CHAPTER V
FINDINGS
Chapter –V

5.1: Findings:

The study have procured primary and secondary data from various sources. Analysis and interpretations are made to arrive inferences and findings of the study are arrived. The findings are arranged head wise.

5.1.1: Over all Generations:

Thermal power is the main stay in power sector in India. Performance of thermal utilities depend on various efficient operational tools such as quantity of generation units generated in a year, PLF %, capacity additions, fuel consumption, secondary oil consumptions, auxiliary consumptions, forced outages, availability, partial loss, etc.

Thermal utilities performance before reforms and after reforms give good performance. However, pre reform performances are low 245.44 billion units per year in 1989-90 as compared to post reforms performances of 617.4 billion units in 2005-05. Pre reforms performances even though have acceleration, their ratings are lower to post reforms. This is due to fuel arrangements, improved technology adopted and better methods of practices implemented. The increasing trend value is \( Y_t = -132.8 + 31.9t \). show better acceleration.
5.1.2: Thermal Power Generations:

Generations of thermal utilities are key success in the power sector. The performance of pre reforms period have a growth of 6 billion units on an average per year. Post reform have generation have an average of 25 billion units per year. The growth acceleration before reforms are marginal due to infant stages and initial technology developmental problems in the sector.

Generation growth of post reforms are due to advancement of technology and better practices, technical advancements, fuel availability, improved PLF, reduction in losses of partial losses and forced outages. Generation growth of 372 billion units in 15 years during post reform period as compared to 240 billion units in 40 years at pre reform period is higher.

There is a better growth in post reforms period on generations especially in thermal as it have a share of 81% in total generation, 500 billion units out of a 617 billion in 2005-06 is a high performance as against 178 billion units out of 245 billion units in 1989-90. The increasing trend value is \( Y_t = 38893.1 \times (1.12626^{*t}) \) are the best indicators of accelerated growth of thermal power generations.
5.1.3: Plant Load factors:

An important performance factor. The percentage of PLF if it is higher, then the performance is better. Pre reforms period PLF measures have a slump. In many years PLF are at low levels during 1980's, that contributed less performances. Improvement in PLF started afterwards due to R&M programmes implemented.

Pre reforms PLF growth are very low. During 1976 to 1990 the PLF growth are up and down. Accelerations are negligible with an variation ranging -35 to 7.8%. The slump in PLF are lower performance factors in plants, not adopting better methods and technical methods.

Post reforms PLF acceleration are steady. 1990-91 PLF stood at 56.5% and raise to 73.71% in 2005-06. The acceleration during these period are better. On an average 1.14% are on the increase of PLF from 56.5% in 1990-91 to 73.71% in 2005-06. This is possible due to fuel availability, lower forced outages, higher availability condition, and reduction in preventive maintenance durations, selection of appropriate capacity equipments.

Hypothesis verifications for plant load factors of state, central and private sectors reveal that, Since the Chi-square value is 10.450. The table value is 15.98. The Chi-square value is greater than the table value, we accept the null hypothesis and confirm that there is no difference between in PLF of central and state.
Since the Chi-square value is 112.689. The table value is 14.85. The Chi-square value is greater than the table value, we reject the null hypothesis and confirm that private Plant Load factors are very high than Central.

Since the Chi-square value is 94.4178. The table value is 14.85. The Chi-square value is greater than the table value, we reject the null hypothesis and confirm that private Plant Load factors are very high than state.

The post reforms PLF growth are gradual and on the accelerated ranges that has improved better performances compared to pre reforms period and paved way for faster growth in generation and profits. The PLF percentage have increased over the years. The trend value is $Y_t = 44.20 + 1.63t$ is an indication of increasing PLF performance.
5.1.4: Auxiliary Power Consumption:

Auxiliary consumption are the power consumption in % for the power plant generations. The consumption pattern is an economic factor. Reduction in this consumption are a good measure. Higher consumption show lower efficiency.

