CHAPTER - 1
INTRODUCTION

India is a land of great diversity in terms of flora and fauna, climate and topography. Its unique identity among the nations of the world is due to its heritage of mountains, rivers and fertile land, etc. Its second position and the first position respectively in population and population density provide a different perspective to the global system altogether. All people use different types of resources for their well-beings, and energy resources are one of them. Energy is essential for nation's economic and social development. People use energy in the form of electricity, heat, oil, fuel gas and wood, etc. All the energy we use mainly comes from conventional sources. Due to the huge increase in population and changing lifestyle, the demand for energy is escalating consequently. All conventional energy resources are getting depleted at rapid rate. Currently, there is a lack of energy in India, which is borne out by power outages and increasing prices of other fuels. With regard to the future prospects of energy, the Indians may make sufficient use of unconventional energy sources such as wind, solar and geothermal Tidal power, etc. which is essential in times to come.

1.1 The Haryana State

Haryana was carved out of Punjab State on November 1, 1966. The Haryana State came into existence, following the recommendations of “Sardar Hukam Singh Parliamentary Committee”. Haryana contributes food grain and milk to the country in a big way. Agriculture engages a major chunk of population in Haryana. Haryana was in the forefront in ushering Green Revolution in the country which enabled India to become self dependent in food production. Moreover, Haryana ranks among the most advanced regions in South Asia and since 1970s Haryana has taken rapid strides in agriculture and manufacturing fields. In terms of the inflow of FDI, Haryana has been ahead of other states since 2000. Sonipat, Faridabad, Yamunanagar. Panipat and Panchkula are considered the prominent industrial towns of the country. Refinery in Panipat being second in the South Asia. Haryana is also known for a huge number of paper, sugar textile and automobile industries. At present, there are twenty one districts in the State.
1.2 Power and Economy of Haryana

Power is important for each and every economy to function. Power industry, specifically in the industrialized world, must play an important role. Without power, the present and future generations will not be able to achieve economic progress and bright prospects for economic growth. There will not be any prosperity on global scale especially for third world countries. Nowadays there is a need for evolving efficient energy demand side technologies. Underdeveloped and Third world countries are faced with severe problems due to depleting energy resources, large fuels imports and less foreign exchange reserves. Rising population calls for a need to adopt new skills and technologies because increasing population will require expansion of energy structure. Transmission and distribution losses need to be reduced for better and cheap power generation. In the present framework, technical and non-technical losses need to be reduced. Technical losses arise naturally due to functional problems. Non-technical losses are attributable to our faulting existing system and pilferage by consumers. Non-technical losses must be avoided and reduced to improve power supply. To some extent, transmission losses are likely to be reduced and power efficiency to be increased by providing smart grids and having technically sound engineers.

1.3 Power Sector in Haryana

Haryana State Electricity Board was set up on May 3, 1967 under the provision of Electricity Supply Act, 1948. The functions of generation, transmission and distribution of power in the whole state were carried out by the Board. On November 1, 1966, when the State of Haryana was formed, the State was allotted 383 MW thermal based power generation capacities. At that time, Haryana Government used to fulfill its electricity needs with Bhakhra Beas Management Board (BBMB) hydro power project located in Punjab State. Later on, Haryana got its share from Nathpa Jhakri project of hydro-electricity of 1500MW, located in Himachal Pradesh and from the power generation units of central undertakings of the Government of India. On November 7, 1975 National Thermal Power Corporation (NTPC) built a gas based plant at Faridabad. But, Power is essential for the development of any state and electricity is considered to be a major part of infrastructure development. For rising population and the increasing industrial area, the fulfillment of even growing demand
for power is of great significance. With the complete electrification of all the 6759 villages by 1998-99, the number of consumers has increased rapidly. Haryana can rightly boost of being the first state in the country in providing electricity to each village.

With the rise in the number of consumers the gap between demand and supply has widened considerably. Power utilities in the state were economically in a bad shape before the initiation of reforms. Reasons behind poor financial performance of the HSEB were poor collection competence of the meter bills and billing faults of Government departments. So, it was an urgent requirement of state government to initiate the implementation of power sector reforms.

