CHAPTER 2

LITERATURE REVIEW

2.1 INTRODUCTION

Thematic review of existing literature is undertaken, including basic tenets of reform and reform expectations, cross-subsidy in electricity tariff, reform impact and the need / experience of according protection to small consumers, contextual global experience, valuation of cross-subsidy together with assessment of cost-of-service, experience of more mature electricity markets as well as developing economies to extract learnings to meet the challenges in India in arriving at cost-of-supply, which is the central theme of the research. The rationale behind the study, by discussing various cost-of-supply studies undertaken in India, is also outlined.

2.2 CONTEXT: REFORM OF THE ELECTRICITY SECTOR – EFFECTS AND ISSUES

Reform of the electricity sector has its own connotations. Tariff reform includes a mandate on progression towards cost-to-serve through legal pronouncements and policy instruments, as well as the opinions of industry experts. Contextually, it is necessary to review existing literature on the subject to assess its requirement and significance.

In case the literature also suggests application of a cost-to-serve model in a reformed / competitive environment, there emerges a necessity of discovering whether international experience suggests rendering of any protection to any segment of consumers in this competitive, cost-to-serve model, particularly to the poor consumers. The path chalked out to deal with this protection need is also explored. In this context, intensive focus is given on literature review of five countries in different stages of reform to elucidate issues on subsidy and

protection needs for vulnerable consumers. Review of literature is also carried out to understand the subsidy regime in the Indian context. Finally, literature is reviewed to gain some understanding on the theory and practice of cost-to-serve calculations.

2.2.1 Literature search process

Literature review process was conducted both online as well as through offline documents. Review was conducted through academic papers in national / international journals, topical books, rules, regulations, policies and judgments of the Hon'ble Supreme Court of India, High Courts, the Appellate Tribunal for Electricity and Regulatory Commissions, media reports etc. Through use of key words for searching (detailed in paragraph 2.2.2), websites accessed for academic papers include Jstor (https://www.jstor.org/), Academia (https://www.academia.edu/), ScienceDirect (http://www.sciencedirect.com/), DeepDyve (https://www.deepdyve.com/), among others. A number of websites could be accessed through use of Google Scholar (https://scholar.google.co.in/), using search-words, for pertinent documents. Office of Gas and Electricity Markets (Ofgem) (https://www.ofgem.gov.uk/) and World Bank reports (http://www.worldbank.org/) were studied in detail. Some of the websites accessed for policies include websites of the Ministry of Power of India (http://powermin.nic.in/), Ministry of Finance of India (http://www.finmin.nic.in/), Planning Commission of India (http://planningcommission.gov.in/index_oldpc.php), Central Electricity Authority (http://www.cea.nic.in/), Central Electricity Regulatory Commission (http://www.cercind.gov.in/), Forum of Regulators (http://www.forumofregulators.gov.in/), Forum of Indian Regulators (https://foir-india.org/). Review of legal pronouncements, with website details of the judgments, are in **Exhibit 1.**

Source details for relevant data of the population of licensees chosen for initial study and 22 governing regulatory authorities are furnished Table 2.1. **These**

55 licensees supply about 97% of India's total energy met.[17] Details of distribution licensees of all States are captured in Table 2.1 (and Table 3.1), excepting Jammu & Kashmir, which is covered under a separate Act, the North-Eastern States (excluding Assam and Tripura, which have been studied), Sikkim and Goa. National Capital Territory of Delhi has also been included for the study. These websites constitute important secondary sources of data for regulatory orders and other information used for fulfilment of all objectives of this study.

Table 2.1: Website details of 22 Regulatory Commissions and 55 Distribution Licensees

Sl. No.	State Electricity Regulatory Commission		Licensee[18]	
	Name	**Website Address**	**Name**	**Website Address**
1.	Delhi Electricity Regulatory Commission	http://www.derc.gov.in/	BRPL	http://www.bsesdelhi.com/HTML/index.html
2.			BYPL	
3.			TPDDL	http://www.ndpl.com/
4.	Haryana Electricity Regulatory Commission	https://herc.gov.in/index.aspx	DHBVNL	http://www.dhbvn.com/
			UHBVNL	http://www.uhbvn.com/
5.	Himachal Pradesh Electricity Regulatory Commission	http://hperc.org/	HPSEBL	http://www.hpseb.com/
6.	Punjab State Electricity Regulatory	http://www.pserc.nic.in/	PSPCL	http://www.pspcl.in/

[17] "Power Supply Position (Provisional) April 2015 to March 2016," Monthly Report of Central Electricity Authority, as available at the website of the Central Electricity Authority at http://www. http://cea.nic.in/reports/monthly/powersupply/2016/psp_energy-03.pdf, last accessed on April 27, 2016

[18] Provides shortened names of the licensees commonly used; full names are available in the websites of the licensees / respective State Electricity Regulatory Commissions and are furnished through the List of Abbreviations.

Sl. No.	State Electricity Regulatory Commission		Licensee[18]	
	Name	**Website Address**	**Name**	**Website Address**
	Commission			
7.	Rajasthan Electricity Regulatory Commission	http://rerc.rajasthan.gov.in/	JVVNL	http://www.jaipurdiscom.com/
8.			AVVNL	http://energy.rajasthan.gov.in/avvnl#
9.			JdVVNL	http://www.jdvvnl.com/jdvvnl/
10.	Uttar Pradesh Electricity Regulatory Commission	http://www.uperc.org/Default2.aspx	DVVNL	http://www.dvvnl.org/
11.			PVVNL	http://www.pvvnl.org/
12.			PuVVNL	http://puvvnl.up.nic.in/
13.			MVVNL	http://www.mvvnl.in/
14.			NPCL	http://www.noidapower.com/
15.	Uttarakhand Electricity Regulatory Commission	http://www.uerc.gov.in/	UPCL	https://www.upcl.org/wss/
16.	Chhattisgarh State Electricity Regulatory Commission	http://www.cserc.gov.in/	CSPDCL	http://www.cspdcl.co.in/
17.	Gujarat Electricity Regulatory Commission	http://www.gercin.org/	TPL - Ahmedabad	http://www.torrentpower.com/
18.			TPL - Surat	
19.			MGVCL	http://www.mgvcl.com/index.php
20.			DGVCL	http://www.dgvcl.com/dgvclweb/index.php
21.			PGVCL	http://www.pgvcl.com/
22.			UGVCL	http://www.ugvcl.com/
23.	Madhya Pradesh Electricity Regulatory	http://www.mperc.nic.in/index.htm	East Discom	http://www.mpez.co.in/portal/Jabalpur_home.portal
24.			West Discom	http://www.mpwz.co.in/portal/Indore_home.portal

Sl. No.	State Electricity Regulatory Commission		Licensee[18]	
	Name	**Website Address**	**Name**	**Website Address**
25.	Commission		Central Discom	http://www.mpcz.co.in/portal/Bhopal_home.portal
26.	Maharashtra Electricity Regulatory Commission	http://www.mercindia.org.in/	BEST	http://www.bestundertaking.com/en/
27.			RInfra	http://www.relianceenergy.in/html/index.html
28.			MSEDCL	http://www.mahadiscom.com/
29.			TPC	http://www.tatapower.com/
30.	Telangana State Electricity Regulatory Commission	http://www.tserc.gov.in/	TSSPDCL	https://www.tssouthernpower.com/
31.			TSNPDCL	http://www.tsnpdcl.in/
32.	Andhra Pradesh Electricity Regulatory Commission	http://www.aperc.gov.in/	APEPDCL	https://www.apeasternpower.com/
33.			APSPDCL	https://www.apspdcl.in/
34.	Karnataka Electricity Regulatory Commission	http://www.karnataka.gov.in/kerc/Pages/home.aspx	BESCOM	http://bescom.org/
35.			GESCOM	http://www.gescom.in/
36.			HESCOM	http://www.hescom.co.in/
37.			MESCOM	http://www.mesco.in/
38.			CESC - Karnataka	http://www.cescmysore.org/en/
39.	Kerala State Electricity Regulatory Commission	http://www.erckerala.org/	KSEB	http://www.kseb.in/index.php?lang=en
40.	Tamil Nadu Electricity Regulatory Commission	http://tnerc.tn.nic.in/	TANGEDCO	http://www.tangedco.gov.in/index1.php?tempno=1
41.	Bihar Electricity Regulatory Commission	http://berc.co.in/	NBPDCL	http://www.nbpdcl.in/
42.			SBPDCL	http://www.sbpdcl.in/

Sl. No.	State Electricity Regulatory Commission		Licensee[18]	
	Name	**Website Address**	**Name**	**Website Address**
43.	Jharkhand State Electricity Regulatory Commission	http://jserc.org/	JBVNL	http://www.jbvnl.co.in/
44.			TSL - Jamshedpur	
45.	Odisha Electricity Regulatory Commission	http://www.orierc.org/	CESU	http://www.cescoorissa.com/
46.			NESCO	http://www.nescoodisha.com/
47.			WESCO	http://www.wescoodisha.com/
48.			SOUTHCO	http://www.southcoodisha.com/
49.	West Bengal Electricity Regulatory Commission	http://www.wberc.net/	WBSEDCL	http://www.wbsedcl.in/irj/go/km/docs/internet/new_website/Home.html
50.			CESC	https://www.cesc.co.in/
51.			IPCL	http://www.indiapower.com/
52.			DPL	http://www.dpl.net.in/
53.			DVC	http://www.dvc.gov.in/dvcwebsite_new1/
54.	Assam Electricity Regulatory Commission	http://aerc.nic.in/	APDCL	http://www.apdcl.gov.in/irj/go/km/docs/internet/ASSAM/webpage/pages/Home.html
55.	Tripura Electricity Regulatory Commission	http://terc.nic.in/	TSECL	http://www.tsecl.in/irj/go/km/docs/internet/TRIPURA/webpage/pages/Home.html

2.2.2 Selection of key words

Electricity tariff, electricity pricing, power / electricity sector reform, reform model, cost-of-supply study, cost-to-serve tariff, real-time tariff, subsidy, cross subsidy, protection for vulnerable / poor / below poverty line customers / consumers, Indian power / electricity sector, electricity laws, open access, electricity / power sector reform / tariff / subsidy in Chile, Argentina,

Philippines, Nigeria, United Kingdom / U.K. are some of the keywords selected for literature review.

