Evaluating Open Access In The Indian Power Sector Using The Transportation Model

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Abstract : *Power is a key resource for the development of infrastructure assets in India. The Indian power sector has witnessed a significant turmoil over the last two decades. It has been providing significant amounts of subsidy to the domestic and agricultural consumers known as Low Tariff (LT) consumers, since long. This conservative strategy of the power sector largely compromised competition in the sector due to the provision of subsidy to the LT consumers. This kind of cross subsidy entails recovering more revenue from the industrial and commercial consumers known as High Tariff (HT) consumers, to make up for the loss of revenue to provide subsidies to the LT consumers. The cost of supply of electricity is the major decision variable. The LT consumer pays subsidized tariff of about 50 to 60 percent of the cost of supply and the HT consumers pay hefty tariffs of about 170 to 180 percent of the cost of supply. In order to encourage competition in the sector, a non-discriminatory open access to the power is allowed for the consumers, wherein it can switch over to a low cost power supplier. This calls for reducing the subsidy to LT consumers and introducing surcharge on HT consumers for switch over to new distribution companies (DISCOM) licensee. The economics of open access system are demonstrated using the transportation model, applied to the power scenario of the state of Maharashtra. The solution reveals an interesting thought process to practise open access in the power sector.*

Keywords: *Cost of supply; Subsidy; Surcharge; Tariff; Open access*

INTRODUCTION

Electricity is a key ingredient for every economic activity. The rapid economic development and the increasing population (1.28 billions) had hard pressed the need of electricity in India (Kolhe and Khot, 2015). However, not everyone is able to get the access to electricity, therefore, halting the growth of the nation. Almost 300 million people do not have access to electricity (Mishra, 2013). Therefore, apart from the demand being the major driving factor, access to electricity does depend on the cost of supply. Further, reforms in the power sector have moved from access to the power to open access to the power due to an adequate surge in supply capacity. Therefore, since long, the Indian government had employed cross-subsidy in order to provide access to the under privileged and weaker sections of the society. However, the provision of cross subsidy brings in a kind of discrimination in the electricity consumers based on the tariff paid by these consumers. Competition is largely jeopardized in the power sector and recently the government has formulated the legal framework of open access to provide non-discriminatory access of power to everyone. However, the economics of open access system is not straightforward as it affects the stakeholders of the power industry in different ways. The power sector in India has gone through a lot of turmoil decade after decade. The International Energy Agency (IEA) defines energy subsidy as "any government action that concerns primarily the energy sector that lowers the cost of energy production, raises the price received by energy producers or lowers the price paid by energy consumers". The subsidies are classified as i) Direct

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financial transfers ii) Preferential tax treatment iii) Trade restrictions iv) energy related services at discounted rates and regulation of the energy sector. The sole objective of the government is to protect its consumers from international price volatility and providing energy access to the poor, particularly.

Cross-subsidies can be defined as a mechanism where by some consumer groups are charged higher tariffs as compared to the cost of supplying power. The additional revenue generated from these consumers is used to balance the revenue shortfall from the other consumers, who are charged lesser as compared to the cost of supplying power (Irwin, 1997).

REVIEW OF LITERATURE

The literature largely reviewed for this study comprises of three sections i) Non-discriminatory open access ii) Cost of supply and iii) Electricity reform

Non-Discriminatory Open Access

Open access gives a choice to the consumers to switch over to a low cost power supplier. In the process, the economy of power supply is protected with the penalty of surcharge levied upon the consumer for the purpose of switchover. Open access provides an opportunity not only to the consumer to look for a low cost power supplier, but also offers an opportunity to the supplier to identify high tariff consumers. Therefore, it works both ways. Bygballe (2017) stipulates that supplier switching process is governed by the competition, organization strategies and dissatisfaction.The necessity of formulating open access in the power sector was developed progressively with the provision of Electricity Act 2003, which would overcome monopoly in the power sector. Prior to this, the power sector sought reforms, regulations, augmentation of generation capacity and private investment through its policy acts that evolved right from 1910, 1948, 1991, 1995, to 1998. The details of the policy are mentioned in the *Table 1*. However, the National Electricity Policy (NEP) and National Tariff Policy have given impetus to the open access to improve service level to the consumers.

Cost Of Supply

Cost of supply is the major determinant in devising the tariff structure for the larger consumer base. Rather, the tariff structure attempts to provide subsidy to LT consumers and ensure the equivalent recovery from the HT consumers.