1.4 Reforms in Haryana Power Sector

Haryana power sector reforms were initiated as a part of the overall power sector reform process initiated in the country under the supervision of the World Bank. Haryana became the second State in the country that implemented the restructuring process at the state level after Orissa. However, the enactment of Electricity Act, 2003 was seen as a major achievement in the approach of power sector reforms in the country. In 1998, Haryana State Electricity Board (HSEB) was split into four successor utilities through the transfer schemes:

a) Haryana Power Generation Corporation Limited (HPGCL)

b) Haryana Vidyut Prasaran Nigam Limited (HVPNL)

c) Uttar Haryana Bijli Vitran Nigam Limited (UHBVN)

d) Dakshin Haryana Bijli Vitran Nigam Limited (DHBVN)

While, Haryana Power Generation Limited (HPGCL) is engaged in generating power from the State owned power plants, the electricity transmission grid is taken care of by Haryana Vidyut Prasaran Nigam Ltd. (HVPNL). The distribution of power is carried out by two companies (discoms) namely Uttar Haryana Bijli Vitran Nigam and Dakshin Haryana Bijli Vitran Nigam in the north and south regions of the State respectively.

The objectives of the Power Sector Reforms in Haryana was “The reforms in the power sector were necessitated to bring about the sustainable growth of the power
industry by attracting investment through congenial environment to meet the growing demand for power”. The further objective of the reforms is to promote and encourage competition, efficiency and economy to ensure the unhindered development of power in the state. Reforms were required to make the power companies financially viable so that the state government may not have to bail them out by covering their losses. The objective of the reforms is to transform the power sector form a liability into an asset. The Haryana Electricity Reform Act, 1997 was passed in pursuance of this objective. This Act provides for the constitution of an Electricity Regulatory Commission to carry out the restructuring of the power sector. It aims to involve consumers to seek their support to facilitate the execution of regulatory and reform process.

1.5 Need of the Study

Given that the reform process was initiated more than one and a half decades ago, it becomes imperative to gauge the status of reforms process and the consumer participation in the regulatory process. This comprises the analysis of the power reforms and Economic Efficiency vis-à-vis the generation, transmission and distribution of power. This analysis has also tried to find out whether the consumers are conscious of their rights and responsibilities. It has also examined the role of the regulatory agency and the availability of regulatory agency and the availability of platforms to have interactions with the stakeholders. The present study not only sheds lights on the impact of reforms but also tends to suggest the right directions for the power sector reforms. Realizing the need for assessing the efficiency and productivity of power sector reforms, the researcher has attempted to analyse the economic efficiency having been achieved in respect of the generation, transmission and distribution of power in the wake of the power sector reforms in Haryana.

1.6 Objectives of the Study

1. To analyze the growth of power sector reforms in terms of power generation, transmission and distribution function.
2. To study the need of the creation of an independent power regulatory body.
3. To examine the efficiency and productivity of the power sector in Haryana.
4. To assess the level of consumer satisfaction through a structured survey.
1.7 Methodology

The study has used primary and secondary data. The secondary sources were the reports of utilities of Haryana government including HPGCL, HVPN, DHBVN, UHBVN, HERC, World Bank study on Power Sector, India CEA Report, Planning Commission Annual Reports on Power Sector, Economic Survey of India, Haryana Statistical Abstracts, etc. The data was analyzed with the help of statistical tools. The comparative analysis is carried out vertically and horizontally. An assessment was made through a consumer survey for the purpose of verifying the customer satisfaction, the level of awareness and the overall quality of service in relation to the recognized standards. A convenient random sampling was adopted.

Detail elaboration of Sampling Method

According to the sampling method adopted, 210 consumers from both utilities – DHBVN and UHBVN distribution were approached. However, some additional consumers (10-12 percent) were also incorporated to reduce sampling errors and to make up for the non-respondents. Thus information was gathered from 210 consumers by conducting structured interviews as per schedules. The detailed survey methodology in terms of selection of districts, sub-samples and the execution of the survey is elaborated in the ensuring pages.