2.3 THEMATIC REVIEW OF LITERATURE

The broad themes of review include basic tenets of reform and reform expectations, cross-subsidy in electricity tariff, reform impact on small consumers, contextual global understanding through study of relevant electricity reform initiatives in Chile, Argentina, the Philippines, Nigeria and the United Kingdom (U.K.), the Indian scenario, valuation of cross-subsidy, pertinent aspects of subsidy and cross-subsidy, cost-of-supply principles and available cost-of-supply studies in the Indian context.

The headings / themes used in subsequent literature review is for convenience of understanding the thematic issues emanating from literature review. These do not reflect the opinion of the researcher on any of the themes studied.

2.4 BASIC TENETS OF REFORM AND REFORM EXPECTATIONS

2.4.1 Requirement of cost alignment as the first step of reform in a standard reform model

Pricing reform is one of the major challenges encountered while traversing the path of reforming the sector (Kessides, 2012). Ideally, there are certain logical steps to be sequentially taken in the path to reform. First, the prices need to be reset at levels to cover both operational as well as financing costs including return on investments and a regulatory framework needs to be established. Privatisation may commence only after these steps are assiduously taken. Reforms undertaken in a different sequence, in departure from the text-book standard model, may lead to poor performance. Since regulated prices were inefficiently low in many developing countries, liberalisation may raise the prices. **Historic pricing distortions in the energy sectors of developing countries in the form of cross-subsidies from industrial customers to residences, reduce progressively with realignment of the prices of the residential customers with underlined costs.**

2.4.2 Limited scope of above-market costs in a competitive model: Social policy objectives not implementable through competitive electricity pricing

Four models of sector structure have been discussed (Hunt & Shuttleworth, 1996), starting with Model 1, where the sector is wholly integrated and is a government controlled monopoly, to Model 4, which has full retail competition. Where the customers have an ease of choice vis-à-vis alternatives that do not have attached above-market costs, ability to impose and collect such costs becomes severely constrained. Only where the sector is a monopoly, above-market costs can easily be collected (as the customers cannot bypass the delivery system). **In an electricity sector model with full retail competition, special dispensations like lifeline rates for the poor, can no longer be accomplished since markets obey the law of one price**. Since the retailers can no longer discriminate, **explicit provisions are needed by other means for these programmes. Imposition of non-by-passable levies is a potential solutions, which can usually be implemented through legislation by allowing charging of a non-avoidable levy on retail sales.**[19]

2.4.3 Power consumption, income level and country-specific features constitute significant determinants of electricity price-cost margins and cross-subsidy levels

Even the reform path may differentially impact diverse countries, which support the suggestion that the prescribed reform steps for a specific country cannot be simplistically imitated in another country, with an expectation of commensurate performance. A successful electricity market of a developed economy, with its formalised structure, cannot be transplanted to a developing economy, anticipating efficient performance of the electricity industry. **Country-specific features including electricity consumption and income**

[19] Other authors accept the work on applied economic theory by Hunt and Shuttleworth (1996) of National Economic Research Associates (NERA) based on research vis-à-vis clients in six continents, as an authoritative though somewhat dated treatise. Social policy obligations which are met / expected to be met by the electricity sector has been discussed here in-depth.

levels constitute significant determinants of electricity price-cost margins and cross-subsidy levels (Erdogdu, 2011).

Policy of network unbundling adopted in Europe (whether transmission or distribution) resulted in synergy losses of 8% due to co-ordination losses. Adoption of unbundling (including separation of retail and generation, observed in some U.S. States) may lead to a permanent cost increase of more than 20% due to enhancement of risks. Vertical synergies have been noted in electricity supply (Cronin & Motluk, 2011).

Shared outputs, which have either been limited or rejected through restructuring, could have delivered later economies instead of unthinking restructuring through divestitures (Meyer, 2012).

2.4.4 Reform expectation: erosion of cross-subsidy: Political and welfare implications including support to low income consumers.

Advantages are earned by large customers when liberalisation takes place, to the detriment of small consumers. The exploitation of small consumers worsen unless the government strengthens regulations (Thomas, 2005).

A discussion on reform structure and expectations indicates that programme of reforms are expected to erode cross-subsidies (Davies, Wright, & Price, 2005). Erosion of cross-subsidies occurred in U.K with the threat of introducing competition, which impacted elderly and low-income consumers. Due to its political and welfare implications, **these issues are addressed through additions to welfare systems and grants by way of provision of direct subsidies with gradual phase-out of cross-subsidies.**

A study of electricity market reform in developing countries (Haselip, Dyner, & Cherni, 2005) examines both favourable and unfavourable consequences of reform initiatives. One view is that market liberalisation leads to a more efficient distribution of resources as **targeted subsidies are a superior method of resource allocation to low-income consumers than across-the-board subsidies**. Thereby, the **States assume responsibility of the poor**. The critics opine that **the impoverished group are adversely affected**. With

removal of restraints on continuing / extending service to the poor, the high-income customers tend to be positively impacted. Market / regulatory incentives to motivate extension of access and improvement of reliability for less affluent consumers by private suppliers, remain the challenges for the policy-makers. In Argentina, at a point when wholesale prices reduced by more than 50%, pricing of high-level residential and industrial consumers exhibited the sharpest reductions (71% and 44% respectively), whereas a contrasting picture emerged from residences in the lowest consumption brackets, usually with the lowest incomes, as they experienced an infinitesimal price reduction of 1.6%. **The advantages and practicability of instituting a "social tariff" in the context of low-income customers have been advocated.**

Development paths which are based merely on economic considerations is the result of financial globalisation (Dubash N. K., 2002). The broader perspective of **public interest is best served if the policy-makers steer the policies towards favourable social and environmental results.**

2.5 CROSS-SUBSIDY IN ELECTRICITY TARIFF

2.5.1 Discouragement of cross-subsidy in electricity tariff

From a World Bank Report, it emerges that **cross-subsidies give the least help to the poorest.** Since businesses pass on costs through higher prices, both the poor and the affluent indirectly pay for cross-subsidy. Net effect on the poor is unpredictable (World Bank, 1994).

Rapid economic growth in Asia is leading to greater demand for electric power and higher levels of capacity investment. Public sector is incapable of satisfying this demand. Private sector participation requires reliance on cost recovery mechanisms. **Electricity prices need to be brought in line with costs** (PPIAF / AD Conference on Infrastructure Development, 2002).

2.5.2 International scenario: specifically approved cross-subsidies in the tariff structure to address socio-political needs, with minimal impact on electricity prices of customers in the productive sectors

In analysis of electricity industries (Gilbert, Kahn, & Newberry, 1996) of U.K., France, U.S.A., Canada, Scandinavian countries, Japan, Germany, New Zealand, Yugoslavia, Argentina, Brazil, Uruguay and Chile, the **broadly consistent picture is that industrial customers pay less than residential customers. Electricity industries in almost all countries price industrial customers at rates lower than the rates charged for others**. Small consumers, particularly commercial firms, bear the burden of fixed cost recovery, whereas the residential consumers benefit from their aggregated political influence to an extent.

In Russia, residential tariffs were proposed to be subject to government regulation at least until 2015 and full elimination of cross-subsidies in electricity tariffs of households was proposed to be achieved in 2015 (Sidorenko, 2009). In South Africa, only specifically approved cross-subsidies are allowed in the tariff structure to meet certain socio-political needs, while ensuring that such **cross-subsidies have a minimal impact on the price of electricity to customers in the productive sectors of the economy** (Electricity Pricing Policy (EPP) of the South African Electricity Supply Industry issued by the Department of Minerals and Energy, Statskoerant, No. 31747, 2008). In the context of Brazilian power sector reform, the view is that **only elimination of cross-subsidies will push customers towards desired market-oriented outcomes** as it is the only sustainable economic solution that provides for long-term expansion of this sector (Rosenzweig, Potts Voll, & Pabon-Agudelo, 2002).

2.6 REFORM IMPACT ON SMALL CONSUMERS

2.6.1 Regulation need for protection of small consumers

Competition and choice in electricity appears to have a built-in bias towards large consumers (Dubash & Singh, 2005). "Rent-seeking" poses a major hurdle to de-regulation (Crew & Kleindorfer, 2002). Regulatory role is

expected to continue, as it provides some process for dividing these rents. When economic organisations are endeavoured to be controlled or guided by society through regulatory processes, a managed resolution of the continuing contingencies is required. Consequently, **governance of public utilities would continue to be based on a regulatory framework.** Small customers, who have no other choice vis-à-vis monopolist extractions, are offered rudimentary protection through regulatory intervention.

