A Regulatory Policy Design Map: A case of Electricity Pricing Policy

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Abstract

The Electricity sector is on the cusp of big business and government. Pricing policies are strategic as they determine the business model of a company. This paper proposes a regulatory policy design map that explores the decision-making criteria and contexts used in selecting appropriate pricing mechanisms. This map is based on a literature survey of electric utility regulation in the USA. An Empirical model of this regulatory policy design map is also proposed and validated through a survey of experts in 7 Indian cities. This regulatory policy design map is not only cross national but also applicable to other regulated network industries and is a contribution to the literature on strategy, public policy and business environment.

Keywords: *Business And Public Policy; Business, Government And Society; Business Environment; Strategy*

Introduction

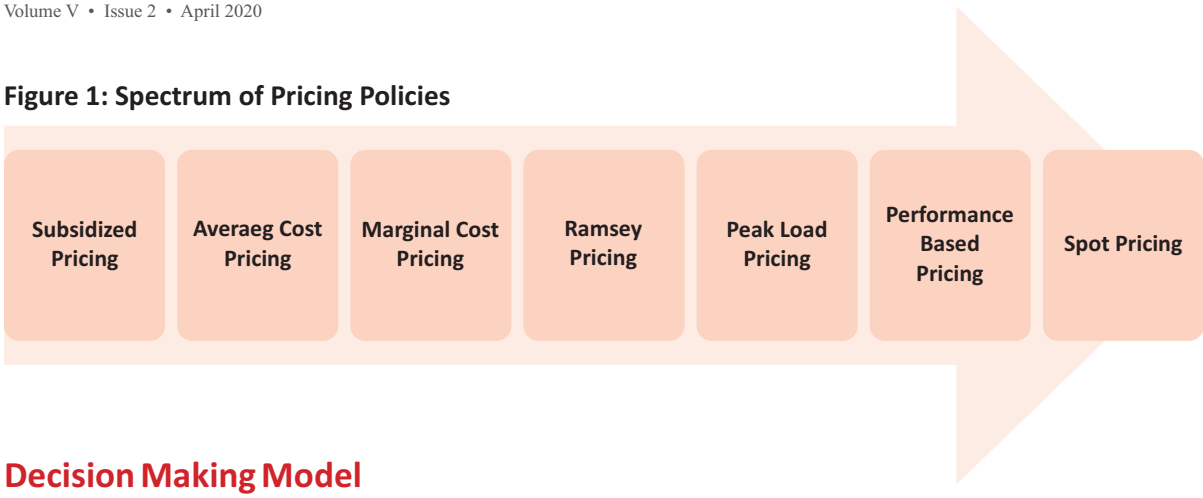
The Electricity sector is on the strategic cusp of Business, Government and Society. It is an integral part of the infrastructure of any economy. It is a sector which is increasingly being privatized all over the world. There have been debates about both regulation and deregulation of the sector. Pricing Policies are strategic as they determine the business model of a company. Electricity Pricing policies are regulated by governments all over the world for economic, social and political reasons. Hence, Electric Utilities in the private sector have to contend with regulation of their tariffs to achieve both economic and social policy aims of the government. Understanding how these electricity pricing policies have changed and evolved in the US under the regulation of State Public Utility Commissions would help us get insights into policies in India, which has adopted the US model of regulation of the electricity sector after the Electricity Act of 2003.

Pricing options: Spectrum of Electricity Pricing Policies

The first question that arises is - what are the pricing options available to a strategic decision-maker? There are two ways in which a menu of electricity pricing policy options can be specified. One way is to consider the historical contexts in which these policies were adopted (Parmesano and Martin 1983). Another way is to consider the political spectrum of options (Enholm, Jaditz, and Malko 1982). At one end of the political spectrum, there will be government ownership and supply, and at the other end, there will be free markets. Being open to all options in this menu is a pragmatic attitude that avoids the grand and yet simplistic dichotomies between central planning and *laissez-faire* (Schneider, Ingram, and DeLeon 2014). Figure 1 shows a political spectrum of seven pricing policies ranging from liberal (pro-government intervention) options on the left to conservative (pro-market) options on the right of the diagram.

