Haryana has become the second State in India which started the reform process of the whole power sector after Orissa and Delhi. Further, Haryana unbundled the Haryana State Electricity Board (HSEB) in August 1998 into different functional entities. The new entities are Haryana Power Generation Corporation Limited (HPGCL) for generation of power and Haryana Vidut Prasaran Nigam Limited (HVPNCL) for transmission and supply of electricity in the State. Uttar Haryana Bijli Vitran Nigam Limited (UHBVNL) and Dakshin Haryana Bijli Vitran Nigam Limited (DHBVNL) are the distribution companies.

The restructuring program was undertaken to cover the losses of HSEB and make the power company financially self-sustaining and sound, ending up with a nut funding source for the progress of the state economy. The State has many thermal power stations. The Panipat Thermal Power Station, Deen Bandhu Chhotu Ram Thermal Power Project, Rajiv Gandhi Thermal Power Project, Indira Gandhi Super Thermal Power Project, Hydroelectric Station WYC, Yamuna Nagar and Kakroi Micro Hydel Project are generating power with a total capacity of 3480.5 (MW).

Evaluation of Power Sector Reforms and Economic Efficiency

Given that the reform process was initiated about one and half decade ago, an evaluation of the status of its impact on economy, efficiency and consumer participation in the regulatory and reform process was due. This involves examining the Efficiency and Productivity of the power sector in Haryana, analyzing the growth of power sector reforms in terms of power generation, transmission and distribution function, reviewing the status of consumer satisfaction in Haryana, assessing the level of consumer awareness through a structured survey, ascertaining the extent to which consumers are aware of their rights and responsibilities, the role of the regulatory agency and platforms for interacting with stakeholders, and the linkages between regulatory decisions pertaining to tariff setting etc and improvement in quality and reliability of service.
An evaluation was carried out through some mathematical and statistical tools like Chi Square Test, Data Envelopment Test and Compound Annual Growth rates. A consumer survey with the explicit objective of reviewing the status of consumer satisfaction and economic efficiency was also carried out.

**Major Findings of the study**

**Power Sector in India**

Power sector has played a crucial role in the Indian Economy in the 21st century. It is essential for economic growth and sustainable development in terms of trickle down effect. Due to paramount increase in population and changing lifestyle the demand of power is increasing in the melting-port. Currently, there is a lack of energy in India, which can be observed in the form of power outages and increasing prices of other fuels. With regard to the future prospects of energy, the Indians may use unconventional energy sources sufficiently such as wind, solar and geothermal Tidal power, etc. which is essential in times to come.

The fast growth of Indian economy has triggered escalation in demand for energy at an average of 3.6 per cent yearly over the last 30 years. The per capita consumption of electricity has gone up from 16.3 (KWH) in 1947-48 to 957.50 (KWH) in 2014-15. In absolute terms, the length of transmission and distribution lines were 23238 (Km) in 1947-48 and are now 9090501 (Km) in 2014-15. The total fully electrified villages in 1949-1950 were 3061 which grew upto 597464 in 2014-15. Village electrification increased at a CAGR of 8.31 per cent.

Total installed generation capacity increased from 1362 (MW) to 255664 in from 1947-48 to 2014-15. The Hydel generation capacity increased from 508(MW) to 40456 (MW) from 1947 to 2015. The total thermal generation capacity was 854 (MW) in 1947-48 and it has gone upto 206358 (MW) 2014-15. Over the period under consideration, it was coal which has registered the maximum generation capacity from 756 (MW) to 175857 (MW). In the year 1947-48, nuclear generation started only in the year 1991-92 with capacity of 32 (MW) and has gone upto 38821 (MW) in 2014-15.

There has been a substantial change in the electricity consumption pattern across different consumer groups. The share of domestic sector has gone up from 423
153

(GWH) 1947-48 to 201189 (GWH) in 2014-15. The share of commercial sector is lowest among all the sectors. Its share in the total electricity consumption was 178 (GWH) in 1947-48 and has gone upto 73421 (GWH) in 2014-15. The share of industrial sector in electricity consumption is highest among all the sectors from 2960 (GWH) in 1947-48 to 404532 GWH in 2014-15. The per capita consumption of electricity in agriculture sector has been static over the years. It has escalated from 125 (GWH) in 1947-48 to 156712 (GWH) in 2014-15.

