Indexed Tariff of specified consumer categories of 25 licensees in 2015-16 with reference to ±20% band of the average cost-of-supply



Source: Present study, details in Exhibit 3.

Table 4.7: Tariff Analysis of Focus Segments in Indexed Format for 2015-16

(Average Tariff = 100) for Three Reference Years				2015-16 Focus Customer Segments						
Sl.No.	Region	State	Licensee	Lifeline	Residential with 100 kWh monthly consump-tion	Residential 300 kWh monthly consump-tion	Commercial 150 kWh monthly consump-tion	Commercial 4000 kWh monthly consump-tion	Commercial High Voltage	Industrial High Voltage
1.	Northern Region	Delhi	BRPL	70	58	63	125	132	125	110
2.		Haryana	DHBVNL	50	64	86	99	108	116	117
3.		Himachal Pradesh	HPSEBL	65	76	82	105	97	139	135
4.		Punjab	PSPCL	93	79	97	115	117	111	112
5.		Rajasthan	JVVNL	83	88	97	136	129	133	115
6.		Uttar Pradesh	MVVNL	55	73	77	119	126	135	124
7.		Uttarakhand	UPCL	42	62	74	102	114	115	103
8.	Western Region	Chhattisgarh	CSPDCL	58	60	79	94	126	113	103
9.		Gujarat	TPL - Ahmedabad	50	80	85	96	95	104	102
10.			MGVCL	50	81	92	98	106	103	101
11.		Madhya Pradesh	Central Discom	54	83	108	129	129	130	123
12.		Maharashtra	RInfra	37	64	75	119	98	137	118
13.			MSEDCL	21	70	104	133	156	190	127
14.	Southern Region	Telangana	TSSPDCL	50	50	104	150	180	172	141
15.		Andhra Pradesh	APSPDCL	43	44	97	150	182	174	144
16.		Karnataka	BESCOM	51	66	93	138	143	147	114
17.		Tamil Nadu	TANGEDCO	61	59	81	128	145	162	129
18.	Eastern Region	Bihar	NBPDCL	45	80	90	130	134	138	134
19.			SBPDCL	43	71	78	123	127	131	127
20.		Jharkhand	JBVNL	41	73	72	154	154	162	157
21.		Odisha	CESU	55	72	87	120	144	127	124
22.		West Bengal	WBSEDCL	54	89	101	105	142	119	118
23.			CESC	56	82	96	99	127	116	106
24.	North-Eastern Region	Assam	APDCL	67	73	88	121	117	115	105
25.		Tripura	TSECL	62	88	91	105	109	115	112

Source: Present study, details in Exhibit 3.

To assess the prevalent cross-subsidy situation, a check against the milestone of achieving tariff within ±20% band with respect to the average cost-of-supply is conducted. Significant points emerge from data extracted through Table 4.5 to Table 4.7.

The summarised results are extracted below in Table 4.8. Details are submitted in **Exhibit 3**.

Table 4.8: Average Deviation from the Band (below 80% of average cost-of-supply for cross-subsidised and above 120% for cross-subsidisers) across 25

	Cross-Subsidised (Getting Subsidy) (-) Below Band of 80% = Non-compliant / (+) Above Band of 80% = Compliant		Cross-Subsidisers (Giving Subsidy) (-) Below Band of 120% = Compliant / (+) Above Band of 120% = Non-compliant			
	Residential 100 kWh	**Residential 300 kWh**	**Commercial 150 kWh**	**Commercial 4000 kWh**	**Commercial High Voltage**	**Industrial High Voltage**
2004-05	(-) 6	(+) 12	(+) 23	(+) 33	(+) 22	(+) 10
2008-09	(-) 8	(+) 9	(+) 14	(+) 24	(+) 19	(+) 1
2015-16	(-) 9	(+) 8	0	(+) 9	(+) 13	0
Compliance with respect to Intermediate Milestones	**Non-compliant**	**Compliant**	**Compliant**	**Non-compliant**	**Non-compliant**	**Compliant**

Source: Present study, details in Exhibit 3.

Table 4.8 indicates slow progression of intermediate milestone of achieving tariff within ±20% band of the average cost-of-supply across the subject licensees. 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 a cross-subsidised tariff category at

71% of average tariff. Residential with 300 kWh monthly consumption, at 88% of average cost, has achieved the intermediate milestone. [70]

Notably, contextual learning from international experience is that industrial tariff is lower than residential tariff. To validate against this learning, industrial tariff in India is checked against two monthly consumption points of residential consumers (100 kWh and 300 kWh) for the 25 licensees studied. Table 4.9 represents the findings in an indexed format for the latest available year.

Table 4.9: Indexed Comparison of Industrial with Residential Tariffs for 2015-16 (monthly consumption 100 kWh and 300 kWh)

Sl. No.	Region	State	Licensee[71]	Industrial vis-à-vis Residential 100 kWh monthly consumption (Residential = 100)	Industrial vis-à-vis Residential 300 kWh monthly consumption (Residential = 100)
1.	Northern Region	Delhi	BRPL	189	173
2.		Haryana	DHBVNL	182	136
3.		Himachal Pradesh	HPSEBL	178	165
4.		Punjab	PSPCL	142	115
5.		Rajasthan	JVVNL	130	118
6.		Uttar Pradesh	MVVNL	171	161
7.		Uttarakhand	UPCL	166	139
8.	Western Region	Chhattisgarh	CSPDCL	171	130
9.		Gujarat	TPL-Ahmedabad	127	119
10.			MGVCL	125	110

[70] The necessity is subsidising a residential customer with 300 kWh monthly consumption (10 times the "lifeline") is not immediately clear.
[71] Table 4.9 provides shortened names of licensees commonly used; long forms of the names are available in the websites of the licensees / respective State Electricity Regulatory Commissions and are furnished through the List of Abbreviations.

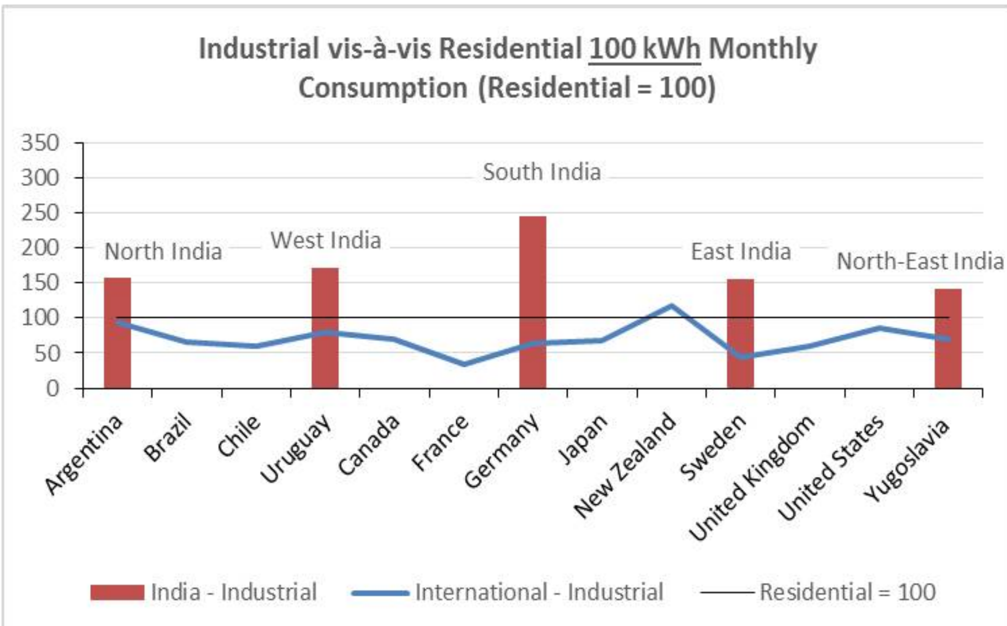
Sl. No.	Region	State	Licensee[71]	Industrial vis-à-vis Residential 100 kWh monthly consumption (Residential = 100)	Industrial vis-à-vis Residential 300 kWh monthly consumption (Residential = 100)
11		Madhya Pradesh	Central Discom	149	114
12.		Maharashtra	RInfra	186	158
13.			MSEDCL	181	123
14.	**Southern Region**	Telangana	TSSPDCL	278	136
15.		Andhra Pradesh	APSPDCL	329	148
16.		Karnataka	BESCOM	174	123
17.		Tamil Nadu	TANGEDCO	217	159
18.	**Eastern Region**	Bihar	NBPDCL	167	149
19.			SBPDCL	179	162
20.		Jharkhand	JBVNL	216	219
21.		Odisha	CESU	174	142
22.		West Bengal	WBSEDCL	133	117
23.			CESC	130	110
24.	**North-Eastern Region**	Assam	APDCL	143	120
25.		Tripura	TSECL	128	123

Source: Present study, details in Exhibit 3.

The position after more than 12 years of mandated tariff rationalisation is that **industrial tariff is higher than residential tariff in all cases**, whereas the internationally accepted position is that industrial tariff is less than residential tariff (Gilbert, Kahn, & Newberry, 1996). There is significant literature on protecting the productive sector of the economy (Rosenzweig, Potts Voll, & Pabon-Agudelo, 2002), (Electricity Pricing Policy (EPP) of the South African Electricity Supply Industry issued by the Department of Minerals and Energy, Statskoerant, No. 31747, 2008). In Table 4.9, there are outliers like Andhra Pradesh, with industry at 3.29 times residential tariff (seen against 100 kWh monthly consumption) and Jharkhand at 2.19 times residential tariff (against 300 kWh monthly consumption).

Indian region-wise average pictures are presented in Figure 4.4 and Figure 4.5, by comparing against the international position, in an indexed format. Residential tariff is considered as 100.

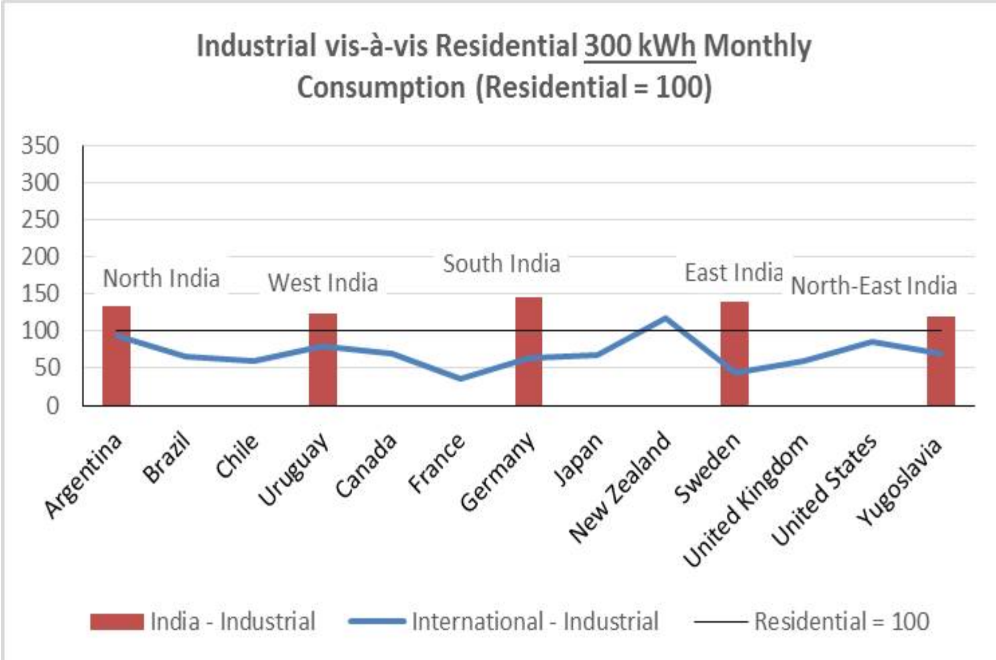
Figure 4.4: Industrial Tariff position of Indian Regions and International Countries: Against Residential 100 kWh Monthly Consumption



Source: International Countries from Introduction: International comparisons of electricity regulation (Gilbert, Kahn, & Newberry, 1996), Indian position arrived at through present study, details in Exhibit 3.

Figure 4.4 indicates region-wise industrial tariff to be considerably higher than residential tariff at 100 kWh monthly consumption point. Of the regions, South India is distinctly higher than the other regions, whereas North-east India is marginally lower than other regions. International scenario is that industrial tariff is lower than residential tariff, in almost all cases.

Figure 4.5: Industrial Tariff position of Indian Regions and International Countries: Against Residential 300 kWh Monthly Consumption



Source: International Countries from Introduction: International comparisons of electricity regulation (Gilbert, Kahn, & Newberry, 1996), Indian position arrived at through present study, details in Exhibit 3.

Figure 4.5 exhibits findings similar to Figure 4.4. Residential tariff in India is lower than industrial tariff, even at a higher consumption point of 300 kWh per month.

Commercial tariff in India is checked against two consumption points of residential consumers (100 kWh and 300 kWh) for the 25 utilities studied. Table 4.10 represents the findings in an indexed format for the latest available year.

Table 4.10: Indexed Comparison of Commercial with Residential Tariffs for 2015-16 (monthly consumption 100 kWh and 300 kWh)

Sl. No.	Region	State	Licensee[72]	Commercial vis-à-vis Residential 100 kWh monthly consumption (Residential = 100)	Commercial vis-à-vis Residential 300 kWh monthly consumption (Residential = 100)
1.	**Northern Region**	Delhi	BRPL	215	197
2.		Haryana	DHBVNL	181	136
3.		Himachal Pradesh	HPSEBL	183	171
4.		Punjab	PSPCL	141	114
5.		Rajasthan	JVVNL	150	137
6.		Uttar Pradesh	MVVNL	187	176
7.		Uttarakhand	UPCL	184	155
8.	**Western Region**	Chhattisgarh	CSPDCL	188	143
9.		Gujarat	TPL-Ahmedabad	131	122
10.			MGVCL	127	111
11		Madhya Pradesh	Central Discom	158	121
12.		Maharashtra	RInfra	215	183
13.			MSEDCL	271	184
14.	**Southern Region**	Telangana	TSSPDCL	341	166
15.		Andhra Pradesh	APSPDCL	398	179
16.		Karnataka	BESCOM	223	159
17.		Tamil Nadu	TANGEDCO	274	200
18.	**Eastern Region**	Bihar	NBPDCL	173	153
19.			SBPDCL	184	167

[72] Table 4.10 provides shortened names of the licensees commonly used; full names are available in the List of Abbreviations.

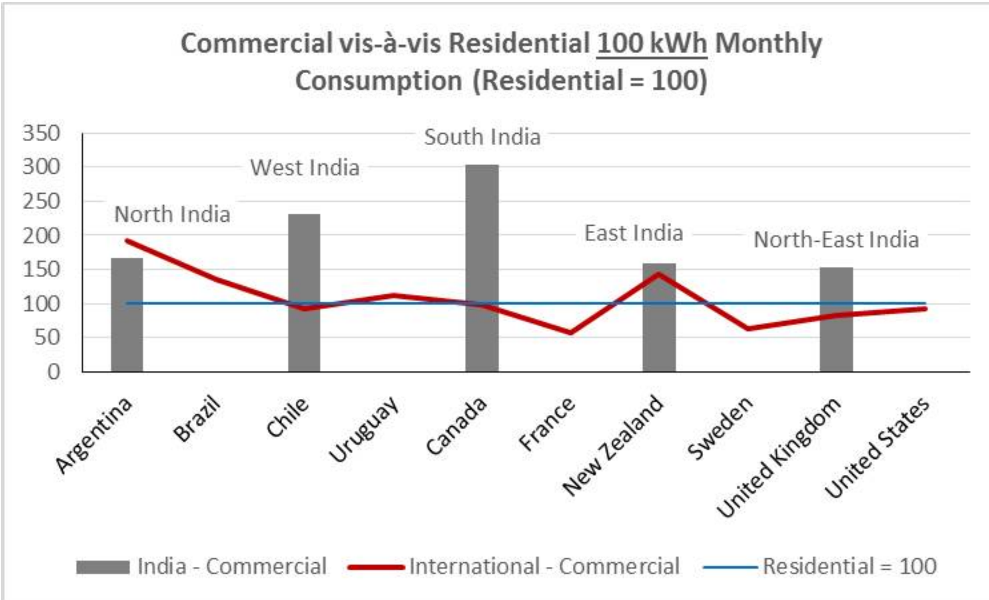
Sl. No.	Region	State	Licensee[72]	Commercial vis-à-vis Residential 100 kWh monthly consumption (Residential = 100)	Commercial vis-à-vis Residential 300 kWh monthly consumption (Residential = 100)
20.		Jharkhand	JBVNL	223	226
21.		Odisha	CESU	177	145
22.		West Bengal	WBSEDCL	134	118
23.			CESC	142	121
24.	**North-Eastern Region**	Assam	APDCL	157	131
25.		Tripura	TSECL	131	126

Source: Present study, details in Exhibit 3.