At the liberal end of the spectrum (Figure 1), we have subsidized lifeline rates through taxes near or below cost with universal service goals (D. C. Brown 1980). Average cost pricing is implemented through a revenue requirement, which is determined by rate of return regulation and met by allocating accounting costs and averaging those costs over customer classes (Jones 1988). In marginal cost pricing, the revenue requirement is met by allocating economic incremental costs caused by different customer classes (Greer 2012). Time-of-use pricing is based on cost or value of service, which varies with the time-of-use (S. J. Brown and Sibley 2015; Berg and Tschirhart 1995). In Ramsey pricing, rates are based on the value of service, which varies with the price elasticity of demand (Horowitz, Seeto, and Woo 1996). In Incentive or performance based regulation, rates are capped by either average or marginal cost techniques and further discounts are given based on value of service criteria determined in the market (P. L. Joskow 2008). Finally, rates are determined in the spot market in spot pricing where there are market institutions for power coordination (P. L. Joskow 2003). Understanding the historical contexts in which these policies were innovated in the USA would give us a better idea of their relevance to India.

Figure 1: Spectrum of Pricing Policies



Decision Making Model

The second question that arises is - How do strategic decision-makers select from this menu of options? The Decision Making model in Figure 2 is based on Multi Criteria Decision Making (MCDM), a strategic decision making tool used extensively in business to address complexity in decision making (Aruldoss 2013). A literature survey of the domain of electricity regulation will help us understand the decision-making criteria used and the historical contexts in which the pricing options were innovated.

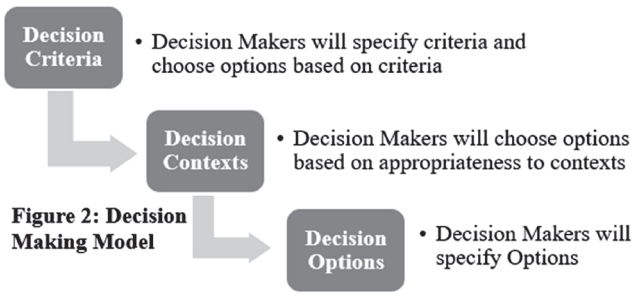


Figure 2: Decision Making Model

Literature Review: Criteria In Electricity Regulation

What are the criteria used by strategic decision-makers to select pricing options? A literature review of electricity regulation in the US yields four primary criteria:

Efficiency: It refers to the degree to which the pricing mechanism minimizes total costs (both economic and non-economic) to society. This criterion comes from the dominant view of allocative efficiency in a competitive equilibrium as being the primary aim of policy(Berg & Tschirhart, 1995; Jones, 1988; Joskow, 2005, 2008).

Free Choice: It refers to the degree to which the pricing mechanism increases choices for consumers and producers, and their ability to make independent and free choices. This criterion comes from the notion of the market as an entrepreneurial discovery process (Kirzner 1997) and that market distortions are due to a loss of freedom to choose and participate in the market process as, with genuine free entry, a monopoly cannot exist and hence, the ideal role of government is minimized to protecting private property rights and promoting free choice (Fleetwood 1995; Steele 2005; Negru 2013; Pham 2017).

Political Feasibility: It refers to the degree to which the pricing mechanism is acceptable to all interest groups in a political equilibrium. This criterion comes from the notion that the costs of regulation outweigh its benefits (Posner 1975; Demsetz 1968) and hence, regulation is explained by a political economic model where regulation is demanded in a political equilibrium by special interest groups representing both producer and consumer interests ''(Becker, 1976; Becker, 1993; Demsetz, 1968; Peltzman, 1993, 2010, 2011; Posner, 1974, 1975; Stigler, 1971, 1972; Stigler & Friedland, 1962).