**Power Sector in Haryana**

**Power Generation**

It has been observed that Haryana demand for power is increasing every day and generation competence was not in a position to compete the demand due to its poor condition. With state restructuring programme, the intention was to bring reforms in the energy sector for sustainable development in state. Haryana Power Generation Corporation Ltd. (HPGCL) developed to keep pace with the growing demand for energy stage. The first step in the reform of the electricity sector in Haryana was made in 1998 in the production of electricity through thermal and hydel. Since 2001, gross generation of electricity (thermal and hydel) pave the way to increase electricity production in the energy sector leading to reforms for years. But from 2011-2012, the thermal and hydel gross production amounted to 18818.61 (MU) but drastically reduced in 2014-15 and reached the level of gross domestic product 13818.0 (MU). It is required to improve the production system of power sector in the coming years in Haryana State.

From the calculation it has been found out that installed capacity for the entire period under study increased at a CAGR of 24.15 per cent. The availability of power increased at a CAGR of 19.13 per cent, for the period under study and power sold increased at a CAGR of 19.30 per cent.

**Power Distribution**

The distribution system of the power sector constitutes the final link between the power sector and the consumers. The efficiency of the energy sector is judged by the consumer, with the performance of this segment basis. However, it is the most vulnerable part of the industry because having the huge losses. For these reasons, the
real challenge of reforms in the power sector lies in efficient management of the
distribution system. The National Policy on Energy in this context, inter alia, stressed
on the restructuring of the distribution companies, efficiency gains and the recovery
of costs of services for consumers to make the sector sustainable at reasonable and
affordable rates.

As part of reforms in the power sector, the former Haryana State Electricity
Board (HSEB) was broken (August 14, 1998) and two state-owned companies
namely, Haryana Power Generation Corporation Limited (HPGCL) and Haryana
Vidyut Prasaran limited Nigam (HVPN) formed. HPGCL was responsible for
operating and maintaining stations of state-owned power generation, where HVPN
was committed transmission and distribution functions. HVPN was reorganized in
(July 1999) and two distribution companies (DISCOMs), namely. Uttar Haryana Bijli
Vitran Nigam Limited (UHBVN) and Dakshin Haryana Bijli Vitran Nigam Limited
(DHBVN) were built for the distribution of power to different types of consumers.
The infrastructure for distribution have been increasing very fast after the reforms in
power sector.

For the entire period under study, the 220 (KV) sub-station increased at a
CAGR of 22.59 per cent. The 132 and 66 (KV) substations increased at a CAGR of
10.64 and 7.79 per cent respectively. The number of transformers increased at a
CAGR of 19.34 per cent for the entire period under study. The CAGR of transformers
before and after reforms was almost identical. The number of transformers and LT
and 11 KV lines increased very fast. In case of LT lines, the overall CAGR increase at
10.33 per cent in the entire period under study and before reform the increase was
7.38 per cent but it was merely 0.64 per cent after reforms. In the case of 11 (KV)
Lines the CAGR increase during the entire period was 11.91 per cent and before
reforms the increase percentage was 6.30 per cent and after reforms it was 4.80 per
cent. So it can be summarized that, there was not much increase in both the lines after
reforms.

Power Transmission

Electric Power Transmission is a bulk movement of electrical energy from a
generating site to electrical Substation. Haryana Vidyut Prasaran Nigam Limited
(HVPNL) was established as a company under the Companies Act, 1956 on 19 August 1997 and was awarded the certificate for business on 18 September, 1997. Subsequently, the transmission and distribution business from Haryana State Electricity Board (HSEB) was transferred in early August 14, 1998 to HVPNL.

On July 1, 1999 the distribution business was given to Uttar Haryana Bijli Vitran Nigam Limited (UHBVNL) in the north zone and Dakshin Haryana Bijli Vitran Nigam Limited (DHBVNL) was given the charge of the south zone.

During the entire period under study, the 220 (KV) transmission line increased at a CAGR of 6.31 per cent and before reforms it increased at a CAGR of 5.17 per cent and after reforms it increased at a CAGR of 6.52 per cent. The 132 and 66 KV lines increased at a CAGR of 1.96 and 3.19 per cent respectively during the entire period. It was found that the total length of transmission line was 12703 (Km). The total number of 132 (KV) Substations are 180, the maximum of all the categories, whereas the total number of Substations are 396.

