CHAPTER - 1

INTRODUCTION

It is difficult to say when exactly the first power plant was built in British India. There are, however, scattered reports available and it is said that in January 1887, Kilburn and Co. secured an electric lighting license as agents of the Indian electric company limited. The company changed its name to the Calcutta Electric Supply Corporation (CESC) soon afterwards. The first power generating company in Calcutta was started in 1899. There is yet another report which speaks of the first diesel power station established in Delhi in 1905. This was a private plant set up by an Englishman in the name of M/s John Fleming. He was given a license under the provisions of the Indian Electricity Act 1903. This particular company, after getting a license set up a small 2 MW diesel set at lahori gate in old Delhi. Later on, the same company was converted to the Delhi Electric Supply and Traction Company. The first hydro electric station in India was erected at Sivasamudram in Mysore in 1902. This was followed by the hydro-electric station for the Bombay area [1].

One issue, however, is very clear and it is that most of the electrification was limited to large towns and cities. The emphasis was on supply to large urban concentrations and there was little coordination or cooperation between the different suppliers. The exact composition between private and public sector plants varied from province to province but there is no doubt that primarily, it was dominated by private plants. In addition to the private and public utility power stations, there were a number of industrial and railway installations having their own plants. The fact remains that India was facing tremendous power shortage. The growth in plant capacity did not keep pace with the growth in load since 1940. There was an acute power shortage in Bombay, Delhi, parts of Uttar Pradesh, Madras and West Bengal. During the war years, it was not possible to find additional plant or equipment. Several restrictions were imposed on new connections and measures like staggering
of holidays were in position. It is not just that the installed capacity was insufficient, the condition of the plants were also a matter of concern since quite a few plants were more than 25 years old [1,2].

In its earliest incarnations, electricity was a kind of magical force, something to be exhibited at the sideshow to curious awestruck onlookers. But it quickly became an essential part of daily life, something now taken for granted by almost everyone in the industrialized world. At its most fundamental level, what it does is give us light and heat when it is dark and cold. That is, electricity liberates humanity from the constraints of nature and contravenes the ordering of day and night. The power that travels through poles and wires is an invisible yet vital force that connect us each to the other. Power is about the way in which electricity is generated and distributed. The way decisions about the generation and distribution of electricity are made affects us all [5,12].

In the pre-independence era, the power supply was mainly in the hands of private sector that too restricted to the urban areas. After independence, the government of India felt the need for broadening electricity supply industry with a view to rationalize its growth all over the country. With the formation of State Electricity Boards (SEB’s) in the various parts of the Country in the early 50’s, a significant step was taken in bringing out systematic growth of power supply industry all over the country. In the case of India, the installed capacity was only about 1,362 MW in 1947, 1713 MW on 31.12.1950 and rose to 1,05,046 at the end of 9th plan (31.03.2002) and has grown to about 201637 MW by 30 April 2012. The electricity generation in the country during April’12 was 74.73 BU as compared to 71.43 BU during April’11. The growth rate during April’12 was 4.62% corresponding to April’11. The consumption of electricity of 4157 GWh as on 31.12.1950 rose to 596186 GWh as on 2004-05. The per capita electricity consumption which was 18.17 kWh during 1950 increased to 619 kWh during the year 2006-07 and rose to 794 kWh during the year 2011-12 [3,5].
1.1 GROWTH IN INSTALLED CAPACITY AND OTHER PARAMETERS

In the case of India, the installed capacity was only about 1,362 MW in 1947 and has grown to about 173,626 MW by March 2011. It is primarily thermal (65 percent) with maximum capacity from coal. The share of hydro is only about 22 percent despite the fact that hydro potential in India is about 84,000 MW at 60 percent load factor. Share of nuclear and renewable is small at 3 percent and 10 percent respectively (Figure 1.1). These percentages, however, undergo a change when viewed in terms of energy generation, especially for hydro and renewable. Though hydro installed capacity is 22 percent of the total, its share in energy generation is only 14 percent. Similarly, renewable though having a share of almost 10 percent in capacity, its share in energy generation is only 2.4 percent. The reason is that the capacity factor for hydro and renewable is much below thermal plants [1].