Fairness: It refers to the degree to which the pricing mechanism produces equitable outcomes including income distribution effects for society as a whole. This criterion comes from the notion that regulation is a process of institutionalizing the evolving notions of public interest (Jones, 1988; Melody, 2016; Rose, 2016; Trebing, 1986) and fairness is based on group norms and a collective will that expands individual action and integrates it into the larger social provisioning process (Jones & Mann, 2001; Trebing, 1969, 1974, 1984).

Literature Review: Evolution of Electricity Pricing Policy

What are the contexts in which the pricing options were selected or innovated? To answer this question, one needs to study the historical evolution of electricity pricing policies. The research question was first formulated as "Why do electricity pricing policies change over time?" (P. L. Joskow 1974). The explanation, especially relevant at that time, was that changing political interests fueled by inflation and environmental concerns brought about changes in pricing policies. 'Political equilibrium' notions '''(Stigler 1971b; Posner 1975; G. Becker 1976; Peltzman 1976) left a great impact on the way the question was answered within neo-classical economics and hence, the evolution and choice of regulated pricing policies has been explained in public-choice utilitarian terms ''(Peltzman, Levine, and Noll 1989). Other explanations have included factors like inflation, rise in oil prices, interest group pressures and changes in industry structure. However, these factors also combine with technological changes that have created not only alternative opportunities but also alternative worldviews that have implicitly affected the choice of pricing policies. Furthermore, the emphasis on explanation and prediction makes these theories less contextually rich and hence, they offer few suggestions for the design of pricing policies.

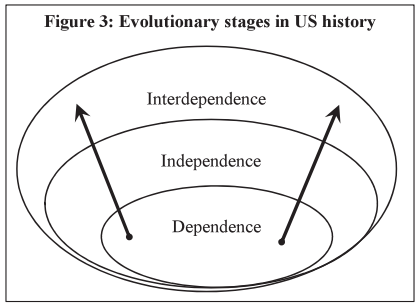
Trebing has studied how the industry and the concomitant institutions have evolved (Trebing, 1976, 1984, 1986) and has identified five phases of evolution - populist reform, political inaction, new deal reforms, post-war stability and disenchantment with regulation (Tool & Trebing, 2019; Trebing, 1984). Jones identifies three stages - upheaval, transition and transformation based on the changing political economy of regulation (Jones 1988; Jones and Mann 2001). Brennan considers legal and regulatory milestones to explain the evolution of electricity pricing policies (Brennan 2013; Brennan and Boyd 1997). Stalon takes a more technical perspective and divides the development of the industry into four stages based on changing technology - the stages of generation economies, interconnection economies, intersystem coordination and intersystem trading (Stalon and Woychik 1995). The literature looks at inter-relationships between different variables - political, economic, legal, technological and policy that influence the form and content of regulation. The studies classify the historical development of electricity pricing policy into three to five stages, based on one or more of these variables and they all use multiple unit of analysis - commissions, laws, regulations, rules and public policies. These studies lack a focus on any one unit of analysis and fail to discriminate between discontinuities and continuities in pricing innovation. The narrative either alludes to regulatory cycles or to a linear progression from one evolutionary stage to another; the change is either towards competition or away from it. The pervasive pattern in the literature has been conceptualized by some as a spiral (Schwartz and Kahn 1972) and by others as a pendulum (Cudahy 1992). These schemes do not capture the fundamental shifts in the relationships between supply and demand that influence regulatory institutions and pricing policies. A study that compares different theories and competing explanations of changes in electricity pricing policies finds a lack of explanatory dominance of any one theory (Huemmler 1996).

Proposed Evolutionary Stages

Figure 3 proposes looking at the history of electricity regulation in the US in three evolutionary stages with a focus on pricing policy. These evolutionary stages define the relationship between supply and demand and are able to discriminate between discontinuities and continuities in the evolution of electricity pricing policy. They have been explored earlier in consciousness studies (Ghose, 1997; Wilber, 1996) and in organizational studies (Ford and Backoff 1988; Nutt and Backoff 1993). This typology of evolutionary stages draws on academic work in sociology and political science, which help us understand how culture, society, economics and business is determined by technology change (Toffler 2009; Fukuyama 2017). While some symbols, ideas, rituals and institutions maybe unique to cultures of different civilizations —(Huntington 1993; Jervis and Huntington 1997), a typology based on evolving techno-economic structures is perhaps more appropriate for the study of economic behavior in markets and is also more universal and globally applicable. The evolutionary stages in the history of electric utility regulation in the US are labelled as dependence, independence and interdependence.