Pre reform period auxiliary consumption show a high %. This ranged between 9.9 % to 11.1% in the years of 1980-1990, Variation are negligible. This is due to non application of reduction measures. Higher consumption pattern. Plant systems and practices, uneconomical usages.

Post reforms period see a variation and reduction. During this period a reduction of 3% are noticed with less fluctuations. The variations are ranged between -1.51% to -10% in the years 19996-97 to 2005-06 except in the year 2002-03 which are 9.5% due to unforeseen conditions of higher maintenance and consumption. Less auxiliary consumption are due to better maintenance, and selection of better equipments and economic measures taken in the plants.

The auxiliary consumption in percentage have decreased over the years. The decreasing trend value is \( Y_t = 10.171 - 0.123681 \times t \). This is a good indication of increased performance.
5.1.5: Preventive/Planned maintenance:

Preventive maintenance percentage reduction is a performance indicator. Among the sectors privates show best performance compared to central and state sector. Private sector show almost one third lower with state and one half lower with central sector indicating their best possible maintenance schedules.

Higher capacity plants such as 500, 250, 210, and 120 MW show less percentage of preventive maintenance as compared to smaller sizes of 110 MW due frequent failures.

Hypothesis verifications for Preventive maintenance reveal among state, central and private sectors that, Since the ‘t’ value is 3.60. The table value is 2.447. The ‘t’ value is greater than the table value, we reject the null hypothesis and confirm that central thermal generation’s planned maintenance is very high than state thermal generations.

Since the ‘t’ value is 8.20. The table value is 2.447. The ‘t’ value is greater than the table value, we reject the null hypothesis and confirm that the private thermal generations is higher than central thermal stations preventive / planned maintenance.

Since the ‘t’ value is 8.25. The table value is 2.447. The ‘t’ value is greater than the table value, we reject the null hypothesis and confirm that private thermal generations is higher than state preventive / planned maintenance.
Pre reforms higher percentage attracted CEA’s attention to take measures for reduction. Post reforms have reduced more than 5% reduction as preventive maintenance and aided more savings in generation and costs with a combined effort of CEA and plants. This is possible by determined scheduling. The PM in percentage have decreased over the years. The trend value is \( Y_t = 12.616 - 0.346374t \). This is a good indication of reduction in preventive maintenance percentage that lead to performance efficiency.
5.1.6: Forced Outages:
Forced outage percentage reduction is a performance indicator. Among the sectors privates show best performance compared to central and state sector. Privates show one third percentage performance lower with state and one half lower with central indicating their best possible forced outage reduction efforts.

Duration wise outages help analyze pitfalls in the outages to further programme in reductions. Mean time analyzes inform capacity wise outages to understand and help planning reduction programmes.

Hypothesis verifications for forced outages reveal among state, central and private sectors that, Since the ‘t’ value is 5.73. The table value is .2.447 . The ‘t’ value is greater than the table value, we reject the null hypothesis and confirm that the Central thermal generations has higher Forced Outages than the state thermal generations.

Since the ‘t’ value is 4.39. The table value is .2.447 . The ‘t’ value is greater than the table value, we reject the null hypothesis and confirm that the private thermal generations has high Forced Outages than the Central thermal generations

Since the ‘t’ value is 26.76 the table value is .2.447 . The ‘t’ value is greater than the table value, we reject the null hypothesis and confirm that the private thermal generations has high Forced Outages than the Central thermal generations.
thermal generations has high Forced Outages than the State thermal generations.

Pre and post reforms forced outages position are indicative of 50 percentages reduction and the improvement made in this outages and subsequent efficiency. Major outages are due to boilers. Improvements in boiler outages and its causes to be further studied and improvements in this needed. However there is a 50% performance efficiency made in forced outages loss percentages in reforms period. The FO in percentage have decreased over the years. The trend value is $Y_t = 17.70 - 0.821978*t$ is a good indication performance efficiency.
5.1.7: Operating Availability:

Operating availability is a performance indicator. Private sector score more availability of 93.09 as compared to central 86.78 and states 77.52 percentages in 2006, stamping their best efforts. Capacity wise availability show that lower capacities of 10/20, 50 and 60 MW plants have less availability and indicate that higher capacities have good availability performance percentages.