The position after more than 12 years of mandated tariff rationalisation is that **commercial tariff is higher than residential tariff in all cases**. In Andhra Pradesh, commercial is at 3.98 times residential tariff (seen against 100 kWh monthly consumption) and in Jharkhand, it is at 2.26 times residential tariff (against 300 kWh monthly consumption).

Indian region-wise average pictures are also presented in Figure 4.6 and Figure 4.7, by comparing against the international position, in an indexed format. Residential tariff is considered as 100.

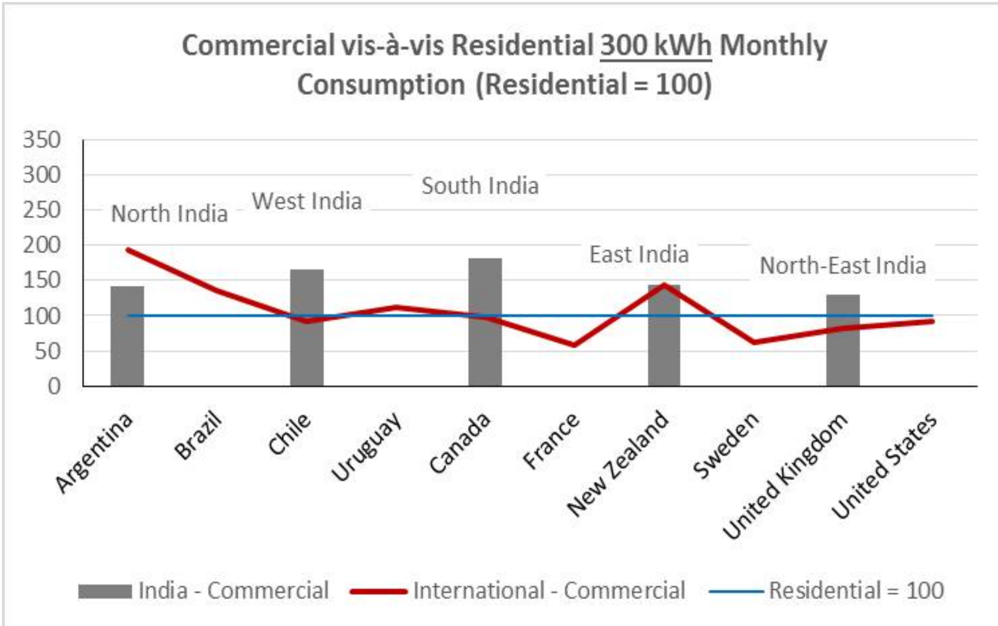
Figure 4.6: Commercial Tariff position of Indian Regions and International Countries: Against Residential 100 kWh Monthly Consumption



Source: International Countries from Introduction: International comparisons of electricity regulation (Gilbert, Kahn, & Newberry, 1996), Indian position arrived at through present study, details in Exhibit 3.

Figure 4.6 exhibits the extent of difference between residential tariff at 100 kWh monthly consumption point and commercial tariff. South India is distinctly higher than the other regions. North, East and North-east India are in a comparatively better position from the aspect of tariff rationalisation. Notably, international picture does not reflect commercial tariff to be necessarily lower than residential tariff, though the deviations from residential tariff are significantly less.

Figure 4.7: Commercial Tariff position of Indian Regions and International Countries: Against Residential 300 kWh Monthly Consumption



Source: International Countries from Introduction: International comparisons of electricity regulation (Gilbert, Kahn, & Newberry, 1996), Indian position arrived at through present study, details in Exhibit 3.

Against monthly consumption point of 300 kWh residential tariff vis-à-vis commercial tariff, Figure 4.7 exhibits that the difference lies only in the extent of deviation in comparison with Figure 4.6 and broadly reflects the same trend.

Another comparison has been made to arrive at the range of deviations. Table 4.11 represents the findings in an indexed format for the latest available year under consideration for the highest tariff in comparison with the lowest tariff in India.

Table 4.11: Indexed Comparison of Highest Tariff with the Lowest Tariff in 2015-16

Sl. No.	Region	State	Licensee[73]	Highest Tariff vis-à-vis Lowest Tariff after Subsidy (Lowest Tariff = 100)	Highest Tariff vis-à-vis Lowest Tariff before Subsidy (Lowest Tariff = 100)
1.	**Northern Region**	Delhi	BRPL	569	569
2.		Haryana	DHBVNL	14413	372
3.		Himachal Pradesh	HPSEBL	515	231
4.		Punjab	PSPCL	*Lifeline Nil* [highest tariff Rs.14.09]	310
5.		Rajasthan	JVVNL	323	163
6.		Uttar Pradesh	MVVNL	715	633
7.		Uttarakhand	UPCL	362	362
8.	**Western Region**	Chhattisgarh	CSPDCL	381	382
9.		Gujarat	TPL-Ahmedabad	248	248
10.			MGVCL	266	266
11		Madhya Pradesh	Central Discom	264	264
12.		Maharashtra	RInfra	670	670
13.			MSEDCL	1406	1406
14.	**Southern Region**	Telangana	TSSPDCL	* [highest tariff Rs. 617]	745
15.		Andhra Pradesh	APSPDCL	* [highest tariff Rs. 614]	873
16.		Karnataka	BESCOM	* [highest tariff Rs.318]	378
17.		Tamil Nadu	TANGEDCO	* [highest tariff Rs.971]	370
18.	**Eastern**	Bihar	NBPDCL	815	711

[73] Table 4.11 provides shortened names of the licensees commonly used; full names are available in the List of Abbreviations.

Sl. No.	Region	State	Licensee[73]	Highest Tariff vis-à-vis Lowest Tariff after Subsidy (Lowest Tariff = 100)	Highest Tariff vis-à-vis Lowest Tariff before Subsidy (Lowest Tariff = 100)
19.	Region		SBPDCL	815	762
20.		Jharkhand	JBVNL	1550	1550
21.		Odisha	CESU	270	270
22.		West Bengal	WBSEDCL	241	234
23.			CESC	208	208
24.	North-Eastern Region	Assam	APDCL	330	236
25.		Tripura	TSECL	199	190

*Lowest Tariff is Nil (Agricultural Tariff), being fully subsidised by the respective State Governments

Source: Present study, details in Exhibit 3.

The above table illustrates the unsatisfactory tariff situation prevailing in India. Even without considering subsidy, **the outlier of highest tariff is at 155 times the lowest tariff** (Jharkhand). There are quite a few instances of the **highest tariff being 7-8 times the lowest tariff**. Once subsidy is considered, the ratio yields **non-mathematical results in quite a few cases as the lowest tariff is zero** (Punjab, Telangana, Andhra Pradesh, Karnataka, Tamil Nadu – the political situation in the South Indian states also becomes apparent, as the States practice profligacy at the cost of economic prudence or consistently follow a policy of high subsidy in popular interest). Tariff rationalisation with focus on cost-of-supply as a vision, doesn't quite exist.

In this context, whether cost-of-supply based tariff structure is at all strictly achieved / achievable, is also a question which is coming up in the course of this research, which needs elaboration. It has been noted in a treatise on international comparison of electricity regulation (Gilbert, Kahn, & Newberry, 1996) that electricity industry in all countries respond to the elastic demands of industrial consumers by pricing their service below rates charged to others. **Overall pricing policy does not reflect Ramsey principles as the commercial consumers appear to cross-subsidise others**. The burden of capital recovery of fixed costs is largely borne by small customers, particularly commercial firms. **Residential customers typically benefit to some degree from their collective political influence**. As an illustration, data has been furnished with the study to indicate that the ratio of industrial tariff and residential tariff is less than one in 14 countries viz. Argentina, Brazil, Chile, Uruguay, Canada, France, Germany, Japan, Sweden, U.K., U.S.A and Yugoslavia and greater than one only in New Zealand (1990). However, comparing commercial with residential, the ratio is more than one in Argentina, Brazil, Uruguay and New Zealand, less than one in Chile, Canada, France, Sweden, U.K., U.S.A. and Yugoslavia with data for Germany and Japan not being available (1990). Thus, **there is apparent cross subsidisation and the commercial class appears to bear a disproportionate burden in most countries**. While economic needs to keep industrial rates relatively close to marginal rates is internationally accepted, it is also recognised that politically it is useful to provide some subsidies to residential customers. This financial burden devolves upon the commercial customers.

Similarly, a study for U.K. covering the period 1948-49 to 1988-89 (Newbery & Green, 1996), exhibited that industrial tariff was the lowest. But the **commercial consumers, who had a lower cost than smaller residential consumers**, had a higher tariff for the first 25 years of the study. This difference between commercial and residential segments, declined over time and disappeared after 1974-75. Even then, some protection was afforded to the small consumers.

Contextually, it may be mentioned that the Economic Survey of 2015-16 is presenting a case for cross-subsidisation **only within the residential category** with higher cost being loaded upon higher consumption (with price inelasticity), relieving burden on industry as well as making tariff simple and transparent (Ministry of Finance, Government of India, 2016). This view is presently neither reflected in the legislation nor the judicial pronouncements, or a policy directive (to be effective, needs to be made mandatory upon the States; however, this might require a legislative framework as the power to issue policy directives by the Central Government to the State / State regulators is presently not available under the 2003 Act on this "Concurrent List" item of electricity, as discussed earlier).

Considering the magnitude of the problem of India, the extent of cross-subsidisation should come through informed policies to serve best the interest of the various stakeholders. Straying from the cost-of-supply regime, if the policies so dictate, should be a conscious step, backed by definite and transparent reasoning. At present, the exit policies are largely coming through the Central Act and subservient policies at Central level, whereas the subsidy policies are dealt with at the State levels, with significant divergence. Need for a central policy structure on subsidy / cross-subsidy seems to be a necessary ingredient for sustainability of the sector, through appropriate legislation, as also has been corroborated through literature survey.

4.4 ASSESSMENT OF COST-OF-SUPPLY THROUGH DEVELOPMENT OF A MODEL AND ESTIMATION OF REALISTIC CROSS-SUBSIDY WITH A SUGGESTIVE APPROACH ON ADDRESSING THE WELFARE ISSUES OF SERVING THE VULNERABLE SEGMENTS: OBJECTIVE 3

4.4.1 Cost-of-Supply Model

The theory of cost approach to pricing is available in literature (Conkling, 2011). The theory also recognises that allocation principles are not an exact science (U.S. Supreme Court acknowledges it as well). Also, it has been seen historically that allocation theories have developed sometimes with a view to increasing proportion of demand-related costs, thereby preserving the commodity in scarcity conditions and at other times, by lowering proportion of demand-related costs, to popularise sale of the commodity. Moreover, for demand-related cost allocation, both co-incident and non-co-incident peak demand responsibilities have found favour with the regulators at various historical points of time.

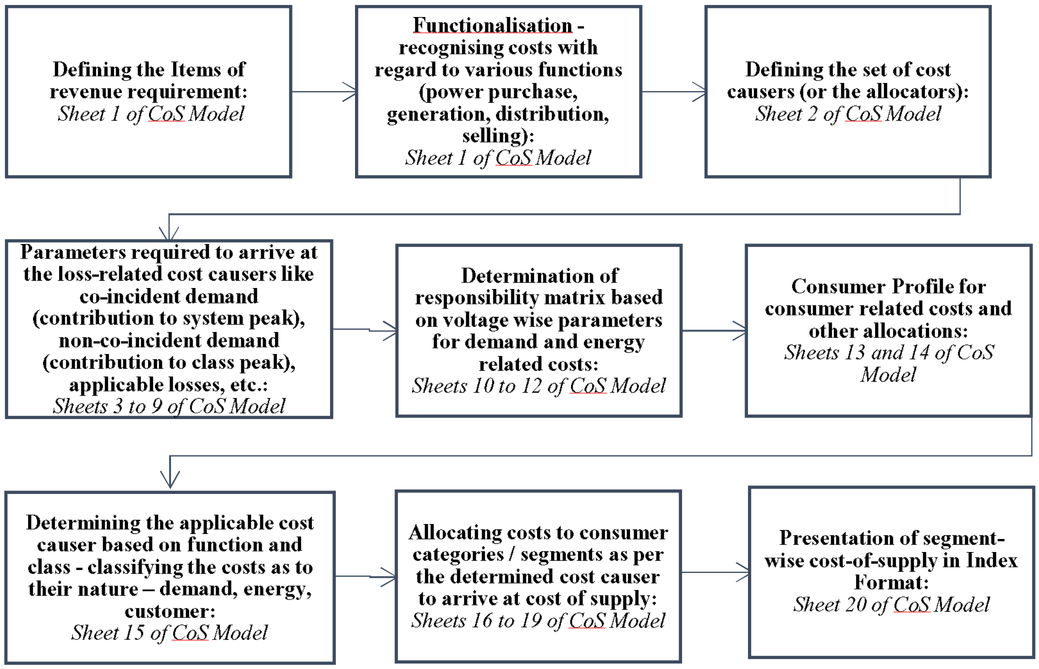
Considering these realities, the cost allocators have been defined with an appropriate combination of both co-incident peak i.e. contribution to system peak and non-co-incident peak i.e. class peak. For fixed and variable cost allocation, an allocation principle has been adopted (in principle, accepting the rationale behind the "Seaboard formula", with modifications). In India as well, the methodology is acknowledged (The Energy and Resources Institute and Dhiya Consulting Private Limited, 2010); paucity of data creates the difficulty in determination of an acceptable number, so simplified models are adopted (Forum of Regulators assisted by PricewaterhouseCoopers Private Limited, 2015).

The cost-of-supply model (CoS Model) with intra category segmentation, has been developed on the basis of real data of a utility, with consideration of voltage level-wise costs based on actual loss levels. Pertinent worksheets of the CoS Model in Excel are in Table 4.12 to Table 4.31. The model is based on independent load curves for all important tariff categories. HT categories have extensive coverage. Load curves for LT categories are based on detailed representative data. The comprehensive load curves are furnished through **Exhibit 4**. Flexibilities have been built into the Excel model to accept changes in allocators. Thus, the CoS Model is not inextricably linked with a specific choice of allocation, but has the robustness to adapt to changing circumstances. The model is replicative; it can accommodate both a different set of parameters and different choice of allocators to derive cost of supply for any given situation. Thus, while the principles of "Seaboard formula" have been adopted, any of the four formulae (discussed in 2.9.1) can be applied by changing the allocators, depending on choice and circumstances.

The CoS Model has been externally validated by experts in the field. The Administrative Staff College of India, Hyderabad, Mr. Rakesh Nath, former member of the Appellate Tribunal for Electricity and former Chairman, Central Electricity Authority and Dr. Geeta Gouri, former member of the Competition Commission of India are the experts who validated the model. The details are in **Exhibit 5**.

The structure of the Excel model, following the Research Methodology outlined in Chapter 3, is given in Diagram 4.1.

Diagram 4.1: Structure of Cost-of-Supply Model in Excel



Elements of the CoS Model and building process (model with real data for 2015-16 for the chosen utility) are as follows.

Table 4.12: Cost Functionalisation: Identifying Items of Revenue Requirement and Allocating Costs to the Functions: Sheet 1 of CoS Model:

- Items of revenue requirement (costs of service) are identified (from tariff order in the exhibited model, can be built up from any reliable accounting / cost record source). All operational costs, selling costs, capital servicing and finance related costs, return, taxes, appropriations etc. are recognised for this purpose.