Table 1.1

<table>
<thead>
<tr>
<th>AREA</th>
<th>UHBVN</th>
<th>DHBVN</th>
<th>STATE</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>Urban</td>
<td>Rural</td>
<td>Sub Total</td>
</tr>
<tr>
<td>Domestic</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td></td>
<td>10 (20)</td>
<td>40 (80)</td>
<td>50 (100)</td>
</tr>
<tr>
<td>Agriculture</td>
<td>0 (0)</td>
<td>40 (100)</td>
<td>40 (100)</td>
</tr>
<tr>
<td>Commercial</td>
<td>10 (100)</td>
<td>0 (0)</td>
<td>10 (100)</td>
</tr>
<tr>
<td>Sub total</td>
<td>20 (20)</td>
<td>80 (80)</td>
<td>100 (100)</td>
</tr>
</tbody>
</table>

Note: The figures given in the brackets represent percentage shares in the total
According to the methodology of the study 10 consumers from each district which included consumers from domestic, agricultural and commercial categories were targeted. An attempt was made to cover women consumers also to ensure gender balance. However, only 20 percent respondents account for female population.

**Sampling Methodology**

**Stage One**

In order to give it representative character across the state, convenience random sampling approach was applied. The following factors were taken into account while formulating the sample:

(i) Geographical area spanning both the distribution utilities.

(ii) Literacy rates of the districts.

(iii) Consumers from both rural and urban areas.

(iv) The number of consumers from each of the chosen areas.

(v) Measurement level concerning the agricultural sector.

**Stage Two**

In order to make the representation of consumer category fair and consistent in the sample, the share of each consumer category in the overall power consumption in the state was also factored in.

**Stage Three**

While collecting data from each district, it was taken into consideration that there is appropriate geographical representation, sample villages from each block are included and consumers from both urban and rural areas are included. While selecting rural households from each district, large towns of each block were selected and from the selected villages the same number of sample households were taken.

For sub-agricultural consumers samples of each block are drawn randomly and equal number from each of such villages. It was ensured that agricultural consumers be included in such a way that consumers who had meters and who did not have meters stand represented in a fair proportion as they occur in the real population of agricultural consumers.

Rural areas accounted for approximately 70 percent of the sub sample. This was in synchronization with the overall distribution of population at the state level.
Selection of Neighborhoods, Blocks and Sampling Units

Considering the jurisdiction of the two electricity distribution companies operating in the state, Haryana is divided into two groups of districts. Group I comprises those districts which fall under Uttar Haryana Bijali Vitran Nigam (UHBVN) and Group II has the districts which are under the purview of Dakshin Haryana Bijali Vitran Nigam (DHBVN).

The districts under DHBVN and UHBVN were further divided into two zones each namely (1) East zone and Western zone to ensure representative sampling geographically.

Table 1.2

<table>
<thead>
<tr>
<th>S. NO.</th>
<th>UHBVN</th>
<th>DHBVN</th>
</tr>
</thead>
<tbody>
<tr>
<td>1</td>
<td>Panchkula</td>
<td>Sirsa</td>
</tr>
<tr>
<td>2</td>
<td>Ambala</td>
<td>Fatehabad</td>
</tr>
<tr>
<td>3</td>
<td>Yamunanagar</td>
<td>Hisar</td>
</tr>
<tr>
<td>4</td>
<td>Kurukshetra</td>
<td>Jind</td>
</tr>
<tr>
<td>5</td>
<td>Kaithal</td>
<td>Bhiwani</td>
</tr>
<tr>
<td>6</td>
<td>Karnal</td>
<td>Mahendergarh</td>
</tr>
<tr>
<td>7</td>
<td>Panipat</td>
<td>Rewari</td>
</tr>
<tr>
<td>8</td>
<td>Sonepat</td>
<td>Gurgaon</td>
</tr>
<tr>
<td>9</td>
<td>Rohtak</td>
<td>Faridabad</td>
</tr>
<tr>
<td>10</td>
<td>Jhajjar</td>
<td>Mewat</td>
</tr>
<tr>
<td>11</td>
<td>-</td>
<td>Palwal</td>
</tr>
</tbody>
</table>

The entire areas in four zones rating is given in Table 1.3
Table 1.3
Classification of Districts under UHBVN and DHBVN into Eastern and Western Zones