Pre and post reforms performance of this has shown an improvement of 10% on higher side during post reforms. This is a better availability achieved by incorporating and avoiding outages in a systematic way.

Despite its improved performances over last five years in post reforms period, 2005-06 see a slump due to non availability of gas and coal shortages. Gas availability and coal availability to improve operating availability is the important aspects. The Operating Availability in percentage have increased over the years. The increasing trend value is $Y_t = 69.68 + 1.17^t$ is a good indicator of operational availability status in thermal utilities which is an improved performance.
5.1.8: Specific Coal Consumption:

Specific coal consumption is a performance indicator, Per unit consumption of coal quantity. This has been over the years reduced. Pre and post reforms consumption show a reduction of average 0.050 kg per unit. This is possible by various technical and equipment efficiency methods adopted through analyses and systematic approaches. Even a 10 gram of coal saving per Kwh will fetch a substantial saving in cost and fuel. Thermal plants coal consumption efficiency need further reduction to reduce unit cost of power as well as to improve fuel problems.

Coal quality available in regions and its consumption matters much. Mixing of better heat rated coal and good quality coal even if requires imported coal for this purpose as done by Dhanu thermal plant to improve consumption performance.

The coal consumption performance is the base of power generation, selecting a good mix to improve heat rate and coal consumption is the correct solution to improve further the efficiency and increase better consumption performance. The Specific Coal Consumption in percentage has decreased over the years. The decreasing trend value is \( Y_t = 0.7781 - 0.007060^*t \), is an indicator of improved efficiency and performance improvement during reforms period.
5.1.9: Partial Loss Percentage : (Due to equipment):

Partial losses due to equipments, caused mainly due to boiler and its auxiliary in the high range as compared to turbine and its auxiliary. In the next lowest are the generator. How ever more of loss occurred in miscellaneous mechanical and electrical areas losses. Pre reforms partial losses % are on the high side in equipment causes in the range of 14 to 16%. These are attributed to make of the machine, which have been classified and reported to BHEL and Russian manufacturers to develope and rectify design aspects of major flaws.

Post reforms % show at the range of 13.25 to 8.33% in the reducing level. This has been possible due to scientific study of equipment faults and their history analysis.

The decreasing trend value of \( Y_t = 15.678 - 0.613681^t \) is a reducing indicator that are possible in the partial loss reduction. The Partial Loss in percentage has decreased over the years as the loss prevention by making the equipment in ready and usable condition without repairs and maintenance available for generations.
5.1.10: Partial Loss Percentage (Due to Low System Demand / Reserve shutdown):
Less generation by operating units are due to system load variation (Low system Demand). Low load or non utilization of available units are due to their complete shutdown and for want of load (Reserve shutdown) and their main cause are found more in the eastern region at 11.03%. Load prediction and less concerted efforts, planning are the general causes.

Higher loss ranging 5 to 6% in pre reforms as compared to lower 2.1% to 0.92% are made possible due to concentrated load study and balancing acts that are trained with the partial loss reduction among operators and engineers by adopting very accurate predictions.

The period partial loss due to LSD/RSD in percentage has decreased over the years. The trend value is \( Y_t = 4.595 - 0.297582t \) is the indicator of loss reduction pattern that made possible. System causes loss reduction is a good reduction effort without any input spend on it.
5.1.11: Secondary Oil Consumption:

Fraction of reduction on this Secondary Oil Consumption will save huge cost. Oil seal leakages, flow pattern study have made major saving system. Pre reform consumption have higher consumption range of 10.6 ml/Kwh has been very much reduced in the post reforms period at 0.63 to 4.36%.

This is possible due to leakage pattern arresting, oil seal technologies development and in-depth consumption study.