Open access system invites three costs; i) Cross subsidy

Table 1: Chronology Of Reforms In Indian Power Sector

Laws/ Policy	Objective	Impact
The electricity act, 1910	Infrastructural framework for supply of electricity	Attracted private capital
The electricity act, 1948	Mandated creation of SEBs	Ownership in the hands of SEBs
IIIP Proces, 1991	Private investment in power generation	Projects from private players came into generation
The electricity amendment act, 1998	Making transmission a separate activity	Central transmission utility and state transmission utilities were set up.
Mega power policy, 1995	Setting up of mega power plants	Mega power plants gets benefitted
The Regulatory commission act, 1998	Provision for setting up of central/state electricity regulatory commission	Independent regulatory mechanism
National Electricity policy	Competition and protection of consumer	More players influenced to invest and more efficient consumer service
Electricity act, 2003	Providing reliable and quality power to customers at reasonable rate	Investment in capacity addition
National Tariff Policy	Tariff structuring	Attractive tariffs for players

Source: Kumar, 2013

surcharge ii) transmission charges and iii) wheeling charges (Ankit Kumar, 2013). Transmission charges are needed to be paid by the consumer to the transmission licensee for the purpose of using the transmission facilities. Similarly, the distribution charges are needed to be borne by the consumer towards using the distribution facilities of the distribution license. These charges are paid in the proportion of the voltage. Mishra (2013) stipulates that consuming one unit of electricity is equivalent to more than four units of electricity at the generation stage. This suggests the transmission and distribution losses of about 25% in the Indian power sector. However, these 25 percent losses are not paid since these are either stolen, given free or wasted during transmission. Ranade (2017) alarmed the deep reality of power theft crisis in India, when a young electrical engineer was killed on duty in a rural area of Haryana. Thus, the DISCOMs are finacially weaker due to these losses and tariff collection related issues.

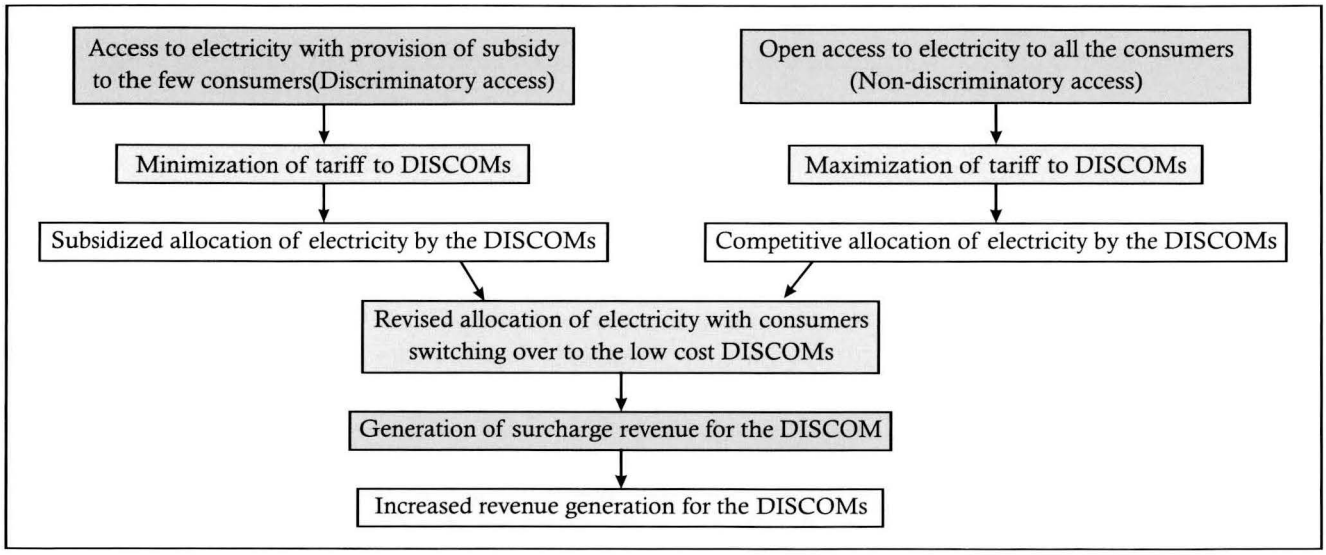
Charan and Devi (2009) stipulated that the administration of open access to power in the Indian power sector, will make it more competitive and attract the foreign investors for free and fair power trade. However, Singh (2005) cautions about the idea of open access since it can jeopardize the revenue generation of the utility. This is because if the surcharge levied for the switchover of HT consumers is more than the tariff payable to the competitive supplier, then HT consumers will go for captive generation, which might incur more losses to the utility companies.