**Power Consumption and Connection**

As far as power availability is concerned Haryana can be categorized as one of the richest States. Planning Commission has estimated per capita consumption of power as 1029 (KWH) against the all India average of 884 units for the FY 2012-13. This increase in per capita consumption of power is a result of high budgetary support provided during the planning period. It has been observed that the total consumption of electricity started increasing rapidly after 1980-81. The consumption of power increased at a high rate after 2000-01. In view of the rapid hike in demand for consumption, the need for more power generation resources is being acutely felt to meet the growing demand. For the entire period under study, the electricity consumption in Haryana increased at a CAGR of 5.55 per cent.

Power connection have been increasing very fast especially after reforms. It has been observed from the data collected from statistical abstract of Haryana that the maximum connections in the household have been increasing at the annual growth rate of 12.47 per cent before the reforms and 7.45 per cent after the reforms. Similarly, if we compare the household sector in which the connections increased at
the CAGR of 3.40 per cent which is higher than the agriculture sector (3.33 per cent) and commercial sector (1.29 per cent).

**Transmission and Distribution Losses**

For better and cheap power generation, transmission and distribution losses need to be reduced. The level of transmission and distribution losses (T&D) is one of the important indicators for the measurement of the energy efficiency. In the present scenario, the energy losses consist of technical losses as well as commercial losses, thus there is an urgent requirement to alleviate them. The power losses are technical and non-technical losses. Technical losses are naturally occurring losses and they are caused by the actions which are internal to the power system. It consist mainly of power dissipation in electrical system components such as transmission lines, power transformer measurement system, etc. Whereas, non-technical losses are caused by the actions external to the power system, or by loads and various conditions where, technical losses computation fails to take into account such as pilferage, defective meters, error in meter reading and estimation of unmetered supply of energy. Reasons for commercial losses are losses at consumer end meters, tampering/bypass of meters, pilferage of energy, energy accounting system, error in meter reading, false bills and receipt of payment.

It has been observed from the data collected from the planning commission report that the transmission and distribution losses as percentage of electricity available are very high. The losses went up to 37.65 per cent in 2003-04. The lowest range was also in the range of 25.4 per cent. The researchers have discussed this issue with the high officials of the department and they have shown their inability to check it. The reasons behind these losses are technical and political. The transmission and distribution losses went up to 37.65 per cent in 2003-04. The lowest range was also 25.4 per cent.

**Renewable Energy**

Renewable energy is essential to the rapid development of the state. Thus, the availability of renewable energy is a major issue in the current political and economic climate. Due to its versatility, it is a crucial resource to explore.
Haryana was generating 75.60 (MW) power upto 2004-05. But at present 195.99 (MW) power is generating in Haryana from renewable resources. HAREDA is also trying to increase the use of renewable energy resources. It has suggested that there is a definite possibility of generating power from the agricultural and forest biomass available in the state.

**Power Sector and Economic Efficiency**

Economic Efficiency was calculated by input-oriented DEA model. The technical efficiency calculated under constant returns to scale assumption is called overall efficiency (OTE), which refers to the success or failure of a decision making unit (DMU) in transforming inputs into outputs. The overall technical efficiency is further decomposed into pure efficiency (PTE), which means the input utilization by the firm and scale efficiency (SE), which means the utilization of the plant size.

**Model 1** shows OTE, PTE and SE scores of power sector of Haryana for the period 1998-99 to 2014-15. It is a basic model, since under this model all inputs and outputs of power sector in Haryana for calculating different efficiency measures were considered. The inputs used in the model are installed capacity, number of transformer, Lt lines, 11 (Kv) lines, 220 (Kv), 132 (Kv), 66 (Kv) substations, 220 (Kv) lines, 132 (Kv) and 66 (Kv) transmission lines. From this model, it is clear that power sector in Haryana is 99.5 per cent efficient in utilizing its inputs, however in realizing the scale economies it is only 97.7 per cent efficient.

**Model 2** includes short coming of model 1, it takes into account both pre and post reform period. In model 2, the inputs of which data was not available (installed capacity, number of transformer, Lt lines and 11 Kv lines) were not considered. For the entire period, the mean OTE score is 0.932 which implies that approximately 7 per cent inefficiency is present there. For this amount of both managerial and scale factors are equally responsible as indicated by the mean PTE and SE score.