The secondary oil consumption percentage has decreased over the years. The trend value is \( Yt = 8.70 - 0.730804 \times t \). This is a good effort and savings made resulted in imported commodity, which is more costlier and less available item. Development of new substitutes and a good R&D will further reduce the consumption in future.
5.1.12: Renovation and Modernization (R&M):

This is a step forward on plant operation efficiency after seeing a below normal output of power stations. The effort of renovate and modernize the older plants as a means of augmenting capacity economically improved performance, PLF and more generation.

Various plan periods of $7^{th}$, $8^{th}$, $9^{th}$, $10^{th}$ Plans Renovation and Modernization programmes added additional generations to the tune of 53550 million units at a very nominal expenses spent on plants. This has given new, replaced and renovated condition that bring more power generation, efficiency, maintenance losses and improved performances.

Despite for the steam lining of all plants the results have encouraged status and condition of plants. The programme have increased life and age of plant and equipments services with an expert team involved in it as national policy.

Post and pre reforms period have a good achievement. However financial arrangements in post reforms period have a slump in this during initial stages are now covered up to have a good financial arrangement guaranteed in the post reforms thrust.
5.1.13: Per-capita Electricity consumption in India:

In the Growth of Indian per-capita capacity consumption, thermal generation have a substantial role in meeting and increasing this consumption. Other power generation sources are very meager contribution with a combined contribution of less than cumulative 19% from five sources such as nuclear, Hydro, cogenerations, renewable, wind. Year wise per-capita consumption increase are possible with the higher level generation of thermal contribution only.

Even lesser developed countries such as middle east nations, and south American nations are having twice the per-capita consumption than India. The consumption pattern increased in domestic, agriculture sectors due to free and cross subsidy of power by governments.

As the public awareness and more use of electricity driven domestic and household equipments increased even among villagers, demand and per-capita consumptions have increased very much from 16.5 kwh in 1950 to 616 kwh in 2006 with a trend value of $Y_t = -116.9 + 41.2*t$. But the major supply source of thermal generation become the backbone of the nation in the offshoot of per-capita increase.
5.1.14: Installed Capacity:

Installed capacity grown from 107 MW in 1915 to 124287 MW in 2006. Growth of power plant installations since 1915 is marginal. In the first 75 years it is 63500 MW. The growth of power installation since 1991 is very high. It is 58201 MW in just 15 years with a higher average growth. The power sector's major demands of power are met by huge thermal capacity addition only.

Power supply and demand persisted for 13% as peak load demand. Energy loss, commercial losses are hovering around 35 to 40% as national average. Powers produced are unable to meet requirements of growing population demand leaving a huge gap. Power cuts and black out has become order of the day. The only saviors are more installations and bulk installations of thermal plants. To augment this large capacity, and to meet the nations 8% GDP growth, planning and targets needs to be met.

Plants in the size of 4000 MW as ultra mega power projects in higher economies of scales are the latest plan by ministry of power for the XIth plan to meet the target of 212000 MW target achievement in 2012. Installed capacity addition is the only way out to meet power shortages. The present trend value is $Y_t = -18762 + 4280*t$ is a good pace of increase of the nations essential service. The supply and demand narrowed only by capacity addition. Any lag in this will affect shortage of power and frequent disturbances.
5.1.15: Rural Electrification:

Growth of rural areas, tapping agricultural and village natural resources are the rural electrification development strategy of India. Reaching out rural area in the power map is a wide gap. Out of 5,87,258 total inhabited villages in the country as per 1991 census, 5,08,863 villages i.e. 87% villages have been declared electrified by March 2002. A balance of 77,897 villages still remain un-electrified since long from, 1897 as the power supply entered Indian scene. India’s unelectrified villages are 13% villages numbering 77897 in 2002.