Problem Formulation

The objective of the research is to model the open access power supply system in India. However, the cross subsidy provided by the government compromises the revenue of the DISCOMs and competition in the sector. The transportation model is formulated with 4 sources of power (DISCOMS of the state of Maharashtra) and 4 demand centres i.e. industrial, commercial, agricultural and domestic. The cost elements of connecting sources with demand centres are represented by the tariff, expressed as the percentage of the cost of supply. Firstly, the difference of the tariff by solving maximization of the tariff to the DISCOMs (without subsidy) and minimization of tariff (with subsidy) gives the amount of revenue forgone by the DISCOMs due to discrimination and subsidized power allocation. Secondly, the shifting power allocation from minimization (with subsidy) to maximization of power allocation (without subsidy) objectively models the non-discriminatory open access, where due to the revised power allocation, those consumers who have switched to the new DISCOM, needs to pay the surcharge to the DISCOMs. In short, the power situation is best formulated by the transportation model, where the DISCOMs not only recuperates the revenue lost due to subsidy, but also generates additional revenue due to levy of surcharge on consumers to avail the open access power supply system. *Figure 1* shows the outline of an open access system.

METHODOLOGY

The classic transportation model of Operations Research is employed to seek a desirable solution to the open access issues of power sector. Although the transportation model is developed for identifying low cost logistic network of military operations, however, it can be used widely to model and solve the industrial, legal and social issues. The scenario of power in the state of Maharashtra is analysed. The secondary data is employed in the decision making process and the report (Forum of regulators, 2015) has expressed the brief methodology for minimizing cross-subsidy. In the state of Maharashtra, there are four DISCOM licensee, which supply power to most of the areas of the state.These four major power suppliers are i) Maharshtra State Electricity Distribution Company Limited (MSEDCL) ii) Bombay Electric State Transport (BEST) iii) R- Infra and iv) Tata Power



Source: Compiled by the author

Figure 1: Outline of Open Access to Electricity

Corporation (TPC). The last three DISCOMs supply power to Mumbai, while the first DISCOM supplies power across the rest of areas of Maharshtra.The issue of open access is formulated as a transporation model. The secondary data pertaining to the cost of supply, supply capacities of DISCOMs have been employed to formulate the effectiveness matrix. The boundary condition of open access states that subsidy is set equal to zero and a surcharge is introduced.

RESULT AND DATA ANALYSIS

In order to formulate the open access of power, the cost of supply has been considered as the relevant decision variable in the study. This is because, the cost of supply comprises of the four components; i) generation cost ii) transmission cost iii) distribution cost and iv) back up cost. Therefore, it is the single decisive measure, to formulate the tariff structure and surcharge duty.

The cost of supply matrix (in percentage) of four DISCOMs supplying power to the four consumers i) Industrial (HT consumer) ii) Commercial (HT consumer) iii) Domestic (LT consumer and iv) Agriculture consumers (LT consumer) is developed as shown in *Table 2*.

In order to provide electricity at subsidized rate, the LT consumers are charged a tariff, which covers only 50 to 60 percent of the cost of supply. Therefore, the objective of the utility is to allocate the power with subsidy, which invariably aims at minimizing the tariff.

Minimize Tariff With Subsidy

$$\sum_{i=1}^{I} \sum_{j=1}^{J} Cij.Xij \quad \text{.....(1)}$$

Cij : Electricity Tarrif expressed as a percentage of cost of supply

Xij : Allocation of power to consumer by DISCOM

Table 2: Tarrif As Percentage Of Cost Of Supply

DISCOMs/Consumers	Industrial	Commercial	Domestic	Agriculture	Supply
BEST	120	130	50	45	**80**
Red Infra	150	170	60	40	**70**
TPC	140	180	65	47	**60**
MSEDCL	160	175	67	39	**150**
Demand	**90**	**90**	**120**	**60**	**360/360**

Source: Compiled by the author

In order to allocate the subsidized power (without open access), the problem is solved as a minimization problem to allocate the power to the consumers with minimum tarrif, expressed as a cost of supply. The total cost of supply of this plan comes out to be Rs. 35170 with subsidy. The power allocation is mentioned in the *Table 3*.