In another paper, Crew & Kleindorfer emphasises **need for continuance of regulation in the context of electricity**. The outlook for deregulation not being adequately enticing, further deregulation should be undertaken with caution (Crew & Kleindorfer, 2002). Similarly, there is criticism of light-handed regulation, which has allowed profits to exceed the thresholds which were found reasonable under the discarded framework of rate-of-return regulation (Bertram & Twaddle, 2005).

2.6.2 Analysis of benefit to residential and small consumers post-reform

Lessons from twenty years of electricity market liberalisation has been analysed (Joskow, 2008). **Benefits of retail competition are not apparent in the context of residential and small commercial consum**ers. Due to higher costs of transaction, change-over costs as well as market dominance, there is a likelihood of enhancement of retail prices, particularly in a shorter time span. Where it has been ordained by the policymakers that competition will not be extended to all retail customers (viz. residences and small commercial establishments), Joskow recommends that the distribution utility or a designated supplier, is required to be imbued with the responsibility of supplying electricity to these small consumers by procuring electricity from competitive wholesale markets or procuring it from its own generation sources. **Retail competition cannot succeed if regulated tariffs at below-market costs are made available by policy-makers, to insulate consumers from high market prices.** Significant departures from text book models are also not recommended.

A study has established both the principles and real-life concerns of the reform path, with particular emphasis on the South American experience (Chisari,

Estache, & Waddams Price, 2001). While regulatory reforms might usher in long-term gains to customers through lowering of costs and tariffs, the poor customers are not necessary beneficiaries of the reform regime, either in terms of quantum or timing. The **traditional cross-subsidies might be eroded with introduction of competition with adverse effects**. Among others, **fresh subsidies might become essential to safeguard the interest of the poor** customers and to ensure that they are also beneficiaries of the reform regime, even in the short term. A tailored programme could be an expensive but ideal solution.

A study for U.K. covering the period 1948-49 to 1988-89 (Newbery & Green, 1996), exhibited that of the three main consumer categories, industrial tariff was the lowest. While the **commercial customers had a lower cost than smaller residential customers**, their tariff was higher for the first 25 years of the study. **Political reasons prevented raising of the prices of residential customers, though their costs are likely to be the highest**. This difference between commercial and residential segments, declined over time and disappeared after 1974-75. Even then, the price rises were not to the detriment of smaller consumers, as unit rates were revised, rather than the standing charges.

2.6.3 Progression of price regulation mechanism – from marginal costing to social welfare maximisation

In an analysis of performance based regulation (PBR) in the context of transmission pricing, a detailed view on progression of PBR is presented (Vogelsang, 2006). While from the economist viewpoint, optimal PBR is desirable, it is only initially that such optimal was conceived as marginal cost (till the seventies of the last century). However, in the eighties, there was a deviation from marginal prices by mark-ups which are inversely proportional to demand elasticities. Regulators' information gaps on costs and demand functions have been identified as the deficiency of Ramsey pricing. The third change came under this environment of incomplete information. The need for regulated utilities to make economic profits to divulge information and limiting of such profits by giving the utilities a bouquet of regulatory options

for selection, were the principles of the third modification. There is further movement away from optimality, in what has been termed as the fourth change. **Maximization of social welfare is being achieved through pricing. While this may not be the optimal price regulation, regulatory economics are more relevant from the viewpoint of practical application**.

2.7 GLOBAL UNDERSTANDING: COUNTRY EXPERIENCES

Countries have been chosen on the basis of demographic profile, maturity level of electricity reform as well as some apparent relevance / learning in the context of vulnerable consumers. Chile, Argentina, the Philippines, Nigeria and the United Kingdom (U.K.) have been selected for the purpose of the study, with focus on protection rendered to the poor consumers in the electricity system, through subsidy or cross-subsidy, whether through revenue support or capital funding.

2.7.1 Chile

a. Overview

With the reform initiatives starting from as early as 1982, the comprehensive reform of electricity sector undertaken by Chile is considered to be a pioneering effort. An illustration of successful power sector reform in a developing economy, Chile is not only a prototype for other privatisations in South America, but also serves as a model across the world (Pollitt M. , 2004). Pollitt also observes that significant efficiency improvements have been seen in the sector, with lowering of prices and enhancement of profits. Electricity tariffs in Chile are low by global benchmarks. High rate of investment and strong financial performance by the involved companies are exhibited. Chile also has successful rural electrification programme (only 14% of rural households were without electricity in 2002 compared with 62% without electricity in 1982).

Unlike many other South American countries, Chilean system was based on competitive markets and a legislation-based regulatory system which attempted replication of marginal cost pricing (Spiller & Martorell, 1996).

Chile has a population of 17.6 million in 2013, of which 0.9% are under poverty headcount i.e. around 0.16 million (World Bank); insignificant in comparison with India's poor population of 272.5 million.

b. Capital subsidy scheme for rural electrification

In a case study by the World Bank (Barnes, 2005), it is observed that Chile's rural electrification model may have substantial relevance to programs in other countries. However, competitive environment for subsidy funding is a pre-requisite for such replication. The project evaluation methodology is a three-part process, with initial economic evaluation to appraise the project where gross social benefit is calculated, considering the forms of energy in use that would be displaced by electrification like kerosene lanterns, dry cells, automotive batteries etc. Families are classified by socio-economic status, and Economic or Social NPV (ENPV) is calculated for each group. If the ENPV is greater than the initial project cost, the project passes the initial test and goes into the regional electrification database. Financial analysis and rate of return calculation are simultaneously undertaken, with maximum subsidy amount being placed above the financial break-even point. A project qualifies for subsidy if it is both economically and financially attractive, respectively for the country and the utilities. The lowest request for subsidy per user is selected. Investor owned utilities and co-operatives compete for the subsidy funds.

The community, being the beneficiaries of the project, have a definitive role, particularly in the decision on the individual user's monetary contribution to the initial project cost. The utilities may finance the same, with recovery through the users' periodic electric bills. The user / municipality also contribute additionally to increase the possibility of approval for projects with limited funds, affecting economic feasibility and consequent subsidy approval (Barnes, 2005).

While **the users are expected to pay the running (revenue) costs, the project cost (capital) of rural connectivity are shared between the State (subsidy constitutes the majority share), the companies and the users** (Pollitt M. , 2004). A lesson from the Chilean experience is that subsidies are

so designed that the users or the beneficiaries perceive the marginal cost of providing the service (Serra, 2000).

2.7.2 Argentina

a. Overview

Reform of the electricity sector of Argentina is considered a significant case study, particularly in the context of developing countries. It went through a phase of success in the 1992-2002 period, a crisis period in 2002 and post-crisis developments (Pollitt M. , 2008).

Around 2002, electricity tariffs in Argentina were the lowest in South America, as also by global benchmarks. In May 2002, residential tariffs were 2.5 US cents per kWh (against 9.8 cents per kWh in USA), while industrial tariffs were as low as 1.3 US cents per kWh (against 5.9 cents per kWh in USA). However, a rise of 25% was exhibited on the price for the smallest residential customers (constituting around 38% of total customer base) (Pollitt M. , 2008).

Notably, Argentina had a population of 42.5 million in 2013, of which 1.8% are under poverty headcount i.e. around 0.7 million (World Bank); not of any significance vis-à-vis India's poor population of 272.5 million.

b. Issue of supply to the poor

Welfare loss occurred for poor consumers, as they had to pay for the power which they had earlier received without paying for it. This suggests that **benefit of electricity reform was not available to the poorest** (though electricity reform brought down prices). Pre-crisis, **disproportionate benefits from the falls in the wholesale prices were availed by the industrial customers.** While the Argentinian crisis of 2002 is attributed to macro-economic reasons, retrograde steps were taken to protect the electricity sector in the form of low prices for everyone, including the affluent. Thus, the price control did not discriminate. The inability to return to market determination i.e. low electricity prices through contrivance had consequent negative effects like enhanced electricity demand. State subsidies to wholesale power markets

to thwart price increases were reportedly about 0.5% of GDP (Pollitt M. , 2008).

Supply to the poor is a significant issue in Argentina. Successful reduction of non-technical electricity losses i.e. unpaid usage of electricity, resulted in a significant number of people losing access to electricity service (though they were earlier enjoying illegal electricity connections). Inevitable consequences were that network expansion in poorer areas were being made through reimbursement by public authorities, i.e. subsidy through indirect public funding. Thus **the perceived success of reform in Argentina (enhanced quality of service and network development) was possible only through the subsidy route** (Haselip, Dyner, & Cherni, 2005). **Other observations include a discussion on social tariff as, through the reform process, low-income customers have benefitted the least and disproportionate economic benefits have traversed to the larger customers**.