**Model 3** measures the efficiency in distribution. The researcher took distribution as output against the inputs (220 Kv, 132 Kv, 66 Kv substations, 220 Kv lines, 132 Kv lines and 66 Kv transmission lines) which are part of distribution process. Like model 1 in model 3 also, pre-reform period is out of picture.
In brief, it can be said that, an average 21.3 overall inefficiency is present in the distribution process. This inefficiency was caused by under utilization of inputs as well as inappropriate size of scale, of which latter is a major source of inefficiency. In the post reform period, on average managerial inefficiency of about 0.06 per cent and 20 per cent scale inefficiency is present in the distribution process.

**Model 4** shows the profit maximizing efficiency of power sector in Haryana in pre and post reform period. In this model, revenue from power scale and revenue from other sources as the measure of outputs and total cost (with some discrepancy) as input was taken. Purpose of the model is to examine whether power sector in Haryana is maximizing the profits (TR-TC) or not. It has been shown that on average 43.6 per cent inefficiency is present in entire period of the study. The source of this inefficiency is both under utilization of inputs and inappropriate size of scale as indicated by very low mean PTE and SE scores.

**Model 5** is also profit maximizing model. In this model, those sub-parts (power generation cost, repair and maintenance cost, employee cost, administration and general expenses and depreciation) of total costs on which data was available in both pre and post reform period instead of total cost was taken. It has been concluded that mean OTE score of power sector in Haryana for the entire period is 0.710 and therefore indicates the presence of 29 per cent in efficiency and contributed by both scale and managerial factors.

In brief, the finding reveals that power sector reforms significantly improved the efficiency in input utilization, but as far as scale efficiency are concerned, power sector completely fails at this front. Power Sector in Haryana is still operating with inappropriate size of scale and therefore, still unable in realizing the economies of scale or minimizing the diseconomies of scale. There is no proper utilization of the resources and advance technology. The adhoc policy is in picture and Government should focus on permanent policy.

**Primary study of Economic Efficiency and Consumer Satisfaction**

The primary study has tremendously analysed the estimated results for the Chi-square Test on the various variables with the efficiency in power sector reforms (Y). The model reveals that the variables X₂ (power voltage), X₄ (billing efficiency),
$X_3$ (energy efficiency) and $X_6$ (distribution service efficiency) are significantly affecting the behavior of $(Y)$. However, the variables $X_1$ (power cut information) and $X_3$ (tariff rate charge) are insignificant. The coefficient of $X_2$, $X_5$ and $X_6$ are statistically significant at $\alpha=0.05$ per cent level of significance. Moreover, Phi-value of these variables have been showing high correlation among them. The variable $X_6$ (distribution service efficiency) tremendously affect the variable $Y$ with Phi-value (0.345).

**Key Findings of the Survey**

**Quality of Electricity Supply**

Quality of electricity supply is one of the most important features of consumer satisfaction. As part of the conditions and regulations of HERC license, distribution licensees are required to provide not only reliable but also good quality power supply (in terms of voltage, frequency, etc.). Lack of good quality and reliable supply leads to low customer satisfaction and a significant burden on consumers for damaged electrical appliances.

Most consumers said that they do not get prior information about power cuts. Most of the respondents said that it would be helpful if they are transmitted information about power cuts through television, SMS, village Sarpanch (head), advertisements in local newspapers etc. About 62 per cent of consumers are satisfied from the power voltage. The quality of power has improved.

The above given observations imply that steps should be undertaken to respond to consumer concerns proactively, promptly and sincerely. In addition, information about all these initiatives and efforts should be shared with consumers to make the process participatory and acceptable, to consumers leading to desired results.

**Tariffs and Other Related Matters**

Tariff payable is also an important attribute of consumer satisfaction. While high rates lead to energy usage falling short of minimum required energy consumption. Tariff should be high enough to cover the cost of supply adequately and thus ensure sustainability of supply. If required, government should provide subsidies to deserving consumers but in a transparent and accountable manner, so as to avoid
misuse of energy funds. Most consumers (81.9 per cent) believe that they pay unreasonable tariffs for electricity. Only 10 per cent found tariff change reasonable. 8 per cent consumers were not sure about the change.

This has been found out that about 54 percent consumers who applied for new connection during the last four years (2010-11 to 2014-15) are not satisfied with the procedures required to be followed to get new connections. Non-transparent process and high charges being taken from consumers for new connections are the major irritants articulated by them.