![Pie chart showing installed capacity from different sources as in March 2012 (in Percentage)](Image)

Source: Central Electricity Authority

On the issue of ownership, while it was predominantly private sector owned (about 60 percent) at the time of independence, the situation has completely changed today where 79 percent of the installed capacity is in the public sector (about 32 percent in the central sector and about 47 percent in the state
sector). Private sector ownership is limited to 12 percent only. It is not only the type of ownership which has undergone a change; the ratio of thermal to hydro capacity has kept fluctuating between 23 percent and 45 percent. The ideal mix as far as India is concerned is 60:40.

In per capita terms, India’s growth has been less than modest and today, India’s per capita consumption is only about 794 units as compared to a world average of 2429 units. A perusal of the per capita consumption levels of some of the developed countries gives an idea of the extent of deprivation in India when it comes to electricity consumption [2].

![Figure 1.2](image1.png)

Per Capita Consumption of Electricity in India & Some Developed Economies in Kwh/year

Source: Central Electricity Authority

![Figure 1.3](image2.png)

Figure 1.3 Per Capita Consumption of Electricity in India

Source: Central Electricity Authority
In per capita terms, India’s growth has been less than modest and today, India’s per capita consumption is only about 794 units as compared to a world average of 2429 units. A perusal of the per capita consumption levels of some of the developed countries gives an idea of the extent of deprivation in India when it comes to electricity consumption [2]. This is not to suggest that India’s per capita consumption has been static over the years. It has been growing at about 7.3 percent per annum (Figure 1.3).

What is important to note here is that there has been a noticeable change in the electrical consumption pattern across different consumer groups. The shares of domestic and agricultural sectors have gone up at the cost of industrial and commercial consumers. The share of the domestic sector has gone up from 10.8 percent in 1970-71 to 29 percent in 2011-12. The corresponding figures for the agricultural sector are 10 percent and about 21 percent, respectively. As compared to this, industrial consumption has dropped from 61.6 percent to about 38 percent during the same period.

Though India’s generation has increased at a modest pace of about 8% since independence, there have been consistent shortages, both in terms of load and energy requirements. Peak demand shortage is to the extent of 10.3% even today (2010-11) whereas the energy shortage is about 7.5%. The extent of shortages over the last fourteen years is indicated in the figure 1.4.

![Energy and Peak Shortage](source.png)
A shortage in power supply is not surprising considering the fact that there has been a consistent shortfall in every plan period in the capacity addition achieved vis-à-vis the targets (Figure 1.5). The shortfalls are due to various reasons, such as, over ambitious targets, delay in placement of order for main plant, delay in environment clearances, rehabilitation problems leading to litigations, geological surprises in case of hydro projects, non-availability of gas etc. It is to be noted that figure for Eleventh Plan are only for the period 2007-11. Figure 1.5 shows the targets or achievements for capacity addition in various five years plans in MW.

![Figure 1.5](image)

**Figure 1.5**

**Targets/Achievements for Capacity Addition in Various Five Year Plans (in MW)**

*Source: Central Electricity Authority*

The immediate impact of the repeated shortfall in capacity has been the setting up of captive power plants by the industrial sector. The setting up of these plants had become imperative given the poor quality of power supply that the industry had to face. Given the nature of the industry in certain cases, like aluminium and steel where there is a need for a continuous source of supply, there was no escape but to set up captive power plants. The regime of high cross subsidies has encouraged the industrial sector to set up their own captive power plants. The industrial sector along with the commercial sector
and the railways helped the utilities to recover a part of their losses they faced while supplying power to the domestic and the agricultural sectors. [1,2].

1.2 LOSSES IN ELECTRICAL POWER SYSTEM

In order to study the technical and non technical losses in electrical power system, the logical and first step is to understand the complete picture of power system and power system losses. The complete picture of power system start from generation then transmission and at last to distribution is shown in the figure 1.6.