Dependence: The initial stage of dependence is primarily the phase of rural electrification, which is marked by a dependence of demand on supply and is concerned with providing universal service. The discourse in this stage has been characterized as modernist planning '''''(Throgmorton 2003; 1992) where massive investments in capacity are made and early adopters of the electricity service needed to be educated on its uses and hence, supply created its own demand (D. C. Brown 1980; Technology Futures 1984). The pricing policies such as subsidized rates and rate of return regulation with average cost pricing were innovated in this phase (Berg and Tschirhart 1995) with a focus on fairness (Jones and Mann 2001).

Independence: The next phase is marked by independence of supply and demand. Even in the US, this stage was primarily an urban phenomenon and occurs in the context of technological improvements in metering that present opportunities for better capacity utilization. Pricing policies such as marginal cost, Ramsey and peak load (time-of-use) pricing in this stage were



innovated in this phase with a focus on efficiency (Berg and Tschirhart 1995; Parmesano and Martin 1983; Heald 1996). Fairness was addressed in the quasi-judicial ratemaking process in the Utility Commissions.

Interdependence: The last phase is marked by interdependence between supply and demand and occurs in the context of the information revolution which makes spot markets possible. Pricing policies such as incentive regulation and spot pricing go beyond simplistic notions of efficient free markets and take into account information asymmetry and moral hazard problems (Armstrong, Laffont, and Tirole 1995; Laffont and Martimort 2009) and also build in free choice and free entry with the notion of contestability of markets (Shepherd 1984; Baumol and Lee 1991; Baumol and Willig 1986). The information revolution has enabled real time measurement of consumption and also greater consumer choice of the utility service provider. Hence, regulatory instruments like spot pricing have become possible but only with a plethora of market-based institutions such as the Independent system operators and market aggregators which highlight the interdependence between supply and demand. And while all these changes are happening in the market, the rate of return regulation process at the Utility Commission continues to ensure fairness.

Relationship between the evolutionary stages: Each stage of evolution not only prepares the stage for the subsequent stage, but also retains its essence. The subsidized rates innovated in the stage of dependence created an infrastructure for the subsequent stages of independence and interdependence and yet, at the same time, the essence of these innovations still exist in a more targeted version and enabled by information technology. Ironically the promises of more choice for customers would not have been possible without the developments made in the preceding stages of dependence and independence. Nor could the system have leap-frogged into the interdependence stage from the stage of dependence. The stage of dependence subsidized an interconnected electricity network that made wheeling possible in the stage of interdependence. Innovations in metering technology, time-of-use and marginal cost pricing during the stage of independence gave firms greater insight into customer preferences and their own cost structures making wheeling and competition in real time feasible. Hence, Figure 3 depicts each subsequent stage as including the preceding stage and then going beyond it.

Cross-national and Developmental typology: Development theorists have argued that unique technological and institutional rigidities contribute to internal structural features unique to developing economies (Adelman and Morris 1997). Table 1 builds on one such structural feature of developing economies - policies innovated sequentially in industrialized countries like the US are adopted concurrently in developing countries which are only partially industrialized. Hence, the evolutionary stages of dependence, independence and interdependence describe regulatory technologies that have been sequentially innovated in historical contexts that can be labelled as rural, urban and informational. These labels describe the context of the physical technologies that made innovations in regulatory technology possible and also describe concurrently occurring market realities in developing countries.