<table>
<thead>
<tr>
<th>Zone</th>
<th>DHBVN</th>
<th>UHBVN</th>
</tr>
</thead>
<tbody>
<tr>
<td>Eastern Zone</td>
<td>Faridabad, Palwal, Gurgaon,</td>
<td>Panchkula, Ambala,</td>
</tr>
<tr>
<td></td>
<td>Mewat, Mahendergarh, Rewari</td>
<td>Yamunanagar, Karnal, Panipat</td>
</tr>
<tr>
<td>Western Zone</td>
<td>Sirsa, Hisar, Fatehabad</td>
<td>Kurukshetra, Kaithal, Sonepat</td>
</tr>
<tr>
<td></td>
<td>Jind, Bhiwani</td>
<td>Rohtak, Jhajjar</td>
</tr>
</tbody>
</table>

Table 1.4
Domestic, Agricultural & Commercial - 210 Consumers (Data Collected 210)

<table>
<thead>
<tr>
<th>Consumer</th>
<th>Number of respondents</th>
<th>Percentage shares</th>
</tr>
</thead>
<tbody>
<tr>
<td>Category</td>
<td>State UHBVN DHBVN</td>
<td>State UHBVN DHBVN</td>
</tr>
<tr>
<td>Domestic</td>
<td>110 50 60</td>
<td>79 79 79</td>
</tr>
<tr>
<td>Agricultural</td>
<td>80 40 40</td>
<td>12 13 10</td>
</tr>
<tr>
<td>Commercial</td>
<td>20 10 10</td>
<td>10 9 11</td>
</tr>
<tr>
<td>Total</td>
<td>210 100 110</td>
<td>100 100 100</td>
</tr>
</tbody>
</table>

Schedules: Typology, Preparation and Administration

With a view to keeping survey objective and elements, schedule/questionnaire survey was first developed in English. The Schedules were shared with all participants for the field test. Then, the revised Schedules in the vernacular language were prepared in order to increase understanding of the respondent. The survey was carried out with the interview method using a structured Schedule.

Process Adopted to Accomplish the Consumer Satisfaction Survey

Before embarking upon the survey, a scientific and detailed research methodology was drawn up with the help of HERC and experts in the field and the pilot survey was conducted in consonance with the methodology.

Statistical Tools

To achieve the various objectives of the study, some mathematical and statistical tools like Chi Square Test, Data Envelopment Test and Compound Annual Growth rates are used in the study. Compound Annual Growth Rate is computed (2014-15) by using the following formula:

\[ Y = ab^t \]
Where

\[ Y: \text{Installed Generation Capacity} \]
\[ a: \text{Intercept} \]
\[ t: \text{Time} \]
\[ b: 1+r \text{ and } r \text{ is Compound Annual Growth Rate} \]

The logarithmic transformation of this function gives:

\[ \log Y = \log a + \log b \] (which is a log-linear function).

The values of parameters a and b in equation are estimated by using ordinary least square (OLS) method.

\[ \text{CAGR (g)} = \left( \text{Antilog (log b)} - 1 \right) \times 100 \]

**Data Envelopment Analysis**

Data Envelopment Analysis (DEA) is a linear programming technique initially developed by Charnes, Cooper and Rhodes (CCR) (1978) and further generalised by Banker, Charnes and Cooper (BCC) (1984) to gauge the efficiency of public sector non-profit organisations. DEA calculates the relative efficiency scores of various decision making units (DMUs) in the particular sample. The DEA measure compares each of DMUs in that sample with the best practice in the sample. It tells the user which of the DMUs in the sample are efficient and which are not. The ability of the DEA to find out possible peers or role models as well as simple efficiency scores makes it superior to other methods. As an efficient frontier technique, DEA ascertains the inefficiency in a particular DMU by comparing it to similar DMUs regarded as efficient.