![Figure 1.6 Power System](image)

We know that there are certain losses which affect the economy of the power system. It is a well known fact that all energy supplied to a distribution utility does not reach the end consumer. A substantial amount of energy is lost in the distribution system by way of technical and non technical losses. The distribution system accounts for highest technical and non technical losses in the power sector.

In India the percentage of transmission and distribution losses has been quite high. The term distribution losses refers to the difference between the amount of energy delivered to the distribution system and the amount of energy customers is billed [5]. Distribution line losses are comprised of two types: technical losses and non technical losses. However, as per sample studies carried out by independent agencies including TERI, these losses have been estimated to be as high as 50% in some states. In a recent study carried by SBI capital markets, the transmission and distribution losses have been estimated
as 58%. The transmission and distribution losses in the advanced countries of the world ranging from 4-12%. However, the transmission and distribution losses in India are not comparable with advanced countries as the system operating conditions are different in different countries. This research work is handling the potential of technology option to reduce the technical and non-technical losses in the Indian power system and its economic consequences in Indian economy. The importance of reducing technical and non technical losses in the power system is well known. The electrical utility is probably the largest and most complex industry in the world. The electrical engineer who works in this industry will encounter challenging problems in designing future power system to deliver increasing amount of electrical energy in a safe, clean and economical manner. The more power flows through the network, the voltage drop becomes more excessive and power quality decline. In addition large real power causes more energy losses unnecessarily, when power is distributed to end users. The relationship between the input power ($P_{\text{in}}$), output power ($P_{\text{out}}$) and the losses ($P_{\text{loss}}$) associated in a power system is highlighted in fig. 1.7. The efficiency of the Power system can be written as:

\[
\text{Efficiency} = \frac{P_{\text{out}}}{P_{\text{in}}} = 1 - \frac{P_{\text{loss}}}{P_{\text{out}} + P_{\text{loss}}} = \frac{P_{\text{out}}}{P_{\text{out}} + P_{\text{loss}}}
\]

Fig.1.7

Relationship between I/O Powers with Associated Losses in a Power System

This thesis was undertaken to assimilate the details of technical and non technical losses occurs in power system and also investigate the nature of technical and non technical losses, sources of losses, measurement of technical and non technical losses and how to reduce these losses and solution.
methodology for reducing the technical and non technical losses in power system with the help of field survey and practical case studies.

It is well known that a substantial amount of energy is lost in the distribution system by way of technical and non technical losses. In addition, shutdown and breakdown in the system also prevent the delivery of energy to end consumers causing revenue loss. The distribution system accounts for highest technical and non technical losses in the power sector. The endeavour of a power distribution utility should be to reduce revenue leakage by eliminating causes of non technical losses and by minimizing technical losses. Some measures taken by selected utilities to reduce them, and possibly their impact on the system. In general, system losses increase the operating costs of electric utilities and typically result in higher cost of electricity. The increase in the electricity price to customers will depend on the regulatory treatment of the losses in the tariff. The reduction of system losses in any utility is important because of its economic, financial and social repercussions for the electric utility, the customers and even the operating country. System losses by and large pose a major challenge for regulatory agencies. Depending on the regulatory arrangement, losses can have adverse and varying levels of financial effects on the customers and the utility. On one extreme, if the utilities were allowed to pass on its entire loss burden to the customers, irrespective of the magnitude of loss, there would be no incentives for it to enact loss reduction measures. This may not be fair to the customers because certain operating inefficiencies of the utility that impacts the system losses could be passed on to them. On the other extreme, it would be unfair for the utility to shoulder all the responsibility of the system losses [6].

1.3 TECHNICAL LOSSES IN POWER SYSTEM

Technical losses in power system are caused by the physical properties of the components of the power system. The most obvious example is the power dissipated in transmission lines and transformers due to internal electrical resistance. Technical losses are naturally occurring losses (caused by action
internal to the power system) and consist mainly of power dissipation in electrical system component such as transmission lines, power transformers, measurement system, etc. Technical losses are possible to compute and control, provided the power system in question consists of known quantities of loads [5].