**Metering and Billing**

Accurate metering and billing are one of the important determinants for the consumer satisfaction. Given that in a number of industries, energy cost constitutes a major chunk of the total cost of production, metering and billing issues are indeed very important. Moreover, unlike agricultural consumers, industrial consumption is believed to be fully metered. About 82 per cent consumers have purchased their own energy-meters.

With regard to Bills, about 80 per cent of the respondents think that they get incorrect bills. The time taken by the authorities in rectifying bill related complaints has improve after the reform but still it takes a week in resolving the problem. As for as bill payment in concerned it is the agriculturist with face the problem because maximum of them don't have digital knowledge. They are not aware of the E-payment option.

**Awareness of the Reforms and Regulations**

Effective consumer participation and awareness was invited after reforms in the power sector. Awareness about reforms, regulatory process as well as energy efficient equipment is important. Some of the perception from the consumer survey is that it has been reported that most consumers (approximately 90 per cent) have the knowledge of energy efficiency equipment. Interestingly, 95 per cent of them have started with efficient equipment in terms of energy, such as compact fluorescent lamps, fans, refrigerators, etc., to save power.
Awareness about the energy efficient equipment is being done through various measures like seminars, providing cheap loans, literatures, advertisements, TV, radio, and capacity building programmes.

**Complaint Redressal Mechanism**

Establishment of good complaint redressal mechanism is one of the important factors for the consumer of power in Haryana State. On the whole, the status of the complaint redressal process is not satisfactory. Most consumers are ignorant of the complaint redressal process. Apart from the above, traditional method to register complaint have been used.

**Policy Implications based on Empirical Findings**

- Productivity is a good measure for overall evaluation of the power units. The study concluded that Haryana Power Generation Corporation Limited (HPGCL) needs to raise its productivity through maximum utilization of the assets and seasonal changes should be handled tactfully.

- Dakshin Haryana Bijli Vitran Nigam Limited (DHBVNL) and Uttar Haryana Bijli Vitran Nigam Limited (UHBVNL) should make strict rules for collection of bills, must impose high penalty on default consumers. Staff should be made accountable and incentive should be given for the achievement concerning effective financial planning.

- Haryana Power Generation Corporation Limited (HPGCL) in the power unit is hereby advised on the basis of the present study, to manage the working capital for day to day operational activities.

- Senior executives should be provided training on working capital management and capital budgeting in order to take effective financial decisions.

- There is a need of privatization of power distribution at local level. It is suggested that it should be given in private hands as in today’s world of competition private sector has more chance to show better results.

- The private players should be encouraged in generation, transmission and distribution functions. The Public Private Partnership (PPP) route should be used to support the electricity supply in the peak hours of demand.
• Reform and restructuring of the power sector would not be successful unless the requisite resources are generated to finance expression and modernization of all parts of the system, i.e. generation, transmission or distribution. In the long run, investment in generation could be largely mobilized from the private sector. Private investment would be slow to come in the transmission segment. While supporting the creation of an enabling framework to attract private investment in transmission in the longer term, the setting up of state-owned transmission companies whose functions should be restricted to wheeling of electricity is recommended.

• Enhanced use of natural and renewable energy sources is needed to help take the burden off our current dependancy on fossil fuels. Power generation from renewable energy sources is increasingly becoming important all over the world as we strive to mitigate green house gases and climate change issues important for our survival on Planet Earth. A diversified portfolio of power projects in which green energy generation can play important role.

• With a good solar irradiation conditions in many parts of India especially in Rajasthan, Reliance Industry has already developed a 6,000 (MW) solar power park. Haryana should also follow such initiative to generate power.

• The use of hydropower can be trebled, notably to supply the north. India has enough hydro potential to meet this increase, but will require new line connections to the centers of demand. The environmental and social impacts of hydropower projects need to be carefully considered in the planning process.

• The technical challenges of the electricity sector in Haryana include low efficiencies of thermal power plants, continued reliance on coal plants, and inadequate transmission and distribution networks. Improving the efficiency of electricity generation from coal is needed to exploit the extensive domestic coal resources and reduce air pollution.

• Power Generation from Natural Gas should be increased it has increased from the last many years as the study shows but not upto that extent.

• LED tubes would definitely help the power units to remove power shortage