Table 1: A cross-national developmental typology

Physical Technology	Rural		Urban			Informational	
Regulatory Technology	Dependence		Independence			Interdependence	
Electricity Pricing Policies	Subsidized Rates	Average Cost Pricing	Marginal Cost Pricing	Time-of-Use Pricing	Ramsey Pricing	Price-Cap/ Incentive Regulation	Spot Pricing

Table 1 summarizes the cross-national developmental typology. The typology is useful in pricing policy design. Subsidized rates and average cost pricing are relevant to rural and agricultural contexts. Marginal cost pricing, Time-of-use and Ramsey pricing are relevant to industrialized and urban contexts. Price caps with incentive regulation or performance-based pricing and spot pricing are relevant to the electricity transmission sector where wholesale trading of electricity is enabled by the information revolution.

A Regulatory Policy Design Map: An Empirical Model

The Decision-Making Model in Figure 2 has been now transformed into a Regulatory Policy Design Map in Figure 3 using insights gleaned from the literature survey on regulatory decision criteria and regulatory contexts. The pricing options specified in Figure 1 are appropriate to policy contexts specified in the developmental typology in Table 1 and these options are selected using decision criteria such as efficiency, fairness, political feasibility and free choice.

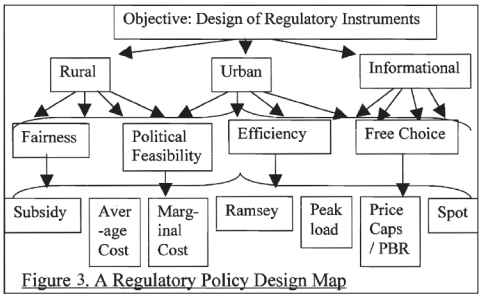


Figure 3. A Regulatory Policy Design Map

Empirical Model and Validation: The Regulatory Policy Design Map in Figure 3 is an Empirical Model that was validated in a survey of experts in 7 cities in India using both quantitative and qualitative research techniques. Annexure 1 gives the names, locations, designations and professional backgrounds of the 34 Electricity Policy experts in the survey spread over 7 cities in India. The Quantitative portion of the survey used AHP or the Analytic Hierarchy Process, which is a Multiple Criteria Decision Making Technique ' (T. L. Saaty 2013; T. Saaty and Vargas 2012; Peniwati 2017). AHP was used to make pairwise comparisons of the regulatory decision criteria (refer to Table 2 in Annexure 2). Ordinal scores were elicited on a standard rating scale to rank each pricing option on the regulatory criteria (refer to Table 3 in Annexure 2) to reduce complexity while maintaining reliability (Nutt 2008; 2006; 2002). The Qualitative portion of the survey probed further into the relevance of the technological contexts to the choice of the pricing options. The dialogue was substantially based on the regulatory contexts in the developmental typology in the Regulatory Design Map.

Results: The Results of the Quantitative portion (refer to Table 4, Annexure 2) give the weights and ranks of the regulatory criteria and the cumulative weighted ranks of the pricing options. The Qualitative dialogue led to the specification of 3 Models by the experts and a convergence on the developmental typology by a majority of experts (refer to Tables 5 and 6, Annexure 3).

Conclusions: The expert survey proved the relevance of the regulatory policy design map including the criteria, the contexts and the pricing options to the Indian electricity industry in the minds of the Indian experts.

Ranking of Regulatory Criteria and Regulatory options: The Kendall's coefficient of concordance is used to determine whether there is agreement among experts of different backgrounds, cities and professions. Areas of broad agreement among experts are the first rank for economic efficiency and the lowest rank for political feasibility. There is less agreement on fairness and free choice with economists preferring free choice and engineers preferring fairness for the second priority. There is near unanimity on the lowest and highest 2 ranks along each value. Spot pricing and subsidized rates, which are at two opposite ends of the political spectrum, drive most of the variation and incentive regulation, is consistently ranked high.

The Relevance of Regulatory Context: The Qualitative portion of the survey validated the significance and relevance of the regulatory contexts in the developmental typology to the choice of regulatory instruments and institutions. Tables 5 and 6 in Annexure 3 show the convergence of experts around 3 clusters of prescriptive models. However, there seems to be a consensus that the rural areas would need average cost pricing and subsidized rates, urban industrial areas would need options such as marginal cost pricing and incentive regulation, and the information revolution has enabled wheeling and spot pricing in inter-regional trade across electricity transmission zones. Hence, the broad contours of the developmental typology model from the US has been validated.