There are several different ways to present the linear programming problem for DEA. The simplest general presentation of DEA based upon such assumption as constant returns to scale (CRS) and an objective of minimising inputs for a given level of output (an input-orientated version of DEA), proceeds by solving a sequence of linear programming problems:

(1) Minimise \( E_n \) with respect to \( w_1, w_2, \ldots , w_N, E_n \)

Subject to:
where there are $N$ organisations in the sample producing $I$ different outputs ($y_{in}$ denotes the observed amount of output $i$ for organisation $n$) and using $K$ different inputs ($x_{kn}$ denotes the observed amount of input $k$ for organisation $n$). The $w_j$ are weights applied across the $N$ organisations. When the $n$th linear program is solved, these weights allow the most efficient method of producing organisation $n$’s outputs to be determined. The efficiency score for the $n$th organisation, $E_n^*$, is the smallest number $E_n$ which satisfies the three sets of constraints listed above. For a full set of efficiency scores, this problem has to be solved $N$ times — once for each organisation in the sample.

The above formula is saying that the efficiency score for the $n$th organisation should be minimised subject to a number of constraints. The factors that can be varied to do this are the weights $w_j$ and the score $E_n$ itself. The weights are used to form the hypothetical organisation lying on the frontier. The constraints are that the weighted average of the other organisations must produce at least as much of each output, as does organisation $n$ (the first set of constraints above), while not using any more of any input than does organisation $n$ (the second set of constraints above). The third set of constraints simply limits the weights to being either zero or positive. The efficiency score is being minimised because it represents the smallest proportion of existing inputs that organisation $n$ can use and still produce its existing output if it was using the best practice observed in the sample.

One simple addition to the DEA formulae above enables the change to variable returns scale (VRS). This change slackens the simplistic assumption that inputs normally will move in exact proportions to the scale of operations: it allows for the existence of economies and diseconomies of scale. The additional constraint is that the weights in the DEA formula must sum to one. The variable returns to scale DEA linear program is given by:
(2) Minimise with respect to
Subject to:

\[ \sum_{j=1}^{N} w_j y_{ij} - y_{iw} \geq 0 \quad i = 1, \ldots, l \]
\[ \sum_{j=1}^{N} w_j x_{kj} - S_j X_{kn} \leq 0 \quad k = 1, \ldots, K \]
\[ \sum_{j=1}^{N} w_j = 1 \]
\[ w_j \leq 0 \quad j = 1, \ldots, N \]

The estimation of technical efficiency with CRS and VRS assumptions allows the overall technical efficiency (OTE) to be decomposed into two collectively exhaustive components: pure technical efficiency (PTE) and scale efficiency (SE) i.e.,

\[ \text{OTE} = \text{PT} \times \text{SE} \]

**Chi-square Test**

Chi-square is a multi-purpose statistical test used to examine the significance of relationships between two (or more) nominal-level variables. In the present study, the following variables are taken:

Y-Efficiency in Power Sector Reforms considered as problem type variable and \( X_1 \) (power cut information), \( X_2 \) (power voltage), \( X_3 \) (tariff rate change), \( X_4 \) (billing efficiency), \( X_5 \) (energy efficiency), \( X_6 \) (distribution service efficiency) are considered treatment type variables. The research question is whether (Y) variable significantly depends on the treatment variables.

**Assumptions of the Chi-square Test**

The assumptions for Chi-square test for independence are:

Assumption #1: The two variables should be measured at an ordinal or nominal level (i.e., categorical data).

Assumption #2: The variable should comprise of two or more categorical, independent groups. Example independent variables that meet this criterion include gender (2 groups: Male and Females), ethnicity, physical activity level (e.g., 4 groups: sedentary, low, moderate and high).
1.8 Limitations

The researcher has to be dependent on the data available but due to many factors being involved reliability of the secondary data is always limited. Likewise, primary data also contribute to the limitations of the study. Due to the busy work schedule and prior engagements of the respondents, frequent visits had to be made for getting questionnaires filled up. The other limitation stemming from the primary data could be attributed to the attitude and sincerity of the respondents in filling up the questionnaires. This job demands high level of seriousness from the respondents but due to their personal priorities, and indifferent attitude the process of data collection suffers from imperfections. Despite above mentioned limitations the conclusions of the present study are quite useful. Further, on the basis of the findings certain recommendations are made to effect and improvements in various areas of power sector in Haryana.

1.9 Chapter Scheme

1. Introduction
2. Review of Literature
3. Power Sector Reforms in India and Haryana
4. Performance of Power Sector in Haryana: Before and After Reforms
5. Power Sector Reforms and Economic Efficiency: Data Envelopment Analysis
7. Conclusion and Policy Implications.