To electrify this 77897 villages, rural electrification programme under Power Finance corporation financial assistance and tapping the thermal power generation are only source of vital linkage. As the rural electrification programme’s new power installations in renewables, cogeneration, small captive generation have yet to develop schemes and projects to meet the requirement not come up due to financial, technical and economical constraints. Augmentation of thermal power generation in the vicinity in a large scale are the only solution to serve this needy village rural electrification programme to complete balance 40,160 villages in 2007.
5.1.16: Financial Performances of Thermal power Utilities:

In the wake of poor financial status and financial un-health of state power utilities, the status of financial performance are very a difficult factor to manage. SEB’s show a very poor rate of return. Minimum statutory requirement of 16% ROR each year never met. Instead the SEB’s Rate of Return on negative side go on increasing in the pre reforms period and in the beginning of reforms period.

1991 to 2000-01 the rate of return increased to -41.5 % accumulating huge losses from 1991 to 2000-01 alone Rs. 65787 crores due to subsidy to farmers, cross subsidy to domestic consumers. At this rate of losses the SEB’s nether able to pay the generation power purchase payments or make any new power installation to the growing power need of the nation.

Reforms and commercial losses reduction have played major role containing the huge loss situation and it start a reduction in losses since 2001-02 from a rate of return (RoR) from -37.9 % to -28.13 %. Otherwise the SEB’s become bankrupt. The trend value is $Y_t = -18.82 - 1.51500*t$ is an indicator of SEB’s loss status. The danger level needs to be sustained to serve the backbone services of the daily citizen needs of the nation, otherwise it may lead to a huge deficit in the national economy. Where as the efficient central and private thermal generation utilities like NTPC, NLC, Reliance Energy have shown a huge profitisation in the range of huge billions of rupees and grow faster. Reform and restructure in SEB’s working are the only way to come out of heavy accumulated losses and retrieve for profit, like central and private power generators.
5.1.17: Power Tariff:

Generation, transmission and distribution and their cost form total cost of power. Tariff are the price fixed by power seller or distributor to end user the customer. Tariff of state SEB’s are the main causes of huge losses that dose not meet cost of power supplied to consumer and ultimately ruined the SEB’s thermal power generation healthy status to a poor, under developed utility in the long run due to a huge accumulate loss.

The cost of power and tariff/sold price of power in each state for 1975-76 and 2000-01 show wide variation. Cost of power has a variation of 1034.43 % to a maximum of 2270 %. Tariff/ Sold price variation are 601.9 % to a maximum of 1832 % only. This has led to a huge gape and leading to more than Rs. 1,55,432 crores in between 1991 to 2001-02 in 10 years. The gap are due to 67,325 crores subsidy provision by SEB’s and the balance due to commercial losses and cross subsidy to domestic consumers from a skewed tariff and lower than price or tariff of the actual cost that meet only 68.6% in 2001-02.

Hypothesis verifications for average cost of supply and average tariff reveal that, the Calculated ‘t’ value is 6.08. The table value is 2.262. The calculated ‘t’ value is higher than the table. Hence the hypothesis gets rejected. There is a difference between the Average Cost of Supply and tariff of power in SEB’s, that make SEB’s loss.
Hypothesis verifications for real average cost of supply and average tariff reveal that, the Calculated ‘t’ value is 4.45. The table value is 2.262. The calculated ‘t’ value is higher than the table. Hence the hypothesis gets rejected. There is difference between the Real Average Cost of Supply and real tariff of power in SEB’s that lead to losses

State and Central regulatory commissions formed in 1998 and set order to rationalize the cost of supply and tariff fixation to each category of consumer. So that tariffs really save the thermal utilities that supply 81% of the nation’s power to realize its cost to develop further.
5.1.18: Power Revenue:

The average cost of supply (ACS) and average revenue realized (ARR) gap is an important measure of financial results per unit of power. The gap between ACS and ARR decreased from 0.38 to 0.20 per unit during 1996-97 to 2004-05 period. The gap as it widen will increase loss. Thermal power plants power generation which is 81% of the total power supplied to customers suffer heavily due to this widening gap. Reforms have initiated steps to contain this gap and narrowing it recently since 2002-03 by tariff hike, collection efficiency and loss reductions.