Conclusion: Applicability and Generalization

The history of electricity regulation in the USA is examined from the lens of developmental theories. The three-stage evolutionary model helps to understand the discontinuities and continuities in the innovation of electricity pricing policies in the USA and helps us also understand how economies evolve (Chowdhury, 2019) and how the digital economy impacts the electricity industry (Krishnamoorthy & Sampath, 2018). The model makes a theoretical contribution to the literature on the evolution of electricity pricing policies by applying a theory from a different field to this domain of electricity regulation.

Structural rigidities identified in the development policy literature point to a situation where policies innovated sequentially in an industrialized country may occur concurrently in developing countries. A cross-national and developmental typology is derived from this evolutionary model makes a policy contribution to better policy design as it helps us understand which policies are relevant in rural, urban and informational contexts.

The Regulatory Policy Design Map helps us understand the internal mental models of policy actors in the public policy process (Yadav, 2016). The expert survey was conducted in 1997 among policy experts and the recommendations of setting up Independent Regulatory Commissions in Table 5, Annexure 3 shaped the new Electricity Act of 2003 and hence the study, which was widely circulated among policy experts in India has made an impact on the legislation. Since the passage of the Act, the Independent Commissions have been selecting the spectrum of policy options in the Regulatory Policy Design Map using the regulatory criteria and contexts. These policies such as subsidized rates are still debated as late as in last month's elections in Delhi.

The regulatory policy design map is not only cross national but also applicable to other regulated network industries such as Telecommunications, Water and Gas and is a contribution to the literature on strategy, public policy and business environment.

Annexure 1: Expert Survey Respondents

City in India	Academician / Professor, - primarily doing academic research with some background in the economics of electricity pricing [12]	Government Bureaucrat / Administrator or Policy Consultant (inter-disciplinary) [11]	Engineer with a government undertaking (Central or State) [11]
Mumbai	1) Dr. Raghabendra Jha, Professor; Economics; 2) Dr. R. Nagaraj, Professor, Economics; 3) Mr. Puneet Chitkara, Research Scholar, Indira Gandhi Institute of Development Research (IGIDR)	1) Mr. Prabhakar Patil, Under Secretary, Energy 2) Mr. A. B. Kambli, Deputy Secretary Power and Industry; The State Government of Maharashtra Mantralaya 3) Dr. Jyoti Parikh, Senior Professor; Energy and Environment, (IGIDR)	1) Mr. P. Pentaiyya, Deputy Mgr. & 2) Mr. R. J. Dubey, Sr. Engineer, Power Grid Corporation of India Ltd. 3) Mr. B.B. Kulkarni, Chief Engineer, Commercial 4) Mr. S.V. Bapat, Sup.Eng.; Commercial 5) Mr. R. Rajagopal, Sup.Eng., Corporate Planning 6) Mr. M.R. Ambhore, Technical Director, Generation Projects Maharashtra State Electricity Board
Ahmeda bad	4) Dr. Sebastian Morris, Professor, Economics, 5) Dr. Saumen Mazumdar, Asst. Professor, Public Systems ; Indian Institute of Management		
Chen-nai	6) Dr. S. Bhattacharya, Research Fellow 7) Dr. U Shankar, Director, Madras School of Economics,		