Technical losses on distribution systems are primarily due to heat dissipation resulting from current passing through conductors and from magnetic losses in transformers. Technical losses occur during transmission and distribution and involve substation, transformer, and line related losses. These include resistive losses of the primary feeders, the distribution transformer losses (resistive loses in windings and the core losses), resistive losses in secondary network, resistive losses in service drops and losses in kWh meter [6]. Losses are inherent to the distribution of electricity and cannot be eliminated. Technical losses are due to current flowing in the electrical network and generate the following types of losses:

- Copper losses those are due to $I^2R$ losses that are inherent in all inductors because of the finite resistance of conductors
- Dielectric losses that are losses that result from the heating effect on the dielectric material between conductors
- Induction and radiation losses that are produced by the electromagnetic fields surrounding conductors.

Technical losses are possible to compute and control, provided the power system in question consists of known quantities of loads. The following are the causes of technical losses:

- Harmonics distortion
- Improper earthing at consumer end
- Long single phase lines
- Unbalanced loading
- Losses due to overloading and low voltage
- Losses due to poor standard of equipments.
1.4 NON TECHNICAL LOSSES IN POWER SYSTEM

Non technical losses, on the other hand, are caused by actions external to the power system or are caused by loads and condition that the technical losses computation failed to take into account. Non technical losses are more difficult to measure because these losses are often unaccounted for by the system operators and thus have no recorded information [9].

Non technical losses (NTL), on the other hand, occur as a result of theft, metering inaccuracies and unmetered energy. NTLs by contrast, relate mainly to power theft in one form or another. They are related to the customer management process and can include a number of means of consciously defrauding the utility concerned [10]. Theft of power is energy delivered to customers that is not measured by the energy meter for the customer. This can happen as a result of meter tampering or by bypassing the meter. Losses due to metering inaccuracies are defined as the difference between the amount of energy actually delivered through the meters and the amount registered by the meters. All energy meters have some level of error which requires that standards be established. The most probable causes of non technical losses are:

- Tampering with meters to ensure the meter records a lower consumption reading
- Errors in technical losses computation
- Tapping (hooking) on LT lines
- Arranging false readings by bribing meter readers
- Stealing by bypassing the meter or otherwise making illegal connections
- By just ignoring unpaid bills
- Faulty energy meters or un-metered supply
- Errors and delay in meter reading and billing
- Non-payment by customers.
Non Technical Losses (NTLs) are caused by actions external to the power system, or are caused by loads and conditions that the technical losses computation failed to take into account. NTL are more difficult to measure because these losses are often unaccountable. The aim in this thesis work is to first compute the technical losses and then impact of non technical losses on them is shown. Technical losses will be simply calculated using load flow method of power system. This will be done because non technical losses are more difficult to measure. As NTL cannot be computed and measured easily, but it can be estimated from preliminary results, i.e. the result of technical losses are first computed and subtracted from the total losses to obtain the balance as NTL. The technical losses are computed using appropriate load-flow studies simulated under MATLAB environment. Although some electrical power loss is inevitable, steps can be taken to ensure that it is minimized. Several measures have been applied to this end, including those based on technology and those that rely on human effort and ingenuity [6].

Reduction of NTLs is crucial for distribution companies. As these losses are concentrated in the low-voltage network, their origins are spread along the whole system and are most critical at lower levels in the residential and small commercial sectors. Overcoming and recovering NTLs is essential and requires significant investment in the means of doing so [11].

1.5 ELECTRICITY THEFT IN POWER SYSTEM

A non technical loss is defined as any consumed energy or service, which is not billed because of measurement equipment failure or ill intentioned and fraudulent manipulation of said equipment. Therefore, detection of non-technical losses includes detection of fraudulent users [5]. Electricity theft is defined as a conscience attempt by a person to reduce or eliminate the amount of money he will owe the utility for electric energy. This could range from tampering with the meter to create false consumption information used in billings, to making unauthorized connections to the power grid. Non-
payment, as the name implies, refers to cases where customers refuse or are unable to pay for their electricity consumption [8].