In Argentina, "re-reform" of the electricity market is being witnessed (Haselip & Potter, 2010). As the relatively lower price of electricity led to a supply shortage, Government intervention became imperative through policy and institutional changes, notably energy efficiency measures through demand-side management programmes, pre-paid metering to minimise distribution losses etc. There was also an indefinite extension of the key non-market initiative of "4-year framework agreement" to supply to urban low-income tenements (this had been initiated during the initial reform phase). Local authorities reimburse the distribution utilities for the unpaid bills from illegal connections for entire post-privatisation period, through these agreements. The distribution utilities are recompensed for supply to the slums as well as to finance the infrastructure need for supplies (the Federal and State Governments contribute to a dedicated fund). A tax is also levied on payments by the legalised consumers (individual households with meters, as opposed to community metering) to finance the specific fund. The study concludes that despite its shortcomings, the ideas-based ideological former path of reform had a discernible "vision". The post-crisis path of pragmatism adopted through the energy policy did not offer the same.

Pollitt observes that undue political interference in electricity pricing undermines organised markets and effective regulation (Pollitt M. , 2008). There is also criticism of the centralised decision making process in Argentina which reduces regulatory credibility (Spiller & Martorell, 1996).

c. Issue of subsidy

In a recent development, Wall Street Journal reports that Argentina announced a cut on electricity subsidies to wholesale power distributors on 27 January, 2016, increasing their cost by an estimated 350% and saving the government in billions. 2.9% of Argentine GDP (more than 12% of all federal spending, excluding debt repayments) went to meet energy subsidies in 2014. Reasons for subsidy reduction are cited as wasteful use of electricity due to cheapness, decline in quality due to frozen rates, lack of investments, repeated blackouts etc. (Turner, 2016). Reports are also indicating introduction of a social tariff on affluent customers that will provide funds to lessen the impact on poorer households (expected to assist 20% of the 4.6 million users in Buenos Aires area) (Associated Press, 2016).

Literature is yet to be available on the impact of this recent development, indicating down-sizing of both subsidies and cross-subsidy in tariff.

2.7.3 Philippines

a. Overview

The Philippines had a population of 97.6 million in 2013, of which 13.1% are under poverty headcount i.e. around 12.8 million (World Bank). It is a country with a significant population and poverty base, though it may not be strictly comparable with India.

The Philippines proceeded along a reform trajectory, through partial opening of the electricity sector. In an empirical study of the welfare impact of introduction of private sector participation, the conclusion is that the customers and investors have benefitted on an overall basis. Reform with private sector participation generally enhanced social wellbeing (Toba, 2003).

b. Universal charge to recover cross-subsidy

As a part of the reform initiatives, a universal charge was levied on all electricity customers (Cham, 2007) to cover various expenditures in the nature of stranded debts and contract costs, making electricity accessible in remote and rural areas, encouragement of local renewable energy sources through fiscal initiatives, environmental charges and **mitigation fund to address the issue of cross-subsidy elimination. Poor customers who would not manage payment for electricity in entirety would be subsidised under a lifeline rate for a period of ten years, after cross-subsidy removal.**

A separate charge is imposed on all consumers for recovery of shortfalls on account of the subsidy on lifeline tariff and inter-segment **cross subsidy** till full recovery of the under-recoveries is allowed (Forum of Regulators assisted by PricewaterhouseCoopers Private Limited, 2015).

Subsidised tariff addresses the issue of making electricity available for the poor (Mouton, 2015). **Collectively financed by all consumers i.e. residential, commercial and industrial, the benefit is restricted to specific residential beneficiaries alone, and is allowed solely on the basis of the consumption of the household without any connectivity with the revenues of the household.** The system has apparent shortcomings as the **subsidy is not exclusive for the marginalised end-users**, as per legal requirements. **Secondary residences of affluent households with low usage, end up benefitting from lifeline rates.** There are instances where the electricity consumption of low-income households exceed the boundaries available under lifeline tariff due to higher number of members (poor family of ten consumes more than a wealthier childless couple), usage of older, less energy-efficient equipment etc. These lifeline rates apply for another ten years from 2012.

c. Lifelines rates

Lifeline subsidy / discount scheme of Meralco (Philippines) is furnished in Table 2.2 as illustration.

Table 2.2: Lifeline Discount in Meralco (Philippines)

Residential (Consumption)	Lifeline Discounts
0 to 20 kWh	100%
21 to 50 kWh	50%
51 to 70 kWh	35%
71 to 100 kWh	20%

Source: Summary Schedule of Rates effective March 2016 Billing of Meralco (Manila Electric Company)[20]

Interestingly, the distribution utility Meralco opposes lifeline rates as they perceive it as unfair to the better consumers and favouring the difficult consumers (Mouton, 2015).

While the apparent steeper cost-of-supply of electricity in the Philippines, particularly in the context of its Asian neighbours has been criticised, a study (KPMG Global Energy Institute, 2013-14) surmises that in the Philippines, the prices are reflective of the real cost-of-supply, whereas the neighbouring countries (Thailand, Indonesia, Malaysia, Korea and Taiwan) enjoy subsidies in the form of direct government grants for utility losses, tariff caps and fuel cost caps etc. that reduce their average tariffs. These subsidies, however, have been considered unsustainable in the long run as such subsidies have been viewed as unsound economic practice. The Philippines' tariffs, driven by supply costs, are considered as sustainable. **A fully cost-reflective tariff structure, according to the study, protects both the customers from tariff shocks and the investors and developers from recovery risks of their investments.**

[20] From the Summary Schedule, all other consumer categories are seen to provide lifeline rate subsidy and senior citizen subsidy.

2.7.4 Nigeria

a. Overview

Nigeria is a poor country. 53.5% of its population of 172.8 million in 2013 are under poverty headcount i.e. around 92.4 million (World Bank). India's comparable poverty headcount figures are 21.3% and 272.5 million.

Electricity is not available for the majority of Nigerians; the supply to those provided with electricity is also irregular (Okoro & Chikuni, 2007).

There is significant co-relation between availability of power and socio-economic advancement. In spite of abundant natural resources, acute electricity problems are faced by the country. Electricity demand is significantly higher than the prevailing intermittent supply conditions (Sambo, 2008).

In spite of plentiful resources in the form of gas and minerals, Nigeria suffers from electricity poverty. As an instance, per-capita electricity consumption was only 136 kWh, which was low in comparison with other neighbouring West African countries (Ghana and Ivory Coast; which are not endowed with such rich resources, had per-capita electricity consumption of 309 kWh and 174 kWh respectively) (Tallapragada, 2009).

Privatisation of distribution sub-sector was fully effected in Nigeria in November 2013, with 11 distribution companies, though one had to be taken over by the Government in June 2015 due to non-performance (KPMG Nigeria, November 2015).

Since privatisation effort is of a very recent date, the effects are yet to emerge clearly.

b. Inefficiency, subsidy, cross-subsidy and associated issues

Past literature (Tallapragada, 2009) exhibits that while 60% of sales is made to the residential base, proportionate revenue collection share from residential customers is not as high. The tariff structure for commercial and residential customers is also dissimilar, with residences enjoying lower tariffs (cross-subsidy). Existence of unmetered supply for a large segment of residential

customers, billed on the basis of estimations, compounds the problem. Unpaid bills are substantial and are allowed to accumulate, without effective realisation policy and bad debt management. About two-thirds of the receivables are from residential consumer category. Electricity tariff in Nigeria is one of the lowest in the world; operating or capital investment costs are not met by this tariff. Inefficiencies in the form of high line losses and poor collections are major issues, contributing to almost 50% of the notional revenue seepage.

One of the measures for improvement of the sector has been suggested to be discarding of the prevalent estimated billing system and introduction of an accurate billing system with rebates or subsidies to support demand-side management improvements. As a concept, consumers of electricity need to be ready to pay for the amount of energy consumed (Okoro & Chikuni, 2007).

Other available literature on the subject reflects the dismal position of the Nigerian power sector. A study (Obafemi & Ifere, 2013) comments that metering and billing are highly inefficient. There are instances of both raising of exorbitant monthly electricity bills as well as illegal waivers of the same. As theft of electricity is rampant, sector improvement requirements include enabling legislation together with strict inhibitors for both staff and customers upon detection of meter tampering, electricity pilferage and unwarranted debt write-offs. Only two-fifths of Nigerian population have effective access to electricity (while estimated demand is 10,000 megawatts and 7,500 megawatts of capacity are in place, supply is only 3,500 megawatts through the grid - available public-sector capacities are dilapidated under-performers and gas supply shortages cause thermal plants to lose up to one-third of their capacities). Due to shortages, expensive self-generation is resorted to by the public which has a high cost to the economy.

Multi-year tariff introduction proposal from 2009 is discussed (Tallapragada, 2009). The expectation was diminishing government subsidy over a three-year span, with attainment of cost-reflective tariff thereafter. However, the principle of multi-year tariff includes **affordability by various classes of society**, together with the requirement that every unit supplied should

comprise both an efficient cost component and an acceptable return on the investments made. Read together with the proposal for subsidy withdrawal, cross-subsidy continuity is indicated.

Cost reflective tariff was attempted by the Regulatory Commission and there are four residential categories, with lifeline at 50 kWh consumption (KPMG Nigeria, November 2015).

High level of cross-subsidy is exhibited through the Multi Year Tariff Orders (MYTO). As an example, lifeline rate varies between 10.8% and 15.2% of the highest residential tariff category for Ikeja Distribution Company, the utility with the highest load (KPMG Nigeria, November 2015) (Nigerian Electricity Regulatory Commission, 2015).