- Revenue requirement (costs) are segregated into power purchase, generation, distribution and selling functions (also, transmission, if the function exists). Further, distribution-related costs are sub-divided into sub-categories based on voltage level of supply. The categories for the exhibited model are a) expenses upto 33 KV voltage level, b) expenses between 33 KV and 6 KV voltage level and c) expenses in the LT level. This bifurcation may need some allocation / pro-ration of joint or common costs across functions. Cost auditing data usually meets with this criterion.

Table 4.13: Cost Allocators: Basis for Classification of Cost: Sheet 2 of CoS Model:

- Service incurs costs primarily due to three major cost causers / allocators viz. a) demand, b) energy and c) number of consumers. Cost causers / allocators are defined at this level. Certain costs are related to a particular allocator and some are related to a combination of two or more allocators. This sheet lists out the possible allocators. The final choice of the specific allocator to use is left for a later stage (with freedom to choose any of the identified allocators, which allows tailoring of the CoS Model to meet specific needs).

Table 4.14 to **Table 4.20**: Parameters to arrive at cost allocators: applicable losses, peak load contribution and other operating data, through the following tables:

- **Table 4.14: System Loss Data: Loss at Each Voltage Level as Percentage of System Input (in MU): Sheet 3 of CoS Model**
- **Table 4.15: Determination of Average Loss Responsibility: Sheet 4 of CoS Model**
- **Table 4.16: Determination of Peak Loss Responsibility: Sheet 5 of CoS Model**
- **Table 4.17: Average Loss Allocation: Computing Average Losses for Each Voltage at Responsibility Level: Sheet 6 of CoS Model**
- **Table 4.18: Peak Loss Allocation: Computing Peak Losses for Each Voltage at Responsibility Level: Sheet 7 of CoS Model**

- **Table 4.19: Peak Load Contribution: Derivation of Co-incident Peak Demand: Each Category's Contribution to System Peak: Sheet 8 of CoS Model**

- **Table 4.20: Operating Data for Demand & Energy: For Allocation before Loss Gross Up: Sheet 9 of CoS Model**

  - Parameters which form the base of the loss-related cost allocators are ascertained. Such parameters are average loss, peak loss, system peak (co-incident peak demand), class peak (non-co-incident peak demand), peak contribution factor, system load factor.

  - Average technical loss is required to be computed for each voltage level separately. On the basis of such losses and details of commercial losses, voltage level-wise responsibility of average losses are arrived at.

  - Peak losses are based on loss load factor, computed through an empirical formula, on the basis of system load factor. Thus, peak loss responsibility for each voltage level is arrived at.

  - For each consumer category, load factor and class peaks are derived on the basis of load curves for a stable period of consumption. Class peak for each consumer category is determined based on annual sales and computed load factors.

  - Demand contribution of each consumer category to the overall system peak demand is determined to arrive at the peak co-incident demand.

  - Important products derived from these computation are level-wise average loss (to be used for deriving energy responsibility) and level-wise peak loss (to be used for ascertaining demand responsibility).

Table 4.21 to **Table 4.23**: Determination of responsibility matrix based on voltage wise parameters for demand and energy related costs, through the following tables:

- **Table 4.21: Loss Responsibility Matrix for Energy Responsibility: Grossing Annual Consumption with Average Losses and Arriving at Energy Responsibility for Each Consumer Category: Sheet 10 of CoS Model**
- **Table 4.22: Loss Responsibility Matrix for Demand Responsibility: Grossing Class Peak with Peak Losses and Arriving at Demand Responsibility for Each Consumer Category: Sheet 11 of CoS Model**
- **Table 4.23: Allocation of Loss Responsibility: Overall Matrix for Energy and Demand Responsibility: Sheet 12 of CoS Model**
    - Annual consumption of all consumer categories are grossed up with average losses to ascertain the energy responsibility for each consumer category.
    - Similarly, class peak for consumer categories are grossed up with peak losses to arrive at the demand responsibility for each consumer category, at lower than 33 KV voltage level.
    - Peak contribution based on system peak is also derived consumer category-wise, for responsibility at 33 KV voltage level.
    - At the end of this step, a comprehensive voltage level-wise matrix for energy and demand responsibility is formed covering the overall consumer base of the licensee.

Table 4.24 to **Table 4.25**: Consumer related cost allocation: consumer profile, number of consumers, through the following tables:

- **Table 4.24: Number of Consumers: For Consumer Related Cost Allocation: Sheet 13 of CoS Model**
- **Table 4.25: Consumer Profile: Segment-wise Details (number of consumers in each slab for the segmented categories and corresponding sales): Sheet 14 of CoS Model**
    - Consumer details are necessary for eventual cost allocation of the consumer related costs. Consumer profile comprising segment-wise details on annual consumption and number of consumers is prepared from database. Percentage contribution of each consumer-class to the overall consumer base is computed.

Table 4.26: Cost Classification: Classifying Cost among Three Cost Inducers: Sheet 15 of CoS Model:

- Cost, which had been functionalised in Table 5.1 into power purchase, generation, level-wise distribution and selling functions, is further segregated into demand, energy and consumer based classifications through use of the chosen cost causer, determined on the basis of function and class; there is freedom of choice in selection of the cost causer (built-in through the model). This flexibility allows different formulae on cost-of-supply to be applied by simply changing the choice of cost causer. **This makes the model replicable and amenable to application in different scenarios and the allocations proposed through any of the four formulae, as chosen, or variations / combinations of the same can be accommodated (the Seaboard formula, the United formula, Modified Fixed-Variable (MFV) formula and the Straight Fixed-Variable (SFV) formula discussed in paragraph 2.9.1).**

- All costs are thus classified through use of the chosen cost causer. Suitable mix factors are applied to allocate cost items amongst the applicable cost causers for those cost items which are related to a combination of cost causers, generally following the Seaboard formula. Generation related costs (demand-based portion) are largely driven by co-incident peak contribution and distribution costs are majorly class peak driven.

Table 4.27 to **Table 4.30**: Allocating costs to consumer categories as per determined cost causer, through the following tables:

- **Table 4.27: Cost Allocation: Category-wise Allocation of Costs: Sheet 16 of CoS Model**
- **Table 4.28: Cost Allocation: Intra-category or Segment-wise Cost Allocation: Sheet 17 of CoS Model**
- **Table 4.29: Derivation of Cost of Supply: In Paise per kWh: Sheet 18 of CoS Model**
- **Table 4.30: Additional Derivation: Voltage Level Wise Costs: Sheet 19 of CoS Model**
    - Costs are allocated to the consumer categories as well as into segments (i.e. intra-category, as applicable) on the basis of applicable cost causer to ascertain demand-based, energy-based and consumer-based costs.
    - Costs are aggregated to arrive at the final computed cost for each consumer category and accordingly cost of supply is derived.
    - Also, voltage level-wise costs may be derived considering the cost classification as appropriate.

Table 4.31: Cost of Supply Index: Presentation in Index Format vis-à-vis Average Tariff: Sheet 20 of CoS Model

- Following determination of cost-to-serve for each consumer segment, the matrix is presented in index format, expressed as a percentage of average cost-of-supply.

CoS Model follows.

Table 4.12: Cost Functionalisation: Identifying Items of Revenue Requirement and Allocating Costs to the Functions

(in Rs. Lakhs)

	As per Tariff Order					Allocation of Distribution Expenses		
Sl. No.	**Head of Accounts**	**Generation**	**Selling**	**Distribution**	**Total**	**Expenses upto 33 KV**	**Expenses < 33 KV to 6 KV**	**Expenses LT**
1	Employee Cost	13249	13642	45110	72001	4962	9924	30224
2	Contracted Manpower	3460	0	0	3460			
3	Water Charges	225	0	0	225			
4	Coal and Ash Handling Charges	1515	0	0	1515			
5	Operation and Maintenance Expenses	14808	4002	27432	46242	5114	8786	13532
6	Rent	21	0	0	21			
7	Rates & Taxes	575	51	216	842	40	69	107
8	Insurance	667	26	278	971	52	89	137
9	Lease Rental	270	48	793	1111	148	254	391
10	Cost of Outsourcing	0	950	0	950			
11	Interest on Capital Borrowings	6163	1383	24715	32261	4608	7915	12192
12	Temporary accommodation	1161	1341	653	3155	122	209	322
13	Interest on Security Deposit	0	9322	0	9322			
14	Other Finance Charges	397	459	224	1080	42	72	110
15	Bad Debts	0	2674	0	2674			
16	Depreciation	9694	2136	23250	35080	4335	7446	11469
17	Advance against Depreciation	4148	914	9949	15011	1855	3186	4908
18	Written off Intangible Assets	21	4	47	72	9	15	23
19	Service Tax / Entry Tax	0	0	1103	1103	206	353	544
20	Returns	18835	2334	33620	54789	6268	10768	16585
21	Income Tax	3766	467	6725	10958	1254	2154	3318
22	**Gross Fixed Charges (1 to 21)**	**78975**	**39753**	**174115**	**292843**	**29013**	**51241**	**93862**
23	Less: Income from Non-Tariff Sources	706	0	7563	8269	1410	2422	3731
24	Less: Benefits passed on to consumers for Auxiliary Services	0	0	100	100	0	0	100
25	Less: Income from Other Business	0	0	440	440	73	129	238
26	**Total Deductions (23 to 25)**	**706**	**0**	**8103**	**8809**	**1483**	**2551**	**4069**
27	**Net Fixed Charge for the year 2015-16 (22-26)**	**78269**	**39753**	**166012**	**284034**	**27530**	**48689**	**89793**
28	**Variable Cost**	**193062**	**174747**	**0**	**367809**			
29	**Annual Revenue Requirement (ARR) (27+28)**	**271331**	**214500**	**166012**	**651843**	**27530**	**48689**	**89793**
	True-up Flow 2011-12	675	139	108	921	18	32	58
	True-up Flow 2012-13	3104	2196	1700	7000	282	499	919
	Overall ARR	275110	216835	167820	659764	27830	49219	90771

Sheet 1 of CoS Model.

Table 4.13: Cost Allocators: Basis for Classification of Cost

			Related to							
Classification Base	**Options**	**Mix Factors**	**Demand of All**	**Demand < 33 KV**	**Demand LT**	**Energy of All**	**Energy < 33 KV**	**Energy LT**	**Number of Consumers**
Demand	1		100%						
Demand	2			100%					
Demand	3				100%				
Energy	4					100%			
Energy	5						100%		
Energy	6							100%	
Consumer	7								100%
System Load Factor	8	62%	38%			62%			
Long Term Power Purchase Load Factor	9	72%				72%			
Employee Base	10	82%	82%			18%			
Demand Energy Mix	11	50%	50%			50%			
Demand Energy Mix	12	50%		50%			50%		
Demand Energy Mix	13	50%			50%			50%	
Demand Consumer Mix	14	90%			90%				10%
Operation Base	15		23%	2%	5%	64%	2%	5%	0%
Expense Base - Generation	16		29%			71%			
Expense Base - Distribution	17		76%			24%			
Expense Base - Distribution	18			75%			25%		
Expense Base - Distribution	19				70%			30%	

Sheet 2 of CoS Model.

Table 4.14: System Loss Data: Loss at Each Voltage Level as Percentage of System Input (in MU)

System Data	In MU	
Input to 220/132 KV		
Long Term Import (Gross)	318.722	
Supplemental Import	4494.777	
Major station sent out	5327.271	
Input from 33 KV, UI, less export	-63.164	
Overall	**10077.605**	
		System Input:
Output to 33 KV from 220/132 KV	9909.204	**11058**
Overall	**9909.204**	**1.52%**
Input to 33 KV		
From 132 KV	9909.204	
From other station sent out (except Major)	1080.816	
To 132 KV	100.190	
Overall	**10889.830**	
Output from 33 KV		
Sale to 33 KV consumers	628.998	
Total	628.998	
Lower voltage supply	10124.480	
Overall	**10753.478**	**1.23%**
Input to 20/11/6 /3.3 KV	10124.480	
Output		
Sale to 20/11/6/3.3 KV consumers	2425.012	
Output to LT	7433.879	
Total	**9858.891**	
		2.40%
Lower voltage supply		
Input to lower voltage	7433.879	
Sale to LT consumers	6406.318	
Company's premises consumption	16.500	
Overall	**6422.818**	**9.14%**

Sheet 3 of CoS Model.

Table 4.15: Determination of Average Loss Responsibility

a): *Average Loss Responsibility: Percentage-wise*

		Commercial Loss Responsibility				Technical Loss Responsibility								
Voltage Levels	**Sales (MU)**	**Commercial Loss as % of Overall System**	**Commercial Loss Responsibility Factor**	**Commercial Loss (MU)**	**Consumption responsible for Technical Loss**	**Technical Loss as % of Overall System**	**Upto 33 KV (MU)**	**< 33 KV to 6 KV (MU)**	**From LT (MU)**	**Overall Technical loss (MU)**	**Overall System Units (MU)**	**Commercial Loss %**	**Technical Loss %**	**Overall Loss %**
A	B	C	D	E=C*System Units	F=B+E	G	H	I	J	K=H+I+J	L=F+K	M=E/L	N=K/L	O=M+N
33 KV	673	0.0%	0%	-	673	2.76%	19			19	692	0.00%	2.76%	2.76%
<33 KV to 6 KV	2384	0.0%	0%	-	2384	2.40%	69	64		134	2518	0.00%	5.32%	5.32%
LT	6420	4.1%	100%	452	6872	5.06%	216	201	559	977	7849	5.76%	12.44%	18.20%
Overall	**9477**	4.1%	**100%**	**452**	**9929**	**10.21%**	**305**	**265**	**559**	**1130**	**11058**	**4.09%**	**10.21%**	**14.30%**

b): *Average Loss Responsibility: Unit-wise*

Voltage Levels	**Overall**	**Upto 33 KV Level**	**Upto 6 KV Level**	**LT Level**
Supply for sales upto 33 KV (MU)		692		
Supply for sales below 33 KV upto LT (MU)		2518	2448	
Supply for sales at LT		7849	7632	
System Input (MU)		11058	10081	7431
Consumption responsible for Technical Loss (MU)	9929	673	2384	6872
Technical Loss Units	1130	305	265	559
Voltage-wise Loss %		2.76%	2.63%	7.53%
Next level supply (MU)		10081	7431	
Loss Units allocated to 33 KV sales (MU)	19	19		
Loss Units allocated to sales upto 6 KV (MU)	134	69	64	
Loss Units allocated to LT sales (MU)	977	216	201	559

Sheet 4 of CoS Model.