Bang-alore	8) Dr. V.Ranganathan, Professor, Economics & Energy ; Indian Institute of Management		7) Mr. B.G. Rudrappa, Former Chairman, Karnataka State Electricity Board
Hyder-abad	9) Prof. R.K. Mishra, Dean, Institute of Public Enterprise; Osmania University Campus 10) Dr. Arif Waqif; Professor, Economics, Administrative Staff College of India	4) Mr. T.L. Sankar, Principal, 5) Dr. Usha Ramachandran, The Administrative Staff College of India	8) Mr. K. Balarama Reddy, Former Chairman, Andhra Pradesh Electricity Board.
Bhuba-neshwar		6) Mr. Dhirendra K. Roy, Member, Orissa Electricity Regulatory Commission, 7) Bruce J. Ambrose, Vice President, National Economic Research Associates, Inc	9) Mr. Mahendra Kumar, Director, Commercial, Grid Corporation of Orissa Limited,
New Delhi	11) Dr. Ashok V. Desai, Consulting Editor, Business Standard 12) Mr. Sanjay Mohanty, Area Convenor, Energy Division, Tata Energy Research Institute	8) Mr. L.P.Sonkar, Joint Advisor, Planning Commission 9) Dr. Debabrata Chattopadhyaya, PMI 10) Dr. Kapil Thukral, Senior Manager, KPMG Peat Marwick 11) Mr. R.K. Kapoor, Director, Independent Power Producers Association of India	*10)* Mr. K.K. Agrawal, Dy. General manager, Commercial; Power Grid Corporation of India limited *11)* Mr. L.R.Suri, Former Member, Central Electricity Authority (CEA) and former chairman Haryana State Electricity Board, Senior Fellow, TERI

Annexure 2: Quantitative Portion of The Survey

Table 2: Pairwise comparison of regulatory criteria using the AHP – The Question

IMPORTANCE OF A OVER B								IMPORTANCE OF B OVER A
	A	V		M		M	V	A
	B		S	O		O		B
	S	S	T	D		D	S	S
	O	T	R	E	E	E	T	O
COLUMN A	L	R	O	R	Q	R	R	L COLUMN B
	U	O	N	A	U	A	O	U
	T	N	G	T	A	T	N	T
	E	G		E	L	E	G	E
Fairness							X	Efficiency

Table 3: Ranking of the Pricing Options along each regulatory criterion

Pricing policies	EFFICIENCY
Score of the mechanisms along the criteria →	0 2 4 6 8 10
Subsidized Lifeline rates	
Average Cost Pricing	
Marginal Cost Pricing	
Incentive Regulation	
Time-of-use Pricing	
Ramsey Pricing	
Real-time Spot Pricing	

Table 4: Results – Ranking of Regulatory Criteria and Pricing options

Regulatory Criterion	Weight	Rank	Pricing Option	Cumulative Weighted Rank
Efficiency	0.36	1	Time-of-Use Pricing	1
Fairness	0.23	2	Incentive Regulation	2
Free Choice	0.21	3	Spot Pricing	3
Political Feasibility	0.20	4	Ramsey Pricing	4
Total	1.0		Marginal Cost Pricing	5
			Subsidized Rates	6
			Average Cost Pricing	7

Annexure 3: Qualitative Portion of the Survey

Table 5: Institutional Models prescribed by experts

Model No.	Institutional Prescriptions: Regulatory Instruments	Institutional Prescriptions: Implementing Organizations/Institutions
Model 1	• Marginal cost pricing (3) • LRMC (1) • Incentive Regulation (1)	• The same institution is good enough for both Rural and Urban areas. • The existing institutional structure is fine and IRC would be helpful.
Model 2	• Public supply may still be necessary in rural areas. • All instruments are relevant and can be judiciously used. • Spot pricing is possible only in the long term	• Separate rural infrastructure development agency is needed. • Rural co-operatives, panchayats can be experimented with for non-renewables. • IRC can have jurisdiction in the Urban areas.
Model 3	• IRC will institute a quasi-judicial review process for pricing • TOU rates are attractive on a targeted basis • Incentive Regulation, Marginal Cost Pricing are favored options. • Average Cost Pricing and cross-subsidies inevitable in rural areas.	• Separate IRC from all other policy-making. • IRC must have sole jurisdiction over pricing. • Rural areas can get external financing but pricing should be with the IRC. • Discos will share the rural burden. • Inter-regional trade is desirable and wholesale wheeling is possible in the medium term. Retail wheeling is not feasible.

Table 6: Cumulative cluster frequencies and percentages – convergence of expert opinion

Institutional Model	Count	% age
Model 1	5	14.7
Model 2	12	35.3
Model 3	17	50

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