In order to withdraw subsidy from the LT consumers, electricity distribution is initiated to maximize the tarrif, which also fulfills the promise of the open access scenario. Therefore, the objective is to maximize the tarriff.

Maximize Tarrif Without Subsidy

$Tij =$

$\sum_{i=1}^{I} \sum_{j=1}^{J} Cij.Xij + \Sigma \Sigma$ Yij.Zij .....(2)

where, generation of the surcharge amount

$$Sij = \Sigma \Sigma \text{ Yij.Zij} \quad .....(3)$$

Zij: Revised allocation under open access

Yij : Surcharge payable per unit of revised allocation

In order to encourage open access , the problem is solved as a maximization problem to allocate power to the consumers who are paying larger cost of supply. The maximum cost of supply of this plan (revenue to DISCOM) comes out to be Rs. 40420 without providing subsidy to LT consumers. The power allocation is mentioned in *Table 4*.

The total revenue generation of the DISCOMs due to HT consumers has increased from Rs. 25,000 to Rs. 30, 300 with the withdrawal of subsidy from the LT consumers. On the other hand, the revenue loss of the DISCOMs due to the provision of subsidy to the LT consumers has reduced to Rs. 10,120 from Rs. 10, 170. Moreover, the DISCOM are able to levy surcharge for the consumers prefering to change the power supplier. Now, the DISCOM can generate the revenue through surcharge as shown in *Table 4*. In short, the net increase in revenue generation of DISCOM is Rs. 5250 (Difference between Rs.40,420 and Rs. 35,170). In addition to this, the revenue generated by the DISCOMs due to open access is (80 @ 10= 800 Rs.) for BEST, (30 @10= Rs. 300) for Red Infra, (60 @10=600 Rs.) for TPC, and (90 @10 = 900 Rs.) for MSEDCL. Thus, a surcharge is levied on consumer switching due to open access as 10 units per unit consumption. In this way, DISCOMS generates total revenue of Rs. 7850, out of which Rs. 5250 are due to the withdrawal of subsidy and Rs. 2600 are due to the

Table 3: Subsidized Allocation Of Elecricity Of Utility

DISCOMs/ Consumers	Industrial	Commercial	Domestic	Agriculture	Supply
BEST	120	130@80	50	45	**80**
Red Infra	150@30	170@10	60@30	40	**70**
TPC	140@60	180	65	47	**60**
MSEDCL	160	175	67@90	39@60	**150**
Demand	**90**	**90**	**120**	**60**	**360/360**

Source: Compiled by author

Table 4: Power Allocation Without Subsidy

Dscoms/ Consumers	Industrial	Commercial	Domestic	Agriculture	Supply
Best	-120	-130(s)	-50@20	-45@60	**80**
Red Infra	-150(s)	-170@30	-60@40	-40	**70**
TPC	-140(s)	-180@60	-65	-47	**60**
MSCLD	-160@90	-175	-67@60(s)	-39(s)	**150**
Demand	**90**	**90**	**120**	**60**	**360/360**

Source: Compiled by author

levy of surcharge. However, the surcharge amount is needed to be cautiously set up in such a way that it must be low enough for three reasons, First, it should encourage the consumers to switch over to low cost supplier; second, it should ensure that industrial consumers will not revert to captive power generation; and third, it will utilize the idle capacity of power generation. Further, it should be high enough so that open access consumers will not exploit the DISCOMs with frequent switching over and rather stay with the concerned DISCOM for the reasonable amount of time.

CONCLUSIONS

This research has demonstrated the likely scenario of implementing open access in the power sector. In a very simple and methodical way the economics of open access have been put forward from the perspectives of consumers and DISCOMs. The government has graded the demand side of power as subsidized consumers and non-subsidized consumers with the provision of cross subsidy. However, it has not graded the supply side of power supply based on service level. Therefore, policy intervention on the supply side is needed to practice the open access systems which will enhance the service quality of DISCOMS. Therefore, open access would minimize power subsidy and the maximum surcharge revenue of the financially weaker DISCOMs. In the process of minimizing subsidy, the LT consumers are likely to face higher tariff, while in the process of maximizing surcharge, the HT consumers are likely to shift to captive power generation. Therefore, the study has the implications of undertaking the reforms of an open access system to encourage competition in the power sector of India. This would also pave the way for huge capital investment and reforms on the supply side of the power sector. The future research should be carried out in the area of optimizing the surcharge fee and idle capacity of generation to facilitate open access power system.

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