Table 4.16: Determination of Peak Loss Responsibility

a) : *Peak Loss Responsibility: Parameters*

Licensee System Load Factor	62%
Coefficient for Loss Load Factor	0.3
Loss Load Factor	45%

b): *Peak Loss Responsibility: Percentage-wise*

Voltage Levels	Consumer Demand	Demand grossed for Commercial Loss	Level-wise Peak Technical Loss %	Input at 33 KV	Input at 6 KV	Input at LT	Peak Demand Loss	
	MW	MW	%	MW	MW	MW	MW	
To 33 KV Demand	139	139	3.76%	144				
To 6 KV Demand	637	637	3.27%	687	661			
To LT Demand	1599	1668	6.90%	2008	1933			
Voltage-wise Demand	2375	2443	13.93%	2839	2594	1863		
Loss MW				107	93	196		
To 33 KV Demand				5			5	
To 6 KV Demand				26	24		50	
To LT Demand				76	69	196	341	
Voltage-wise MW				139	637	1668		2839
Voltage-wise Loss %				**3.76%**	**3.58%**	**10.51%**		

c): *Peak Loss Responsibility: Unit-wise*

Voltage-wise category	Upto 33 KV (MW)	< 33 KV to 6 KV (MW)	At LT (MW)	Overall Loss (MW)	Overall Peak Demand (Input Level) (MW)	Overall Loss %
Upto 33 KV	5			5	144	**4%**
<33 KV to 6 KV	26	24		50	687	**7%**
LT	76	69	196	341	2008	**17%**
Overall	**107**	**93**	**196**	**396**	**2839**	**13.93%**

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Table 4.17: Average Loss Allocation: Computing Average Losses for Each Voltage at Responsibility Level

	As % of Overall System		Sales Mix	At Responsibility Levels		Allocation Basis	
Voltage Levels	Technical	Commercial		Technical	Commercial	Technical	Commercial
132 KV	1.52%	0.00%					
33 KV	1.23%	0.00%	7%	0.17%	0.00%	2%	0%
Next upto 6 KV	2.40%	0.00%	26%	1.21%	0.00%	12%	0%
LT	5.06%	4.09%	68%	8.83%	4.09%	86%	100%
Overall	**10.21%**	**4.09%**		**10.21%**	**4.09%**		
Percentage effect	71%	29%					

Peak Losses %

Overall System Unit (Gross)	11058.7	MU
Maximum System Demand	2035.0	MW
System Load Factor	61.9%	
Coefficient assumed	0.30	
Loss Load Factor	0.45	
System Units	11058.7	
Total Loss of units	1581.4	MU

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Table 4.18: Peak Loss Allocation: Computing Peak Losses for Each Voltage at Responsibility Level

	As % of Overall System Input		Demand Mix	At Responsibility Levels		Allocation Basis	
Voltage Levels	Technical	Commercial		Technical	Commercial	Technical	Commercial
132 KV	2.08%	0.00%					
33 KV	1.68%	0.00%		0.19%	0.00%	1%	0%
6 KV	3.27%	0.00%		1.74%	0.00%	13%	0%
LT	6.90%	4.09%		12.00%	4.09%	86%	100%
Overall	**13.93%**	**4.09%**		**13.93%**	**4.09%**		

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Table 4.19: Peak Load Contribution: Derivation of Co-incident Peak Demand: Each Category's Contribution to System Peak

	Nature of Supply with Voltage Consideration	Annual Sales	Co-incident Demand of the Study Data with System Peak	Loss	Co-incident Demand Responsibility	Co-incident Demand @ Overall Utility Peak	Peak Contribution in %
		MU	MW	MW	MW	MW	
		A	**B**	**C**	**D**	**E**	**F**
LT Consumers	LT Residential Lifeline	24	0.0024	0	4	3	0%
	LT Residential	4000	11	13	895	751	37%
	LT Commercial	1186	58	70	439	368	18%
	LT Industrial	822	51	61	194	163	8%
	LT Public Bodies	63	6	7	20	17	1%
	LT Public Lighting	245	53	64	64	54	3%
	LT Public Water Works, Municipal, Government School, Private Educational Institutions	61	4	5	20	17	1%
	LT Short Term Supply	6	0.0014	0	1	1	0%
	Overall LT	**6406**	**183**	**221**	**1637**	**1373**	**67%**
HT Consumers	HT 33 KV other than Traction	517	69	72	88	88	4%
	HT Metro Railway	112	23	24	30	30	1%
	HT Industrial below 33 KV	1084	160	172	182	182	9%
	HT Commercial below 33 KV	643	167	180	204	204	10%
	HT Residential and HT Co-operative Housing Societies	346	79	85	109	109	5%
	HT Tramways	4	1	1	1	1	0%
	HT Public Water Works and Public Utility	278	29	32	33	33	2%
	HT Construction Power, Private Educational Institutions, HT Sports Complex and Auditorium	27	7	7	7	7	0%
	Overall HT	**3009**	**541**	**579**	**654**	**654**	**32%**
	HT Supply to another Licensee	41	7	8	8	**8**	0%
	Overall	**9457**	**725**	**800**	**2299**	**2035**	**100%**

Voltage-wise Category	Overall Loss %
Upto 33 KV	4%
< 33 KV to 6 KV	7%
LT	17%
Overall	**13.93%**

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Table 4.20: Operating Data for Demand & Energy: For Allocation before Loss Gross Up

	Nature of Supply with Voltage Consideration	Load Factor	Class Peak	Sales	Peak Contribution Factor	Contribution to Peak
		%	MW	MU	%	MW
LT Consumers	LT Residential Lifeline	33%	8	24	0%	3
	LT Residential	50%	911	4000	37%	751
	LT Commercial	37%	365	1186	18%	368
	LT Industrial	45%	208	822	8%	163
	LT Public Bodies	36%	20	63	1%	17
	LT Public Lighting	46%	61	245	3%	54
	LT Public Water Works, Municipal, Government School, Private Educational Institutions	28%	25	61	1%	17
	LT Short Term Supply	45%	2	6	0%	1
	Overall LT		**1599**	**6406**	**67%**	1373
HT Consumers	HT 33 KV other than Traction	65%	91	517	4%	88
	HT Metro Railway	39%	38	112	1%	30
	HT Industrial below 33 KV	55%	224	1084	9%	182
	HT Commercial below 33 KV	33%	222	643	10%	204
	HT Residential and HT Co-operative Housing Societies	33%	118	346	5%	109
	HT Tramways	37%	1	4	0%	1
	HT Public Water Works and Public Utility	50%	63	278	2%	33
	HT Construction Power, Private Educational Institutions, HT Sports Complex and Auditorium	35%	9	27	0%	7
	Overall HT		**766**	**3009**	**32%**	**654**
	HT Supply to another Licensee	49%	10	41	0%	8
			2375	**9457**	**100%**	**2035**
	Maximum overall MW Met					**2035**

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Table 4.21: Loss Responsibility Matrix for Energy Responsibility: Grossing Annual Consumption with Average Losses and Arriving at Energy Responsibility for Each Consumer Category

				Technical Loss Allocation		Commercial Loss Allocation		Overall Loss Allocation		Allocation for All		< 33 KV	Only LT
	Nature of Supply with Voltage Consideration	Sales (MU)	Mix %	Loss (MU)	Mix %	Loss (MU)	Mix %	Loss (MU)	Mix %	Sales (MU)	Mix %	Mix %	Mix %
LT Consumers	LT Residential Lifeline	24	0%	4	0%	2	0%	5	0%	29	0%	0%	0%
	LT Residential	4000	42%	610	54%	282	62%	892	56%	4892	44%	47%	62%
	LT Commercial	1186	13%	181	16%	84	19%	264	17%	1450	13%	14%	19%
	LT Industrial	822	9%	125	11%	58	13%	183	12%	1005	9%	10%	13%
	LT Public Bodies	63	1%	10	1%	4	1%	14	1%	77	1%	1%	1%
	LT Public Lighting	245	3%	37	3%	17	4%	55	3%	300	3%	3%	4%
	LT Public Water Works, Municipal, Government School, Private Educational Institutions	61	1%	9	1%	4	1%	14	1%	75	1%	1%	1%
	LT Short Term Supply	6	0%	1	0%	0	0%	1	0%	8	0%	0%	0%
	Overall LT	**6406**	**68%**	**977**	**86%**	**452**	**100%**	**1428**	**90%**	**7835**	**71%**	**76%**	**100%**
HT Consumers	HT 33 KV other than Traction	517	5%	15	1%	0	0%	15	1%	531	5%		
	HT Metro Railway	112	1%	3	0%	0	0%	3	0%	115	1%		
	HT Industrial below 33 KV	1084	11%	61	5%	0	0%	61	4%	1145	10%	11%	
	HT Commercial below 33 KV	643	7%	36	3%	0	0%	36	2%	679	6%	7%	
	HT Residential and HT Co-operative Housing Societies	346	4%	19	2%	0	0%	19	1%	365	3%	4%	
	HT Tramways	4	0%	0	0%	0	0%	0	0%	4	0%	0%	
	HT Public Water Works and Public Utility	278	3%	16	1%	0	0%	16	1%	294	3%	3%	
	HT Construction Power, Private Educational Institutions, HT Sports Complex and Auditorium	27	0%	1	0%	0	0%	1	0%	28	0%	0%	
	Overall HT	**3009**	**32%**	**152**	**13%**	**0**	**0%**	**152**	**10%**	**3161**	29%	**24%**	
	HT Supply to another Licensee	41	0%	1	**0%**	**0**	0%	**1**		**43**	0%		
	Overall Sales	**9457**	**100%**	**1130**		**452**	**100%**	**1580**		**11038**	**100%**	**100%**	

Category	Overall Loss	Commer-cial Loss	Technical Loss
LT	18%	6%	12%
Upto 33 KV	3%	0%	3%
< 33 KV to 6 KV	5%	0%	5%

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Table 4.22: Loss Responsibility Matrix for Demand Responsibility: Grossing Class Peak with Peak Losses and Arriving at Demand Responsibility for Each Consumer Category

				Technical Loss Allocation		Commercial Loss Allocation		Overall Loss Allocation		Allocation for All		< 33 KV	Only LT
	Nature of Supply with Voltage Consideration	Class Peak (Demand MW)	Mix % w.r.t. Overall Demand	MW	Mix %	MW	Mix %	MW	Mix %	MW	Mix %	% Allocated	% Allocated
LT Consumers	LT Residential Lifeline	8	0%	2	0%	0	1%	2	0%	10	0%	0%	1%
	LT Residential	911	38%	194	49%	39	57%	233	50%	1143	40%	42%	57%
	LT Commercial	365	15%	78	20%	16	23%	93	20%	458	16%	17%	23%
	LT Industrial	208	9%	44	11%	9	13%	53	11%	261	9%	10%	13%
	LT Public Bodies	20	1%	4	1%	1	1%	5	1%	25	1%	1%	1%
	LT Public Lighting	61	3%	13	3%	3	4%	16	3%	77	3%	3%	4%
	LT Public Water Works, Municipal, Government School, Private Educational Institutions	25	1%	5	1%	1	2%	6	1%	32	1%	1%	2%
	LT Short Term Supply	2	0%	0	0%	0	0%	0	0%	2	0%	0%	0%
	Overall LT	**1599**	**67%**	**341**	**86%**	**68**	100%	**409**	**88%**	**2008**	**71%**	**75%**	**100%**
HT Consumers	HT 33 KV other than Traction	91	4%	4	1%			4	1%	94	3%		
	HT Metro Railway	38	2%	2	0%			2	0%	40	1%		
	HT Industrial below 33 KV	224	9%	17	4%			17	4%	242	9%	9%	
	HT Commercial below 33 KV	222	9%	17	4%			17	4%	239	8%	9%	
	HT Residential and HT Co-operative Housing Societies	118	5%	9	2%			9	2%	127	4%	5%	
	HT Tramways	1	0%	0	0%			0		1	0%	0%	
	HT Public Water Works and Public Utility	63	3%	5	1%			5	1%	68	2%	3%	
	HT Construction Power, Private Educational Institutions, HT Sports Complex and Auditorium	9	0%	1	0%			1	0%	9	0%	0%	
	Overall HT	**766**	**32%**	**55**	**14%**			**55**	**12%**	**821**	**29%**	**25%**	
	HT Supply to another Licensee	10	0%	0	0%			0	0%	10	**0%**		
	Overall Licensee	**2375**	**100%**	**396**	**100%**	**68**		**464**	**100%**	**2839**	**100%**	**100%**	

Category	Overall Loss
LT	20%
Upto 33 KV	4%
< 33 KV to 6 KV	7%

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Table 4.23: Allocation of Loss Responsibility: Overall Matrix for Energy and Demand Responsibility

		Energy Responsibiltiy			Demand Responsibiltiy		
	Nature of Supply with Voltage Consideration	**For All**	**< 33 KV**	**Only LT**	**For All**	**Upto HT**	**LT**
		On the basis of Percentage			On the basis of Peak Contribution	On the basis of Class Peak	
LT Consumers	LT Residential Lifeline	0%	0%	0%	0%	0%	1%
	LT Residential	44%	47%	62%	37%	42%	57%
	LT Commercial	13%	14%	19%	18%	17%	23%
	LT Industrial	9%	10%	13%	8%	10%	13%
	LT Public Bodies	1%	1%	1%	1%	1%	1%
	LT Public Lighting	3%	3%	4%	3%	3%	4%
	LT Public Water Works, Municipal, Government School, Private Educational Institutions	1%	1%	1%	1%	1%	2%
	LT Short Term Supply	0%	0%	0%	0%	0%	0%
	Overall LT	**71%**	**76%**	**100%**	**67%**	**75%**	**100%**
HT Consumers	HT 33 KV other than Traction	5%			4%		
	HT Metro Railway	1%			1%		
	HT Industrial below 33 KV	10%	11%		9%	9%	
	HT Commercial below 33 KV	6%	7%		10%	9%	
	HT Residential and HT Co-operative Housing Societies	3%	4%		5%	5%	
	HT Tramways	0%	0%		0%	0%	
	HT Public Water Works and Public Utility	3%	3%		2%	3%	
	HT Construction Power, Private Educational Institutions, HT Sports Complex and Auditorium	0%	0%		0%	0%	
	Overall HT	**29%**	**24%**		**32%**	**25%**	
	HT Supply to another Licensee	0%			0%	0%	
	Overall Licensee	**100%**	**100%**		**100%**	**100%**	

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Table 4.24: Number of Consumers: For Consumer Related Cost Allocation

Nature of Supply with Voltage Consideration	Number	% Allocated
LT Residential Lifeline	207064	7%
LT Residential	2369565	78%
LT Commercial	371157	12%
LT Industrial	64745	2%
LT Public Bodies	2623	0%
LT Public Lighting	17648	1%
LT Public Water Works, Municipal, Government School, Private Educational Institutions	2267	0%
LT Short Term Supply	3500	0%
Overall LT	**3038569**	**100%**
HT 33 KV other than Traction	16	0%
HT Metro Railway	4	0%
HT Industrial below 33 KV	585	0%
HT Commercial below 33 KV	560	0%
HT Residential and HT Co-operative Housing Societies	301	0%
HT Tramways	10	0%
HT Public Water Works and Public Utility	208	0%
HT Construction Power, Private Educational Institutions, HT Sports Complex and Auditorium	58	0%
Overall HT	**1742**	**0%**
HT Supply to another Licensee	1	0%
Overall number of consumers	**3040312**	**100%**

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Table 4.25: Consumer Profile: Segment-wise Details (number of consumers in each slab for the segmented categories and corresponding sales)

Nature of Supply with Voltage Consideration		Category Wise Sales (MU)	Average number in '000
LT Residential			
	Upto 60 kWh	275	758
	61-100 kWh	507	489
	101-150 kWh	703	444
	151-300 kWh	1316	506
	Above 300 kWh	1199	172
	LT Residential : Total	**4000**	**2370**
LT Commercial			
	Upto 60 kWh	52	191
	61-100 kWh	51	51
	101-150 kWh	57	37
	151-300 kWh	114	44
	Above 300 kWh	911	49
	LT Commercial : Total	**1186**	**371**
LT Industrial			
	Upto 500 kWh	88	44
	501-2000 kWh	169	14
	2001-3500 kWh	101	3
	Above 3500 kWh	463	4
	LT Industrial : Total	**822**	**65**

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Table 4.26: Cost Classification: Classifying Cost among Three Cost Inducers:

		Consumer Demand of			Consumer Energy of			(in Rs. Lakhs)			Consumer Demand of			Consumer Energy of				
Sr No.	Items	All	Below 33 KV only	LT only	All	Below 33 KV only	LT only	No. of consumers	Overall	Chosen Option	Demand of all	Demand < 33 KV	Demand LT	Energy of all	Energy < 33 KV	Energy LT	Number of Consumers	Classification
1. A)	Power Purchase cost	86041			88706				174747									
1.B)	**Cost of energy from own generation**																	
	Fuel Costs	-	-	-	193062	-	-	-	193062	4	0%	0%	0%	100%	0%	0%	0%	Energy
	Coal and Ash Handling Costs	-	-	-	1515	-	-	-	1515	4	0%	0%	0%	100%	0%	0%	0%	Energy
	Water Charges	-	-	-	225	-	-	-	225	4	0%	0%	0%	100%	0%	0%	0%	Energy
	Operation and Maintenance Expenses	7404	-	-	7404	-	-	-	14808	11	50%	0%	0%	50%	0%	0%	0%	Demand Energy Mix
	Other Opex excluding Employee Costs	632	-	-	632	-	-	-	1263	11	50%	0%	0%	50%	0%	0%	0%	Demand Energy Mix
	Employee Costs	8355	-	-	8355	-	-	-	16709	11	50%	0%	0%	50%	0%	0%	0%	Demand Energy Mix
	Interest on Capex	6163	-	-	-	-	-	-	6163	1	100%	0%	0%	0%	0%	0%	0%	Demand
	Short-term Loan and Finance Charges	-	-	-	1828	-	-	-	1828	4	0%	0%	0%	100%	0%	0%	0%	Energy
	Depreciation etc.	13863	-	-	-	-	-	-	13863	1	100%	0%	0%	0%	0%	0%	0%	Demand
	Reasonable Return	18835	-	-	-	-	-	-	18835	1	100%	0%	0%	0%	0%	0%	0%	Demand
	Income Tax	3766	-	-	-	-	-	-	3766	1	100%	0%	0%	0%	0%	0%	0%	Demand
	Less : Income and Benefits	(-) 204	-	-	(-) 502	-	-	-	(-) 706	16	29%	0%	0%	71%	0%	0%	0%	Expense Base - Gen
2)	**Expenses upto 33 KV**																	
	Operation and Maintenance Expenses	2557	-	-	2557	-	-	-	5114	11	50%	0%	0%	50%	0%	0%	0%	Demand Energy Mix
	Other Opex excluding Employee Costs	149	-	-	149	-	-	-	298	11	50%	0%	0%	50%	0%	0%	0%	Demand Energy Mix
	Employee Costs	2481	-	-	2481	-	-	-	4962	11	50%	0%	0%	50%	0%	0%	0%	Demand Energy Mix
	Depreciation etc.	6198	-	-	-	-	-	-	6198	1	100%	0%	0%	0%	0%	0%	0%	Demand
	Interest on Capex	4608	-	-	-	-	-	-	4608	1	100%	0%	0%	0%	0%	0%	0%	Demand
	Short-term Loan and Finance Charges	235	-	-	76	-	-	-	311	17	76%	0%	0%	24%	0%	0%	0%	Expense Base - Dist
	Reasonable Return	6268	-	-	-	-	-	-	6268	1	100%	0%	0%	0%	0%	0%	0%	Demand
	Income Tax	1254	-	-	-	-	-	-	1254	1	100%	0%	0%	0%	0%	0%	0%	Demand
	Less : Income and Benefits	(-) 1120	-	-	(-) 363	-	-	-	(-) 1483	17	76%	0%	0%	24%	0%	0%	0%	Expense Base - Dist
3)	**Expenses at <33 KV to 6 KV**																	
	Operation and Maintenance Expenses	-	4393	-	-	4393	-	-	8786	12	0%	50%	0%	0%	50%	0%	0%	Demand Energy Mix
	Other Opex excluding Employee Costs	-	256	-	-	256	-	-	511	12	0%	50%	0%	0%	50%	0%	0%	Demand Energy Mix
	Employee Costs	-	4962	-	-	4962	-	-	9924	12	0%	50%	0%	0%	50%	0%	0%	Demand Energy Mix
	Depreciation etc.	-	10648	-	-	-	-	-	10648	2	0%	100%	0%	0%	0%	0%	0%	Demand
	Interest on Capex	-	7915	-	-	-	-	-	7915	2	0%	100%	0%	0%	0%	0%	0%	Demand
	Short-term Loan and Finance Charges	-	399	-	-	136	-	-	535	18	0%	75%	0%	0%	25%	0%	0%	Expense Base - Dist
	Reasonable Return	-	10768	-	-	-	-	-	10768	2	0%	100%	0%	0%	0%	0%	0%	Demand
	Income Tax	-	2154	-	-	-	-	-	2154	2	0%	100%	0%	0%	0%	0%	0%	Demand
	Less : Income and Benefits	-	(-) 1902	-	-	(-) 649	-	-	(-) 2551	18	0%	75%	0%	0%	25%	0%	0%	Expense Base - Dist
4)	**Expenses at LT**																	
	Operation and Maintenance Expenses	-	-	6766	-	-	6766	-	13532	13	0%	0%	50%	0%	0%	50%	0%	Demand Energy Mix
	Other Opex excluding Employee Costs	-	-	394	-	-	394	-	788	13	0%	0%	50%	0%	0%	50%	0%	Demand Energy Mix
	Employee Costs	-	-	15112	-	-	15112	-	30224	13	0%	0%	50%	0%	0%	50%	0%	Demand Energy Mix
	Depreciation etc.	-	-	16400	-	-	-	-	16400	3	0%	0%	100%	0%	0%	0%	0%	Demand
	Interest on capex	-	-	12192	-	-	-	-	12192	3	0%	0%	100%	0%	0%	0%	0%	Demand
	Short-term Loan and Finance Charges	-	-	573	-	-	251	-	824	19	0%	0%	70%	0%	0%	30%	0%	Expense Base - Dist
	Reasonable Return	-	-	16585	-	-	-	-	16585	3	0%	0%	100%	0%	0%	0%	0%	Demand
	Income Tax	-	-	3318	-	-	-	-	3318	3	0%	0%	100%	0%	0%	0%	0%	Demand
	Less : Income and Benefits	-	-	(-) 2830	-	-	(-)1239	-	(-) 4069	19	0%	0%	70%	0%	0%	30%	0%	Expense Base - Dist
5)	**Selling Expenses**																	
	Operation and Maintenance Expenses	-	-	-	-	-	-	4002	4002	7	0%	0%	0%	0%	0%	0%	100%	Consumer
	Other Opex excluding Employee Costs	-	-	-	-	-	-	77	77	7	0%	0%	0%	0%	0%	0%	100%	Consumer
	Employee Costs	-	-	-	-	-	-	13642	13642	7	0%	0%	0%	0%	0%	0%	100%	Consumer
	Depreciation etc	3054	-	-	-	-	-	-	3054	1	100%	0%	0%	0%	0%	0%	0%	Demand
	Interest on Capex	1383	-	-	-	-	-	-	1383	1	100%	0%	0%	0%	0%	0%	0%	Demand
	Short-term Loan and Finance Charges	-	-	-	-	-	-	1849	1849	7	0%	0%	0%	0%	0%	0%	100%	Consumer
	Bad Debts	582	52	121	1651	52	121	96	2674	15	22%	2%	5%	62%	2%	5%	4%	Operation Base
	Interest on Security Deposits	2030	181	420	5755	181	420	334	9322	15	22%	2%	5%	62%	2%	5%	4%	Operation Base
	Reasonable Return	2334	-	-	-	-	-	-	2334	1	100%	0%	0%	0%	0%	0%	0%	Demand
	Income Tax	467	-	-	-	-	-	-	467	1	100%	0%	0%	0%	0%	0%	0%	Demand
	Cost of Outsourcing	-	-	-	-	-	-	950	950	7	0%	0%	0%	0%	0%	0%	100%	Consumer
6)	True-up Flow	1725	154	357	4890	154	357	284	7921	15	22%	2%	5%	62%	2%	5%	4%	Operation Base
	Overall revenue required	179058	39979	69407	318420	9485	22181	21234	659764									

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Table 4.27: Cost Allocation: Category-wise Allocation of Costs

(in Rs lakhs)

		Demand Based Cost			Energy Based Cost			Consumer Based Cost	
	Nature of Supply with Voltage Consideration	**Applicable to all**	**Sales below 33 KV**	**For LT Sales only**	**Applicable to**	**Sales below**	**For LT Sales**	**Applicable to**	**Overall Cost**
	Allocation basis	**On Contribution to System Peak**	**On Class Peak**						
		MW	MW	MW	MU	MU	MU	Number	
LT Consumers	LT Residential Lifeline	278	151	352	830	26	81	1446	3166
	LT Residential	66045	16963	39519	141108	4483	13849	16549	298517
	LT Commercial	32383	6797	15834	41838	1329	4106	2592	104879
	LT Industrial	14320	3872	9020	28987	921	2845	452	60417
	LT Public Bodies	1477	370	863	2218	70	218	18	5234
	LT Public Lighting	4710	1141	2658	8640	274	848	123	18395
	LT Public Water Works, Municipal, Government School, Private Educational Institutions	1482	469	1094	2166	69	213	16	5508
	LT Short Term Supply	94	29	67	217	7	21	24	460
	Overall LT	**120790**	**29793**	**69407**	**226003**	**7180**	**22181**	**21222**	**496576**
HT Consumers	HT 33 KV other than Traction	7756			15330			0	23086
	HT Metro Railway	2677			3309			0	5986
	HT Industrial below 33 KV	16025	3586		33016	1049		4	53680
	HT Commercial below 33 KV	17965	3544		19579	622		4	41714
	HT Residential and HT Co-operative Housing Societies	9633	1885		10538	335		2	22393
	HT Tramways	66	20		125	4		0	215
	HT Public Water Works and Public Utility	2884	1013		8480	269		1	12648
	HT Construction Power, Private Educational Institutions, HT Sports Complex and Auditorium	579	138		811	26		0	1554
	Overall HT	**57586**	**10186**		**91187**	**2305**		12	**161276**
	HT Supply to another Licensee	683			**1229**			0	**1912**
	Overall Licensee	**179058**	**39979**	**69407**	**318420**	**9485**	**22181**	**21234**	**659764**

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Table 4.28: Cost Allocation: Intra-category or Segment-wise Cost Allocation

	Category Of Consumers	Monthly Consumption Slab (if applicable)	Demand Based	Energy Based	Consumer Based	Overall Cost	Units
			Rs Lakhs	Rs Lakhs	Rs Lakhs	Rs Lakhs	MU
LT Consumers	LT Residential Lifeline		**782**	**938**	**1446**	**3166**	**24**
	LT Residential						
		Upto 60 kWh	8421	10958	5294	24673	275
		61-100 kWh	15520	20196	3417	39133	507
		101-150 kWh	21543	28033	3104	52680	703
		151-300 kWh	40326	52475	3534	96335	1316
		Above 300 kWh	36717	47779	1200	85696	1199
		LT Residential : Total	**122527**	**159441**	**16549**	**298517**	**4000**
	LT Commercial						
		Upto 60 kWh	2422	2081	1330	5833	52
		61-100 kWh	2388	2052	357	4797	51
		101-150 kWh	2631	2261	255	5147	57
		151-300 kWh	5301	4555	305	10161	114
		Above 300 kWh	42271	36324	345	78940	911
		LT Commercial : Total	**55013**	**47273**	**2592**	**104879**	**1186**
	LT Industrial						
		Upto 500 kWh	2924	3519	306	6749	88
		501-2000 kWh	5592	6731	95	12418	169
		2001-3500 kWh	3358	4042	21	7422	101
		For consumption above 3500 kWh	15338	18461	30	33829	463
		LT Industrial : Total	**27212**	**32753**	**452**	**60417**	**822**
	LT Public Bodies						
		Public Bodies Total	**2710**	**2506**	**18**	**5234**	**63**
	Public Lighting						
	Major Municipal Corporation		5673	6508	26	12207	163
	Other Municipalities		2836	3254	56	6147	82
		Public Lighting Total	**8509**	**9762**	**123**	**18395**	**245**

	Category of Consumers		Demand Based	Energy Based	Consumer Based	Overall Cost	Units
			Rs Lakhs	Rs Lakhs	Rs Lakhs	Rs Lakhs	MU
	LT Public Water Works, Municipal, Government School, Private Educational Institutions		**3045**	**2447**	**16**	**5508**	**61**
	Short-Term Supply		**190**	**245**	**24**	**460**	**6**
	Overall LT		**219989**	**255365**	**21222**	**496576**	**6406**
HT Consumers	HT 33 KV other than Traction		7756	15330	0	23086	517
	HT Metro Railway		2677	3309	0	5986	112
	HT Industrial below 33 KV		19611	34065	4	53680	1084
	HT Commercial below 33 KV		21509	20201	4	41714	643
	HT Residential and HT Co-operative Housing Societies		11518	10872	2	22393	346
	HT Tramways		86	129	0	215	4
	HT Public Water Works and Public Utility		3897	8749	1	12648	278
	HT Construction Power, Private Educational Institutions, HT Sports Complex and Auditorium		718	836	0	1554	27
	Overall HT		**67772**	**93491**	**12**	**161276**	**3009**
	HT Supply to another Licensee		**683**	**1229**	**0**	**1912**	**41**
	Overall Licensee		**288445**	**350086**	**21234**	**659764**	**9457**

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Table 4.29: Derivation of Cost of Supply: In Paise per kWh

	Nature of Supply with Voltage Consideration	Monthly Consumption Slab (if applicable)	Demand Based	Energy Based	Consumer Based	Overall Cost
			Paise/kWh	Paise/kWh	Paise/kWh	Paise/kWh
LT Consumers	LT Residential Lifeline	Lifeline	**332**	**399**	**614**	**1345**
	LT Residential					
		Upto 60 kWh	306	399	193	898
		61-100 kWh	306	399	67	772
		101-150 kWh	306	399	44	749
		151-300 kWh	306	399	27	732
		Above 300 kWh	306	399	10	715
		Total Residential (other than Lifeline)	**306**	**399**	**41**	**746**
	LT Commercial					
		Upto 60 kWh	464	399	255	1117
		61-100 kWh	464	399	69	932
		101-150 kWh	464	399	45	907
		151-300 kWh	464	399	27	889
		Above 300 kWh	464	399	4	866
		Total Commercial	**464**	**399**	**22**	**884**
	LT Industrial					
		Upto 500 kWh	331	399	35	764
		501-2000 kWh	331	399	6	735
		2001-3500 kWh	331	399	2	732
		Above 3500 kWh	331	399	0.6	730
		Total Industrial	**331**	**399**	**6**	**735**
	LT Public Bodies					
		Total Public Bodies	**431**	**399**	**3**	**833**
	LT Public Lighting					
	Major Municipal Corporation		347	399	2	748
	Other Municipalities		347	399	7	753
		Total Public Lighting	**347**	**399**	**5**	**751**
	LT Public Water Works, Government Schools, Private Educational Institutions		**496**	**399**	**3**	**897**
	LT Short-Term Supply		**310**	**399**	**40**	**749**
	Overall LT		**343**	**399**	**33**	**775**
HT Consumers	HT 33 KV other than Traction		150	297	0	447
	HT Metro Railway		240	297	0	537
	HT industrial below 33 KV		181	314	0	495
	HT Commercial below 33 KV		335	314	0	649
	HT Residential and HT Co-operative Housing Societies		333	314	0	647
	HT Tramways		210	314	0	524
	HT Public Water Works and Public Utility		140	314	0	454
	HT Construction Power, Private Educational Institutions, HT Sports Complex and Auditorium		270	314	0	584
	Overall HT		**225**	**311**	**0**	**536**
	HT Supply to another Licensee		**165**	**297**	**0**	**461**
	Overall Licensee		**305**	**370**	**22**	**698**

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Table 4.30: Additional Derivation: Voltage Level Wise Costs

Category	Demand Based	Energy Based	Consumer Based	Overall
	Rs. Lakhs	Rs. Lakhs	Rs. Lakhs	Rs. Lakhs
High Voltage upto 33 KV				
Cost	11116	19869	0	30985
High Voltage below 33 KV upto LT				
Cost	57339	74852	12	132204
Low Voltage				
Cost	219989	255365	21222	496576
Overall				
Cost	**288445**	**350086**	**21234**	**659764**

Sheet 19 of CoS Model.