Recent newspaper articles suggest prevalence of cross-subsidy (residential tariff significantly lower than commercial tariff) and agitation against high tariff increase by the Regulatory Commission (Premium Times, 2016), as well as partial roll-back of tariff on another occasion post-agitation (Premium Times, 2015), widespread electricity theft, poor collection, low generation capacity, extensive use of self-generation, black-outs etc. (Financial Times, 2015), which indicate systemic problems.

2.7.5 United Kingdom (U.K.)

a. Overview

The United Kingdom (U.K.) had a population of 63.7 million in 2013 (World Bank). There is no poverty headcount data available (high income country). While it is not comparable with India, certain aspects of U.K. reform model, particularly in the context of consumer vulnerability, have been examined to draw out lessons for developing countries.

The residential electricity markets of U.K. achieved a world-class level of competitiveness by 2008, with significant consumer engagement as its one dimension and competitive retail margins as another aspect (Pollitt & Haney, 2014). Great Britain is considered to be amongst the earliest and most successful residential electricity markets. Vast literature exists on various nuances of the reform process (Newbery & Green, 1996), (Waddams Price,

2005), (Salies & Waddams Price, 2004). Some relevant ones in the context of consumer vulnerability, are detailed in this study.

b. Issue of consumer vulnerability

The ambit of the regulator has been greatly expanded in Great Britain in consumers' interest. Office of Gas and Electricity Markets (Ofgem) has a clearly defined Consumer Vulnerability Strategy (Ofgem, 2013). **The strategy establishes an ongoing program of work to identify and tackle vulnerability. Ofgem has stated that in performance of its duties, the interests of consumers who are of pensionable age, disabled, chronically sick, on low incomes and living in rural areas need to be regarded** as well as meeting the duties placed on it through the Equality Act, 2010. The Strategy endeavours to understand vulnerability – both in respect of the individual and the market.

The division of responsibility between the regulator and the government is documented by Ofgem. They have focussed on making the energy market work effectively for the consumers, in terms of access to services, choice, debt and affordability, through monitoring the market, identifying best practice and where appropriate, creating regulation. Ofgem considers that the government has a wider role - to consider sustainability, security and affordability. The tools available to the government differ as they are able to establish direct price support for certain consumers and energy saving programmes.

The Consumer Vulnerability Strategy Progress Report (Ofgem, 2015) has details on Warm Home Discount Scheme of the government, under which suppliers with more than 250,000 residential consumers (gas and electricity), provide electricity bill rebates and indirect support to low-income consumers. With a focus on fuel poverty, **Ofgem encouraged introduction of tailored social tariffs for vulnerable consumers.**

While Ofgem, in its Progress Report, terms their initiatives as ground-breaking, insufficient literature seems to be available on the subject to test its effectiveness, probably because of the newness of this initiative. However, from the documentation, it is apparent that there is a well-laid process to

identify the vulnerable consumers, which are not necessarily limited to just poor consumers. There is also a **multi-prong strategy to mitigate the issues faced by the vulnerable consumers**. A clear **demarcation between the responsibilities of the government and the regulator in tackling the issue of vulnerability is also exhibited.**

c. Criticism

U.K. model of electricity reform, which is a widely accepted pioneering model, is recently facing criticism, for politically motivated interference in market operations (Pollitt & Haney, 2014). Changes in the policy since 2008 to protect the interests of vulnerable customers is working to the detriment of the customers with inappropriate restrictions (Littlechild, 2014).

Waddams Price suggests that the Labour government of 1997 enlarged the scope of regulatory intervention to include protection of the interests of the customers in the lower bracket of income and the need to consider social leadership extended by the government. Programs to remove fuel poverty were also instituted (Waddams Price, 2005). Her recommendation is against imposing of restrictions at that stage bringing fresh costs and instabilities into the market. She had commented on the i**nnovations brought into the tariff structure at that point, including tariff without standing charges i.e. only variable charge being levied, as well as tariff with no variable charge i.e. only fixed cost** (later eligibility conditions were narrowed down to households with occupants over 60 years old with relatively small energy usage). However, later literature suggests that innovations were whittled down as restrictions appeared on the number of products in total that can be introduced (Pollitt & Haney, 2014), (Littlechild, 2014).

2.7.6 Demographic profile of the selected countries

The demographic profile of the selected countries and India is given in Table 2.3, which indicates that while Nigeria, a poor country, has 53.0% poor population, the number, by head-count, is merely one-third of India. The Philippines, have 13.1% (12.8 million) poor and are generally considered successful in progress towards cost-to-serve tariff. However, their poverty

headcount is just 4.7% of India's poor population. Chile and Argentina have insignificant numbers of poor. India's task of power sector reform is rendered onerous by the sheer force of numbers (Chatterjea & Dwivedi, 2016). It emerges as an important consideration in Indian reform initiatives.

Table 2.3: Demographic Profile of Selected Countries in 2013

Country	Population (Million)	Poverty Headcount[21] (%)	Poor Population (Million)
		(2)	(3 = 1 x 2%)
Chile		0.9%	0.16
Argentina	42.5	(1)	0.70
Philippines	97.6	17.6	12.8
Nigeria	172.8	53.0%	92.4
United Kingdom.	63.7		
India	1279.5	21.3%	272.5

Source: World Bank. Poverty headcount percentage of the Philippines is for 2012, Nigeria 2009, India 2011. For the United Kingdom, a high income country in World Bank analysis, there is no poverty headcount data available

2.8 INDIAN SCENARIO

2.8.1 Tariff of residential and small consumers in India

Concerns have been expressed on politicisation of power pricing, especially for supply to rural and residential sectors. There are comments ranging from a view that residential and agricultural prices of power have been kept at artificially low levels in almost all states for nearly half a century in order to placate the general population, with the consequence that commercial and industrial tariffs are inordinately high (Shahi, 2005), extremely slow progress on tariff rationalisation has been observed (Kumar & Chatterjee, 2012), subsidy to the agriculture and the residential sector has been increasing over the years, even after regulatory reforms began in India (Garg & Gulaty, 2004), etc. In an overview of practices in Indian regulatory framework including case

[21] Poverty headcount data is at $1.90 a day, source: World Bank.

study of three states, the finding is that the regulators are using creative tools to keep tariff in check like regulatory true-up in Karnataka, impracticable efficiency gain targets in Andhra Pradesh, use of regulatory assets in Delhi.

Rationalisation of tariff, wherever attempted, was either met with stiff resistance or was rendered futile by the government with matching subsidy (Dubash & Rao, 2007).

There is serious criticism of subsidy leakage in India. Findings reveal that most states subsidise a substantial portion of residential consumption and much of it reaches undeserving candidates as more than half of subsidy payments (52 percent) India-wide flowed to the richest 40 percent of households in 2010. In contrast, one-fourth of Indian households do not have access to electricity and therefore receive no subsidy. This underscores the need and scope for better targeting, which would also result in lowering of overall subsidy quantum to be made available to households (Pargal & Ghosh Banerjee, 2014).

Significant subsidy and cross-subsidy exist in Indian system. A study covering 55 utilities of India (97% of sales) (Chatterjea, Dwivedi, & Sengupta, 2016) indicates that different states have varying definitions of lifeline consumers, ranging from 15 kWh monthly consumption in Tripura to 200 kWh monthly consumption in Punjab. Some states do not define lifeline, but end up subsidising large chunks of residential / low-end commercial consumers. A ceiling for contracted load is not incorporated in the definition of lifeline in many states and varies between 120 watts to 1000 watts in others. Without "contracted load" or "connected load" in the definition of lifeline, secondary homes of the rich, empty apartments, etc. end up enjoying subsidy. Due to consumption basis of lifeline definition, splitting of consumption is rampant, as people divide their requirement across plural meters to enjoy subsidised tariff.

Consumer profiling together with an analysis of living standards for 7000 consumers with consumption upto 25 kWh (3500 consumers) and between 26-60 kWh (3500 consumers) in urban and fringe areas of Kolkata, has been studied (Indian Institute of Social Welfare and Business Management, 2005).

The study analyses living conditions, family size, demographic profile and lifestyle parameters of the sample population with further refinement in each group. The report is useful in the context that it sets the parameters requiring further analysis to assess lifeline consumption in India. From the demographic profiling in the study, with suitable indexing for inflation, the monthly income parameters available are summarised in Table 2.4.

Table 2.4: Consumer Profiling with Family Income

In Rupees

	Monthly Income		Annual Income	
Monthly Consumption	**Kolkata**	**Fringe Area**	**Kolkata**	**Fringe Area**
Corresponding to Survey Period				
Upto 25 kWh	2525 *	2374 *	30295	28487
26-60 kWh	3967 *	3632 *	47610	43585
Inflation Adjusted - March 2016 (WPI)				
Upto 25 kWh	4368	4107	52410	**49282**
26-60 kWh	6864	6283	82364	**75401**

* Source: Study on Electricity Consumers' Profile & Living Standard (Phase I) by Indian Institute of Social Welfare and Business Management, Kolkata. Other figures are derived

The study gives a starting point that at current prices, about **Rs.50,000 is the annual average income of consumers with monthly consumption within 25 kWh per month and Rs.75,000 is the annual average income of consumers with monthly consumption between 26 kWh and 60 kWh per month.**

Absence of adequate residential electricity consumption data in India has been expressed as a concern and need for development and periodic conducting of a Residential Energy Consumption Survey (RECS) has been given as a recommendation (Prayas (Energy Group), December 2016).