Electricity theft is part of a phenomenon known as “Non-Technical Losses” (NTL) in electrical power systems. It is estimated that electricity theft costs in our country is in crores in a year. According to two studies published in 2004, theft of electricity in India amounted to a nationwide loss of $4.5 billion [5]. This led several states of India to enact and implement regulatory and institutional framework; develop a new industry and market structure; and privatize distribution. The state of Andhra Pradesh, for example, enacted an electricity reform law; unbundled the utility into one generation, one transmission, and four distribution and supply companies; and established an independent regulatory commission responsible for licensing, setting tariffs, and promoting efficiency and competition. Some state governments amended the Indian Electricity Act of 1910 to make electricity theft a cognizable offense and impose stringent penalties. A separate law, unprecedented in India, provided for mandatory imprisonment and penalties for offenders, allowed constitution of special courts and tribunals for speedy trial, and recognized collusion by utility staff as a criminal offense. The state government made advance preparations and constituted special courts and appellate tribunals as soon as the new law came into force. High quality metering and enhanced audit information flow was implemented. Such campaigns have made a big difference in the Indian utilities’ bottom line. Monthly billing has increased substantially, and the collection rate reached more than 98%. Transmission and distribution losses were reduced by 8%.

This thesis aims to investigate the nature of Technical and non technical losses in power systems, their sources, the measurement of non technical losses, some measures taken by selected utilities to reduce them, and possibly their impact on the power system. Power flow calculations of load flow studies are used to discuss relevant aspects of technical losses and the effects of adding NTL in a simplified power system. The results of those simulations are presented.
1.6 TRANSMISSION AND DISTRIBUTION LOSSES IN POWER SYSTEM

In India, average transmission and distribution losses have been officially indicated as 23 percent of the electricity generated. However, as per sample studies carried out by independent agencies these losses have been estimated as high as 45-50 percent in some states. In a recent study carried out by SBI Capital Market, the transmission and distribution losses have been estimated as 50-55 percent. With the setting up of State Regulatory Commission in the Country, accurate estimated of transmission and distribution losses has gained importance as the losses directly affects the sales and power purchase requirement and hence has a bearing on the determination of electricity tariff of a utility by the commission. The officially declared transmission and distribution losses in India have gradually risen from about 15 percent up to the year 1966-67 to about 26 percent in 2011-12. The losses in any system would, however, depend on the some factor (according to Electric Power Research Institute, USA) and these factors are:

- Pattern of energy used
- Capability and configuration of the transmission and distribution system
- Intensity of load demand and load density
- Theft and pilferage of energy and direct tapping from line
- Faulty meters and wrong reading from meters
- Poor quality equipments etc.

In Percent T & Distribution losses for some countries in 2006-07 are given in table 1.1.

<table>
<thead>
<tr>
<th>Country</th>
<th>% T&amp;D Losses</th>
</tr>
</thead>
<tbody>
<tr>
<td>INDIA</td>
<td>33</td>
</tr>
<tr>
<td>NICARAGUA</td>
<td>30</td>
</tr>
<tr>
<td>PAKISTAN</td>
<td>26</td>
</tr>
<tr>
<td>RUSSIA</td>
<td>12</td>
</tr>
<tr>
<td>U.S.A</td>
<td>07</td>
</tr>
<tr>
<td>CHINA</td>
<td>06</td>
</tr>
<tr>
<td>JAPAN &amp; GERMANY</td>
<td>04</td>
</tr>
</tbody>
</table>