Table 4.31: Cost of Supply Index: Presentation in Index Format vis-à-vis Average Tariff

	Nature of Supply with Voltage Consideration	Monthly Consumption Slab (if applicable)	Cost of Supply (Paise/kWh)	Cost of Supply as Percentage of Average Tariff
LT Consumers	LT Residential Lifeline	Lifeline	1345	193%
	LT Residential			
		Upto 60 kWh	898	129%
		61-100 kWh	772	111%
		101-150 kWh	749	107%
		151-300 kWh	732	105%
		Above 300 kWh	715	102%
		Residential Total (other than Lifeline)	746	107%
	LT Commercial			
		Upto 60 kWh	1117	160%
		61-100 kWh	932	134%
		101-150 kWh	907	130%
		151-300 kWh	889	127%
		Above 300 Units	866	124%
		Commercial: Total	884	127%
	LT Industrial			
		Upto 500 kWh	764	110%
		501-2000 kWh	735	105%
		2001-3500 kWh	732	105%
		Above 3500 kWh	730	105%
		Industrial: Total	735	105%
	LT Public Bodies			
		Public Bodies: Total	833	119%
	LT Public Lighting			
	Major Municipal Corporation		748	107%
	Other Municipalities		753	108%
		Public Lighting: Total	751	108%
	LT Public Water Works, Government Schools, Private Educational Institutions		897	129%
	LT Short-Term Supply		749	107%
	Overall LT		**775**	**111%**
HT Consumers	HT 33 KV other than Traction		447	64%
	HT Metro Railway		537	77%
	HT Industrial below 33 KV		495	71%
	HT Commercial below 33 KV		649	93%
	HT Residential and HT Co-operative Housing Societies		647	93%
	HT Tramways		524	75%
	HT Public Water Works and Public Utility		454	65%
	HT Construction Power, Private Educational Institutions, HT Sports Complex and Auditorium		584	84%
	Overall HT		**536**	**77%**
	HT Supply to another Licensee		461	66%
	Overall Licensee		**698**	**100%**

Sheet 20 of CoS Model.

By extracting only the relevant data from the Excel sheets of the model, cost to serve a particular consumer category is demonstrated by way of dispersion with respect to the average cost of the licensee in Table 4.32.

Table 4.32: Cost-of-Supply for Various Natures of Supply with Segment and Voltage Consideration

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%
	61-100 kWh	111%
	101-150 kWh	107%
	151-300 kWh	105%
	Above 300 kWh	102%
	Residential: Total (other than Lifeline)	**107%**
LT Commercial	Upto 60 kWh	160%
	61-100 kWh	134%
	101-150 kWh	130%
	151-300 kWh	127%
	Above 300 kWh	124%
	Commercial: Total	**127%**
LT Industrial	Upto 500 kWh	110%
	501-2000 kWh	105%
	2001-3500 kWh	105%
	Above 3500 kWh	105%
	Industrial: Total	**105%**
LT Public Bodies	Public Bodies: Total	119%
LT Public Lighting		
Major Municipal Corporation		107%
Other Municipalities		108%
	Public Lighting: Total	108%
LT Public Water Works, Government Schools, Private Educational Institutions		129%
LT Short-Term Supply		107%
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%

Nature of Supply with Voltage Consideration	Monthly Consumption Slab (if applicable)	Cost-of-Supply as Percentage of Average Tariff
HT Residential and HT Co-operative Housing Societies		93%
HT Tramways		75%
HT Public Water Works and Public Utility		65%
HT Construction Power, Private Educational Institutions, HT Sports Complex and Auditorium		84%
Overall HT		**77%**
HT Supply to Licensee		66%
Overall Licensee		**100%**

LT indicates both Low and Medium Voltages (below 6 Kilovolts); HT indicates High Voltage (from 6 Kilovolts to 33 Kilovolts)

Source: Present study

The data reveals that **cost-of-supply is higher than the average for all low and medium voltage segments. 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 64% of average cost of the utility** and so on. Where the tariff doesn't match the cost, these low and medium voltage segments become **the cross-subsidised categories.**

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 at 64% of average cost, public water works and public utility category is close behind at 65% of average cost. These are the cross-subsidisers, with tariff detached from cost realities.

Even at the same voltage, cost becomes higher with proximity to peak. Metro Railways, even at a supply voltage of 33 KV, has 77% of the average as its cost, due to peak co-inciding nature of its high voltage supply.

Some features of the comprehensive category and segment (slab-wise) cost-of-supply model developed for the study are summarised below.

- Based on independent load curves for all important tariff categories. HT categories have extensive coverage. Load curves for LT categories are based on detailed representative data. The comprehensive Load Curves are furnished through **Exhibit 4**.
- Demand corresponding to the highest peak load recorded during the year has been duly factored in.
- Due consideration is given to class peak (non-co-incident peak) and system peak (co-incident peak) demands.
- 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.
- Consumer-specific costs have been duly allocated.
- Choice of allocator or cost causer can be made through the model, bringing in flexibility.

The key learnings from this study are as given below.

- Co-incidence 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 HT consumers is significantly lower –
    - Consumers at higher voltages have lower network cost incidence (they are not using lower voltage networks and are not affected by lower voltage level costs / line losses).

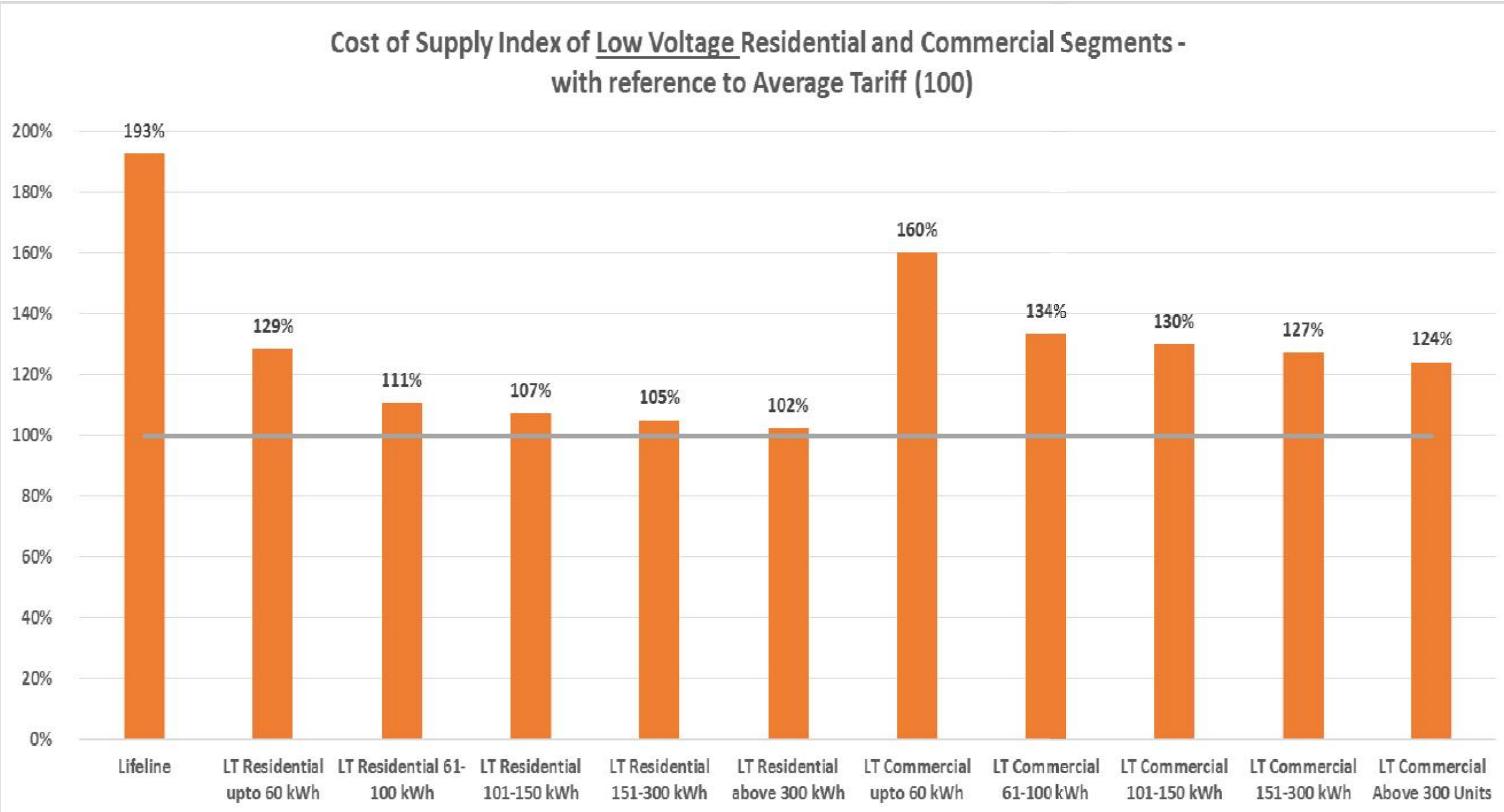
  - Consumer specific costs get distributed over large unit consumption and becomes insignificant
  - Many HT consumers have high load factor i.e. uniform demand during the day. They are matching the generation capacity of the base-load thermal power stations and consequently, they neutralise the fixed cost requirement of these stations.

- 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 spectrum for distribution network, all network costs and line loss related costs, both technical and commercial, are aggregated at this level).
- Similarly, the cost of low-end residential (129% of average; excludes lifeline) / commercial consumers (160% of average) is appreciably higher than the benchmark of average cost.
- The statutory mandate on progression towards cost-of-supply has serious welfare implications. Articulated policies are needed to prevent tariff shocks.

Some Charts are developed using data derived from the model, with reference-point at Average Tariff (Average Tariff = 100).

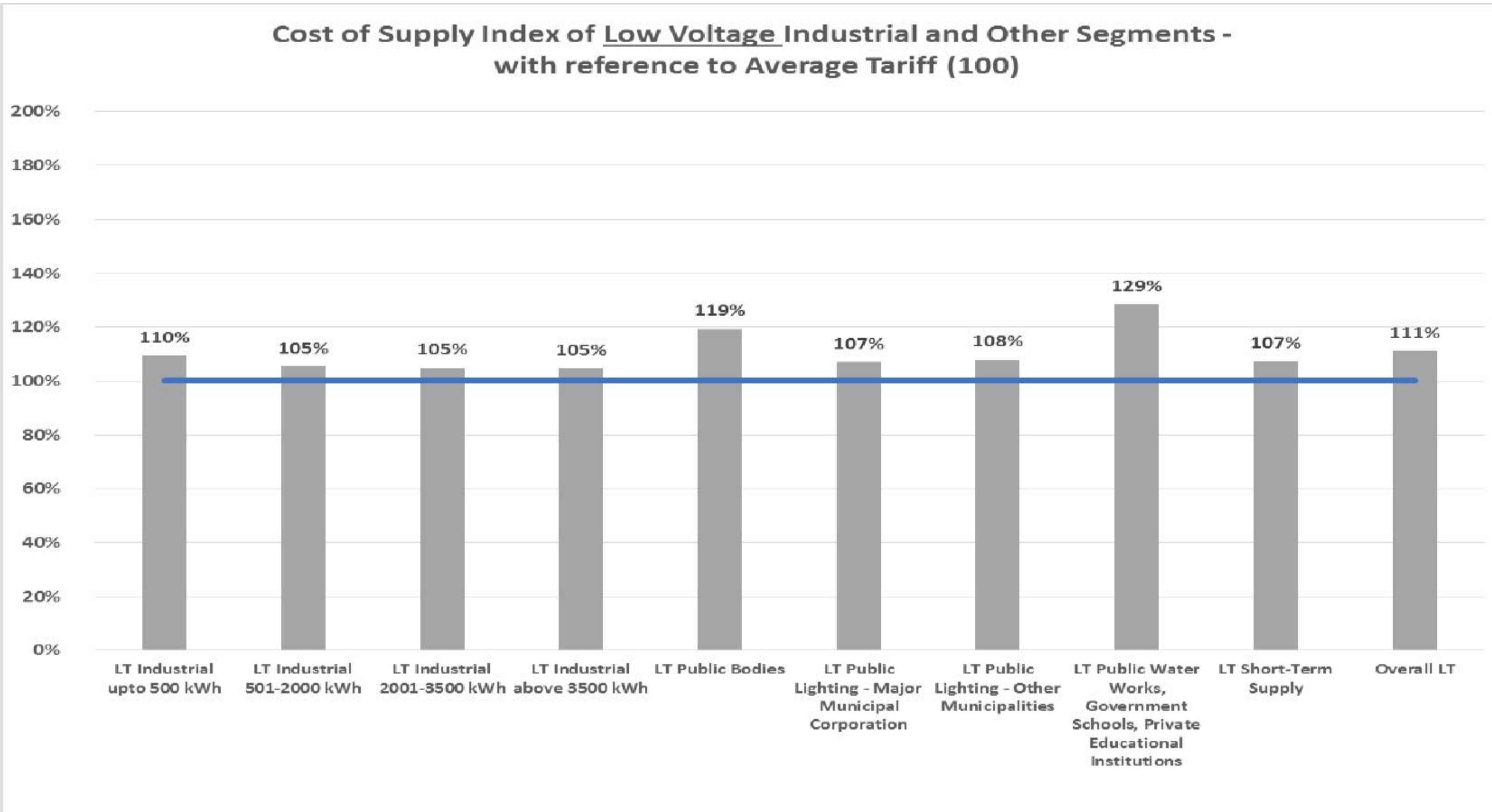
- Figure 4.8 indicates Cost-of-Supply Index of Low Voltage Residential and Commercial Segments
- Figure 4.9 indicates Cost-of-Supply Index of Low Voltage Industrial and Commercial Segments
- Figure 4.10 indicates Cost-of-Supply Index of High Voltage Categories

Figure 4.8: Cost-of-Supply Index of Low Voltage Residential and Commercial Segments - with reference to Average Tariff (100)



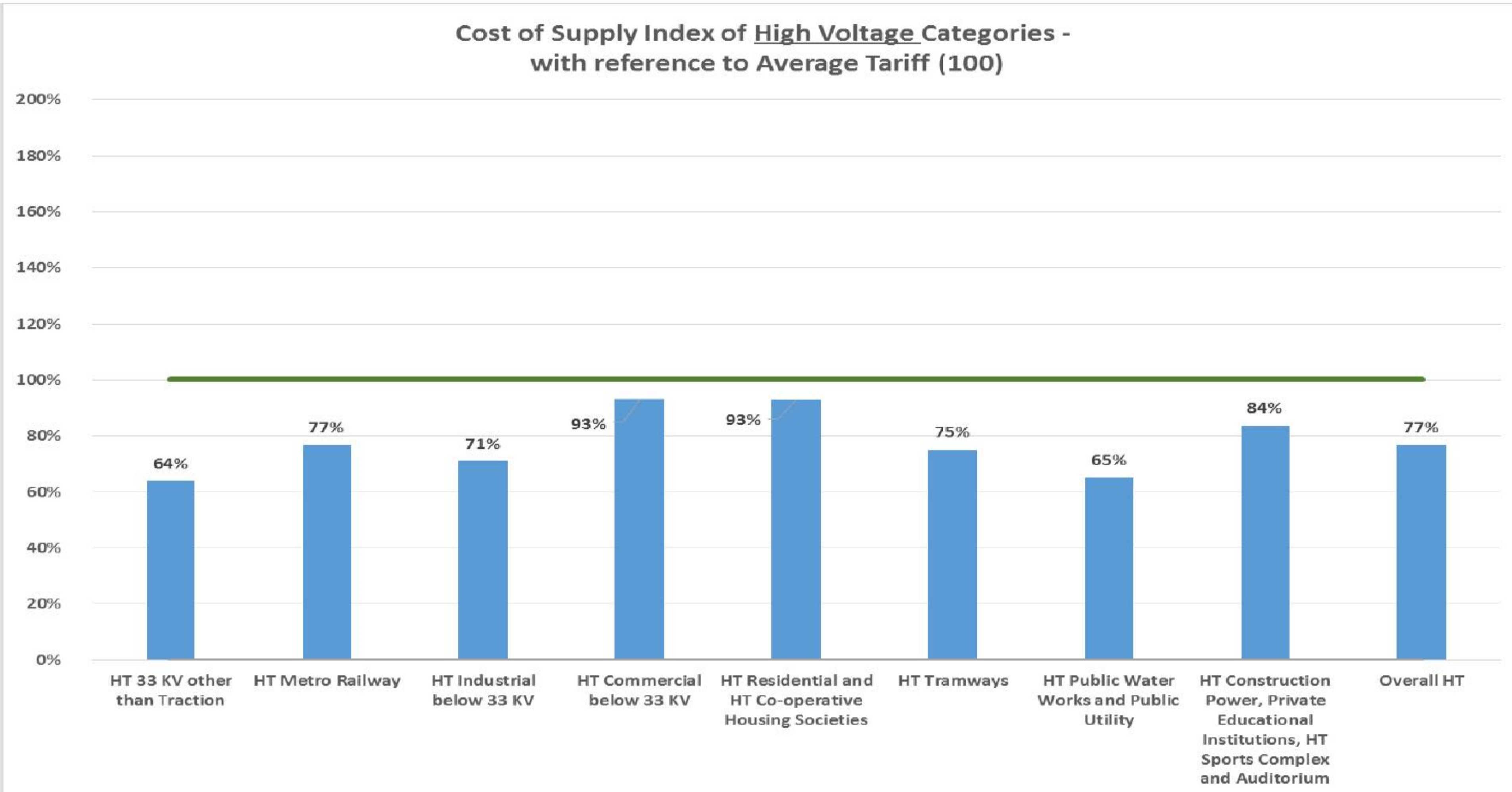
Source: Present study, details in Table 4.32.