2.8.2 Cross-subsidy criticism and subsidy leakage in India

Sub-optimal condition of Indian industrial cross-subsidy has been traced in a number of studies. Sub-optimality was tested estimating demand-variant price-elasticities of demand for industrial consumers using Box-Cox and linear

regressions. The finding is that cross-subsidy was sub-optimal at least for some of these consumers (Chattopadhyay, 2007).

Higher tariffs in industrial sector are failing to compel flow of more cross-subsidy has been demonstrated with graphical and algebraic approaches, with a conclusion that even for the purpose of collecting cross-subsidies, there is a necessity for reduction of industrial tariffs in India (Chattopadhyay, 2004). This study is of the view that competition will thwart cross-subsidies. Even though licensees under government control might still be charging prices higher than the average cost-of-supply to the subsidisers, convenience of private participation into generation would buoy up both self-consumption by the subsidisers and price competition.

A report of the United Nations Foundation (Morgan, T., Menecon Consulting, 2003) has identified the key issues that need to be addressed in the context of Indian subsidy scenario. First is the identification of the segment requiring subsidy. Subsidies may be given to the poorest existing customers as well as the residential / agricultural customers who are presently not connected to the distribution network. Next is the issue of identification of the type of service to be subsidised; access to service could be subsidised for customers without service. Third, is devising of a subsidy mechanism, to reach targeted customer groups and provide incentives for efficient service delivery. A preference for demand-side subsidies has been made over production subsidies. The final issue is quantification of subsidy, unnecessary market distortions should not be created and sustainable, profitable service should not be impeded. However, subsidy should also be adequate to provide **an impetus to the utilities to spread out to poor households with electricity service. To ensure effective targeting of subsidies, lifeline rates need to be circumscribed within modest levels of consumption, such that subsidies are not arrogated by affluent households.**

Another report by the South Asia team of World Bank finds that more than two-thirds of residential subsidies in India leak to non-poor. In spite of this generous subsidy regime, a large majority of the residential tariff subsidies are not reaching the targeted groups. In 2010, 70 per cent of subsidy payments

leaked to households living in the richest 60 per cent of income distribution. Only 14% of subsidies went to households in the poorest income quintile and 16% went to households in the second poorest income quintile (Pargal & Ghosh Banerjee).

2.8.3 Criticism of policy of encouragement of consumer flight without addressing cross-subsidy issues

Cross-subsidising consumers are allowed to move out of the distribution utility's system on payment of an exit charge, through open access of wires. In India, with subsidies, cross-subsidies, distribution losses, withholding of legitimate expenses through creation of regulatory assets etc., the role of open access is circumscribed (Rao, 2012).

Criticism of open access is that large industrial players, who are likely to forsake the system, keep the sector viable to an extent by cross-subsidising the smaller players like agriculture and residential customers. In case they source their power requirement from independent private generators, financial position of the licensees would deteriorate further, leading to diminution in quality of service to the poor. The issue of open access is required to be reviewed at the political level, with due cognisance of the impact on the poor and the vulnerable who have no other option for service (Dubash N. K., 2011). Dubash is of the opinion that while **open access is being encouraged as an economic instrument, it is effectively a political reform mechanism to deal with the historical legacy of electricity tariff and subsidy signalling.**

In the Foreword (Kumar & Chatterjee, 2012), Pramad Deo opines that **since it may not be viable to drastically slash subsidies, they can be indirectly whittled down by allowing the subsidisers (large industry and commercial customers) to exit from the public system, leaving no alternative to the remnant consumers and increasing prices in a roundabout manner.**

2.9 CROSS-SUBSIDY VALUATION

2.9.1 Cross-subsidy definition and measurement are usually based on cost allocation

Public policy and management accounting are interlinked through definition and measurement of cross-subsidy, as it involves significant concerns of identification, measurement and public policy signals. While some scholars dispute the theory of cross-subsidy measurement from cost allocation, most empirical studies are seen to commence from cost allocation (Heald, 1996). Costs are often not accurately captured / allocated by distribution utilities (Joskow & Marron, 1991). In gradually deregulated markets, the critical constituents of consumers' electricity prices continue to be the costs - both internal to the electricity distribution enterprises and the external markets of electricity procured from electricity producers / sellers (Papler & Bojnec, 2012).

Utility services need specialised cost allocation theory, due to the nature of the service (Conkling, 2011). Basic tenets of cost allocation theory are available in the context of gas pricing but holds good for electricity pricing as well, subject to specific modifications. Discussions also include benefits and use of total costs as opposed to marginal costs. Usage of marginal / incremental cost principles in utility service is recommended in three instances i.e. for innovative services which are yet to achieve public acceptance, in competitive fields and for interruptible customers.

While direct costs are easily ascertainable, indirect or joint / common costs require detailed allocation principles. The process starts with functionalization of costs into generation / production, transmission, distribution, etc. These functional costs are further categorised into demand-related, energy-related and customer-related costs.[22]

[22] Electricity cost is broadly studied under three heads: a) customer related costs. The simplest of the three, it is the cost caused by each customer or customer specific costs. Overall cost identified under this head is divided by the number of customers to arrive at customer related cost for each customer, e.g. the cost of printing an electricity bill, the cost of reading a meter,

For allocation amongst demand and energy charges, four formulae have been discussed, namely, the Seaboard formula, the United formula, Modified Fixed-Variable (MFV) formula and the Straight Fixed-Variable (SFV) formula. Table 2.5 compares the formulae for cost allocation with relevant modifications for electricity industry (by expanding / elaborating upon the principles for natural gas supply of U.S.A.).

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etc.; b) commodity cost or energy charge related costs or generation costs. It is the cost of energy in-built into each unit of sale. Apparently simple, the complexity in energy charge allocation arises with the issue of assigning differently priced energy to different categories (as the basket of electricity available to a distribution utility has a number of differently priced electricity products from different sources). While dispatch of electricity usually follows a merit order protocol (exceptions are due to technical reasons of keeping a generating plant running, network constraints, green power sources which are often operated as must-run stations, irrespective of costs, etc.), the basis for assignment of differential electricity charges is a debated issue. Generation / energy-related costs could have a variable and a fixed component (e.g. capacity charges payable to an independent power company), and c) demand-related costs. The issue here is the method of distribution of the cost of network and associated costs amongst the customers viz. determination of the extent of share flowing to a customer who is using the network at its peak i.e., he is a peak causer or sharing of such costs by all users following some predetermined guiding principles etc. The acceptable allocation principles for demand-related costs are "co-incident demand peak-responsibility" (system peak) and "non-co-incident demand peak-responsibility" (class peak) methods or a combination of these two methods. The relationship between the three broad costs could be simplified as the cost of the utility for its readiness or preparedness to serve the requirements placed on it (demand-related costs), the cost of the commodity being served (energy-related costs) and costs relatable to a specific consumer (consumer-related costs).

Table 2.5: Comparison of Formulae for Cost Allocation[23][24]

	Demand Related Costs (%)	Energy Related Costs (%)
Straight Fixed Variable (SFV) Formula		
Fixed costs (including fixed generation costs)	100	
Variable costs (including variable generation costs)		100
Seaboard Formula		
Fixed costs of distribution	50	50
Variable costs (including all generation costs, both fixed and variable)		100
United Formula		
Fixed costs	25	75
Variable costs (including all generation costs, both fixed and variable)		100
Modified Fixed Variable (MFV) Formula		
Fixed costs		
1) Return on equity and associated taxes		100
2) Other fixed costs	100	
Variable costs (including all generation costs, both fixed and variable)		100

Source: Adapted from Energy Pricing: Economics and Principles (Conkling, 2011). Allocation principles outlined above have not remained unchanged throughout their prevalence but been adjusted at times to accommodate prevailing interests of the economy

[23] Cost is also studied from fixed and variable aspects. Variable cost varies with each unit of output whereas fixed cost remains fixed over a specific period, usually relatable with the time period of the analysis and is independent of the output within a band. Fixed costs include cost of investment in capacities or capacity costs. In utility business, these are embedded costs, historic costs or sunk costs and unless recoverable they might become stranded costs (Conkling, 2011).

[24] The formulae addresses various methods of cost allocation into demand and energy related cost buckets. Consumer related costs are usually attributable on cost per consumer basis. In a two part tariff scheme, demand charge / fixed charge is meant for recovery of demand-related costs and energy charge for recovery of energy-related costs. Customer-related costs are either to be separately recovered on per consumer basis or built into fixed charge.

Seaboard Formula has its detractors, primarily because peak load responsibility is being shifted, through allocation of fixed cost on energy related costs / charges, upon off-peak users. Thus, it doesn't give correct signal to peak users and unnecessarily increases off-peak cost (Kahn, 1988). However, variations are permitted by the regulator (Federal Power Commission in this instance).

The necessity of application of judicious principles in allocation as well as the inexact nature of the science of allocation is a leitmotif of literature (Heald, 1996), (Conkling, 2011) and has been recognised by U.S. Supreme Court as well.[25]

A case has been made out for cross-subsidy valuation to be between stand-alone cost and incremental cost of a product for a multi-product utility company. Both incremental cost and stand-alone cost are tools to define subsidy-free prices (Faulhaber, 2002). This definition of cross-subsidy has wide following.