Hypothesis verifications for average cost of supply and average revenue of SEBs reveal that, the Calculated ‘t’ value is 0.6 the table value is 2.262. The calculated ‘t’ value is lower than the table. Hence the hypothesis gets accepted. There is difference between the Average Cost and Average revenue of SEBs that lead to losses.

The revenue gap narrowing have direct effect on the profits and financial performance of the thermal generation utilities along with distribution utilities to sustain and recover cost of power. Revenues gap decrease in the post reforms period will sustain losses of state thermal utilities to growth and recovery of losses in the years to come.

They should strive to increase revenues by reducing commercial losses and improve collection efficiencies and supply cost reductions. The average cost of
supply for 2006-07 are increasing and the revenue realization are touching very near to that, but not above the supply cost. Loss making are reduced much lower compared to previous years due to regulatory commission efforts.
5.1.19: Commercial Losses:

Commercial losses at transmission, distribution and pilferage/theft losses in past are on the increase. Commercial losses have raised in all states in 1985-86 Rs 15.2 billions to Rs. 291.3 billions in 2001-02. These losses have an impact on thermal generators on realizing their payment and specially the SEB’s and their thermal utilities. Commercial loss reduction in transmission and distribution have an impact of realizing only average 50% of the cost of supply. At this rate of commercial losses which are primarily from theft of power accounts for nearly 20 to 25 %. Reduction in this area alone will save Rs. 70 to 75 billions a year. Power distribution un-bundling programme bring new thrust on commercial loss reductions. Power utilities, after reforms resort to unbundling. The unbundling process give importance to identify loss causes, since the distribution utilities are expertise in the task of commercial losses in a circle level and can reduce technical and pilferage, theft of power by deploying high voltage distribution system.

Theft of power is mandated by Electricity Act 2003 to be curbed, will actuate reduction process. In 1990-91 to 2005-06 commercial losses have fluctuations. The reforms and the thrust on losses reduction have brought down since 2002-03 to 2004-05. Huge percentage of commercial losses, reduced to more than 15% on an average. Unbundled utilities on distribution are taking care of this reduction to redeem SEB’s and utility’s financial health in the years to come.
5.1.20: Reforms and States:

Though the reforms initiated in 1991, it took long years to conceptualize the state governments mind set. Only in the year 1996-97 it got serious action after a push from central governments action. In 1998 efforts of regulatory commission setting up, have further initiated reforms momentum. However reforms stipulation of unbundling SEB’s in to different generation, transmission, distribution utilities are till 2007 have gone slow pace. 13 out of 37 have gone for unbundling. States like Tamil Nadu, Kerala are very slow and require extension of time to unbundled it.

Regulatory commissions are not yet fully geared up to go for tariff rationalization and consumer satisfaction. Circle wise profit center and distribution reforms despite financed by central funds have not yet fully picked up to reform fully.

In order to encourage and bring out motivation, ministry of power have been conducting a competition among states, so that they make efforts in reforming and improving financial viability. This effort is very much drive front running states. However low ranked states are not taking up this competition and challenge in a serious manner. This competition may bound to grow initiatives among states in future, if more attractive incentives are offered to these states.
Various states interrupt reforms in a typical political way to put into action. This in-fact are affecting the major power supplying sector, thermal utilities in regaining their accumulated losses specially by State electricity boards who are caught between political gains of the state governments and employees of these state utilities, who enjoyed benefits for a long period and do not want to be reformed.

The process of reforms are slow and very much detrimental to the growth of the sector and in special reference to thermal utilities who constitute major chunk of Indian power scenario by their generation, realizing power sold to distributors and further develop to meet growing power demand. Reforms had liberalized private sector to set up generation units at ease, so that growing private participation and investment in generation units will narrow demand and power supply. Reforms aims mainly at the financial return and stake holders satisfaction. Reform will pave ways for healthy thermal generation and payment realization.

The study elaborate further in Chapter- VI for Suggestions, summary and conclusions.