Figure 4.9: Cost-of-Supply Index of Low Voltage Industrial and Commercial Segments - with reference to Average Tariff (100)



Source: Present study, details in Table 4.32.

Figure 4.10: Cost-of-Supply Index of Low Voltage Industrial and Commercial Segments - with reference to Average Tariff (100)



Source: Present study, details in Table 4.32.

Segment-wise cross-subsidy for the utility derived through the CoS Model, seen against the tariff of the segments (derived through Objective 2 analysis), is illustrated through Table 4.33. This table illustrates the cross-subsidy framework. Since the tariff is specific for every utility (or cluster of utilities in a State), a specific view on tariff dispersion across India cannot be formed, but the table may be relied upon to define the broad contours of the problem.

Table 4.33: Segment-wise Cross-subsidy from Cost-of-Supply Model

Nature of Supply with Voltage Consideration	Monthly Consumption Slab (if applicable)	Cost-of-Supply as Percentage of Average Tariff	Segment-wise Tariff as Percentage of Average Tariff
LT Residential Lifeline	Lifeline	193%	56%
LT Residential	upto 60 kWh	129%	76%
	61-100 kWh	111%	82%
	101-150 kWh	107%	89%
	151-300 kWh	105%	96%
	Above 300 kWh	102%	118%
LT Commercial	Upto 60 kWh	160%	92%
	61-100 kWh	134%	95%
	101-150 kWh	130%	99%
	151-300 kWh	127%	108%
	Above 300 kWh	124%	116%
LT Industrial	Upto 500 kWh	110%	93%
	501-2000 kWh	105%	101%
	2001-3500 kWh	105%	104%
	Above 3500 kWh	105%	105%
LT Public Bodies		119%	96%
LT Public Lighting		108%	95%
LT Public Water Works, Government Schools, Private Educational Institutions		129%	93%
LT Short-Term Supply		107%	105%
HT 33 KV other than Traction		64%	103%
HT Metro Railway		77%	103%
HT Industrial below 33 KV		71%	106%
HT Commercial below 33 KV		93%	116%
HT Residential and HT Co-operative Housing Societies		93%	102%
HT Tramways		75%	104%
HT Public Water Works and Public Utility		65%	103%
HT Construction Power, Private Educational		84%	113%

Nature of Supply with Voltage Consideration	Monthly Consumption Slab (if applicable)	Cost-of-Supply as Percentage of Average Tariff	Segment-wise Tariff as Percentage of Average Tariff
Institutions, HT Sports Complex and Auditorium			
HT Supply to Licensee		66%	87%
Overall Licensee		**100%**	**100%**

LT indicates both Low and Medium Voltages (below 6 Kilovolts); HT indicates High Voltage (from 6 Kilovolts to 33 Kilovolts)

Source: Present study

Table 4.33 is self-explanatory and shows the wide divergence between tariff and cost for each segment.

4.4.2 Vulnerable consumers – an assessment of subsidy need

Welfare implications emerge as a serious issue with the finding that lifeline segment has **193%**, residential category at monthly consumption of 60 kWh segment has **129%** of the average as its cost and so on. While the cost-of-supply study illustrates the significant gap between the tariff of the cross-subsidisers and their cost-of-supply (tariff considerably higher than the cost to serve the cross-subsidisers) and that between the cost-of-supply and the tariff of the cross-subsidised (tariff significantly lower than the cost to serve the cross-subsidised), literature survey of the international experience indicates that some protection is available for the vulnerable consumers. Indian policy documents also offer some rudimentary policy on protection for the lifeline segment,[74] though it has been seen that a clear-cut vulnerability strategy has not developed in the Indian context.

This analysis attempts to focus on the protection need for vulnerable consumers. For the purpose of the present analysis, vulnerable consumer is

[74] Lifeline or "Below Poverty Line" requiring societal support has been interpreted as one consuming below a specified level of 30 kWh per month (Ministry of Power, Government of India, 2005). Clause 8.3 of the Tariff Policy, January 28, 2016 issued by the Ministry of Power, Government of India under Section 3 of the Electricity Act, 2003 states that *"Consumers below poverty line who consume below a specified level, as prescribed in the National Electricity Policy may receive a special support through cross subsidy. Tariffs for such designated group of consumers will be at least 50% of the average cost of supply."* (Ministry of Power, Government of India, 2016).

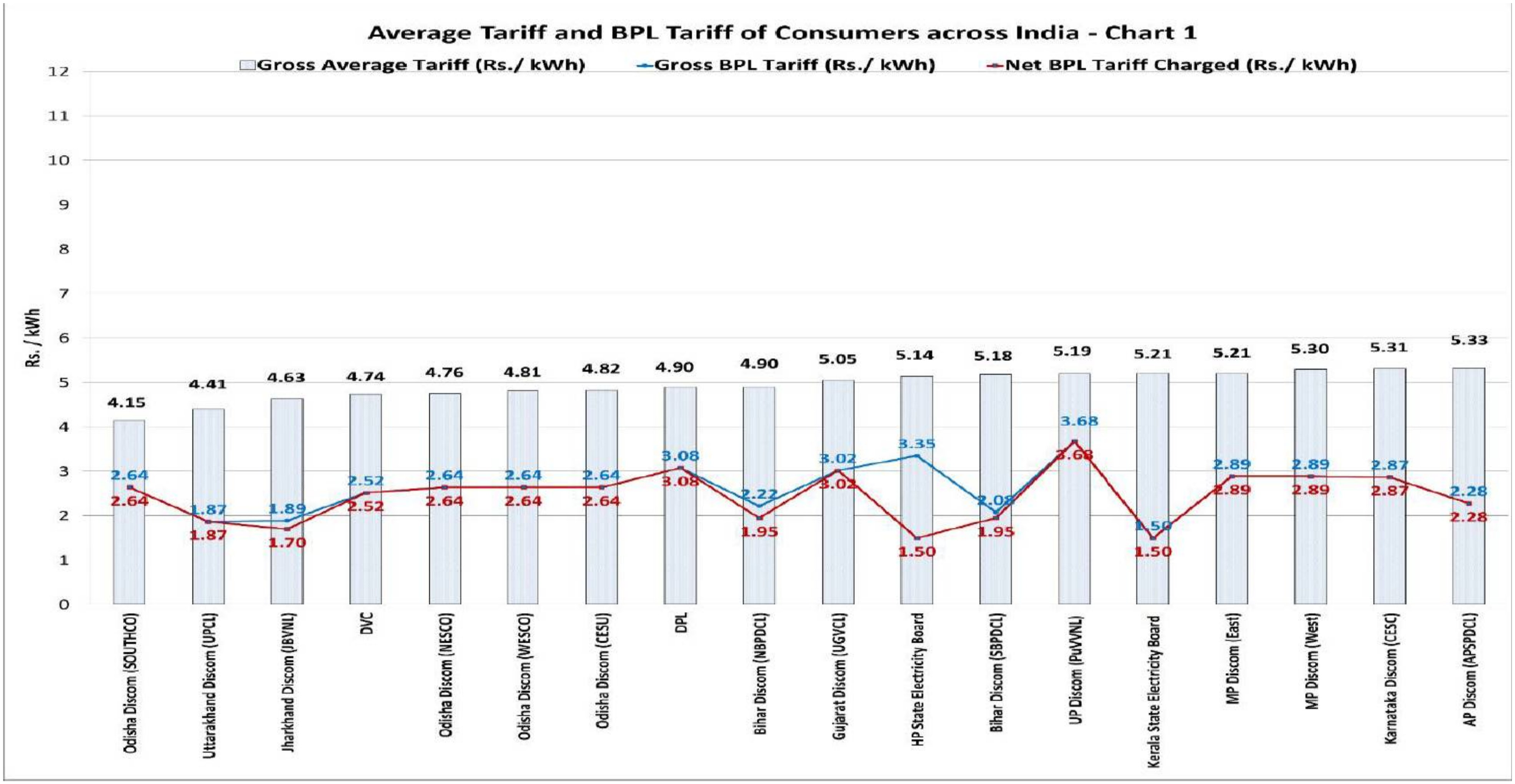
understood to mean lifeline consumer or “Below Poverty Line” customers (“BPL” customers) has been interpreted in line with Indian policy instruments i.e. a consumer with consumption of 30 kWh per month. On an all-India perspective, the support need for vulnerable consumers is attempted to be assessed through this analysis.

The support need derived through this study can be disposed of in two different manners. External subsidy may be provided by the government, which is a solution adopted by countries across the world (Davies, Wright, & Price, 2005), (Haselip & Potter, 2010), (Chisari, Estache, & Waddams Price, 2001). Even U.K. adopts a Warm Home Discount Scheme for some sections of its vulnerable consumers. A subsidy scheme is a well-practised but less elegant solution. On the other hand, in case the support need is decided to be met internally, an unavoidable non-bypassable levy (Hunt & Shuttleworth, 1996), could well be the solution. Universal charge, as has been adopted in the Philippines (Cham, 2007), (Forum of Regulators assisted by PricewaterhouseCoopers Private Limited, 2015) and is levied upon all consumers excepting lifeline consumers, seems a refined solution.

The support need is arrived at through research under Objectives 1, 2 and 3 (cost-of-supply model section). Population of 55 licensees have been chosen, (the steps are detailed in paragraphs 3.10.1, 3.10.2 and 3.10.3; the details of the licensees are available in Table 2.1). Secondary data has been extracted / computed from the State Electricity Regulatory Commissions’ orders / corresponding tariff schedules, notifications on fuel and power purchase cost adjustment and State Government subsidy related documents, for all 55 licensees, of which 2015-16 is the reference year for 49 utilities, and earlier years for 6 utilities (last available). Smoothening for consistency and pro-ration has been done where any financial impact is discussed, to assess the all-India figure. Data summary is in **Exhibit 6**. In the process, representative Average Tariff and representative Lifeline Tariff are also established.

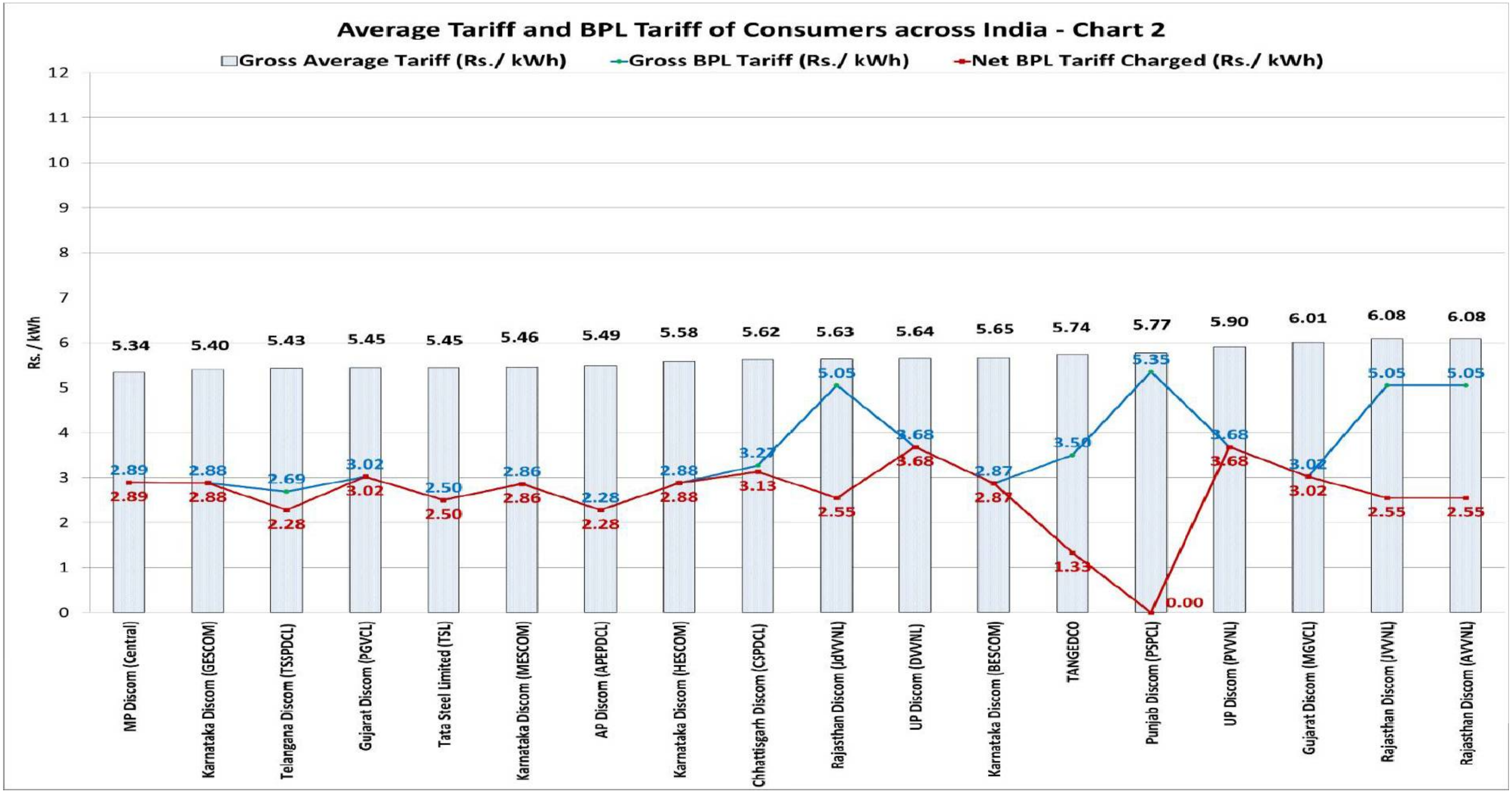
The charts on average tariff of these 55 licensees, together with pertinent data on lifeline consumers, is given through Figure 4.11, Figure 4.12 and Figure 4.13 (also referred with **Exhibit 6**).