Source: Central Electricity Authority
From Table 1.1 it is evidenced that countries such as China, Pakistan and even African nations such as Nicaragua have more respectable T&D losses as compared to India’s average loss level of about 33 percent. In comparison, Pakistan’s T&D losses are about 26 percent, while the loss level in China are close to those in the developed world at a creditable 6 percent. Japan and Germany set Benchmark in power transmission and distribution efficiency with overall loss levels of 4 percent. In broad term, the power sector is expected to achieve break-even at T&D Loss levels of around 20 percent or so. While T&D losses of anything below 20 percent means the power utilities in the country would start making operational profit, any higher loss levels rust the country’s power sector into the dark. According to the Central Electricity Authority data, though the country’s T&D losses have come down marginally by a percentage point from 32.54 percent in 2002-03 to 32.53 percent in 2003-04. While the Government has tried to stem the loss levels through efforts at metering of 11 KV feeders and consumers meter, energy accounting and auditing, the centre key reform project. The Accelerated Power Development and Reforms Programme (APDRP) have been perceived to be losing steam. Taking advantage of the incentives available under APDRP for reducing T&D losses, some states such as Karnataka, Andhra Pradesh and Rajasthan have shown reduction in losses. However, most others, including traditional laggards such as Bihar, Jharkhand and Uttar Pradesh, have been unable to stem their T&D losses.

The transmission and distribution losses for the whole of India during 1995-96 was approximately about 22 percent which has increased to about 26 percent by 2011-12. For 2009-10, the states which have relatively high T&D losses are Jammu & Kashmir (63%), Bihar (38%), Chhattisgarh (38%), Jharkhand (38%) and Madhya Pradesh (35%). The states having relatively low T&D losses include Punjab (19.7%), Himachal Pradesh (14.7%), Andhra Pradesh (18%) and Tamil Nadu (18%). The Uttar Pradesh has very high transmission and distribution losses approx 32.3 percent across different states and ETs in 2009-10 in percentage are shown in Figure 1.8.
1.7 POWER BALANCE

The total quantity of electricity available for sale in a state is its own generation net of auxiliary consumption plus net purchase minus T&D losses. Table 1.2 gives the power balance from 2001-02 to 2008-09 for the whole country. The purchase from outside means purchase from countries like Nepal and Bhutan [1].

Table 1.2
Power Balance

<table>
<thead>
<tr>
<th>Year</th>
<th>Gross Generation</th>
<th>Auxiliary Consumption</th>
<th>Net Generation</th>
<th>Purchase From Outside*</th>
<th>T &amp; D Losses</th>
<th>Total Consumption</th>
</tr>
</thead>
<tbody>
<tr>
<td>2001-02</td>
<td>517,439</td>
<td>36,606</td>
<td>480,833</td>
<td>7,969</td>
<td>166,111</td>
<td>322,691</td>
</tr>
<tr>
<td>2006-07</td>
<td>670,654</td>
<td>43,557</td>
<td>627,077</td>
<td>11,931</td>
<td>183,043</td>
<td>455,965</td>
</tr>
<tr>
<td>2007-08</td>
<td>722,626</td>
<td>45,531</td>
<td>677,095</td>
<td>12,686</td>
<td>187,513</td>
<td>502,268</td>
</tr>
<tr>
<td>2008-09</td>
<td>741,167</td>
<td>47,404</td>
<td>93,763</td>
<td>14,181</td>
<td>180,322</td>
<td>527,622</td>
</tr>
</tbody>
</table>

Source: Central Electricity Authority
It is observed that during this period the auxiliary consumption has varied between 6.3% and 7.1% of the gross generation. In 2001-02, the auxiliary consumption was 7.1% of the gross generation, and it has improved to 6.4% in 2008-09. T&D losses were 34% of the total power available for sales in 2001-02. Since 2001-02, the T&D losses have reduced and were 25% of the total power available for sales in 2008-09.

1.8 POWER SUPPLY POSITION

The peak deficit at the end of the 10th Plan i.e. in 2006-07 was 13.8 percent and the energy deficit was about 9.6 percent. During the year 2010-11, the peak deficit, however, has been 10.3 percent whereas the energy deficit was about 8.9 percent. This does not necessarily imply an improvement in the power supply position since it has been seen that demand for power has come down over the last one year and one of the principal reasons for this is the lower power purchasing capacity of the distribution utilities [1].