A formal definition of cross-subsidy has developed. Cross-subsidy is considered non-existent where the revenue from each product covers the incremental cost of that product (incremental cost is the additional cost of producing a product, over and above other products offered by the organisation; alternatively, incremental cost is the long-term cost that would be avoided, if the product is no longer offered). Two tests are applied, to appreciate existence of subsidy. The first test ascertains whether revenue generated by a product is greater than its stand-alone cost (this is a necessary

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Two extracts from the U.S. Supreme Court and the United States Court of Appeals respectively dwell upon the issue of inexactness of cost allocation, together with an adjunct to adopt a method which yields *"just and sound result"*.
"Allocation of costs is not a matter for the slide rule. It involves judgment on a myriad of facts. It has no claim to an exact science."(324 U.S. at 589) "These circumstances illustrate that considerations of fairness, not mere mathematics, govern the allocation of costs." (324 U.S. at 591) in Colorado Interstate Gas CO, F.P.C, 324 U.S. 581 (1945).
"Mathematical exactness in the apportionment of cost is an impossibility. Because a method may have some infirmities does not of itself condemn it as a proper method. It is the duty of the Commission to select that method which in its considered judgment more nearly reaches a just and sound result." in Colorado Interstate Gas Co. v. F.P.C., 209 F. 2d 717, at 726 (1953) (Conkling, 2011).

but not a sufficient condition to indicate subsidy is actually given by that product). The second test ascertains whether revenue generated by a product is adequate to meet the incremental cost of that product and establishes presence of subsidy in case the response is in the negative (Blagojevic, Markovic, & Dobrodolac, 2010).

Measurement of cross-subsidy in the context of telecommunications industry has analysed formal economic approach to cross-subsidy measurement; the study exhibits through detailed analysis that difficulties exist in deriving a convenient measurement system from theoretical analysis. Use of current cost allocation procedures achieved from ordinary accounting data provides for a more robust method (Curien, 1991).

In the context of Laspeyres Price Index under stationarity assumptions, which converges to Ramsey prices, the observation is that the forecasts require the same forbidding amount of information as the derivation of Ramsey prices. Therefore, better approximations are to be sought. Allocatively inefficient pricing under the rate of return regulation which implied cross-subsidisation of unregulated by regulated services and suppression of allocatively efficient peak load pricing is also criticised (Vogelsang, 2002).

Practical solutions are recommended in incentive regulation, and the same has been found to be superior to optimal regulation methods. It is inferred that marginal cost pricing or Ramsey pricing, which are specific pricing formulae, are not necessarily appropriate for direct application (Viljainen, 2005).

2.9.2 Cross-subsidy valuation: the significance of peak load pricing

A criticism of price-gap calculation is its reliance upon average values. Such distortion through smoothening is exhibited across time-horizons (where varying prices throughout the year is coalesced to a single figure), across products (standardisation; failure to recognise base-load / peak-load variations) across regions etc. (Koplow, 2009).

Peak load pricing has been considered allocatively superior (Vogelsang, 2002).

Another study goes a step further and comments that the theoretical framework of peak load pricing is fairly advanced, and has been used efficaciously in airport and hotel industries. Regulated network industries, like power and telecommunications, had the edge as first-movers and had potential benefits from peak load pricing. However, the regulated nature of electricity, circumscribed the extent of potential profits from innovative pricing etc., thereby limiting application of peak load pricing and eventual loss of the first-mover advantage (Crew & Kleindorfer, 2002).

There are benefits of dynamic pricing. Industries accumulate extensive real-time data on supply-demand fluctuations and can utilise such information to adopt refined stratagems (Joskow & Wolfram, 2012).

While electricity price alignment with marginal costs is desirable from an economist standpoint, a real-world example is provided through real-time pricing of residential consumption to exhibit that both cost of information and contracting outweighs welfare advantages. On an evaluation of the response of residential consumers to time-of-use pricing (hourly tariff with real-time considerations), the finding is that the consumers responded to higher price signals in peak period through energy conservation. However, corresponding increase in electricity consumption was not perceptible in off-peak periods. It is inferred that the estimated costs of the advanced metering equipment needed for the purpose, is not counterbalancing the efficiency gains to these residences (Allcott, 2011).

Similar finding is exhibited, through use of panel data at household-levels from administrative records. It is evidenced average price garners better customer response than expected or actual marginal price. Thus, energy conservation targets are rendered unsuccessful by such sub-optimizing behaviour and welfare implications of non-linear pricing are substantially altered (Ito, 2014).

Dynamic pricing programs are likely to evolve slowly, and is expected to be voluntary in the initial stages. While both cost reduction and technological advances have made dynamic pricing of electricity possible, in reality, the option of real-time tariff is not available to most U.S. residences. Flat-rate

pricing is expected to continue as the default option. If customers with an even demand profile move away from average rates, the cost to serve the households retaining average rates experience enhancement, as their consumption during costlier peak hours remain high (Joskow & Wolfram, 2012).

2.10 OTHER PERTINENT ASPECTS OF REFORM, SUBSIDY AND CROSS-SUBSIDY

Quite another aspect of cross-subsidy is available, where cross-subsidy is understood to be a situation where vertically integrated firms in the electricity sector simultaneously provide regulated and unregulated services, viz., transmission and distribution are regulated, whereas generation and retail are open to competition and these integrated firms use income generated in the regulated sector to cross-subsidise their unregulated activities. This cross-subsidisation leads to an unfair competition between the incumbent and the entrants (Willems, Ehlers, & Marti Fraga, 2007).

With reference to Scottish water system, available literature suggests two methods of pricing cross-subsidy - fully distributed cost (FDC) and subsidy-free prices. For subsidy-free prices approach, cross-subsidy is considered to be present when removal of one service benefits users of other services. Two cost concepts are the cornerstones of this theory, being incremental cost (the increase in cost for producing one unit or serving one customer-group over and above another group) and stand-alone cost (the notional cost of separately producing each unit or serving each customer-group). Absence of subsidy is demonstrated if pricing is within the range between incremental and stand-alone costs. While subsidy-free pricing is conceptually a more correct methodology, it was discarded in the context of Scottish water system in view of its challenging information requirement. In the context of regulatory valuation of cross subsidy, practical implementation has made FDC the methodology of choice and is extensively applied. It uses allocation to directly appropriate all costs across products and customer groups, using accounting principles for joint and common cost allocation (for a multi-product business). **Choice of allocation principles adopted plays a significant role in this**

approach. Principles of accounting for joint / common costs include relative output method (allocation on the basis of each product's share of total output), gross revenue output (allocation with respect to each product's share of total revenue), net revenue (allocation in proportion to each product's contribution to net revenue, after deduction of direct costs) and attribute cost method (allocation on the basis of each product's share of total attributable costs). A cost allocation methodology is outlined, where operational expenditures are allocated on the basis of proportionate shares in output, with function-specific definitions of output. Capital expenditure allocation is on the basis of proportionate capacity shares. Customer service costs may be directly available from costing records. Overhead costs and retained surplus are allocated on the basis of attributed wholesale cost share for each customer group. FDC is feasible to implement as a process (Stone and Webster Consultants Limited, 2005).

In the context of postal system, an allocation system through identification of cost drivers following cost accounting principles is available in academic literature (Blagojevic, Markovic, & Dobrodolac, 2010).

On sustainable development, the comment is that **sustainable developments require recognition of the integrated nature of policies and their effects i.e. a more assimilated perspective** (Steenblik, 2003). The paper analyses subsidies in the context of an OECD workshop on environmentally harmful subsidies. Subsidies had earlier been measured from partial perspective, sector-by-sector. There are disparities on coverage, systems of classification and measurement methods. **Adoption of an inter-connected framework is recommended.**

Vogelsang emphasise the need for simplicity and transparency in the pricing of electricity together with political feasibility (Vogelsang, 2006). **Particularly for retail market of electricity, simplicity has been considered an important parameter**. Sophisticated pricing also means elimination of former cross-subsidies and is politically unpopular. The view presented is that **optimal pricing has been modified to incorporate social needs**. **Practical applications of pricing of electricity is underscored** through this study.

2.11 COST OF SUPPLY

2.11.1 Assessment of prevalent situation through studies and reports: voltage-wise / category-wise details

Prevalent Indian situation has been scanned through regulations on tariff, cross-subsidy and cross-subsidy removal roadmaps (if available), of the State Electricity Regulatory Commissions. A detailed list of the 55 distribution licensees studied for this purpose, is provided in Table 2.1.

To assess the current position, other literature surveyed includes an analysis of impact of tariff orders on Indian power sector (Garg, Gaba, & Bajaj, 2008) which has captured cross-subsidy and cross-subsidy surcharge existing in a few Indian States, where cross-subsidy has been positioned in the context of average cost (average tariff) vis-à-vis average tariff of that category. The study focusses on a few states as well as a few categories of consumers. **Segment-wise tariff or assessment of cross-subsidy vis-à-vis cost-of-supply has not been studied.**

In a review of last 10 years' experience of electricity reforms and regulations (Pandey & Morris, 2009), **high level of cross-subsidy surcharge** in the context of open access is criticised, but the same does not deal with **reduction of cross-subsidy**, which goes hand-in-hand with surcharge reduction.

Another study (Kumar & Chatterjee, 2012) expresses serious concern on slow progress by the State Commissions on tariff rationalisation with specific example of cross-subsidy reduction.