Figure 4.11: Average Tariff vis-à-vis BPL Tariff of consumers across India – first 18 licensees in ascending order of tariff



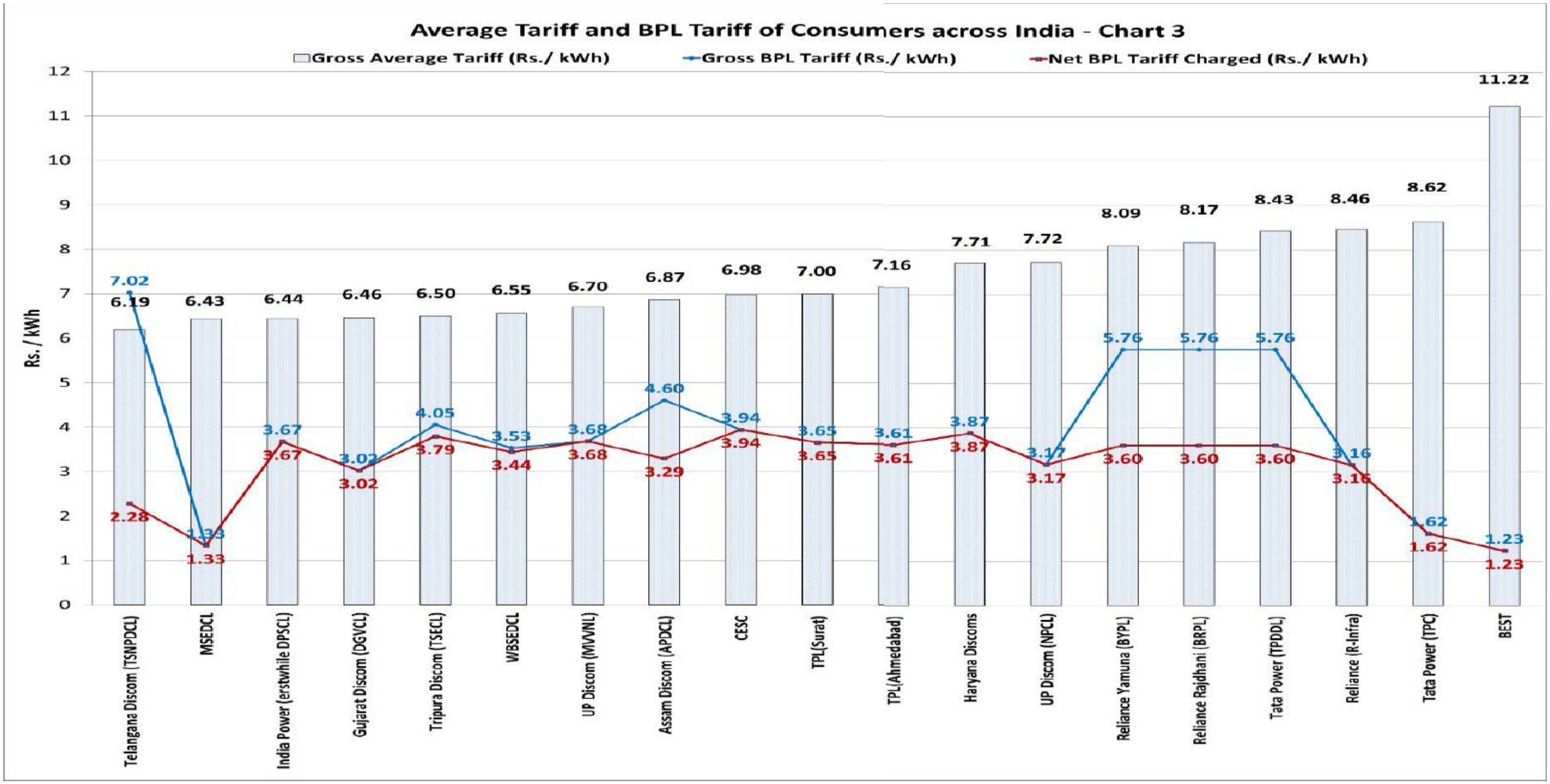
Source: Electricity Tariff in India: Assessment of Support Necessary for Lifeline / Below Poverty Line (BPL) Customers based on their Cost of Service and Management of BPL Support Requirement (Chatterjea, Dwivedi, & Sengupta, 2016). Details also in Exhibit 6.

Figure 4.12: Average Tariff vis-à-vis BPL Tariff of consumers across India – second 18 licensees in ascending order of tariff



Source: Electricity Tariff in India: Assessment of Support Necessary for Lifeline / Below Poverty Line (BPL) Customers based on their Cost of Service and Management of BPL Support Requirement (Chatterjea, Dwivedi, & Sengupta, 2016). Details also in Exhibit 6.

Figure 4.13: Average Tariff vis-à-vis BPL Tariff of consumers across India – last 17 licensees in ascending order of tariff



Source: Electricity Tariff in India: Assessment of Support Necessary for Lifeline / Below Poverty Line (BPL) Customers based on their Cost of Service and Management of BPL Support Requirement (Chatterjea, Dwivedi, & Sengupta, 2016). Details also in Exhibit 6.

For fulfilment of Objective 3, a cost-of-supply model has been created. From such study, the cost-of-supply for lifeline customers is extracted for this part of the discussion. **Exhibit 6** provides details on lifeline survey for the 55 licensees studied. **Exhibit 7** provides details of lifeline definition adopted by the regulators for these 55 licensees.

Support need is determined for the lifeline category both with reference to the average cost-to-serve (average for all categories of customers, as established through Objective 2) and specific cost-to-serve lifeline customers, extracted from the cost-of-supply model**.** Analysis of findings is furnished through Table 4.34.

Table 4.34: Support Need for Lifeline Customers

Support need for Lifeline customers vis-à-vis Average Cost-to-Serve all categories of customers	**Support need for Lifeline customers vis-à-vis Actual Cost-to-Serve Lifeline customers**
• Lifeline customers are seen to constitute only 1.4% of units sold in India.	
• Representative lifeline tariff is.Rs.3.44 per kWh (prior to subsidy).	
• Representative lifeline tariff is Rs.2.57 per kWh (considering current State Government subsidies).	
• Average representative tariff of India is Rs.5.98 per kWh (average cost-to-serve for all categories of consumers)	• Cost-to-serve lifeline customers is 193% of average cost i.e. about Rs.11.55 per kWh
• Support need, to arrive at average cost, is Rs.30.8 billion (considering government subsidy at present level, i.e. incremental need assessed) • Corresponding universal access charge on all consumers except lifeline, is 4 paise per kWh	• **Support need to recover lifeline cost-to-serve, is Rs.98.1 billion** (considering government subsidy at present level, i.e. **incremental need assessed**). • **Corresponding universal access charge on all consumers except lifeline, is 12 paise per kWh.**
• Support need is Rs.41.3 billion (no government subsidy assumed). • Corresponding universal access charge on all consumers except lifeline, is 5 paise per kWh	• **Support need is Rs.108.6 billion** (**no government subsidy** assumed). • **Corresponding universal access charge on all consumers except lifeline, is 13 paise per kWh**

Potential solutions are discussed through Table 4.35.

Table 4.35: Potential Solutions to Address Support Need for Lifeline Consumers

a)	Potential solution could be through charging of a universal levy on all retail sales, which is an internationally accepted solution (Hunt & Shuttleworth, 1996).
b)	This unavoidable levy / universal charge may require appropriate legislative intervention.
c)	Universal charge model was successfully implemented in the Philippines (Forum of Regulators assisted by PricewaterhouseCoopers Private Limited, 2015) with protection of ten years after removal of cross-subsidies available under a lifeline rate to low-income end-users (Cham, 2007).
d)	In the Philippines, residential consumers of Meralco, the largest distribution utility, are given 100% lifeline discount for consumption upto 20 kWh (discount gradually scaled down and is available upto 100 kWh monthly consumption) (Manila Electric Company).
e)	Indicative universal charge is about 13 paise per kWh to render the necessary support.
f)	Since considerable difference exists amongst the States in defining lifeline customer category, legislative action seems a pre-requisite for bringing in uniformity of definition across India.
g)	Another option, of course, could be the State Governments picking up this incremental amount through direct subsidy (Davies, Wright, & Price, 2005).
h)	"Social tariff" for low income consumers may be envisaged (Haselip, Dyner, & Cherni, 2005).

Existence of social policy obligations, even in a competitive model, is not internationally disputed. While subsidy / cross-subsidy is an amorphous issue in Indian power sector and there is significant criticism of subsidy / cross-subsidy, it is the pressure of poverty headcount which compounds the problem. There is a need for recognising the problem as such, accepting that India has the largest poor population in the world and giving a comprehensible shape to the issues. This analysis attempts to "box-up" or give a coherent shape to the problem, as the strategic path to be treaded can only be developed consequently. Otherwise, the entire issue is lost in the overwhelming gamut of issues of Indian power sector and no management decision can emerge from this daunting state.

There should be a well-articulated policy to recognise vulnerability, as suggested by global experience, with a mechanism for identification of the segment needing support. Thereafter, choices of addressing their electricity requirement at affordable rates can be devised either through obligations cast upon the State or other customers, to serve societal benefit objectives. Innovative tariff structuring lessons are also available internationally.

Unless the decision on choice between subsidy and cross-subsidy (or a mix of both) is taken at the union level, it is impractical to address the issue at State levels. It is a critical issue which can create tremendous regional disparities. Addressing this welfare issue by federal governments through clear policy instruments is suggested by international experience.

This has high relevance in the context of the other stakeholders – the cross-subsidisers. Open access policies are formulated and encouraged at the national level, whereas welfare policies / tariff support for electricity is left freely floating and is largely a State responsibility with populist pressures. Both issues need to be addressed under one comprehensive back-to-back policy umbrella.

Through the process of lending coherence to the issues, a quantification of the support need for lifeline consumers in India to serve societal objectives is reached. While the figure can be further refined, it is a reference point for policy-makers and stakeholders to take further action. The financial problem around designing tariff of lifeline customers in India does not appear insurmountable within the existing definition of lifeline customers.

The economic aspect of the issue emerging from the study is not a staggering figure. A **levy of 13 paise per kWh, charged upon all consumers excepting the lifeline segment, can address this need**. **In the context of Rs. 3.8 trillion loss of Indian power sector** (Ministry of Power, Government of India, 2015) **the subsidy figures, external or internal, are not daunting**. **The support constitutes an insignificant portion of Indian GDP (about 0.08%). The incremental support quantum can be met by 13 paise per kWh support from all non-lifeline customers.**

There is a need for identification of the target segment for fulfilment of societal needs, which might be different from the present definition adopted from national policies. Subsidy leakage whereby large chunks of non-lifeline segments are subsidised / cross-subsidised has been identified as an issue faced by the sector. Literature also indicates that the residential consumers upto a fairly high threshold level (even 300 to 400 kWh monthly consumption) desire a subsidised tariff. Tariff schedules reveal that many States have below-cost tariffs for low-end low voltage category of supply for industrial, commercial etc. as well.

Following from the above, is the need for a logical decision on whom to subsidise - identification of the target segment for fulfilment of societal needs. The definition of the lifeline consumer needs uniformity. While many States have defined lifeline or lifeline consumption along the lines of national policy instruments (30 kWh monthly consumption), there are outliers like 15 kWh monthly consumption in Tripura and 200 kWh monthly consumption in Punjab (refer **Exhibit 7**). Some States do not define lifeline, but end up subsidising a large chunk of residential consumers (also low-end commercial etc.). The connected load of lifeline is undefined in many States and varies between 120 watts to 1000 watts in other States.

A definition from a national perspective is advocated, which will help to retain focus on the specific issue. Moreover, the definition should not be too broad-based as it will thwart the crucial issue of competition. Linkage with monthly consumption alone may not be adequate, International experience suggests that monthly consumption level, presently used in terms of policy instruments, does not serve as a good proxy for monthly income. Experts opine that misuse occurs through splitting of load by residential consumers viz. a middle-income family tries to get two / three separate connections / meters installed in various names, all enjoying subsidised tariff. This is also the experience of the Philippines, where purely consumption based lifeline support is given. The subsidy does not exclusively reach the "marginalised end-users", as required by law. Secondary residences of wealthy households with lower usage, often benefit from lifeline rates (Mouton, 2015). Considerable subsidy leakage occurs through this route.

An appropriately low "connected load" needs to be made an integral part of lifeline definition (in case a consumption-based lifeline definition is attempted) to circumvent the issue of subsidy leakage to second households.

An identification route for marking a low-income family, other than consumption as the sole marker, may eventually be developed to weed out unintended subsidy. A concept of "lifeline family", based on income, may be developed (linked with other items like say, cooking gas; once implementation issues are ironed out, a common path might emerge, at least the view is placed on the table as a necessity). This concept is further developed in Chapter 5.

The next choice is on how to subsidise. It could be limited to the Philippines experience of universal charge and a number of other charges, which is effectively cross-subsidy. There is always recourse to additional subsidy from the federal / regional governments, which is an internationally acceptable solution. However, even for this measure, proper identification and delivery mechanisms are desired.

Schemes around the globe offers lessons on subsidy implementation. Chile's rural electrification scheme of weighing social and financial costs and competitive bidding on lowest subsidy requirement is one such scheme. The Philippines' universal charge is another scheme to address cross-subsidy removal. Similar lessons around the globe needs to be synthesized by developing economies to garner maximum benefits, particularly for a country like India, where the huge problem of poor cannot just be wished away. India is presently operating Deendayal Upadhyaya Gram Jyoti Yojana (DDUGJY) (Ministry of Power, Government of India, 2014) for rural electrification. The funding mechanism is such that upto 75% grant is available for general states and 90% for special category states (being North-eastern States, Sikkim, Jammu & Kashmir, Himachal Pradesh and Uttarakhand). Initial grant of 60% and 85% may go up by an additional 15% and 5% respectively; on achievement of prescribed milestones. Electrification need, particularly in remote areas, might need to be assessed against cost-to-serve using the model to evaluate whether grid-connected or off-grid distributed generation should be the preferred choice.

Innovative tariff structures are available, which range from tariff with no fixed charge, to tariff with only fixed charge. Depending on specific requirement, innovations need to be encouraged by developing economies. Presently, many innovations fail to take off as they are not economically viable at subsidised tariffs.

Once a definition of vulnerable consumer segment is reached (which might be higher than 30 kWh monthly consumption as available from present policy instruments) through general consensus between the union and the States (power being a subject in the "Concurrent List" of the Indian Constitution) and a subsidy mechanism thrashed out, a stricter regime of no-subsidy can be established for other consumers. Cost-of-supply based tariff for other segments is advocated. If the present situation is allowed to continue, Indian power sector will keep on drifting with louder clamour for support on this popular and populist issue.

4.5 CHAPTER SUMMARY

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 has been 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 exhibit similar views on cross-subsidy reduction and attainment of cost-of-supply. Global experience suggests 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 / class peak 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, covering over 97% of supply met in India by volume of sales, 25 representative licensees were selected therefrom and indexed tariff of specified consumer categories of these 25 licensees with reference to the band of ±20% of the average cost-of-supply (requirement available from earlier policy instruments, considered an interim milestone for assessment) was exhibited for three years (first, before introduction of National Tariff Policy, second, an interim year and third, the latest available year for which tariff has been determined), post completion of the time period mandated by the erstwhile National Tariff Policy.

Slow progression towards intermediate milestone of achieving tariff within the ±20% band of the average cost across the subject licensees has been observed. 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 a cross-subsidised tariff at 71% of average tariff. Residential with 300 kWh monthly consumption (strangely, a cross-subsidised segment) is at 88% and has achieved the intermediate milestone. Analysis against international scenario was also attempted, which is even less encouraging.

These findings culminate into the final part of the research - assessment of cost of supply through development of a model and a suggestive framework for estimation of realistic cross-subsidy, together with a suggestive approach on addressing the welfare issues of serving the vulnerable segments. A licensee was chosen for fulfilment of this crucial final objective and a cost-to-serve model based on real life data was developed in Excel worksheet format. The comprehensive category and segment (slab-wise) cost-of-supply model is based on independent load curves for all important tariff categories. Demand corresponding to the highest peak load recorded during the year has been duly factored in, due consideration is given to class peak demands (thus both co-incident peak and non-co-incident peak demands have been appropriately considered), 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. The Excel model is replicative and has been validated by experts in the field. The model can accommodate both a different set of parameters and different choice of allocators to derive cost of supply for any given situation. This model is an important product of this study.

The key learnings from the model and study are that co-incidence 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 - not using lower voltage networks and not affected by lower voltage level costs / line losses and their 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 both 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 spectrum of distribution network, all network costs and line loss related costs, both technical and commercial, are aggregated at this level), the cost of 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 cost-to-serve is higher than the average for all low and medium voltage segments. 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 average cost of the utility and so on.

For all high voltage categories, the cost-of-supply is lower than the average. These are the cross-subsidisers, with tariff detached from cost realities. Since their tariff doesn't match their cost, the low and medium voltage segments become the cross-subsidised categories. Thus, the segment-wise cost-of-supply model distinctly brings out the anomalies in tariff structure and the necessity of tariff rationalisation.

Welfare implications emerge as a serious issue with the finding that the cost to serve the lifeline segment is 193% and the segment of residential category with monthly consumption of 60 kWh is 129% of the average cost across all categories. 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. Extensive survey of the tariff process of utilities across India was undertaken to discover the policies and processes for understanding vulnerability. Lessons were extracted from international experience (through study of selected countries where electricity reforms have been successful or countries which are undertaking a process of electricity reform) and validated in the context of a developing economy with a large poverty headcount. Literature review suggested that there are various factors which are affecting the policy processes, including a lack of understanding of the selection process for the subsidised segment.

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