1.9 PROBLEMS IN DISTRIBUTION SYSTEMS

The main issue in distribution systems or rather more appropriately the issue confronting the power sector as a whole, is the reduction of transmission and distribution (T&D) losses to acceptable minimum levels. The all-India T & D losses, which were about 15% till 1966-67, increased gradually up to 22% in 1995-96 which has increased to about 25.6 % by 2009-2010 [1]. During the last few years, some of utilities variously estimated the losses in the range over 30% to 45% much higher than the preceding years. T & D losses in developed countries are around 7-8% only. The reasonable permissible (Technical) energy losses should be about 10%-15% in different states [5].

While the losses in EHV (Extra High Voltage) network are about 4%-5%, bulk of the losses occurs in transmission and distribution system. It is well known that these losses in distribution systems include non-technical or commercial losses and that of power by various users with or without connivance of utility staff. These constitute a large component of overall losses. There are
also losses on account of defective (slow) meters, stuck up/burnt meters etc. Further on account of estimation involved in agriculture sector consumption (30% of total), absence of adequate metering at the system level, deficiencies in consumer metering the validity of figure of T & D losses being reported become questionable. General conclusions are that the reported losses are under estimated and cover up large commercial losses (theft), actual figures are higher, technical losses are also high and bulk of the losses occur in sub-transmission and distribution systems.

Inefficiency, frequent interruptions, flickers and poor voltage also characterize distribution systems. In addition the billing and revenue collections are very poor leading to combined state utility financial losses of Rs. 26,000 crores every year. If the current trend continues, in another three years, state utility financial losses will reach Rs. 45,000 crores a year. It is, therefore, necessary to bring about improvements in planning implementation and operation of T&D systems in a scientific and efficient manner. The present traditional reactive and ad-hoc approach to network development should be replaced by an approach based on technical and reliability requirements, economic considerations of costs of energy loss and expansion of system to meet the growth of prospective demand with least cost [3].

1.10 ECONOMIC CONSEQUENCES OF LOSSES ON COMMUNITY

In an important information provided under RTI Act by Central Electricity Authority regarding transmission loss it was reported that in 2011-12 the transmission losses were to the tune of 165834 million units. If we multiply the cost per unit as Rs 3, then the total loss in financial term will Rs 497502 crores [4]. This is only one year figure. If we add 5 years transmission loss it will be around 2487510 rupees, enough money to build Delhi like metros in all major cities of India, enough money to build roads to take village kids to nearby town schools, enough money to build hospitals to take care our elderly people. The people who use ACs but do not pay for its use, they have factories but in connivance with electrical board people do not keen to pay as
per their use. The reason for the significant amount of non payment is political and economic changes and the response of the governments and the public to those changes. Payment default at the consumer end resulted in Transmission and Distribution companies defaulting on their dues to the generating companies, which in turn accumulate unpaid debts to energy suppliers, banks, and employees. The following are the reasons and their consequences on the whole system:

- The inability to pay for energy has led to rationing, which allows only for a few hours of electricity supply each day.
- Political and economic changes, economic collapse or severe contraction in many countries.
- Declining incomes, high inflation, high unemployment and rising energy prices severely eroded the ability of households to pay for energy and heat.
- In an extreme example, some customers in some countries had threatened to shoot utility officials for attempting to disconnect supplies.
- In most countries, the absence of adequate metering and poor location of meters effectively prevented any action against theft and non-payment.

Thus the assessment of technical and non technical losses in the Uttar Pradesh state will help to provide Uttar Pradesh Power Corporation Limited (UPPCL) policy makers important assistance in making their analysis of the incremental costs and impacts of different combinations of loss reduction options.

The thesis consists of seven chapters. The chapter one deals with basic introduction of power sector scenario in India. The chapter two deals with Indian power system and power sector reforms in India and chapter third includes the complete literature survey. The chapter four deals with details analysis of technical losses with the help of different surveys conducted in the
year 2010-2011 in different areas and case studies. The chapter five deals with
detail analysis of non technical losses with the help of case studies and
MATLAB. At last, chapter six deals with the effect of technical and non
technical losses and its economic consequences in power sector. The chapter 7
deals with conclusion of thesis and recommendation for further work. The
survey details and algorithm used in MATLAB programme is given in
appendices.