A report (Power Finance Corporation Limited, June 2012) endeavours to capture the extent of cross-subsidisation for major agricultural States by providing a comparative picture of the energy sold to "Agriculture" and "Industrial" in percentage terms, vis-à-vis percentage of total revenue derived from these two categories of consumers. This has been considered to be *"the level of cross-subsidy from Industrial consumers to Agricultural consumers."* (paragraph 5.5).

Similarly, the Annual report of the Planning Commission (Power & Energy Division) (Planning Commission (Power & Energy Division), Government of

India, October 2011) exhibits figures of average tariff (all-India and States), average tariff of consumer categories (all-India – major categories), average cost of supply as well as subsidy figures (paragraph 4.4 to 4.7). Gross subsidy figures over 2007-08 to 2011-12 AP, including cross-subsidy (euphemistically termed as *"surpluses generated from sales to other consumers particularly industrial and commercial consumers"*, are also furnished (paragraph 4.8).

A study (CRISIL Risk and Infrastructure Solutions Limited) commissioned by the Forum of Regulators of India, comments upon the absence of notification of milestone-based roadmaps by the Commissions for bringing down the cross-subsidy levels to within ± 20 % of the average cost-of-supply. At end-2009, the cross-subsidy levels still remained high vis-à-vis the targeted ±20% band, provided through the National Tariff Policy. Moreover, **many Commissions were considering average cost-of-supply for determination of category tariff due to paucity of voltage / category wise data availability from the licensees**.

Contextually, it may be mentioned that the Economic Survey of 2015-16 prescribes **cross-subsidisation within the residential category with higher cost being loaded upon higher consumption (with price inelasticity), thereby relieving of burden on industry as well as making tariff simple and transparent** (Ministry of Finance, Government of India, 2016).

2.11.2 Cost-of-supply studies

While some cost-of-supply studies are available on the subject, paucity of data leads to inevitable distortions. A study commissioned by the Forum of Indian Regulators for assessment of cost-of-supply to **agricultural consumers** and methods to **reduce cross subsidy for agriculture category** (The Energy and Resources Institute and Dhiya Consulting Private Limited, 2010) highlights the problem of data inconsistency. This study provides a methodology to arrive at cost-of-supply, discards marginal cost method, is in favour of embedded cost with rationale for such choice, and captures agricultural cross-subsidy on an overall State-specific basis (for a few States). However, **the study is limited to cost-of-supply for agricultural consumption**.

Some guidance on cost-of-supply calculation is available in the Model Regulations for Multi Year Distribution Tariff, which, however, is limited to consumer categories and not segments (Forum of Regulators, assisted by Crisil Infrastructure Advisory).

Even the Appellate Tribunal for Electricity, acknowledging that there is paucity of accurate data, has suggested *"a simple formulation which could take into account the major cost element to a great extent reflect the cost of supply"*.[26]

A recent study, providing some insight on the subject (Forum of Regulators assisted by PricewaterhouseCoopers Private Limited, 2015), **suggests a simplified approach regarding cost-to-serve. It has also underlined the need for detailed cost-of-supply studies. It did not specifically undertake a cost-of-supply study of segments like lifeline, other residential categories at specific consumption levels like low, medium, high (determined usually with reference to a monthly consumption slab), commercial sub-categories** (ranging from small local grocery shops to malls) etc.

An assessment of prevailing status of cost-of-supply studies has been undertaken for all 55 utilities, listed under Table 2.1 (these utilities together cover over 97% of supply met in India by volume of sales). **Intra-category-wise (segment-wise / slab-wise) cost-of-supply has not been undertaken by any utility, which is *inter alia* necessary to ascertain real cost-to-serve lifeline / low-end segments.** Utilities of Punjab, Andhra Pradesh and Telangana are the only utilities to undertake a simple category-wise differentiation. Delhi, Himachal Pradesh and Bihar, undertake a voltage level-wise analysis. Some others arrive at only some voltage level-wise network charges. Available cost-of-supply models largely do not display detailed cost bifurcation in low-voltage categories; absence of allocation of consumer-specific costs is notable. The analyses primarily displays derivation of network

[26] Judgment of the Appellate Tribunal for Electricity in Appeal Nos. 102, 103 & 112 of 2010 dated May 30, 2011, available at http://aptel.gov.in/judgementnew.html, last accessed on March 8, 2013.

related costs by utilities to aid in arriving at network usage charges for customers exiting the system through open access (as the related voltage level network costs are derived). However, as already stated, **the existing models have not analysed segment-wise cost-of-supply or cross-subsidy within the same consumer category.** Dissatisfaction with the models / paucity of data has been commented upon by some of the State Electricity Regulatory Commissions. Details of the extent of data availability under this head have been summarised in **Exhibit 2**.

2.12 REVIEW ANALYSIS

The business problem of acute financial distress of the distribution utilities read with issues of exiting prime customers and the requirement of providing welfare tariff to large swathes of poorer segments points towards the need for realistic determination of cross-subsidy. While literature survey indicates that there are many approaches on cross-subsidy understanding and determination in sectors ranging from postal system, water supply, electricity, telecommunications etc., it is seen that most of the sectors are still under governmental control in India with non-transparent pricing system. Although literature survey indicates that discussions on cross-subsidy must be quantitative and not only qualitative and that it is necessary to define cross-subsidies accurately to arrive at a method of measurement, there is lack of uniformity in understanding the methods of cross-subsidy measurement and implications of the various methods. There is an apparent gap in understanding of a suitable approach on cross-subsidy determination.

While literature survey further emphasises that for a reform model to be successful, it is recommended that tariffs are re-aligned with costs prior to regulatory reforms and introduction of competition, thereby implying reduction / elimination of cross-subsidy, policy instruments (notably, the Electricity Act, 2003, the National Electricity Policy and the Tariff Policy) indicate that such attainment of cost-of-supply was not undertaken at a pre-reform stage. No specific study is available on the extent of progression of tariff towards cost and consequent cross-subsidy reduction in Indian electricity market, within the framework of policy instruments.

The crucial gap which has been identified through literature survey is the absence of reliable data on actual cost to serve the consumers. While this understanding should form the basis of any pricing decision-making, as well as inter-connected steps i.e. how to handle subsidy / cross-subsidy etc., there is no available literature on the differential cost to serve the segments. Cost-of-supply studies are found to be rudimentary, without adequate treatment of consumer specific costs and without analysis of intra-category wise cost segmentation. Moreover, the issue of vulnerable consumers i.e. the requirement of protection of such consumers in a cost-reflective reform model, if any and the methodology of addressing this issue, based on realistic information on cost-to-serve the poor / lifeline / "Below Poverty Line" / vulnerable consumers is not available. Important steps like introduction of competition, exit of large consumers through open access, continuity of cross-subsidy (to the detriment of industrial consumers), proposal to separate the wire business (carriage) and retail business (content) (as proposed through amendments to the electricity law), subsidy provision for large chunks of consumers, introduction of renewable power in a substantial scale, are all being undertaken with imperfect understanding of the cost to serve the various segments.

2.13 CHAPTER SUMMARY

Existing literature was reviewed to assess the requirement and significance of progression towards cost-to-serve in a reformed electricity environment, and its influence on the tariff of the vulnerable segments. With the suggestion emanating from literature survey that application of a cost-to-serve model in a reformed / competitive environment is inevitable, the necessity emerged for surveying international literature on rendering of protection to any consumer stratum. Literature review of five countries in different stages of reform elicited inputs on subsidy and protection needs for vulnerable consumers. Literature review was also carried out to understand the subsidy regime in the Indian context. Finally, some understanding on the theory and practice of cost-to-serve calculations was attempted.

Cost alignment was discovered as the first step of reform in a standard reform model. Limited scope of charging above-market costs in a competitive model was noted. For fulfilment of social policy objectives through electricity pricing, implementation issues were noted and requirement of legislative intent and a non-avoidable levy to meet welfare needs were observed. Reform results in erosion of cross-subsidy with political and welfare consequences including need for support to low-income consumers. International scenario revealed discouragement of cross-subsidy in electricity tariff, with only specifically approved cross-subsidies allowed through the tariff structure to fulfil socio-political obligations, with nominal distortion of electricity prices of the customers engaged in productive activities. Predictably, industrial tariff was found lower than residential tariff in developed countries, with commercial tariff displaying mixed signals vis-à-vis residential tariff. Overall, regulation need for protection of small consumers was observed together with progression of price regulation mechanism from marginal costing to social welfare maximisation. Protection of vulnerable consumers was found to be at a developed level in the U.K., social objectives were endeavoured to be met in Argentina and Chile, the Philippines came with an ingenious solution of universal charge to address cross-subsidy / lifeline consumer issues, whereas Nigeria exhibited extensive cross-subsidy and a struggling electricity sector. Electricity consumption, level of income and specific attributes of the country, were discovered as important factors behind margins and extent of cross-subsidy in electricity pricing. Indian cross-subsidy situation was reviewed with its inability to charge actual costs to consumers. Criticism of the policy of encouragement of consumer flight without addressing the cross-subsidy issue was noted. Finally, definition and measurement of cross-subsidy based on cost allocation was studied in detail, with the underpinning theories. The chapter ends with crystallisation of some requirements, emanating from the review, notably need for a segment-wise cost-of-supply study and specific treatment requirement for vulnerable customers.