Emerging Trends in Energy Management in Pulp and Paper Industry in "New Millennium"

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ABSTRACT

- *Energy costs at many industries to the tune of 20-25%.*
- *With the liberalisation, competition has become tough and we have to produce products in cost effective way for existance/survival.*
- *With increase in electricity tariff year after year, we must find ways and means to cut down on the energy cost by using energy efficient equipments or by reducing energy costs*
- *List down energy savings area and estimate the energy savings potential and implement the Encon schemes.*
- *Culture of conservation by constant monitoring of daily and monthly energy consumption. Energy conservation must receive much attention as the production itself.*
- *Use energy but efficiently, metering equipment is to be provided on all main and sub feeders for accountability and arrest energy wastage, if any.*
- *Energy audit has to be mandatory involving in house Encon team and experts, and implementing the viable schemes.*
- *En-Eff in design, practices have shown 5% -10% marginal increase in energy efficient equipment which may reduce power demand to the tune of 30%.*
- *In-house co-generators to be operated in parallel operation and ensure maximisation of inhouse economic generation of energy and minimisation of the consumption through its efficient utilisation.*
- *Macro level approach for Encon at design stage keeping following approach in view.*
  - *A) Energy efficient technology*
  - *B) Energy saving devices*
  - *C) System flexibility*
  - *D) Life cycle cost vs. initial investment*
  - *E) Standardisation*
  - *F) Utilisation vs multiple equipment*

INTRODUCTION

The year 2000 A.D. has already stepped in and standing at our threshold with new threats as well as hopes. This is the ideal time for every paper and board manufacturing industries to take the stock of the energy generated/utilised and also to address the major issues on Energy Conservation by looking back at the wastages made and arresting them immediately for the survival of the Industry in view of raising trends of energy cost. This is a big threat and needs immediate attention.

Energy Conservation (ENCON) efforts need to be put on fast track especially in old power generating

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plant and in old paper and board industries to reap the benefits of ENCON and also to keep the industry rolling.

With the increasing cost of all raw materials and the energy, one must look for ways and means for cutting down the manufacturing cost only by ENCON methods.

ENERGY SAVING - THE SAVIOUR

"It is the best of times and it is the worst of times". In the present scenario of Indian Industry in particular paper industry, one side there are bright hopes of future growth; on the other side there is tremendous strain with limited infrastructure, depleting resources and increased competition with the liberalisation and opening up the markets. All this has made cost effective operation a necessity. The present recession, temporary though, has made cost competitiveness, in this regard offers an excellent opportunity.

ENERGY SAVING POTENTIAL

The paper industry is highly energy intensive and is the sixth largest consumer of commercial energy in the country. Energy costs is approximately accounts to 25% of the manufacturing cost and hence, Energy Conservation is strongly pursued as one of the attractive options for improving the profitability. One study conducted by CII reveals Rs. 2500 milllion

Annexure-I

Actual Achievement of Energy Savings Per Year

Year of Commissioning		Project Description	Power	Fuels		Total Rs. in	Investment incurred
			Lakh Kwh	Coal Tonnes	F.oil KL	Lakhs	(Rs. Lakhs)
1996-97	1)	Replacement of two feed water pumps with a higher efficiency	5.73	-	-	19.50	9.00
	2)	Use of Fuel-max super magnets on fuel injection pipes of 2270 KVA	-	-	30 (KL) Diesel	2.22	0.72
	3)	**Expansion Project** Installation of high efficiency (83%) AFBC boiler.	-	14400	-	129.60	1075.00
	4)	Installation of high efficiency Feed pump for CFB-5	1.04	-	-	3.54	65.00
	5)	Installation of high efficiency Turbo generator	2.00	-	-	6.80	1575.00
	6)	Vapour absorption heat pump for power plant area.	4.64	-	-	15.78	20.00
	7)	HRPVC and higher size cables	25.20	-	-	85.68	400.00
	8)	Higher efficiency transformers 11/6.6 KV and 11/0.433 KV	20.16	-	-	68.54	180.00
	9)	Energy efficient lighting	3.92	-	-	13.33	28.00
	10)	Installation of 11 KV system instead of 6.6 KV	24.16	-	-	82.14	450.00
	**	**Power Share of 10MW**					
	11)	Investment in Expansion Project of A.P. Gas Power Corporation	250.00	-	-	625.00	933.00
		Sub Total	**336.85**	**14400**	**30**	**1052.13**	**4735.72**

Year of Commi-ssioning		Project Description	Power	Fuels		Total Rs. in	Investment incurred
			Lakh Kwh	Coal Tonnes	F.oil KL	Lakhs	(Rs. Lakhs)
1997-98	1)	Installation of VFDs in 1 no. Process Water Pump (250 KW) and 1 no. former pump (55KW)	6.00	-	-	15.00	16.5
***	2)	Utilisation of Wind Energy (in place of Grid Energy) purchased from Wind Farm in Ramagiri Hills of A.P.	27.80	-	-	81.40	-
	**	Power Share of 10 MW in APGPCL	National energy Savings of 250				
		3.5 MW out of 60 MW Heat recovery steam Turbo-Generator commissioned during December, 1998.	lakh KWH already shown in 1996-97 have been actually commenced since December, 1997.	-	-		
	*	**Expansion Project**					
	1)	Hybrid (AC & DC) Drive for PM-IV 111 Nos. motors (4,675 KW)	37.40	-	-	95.74	440.00
	2)	Assorted sizes of VFDs (AC) used in PM-IV complex 110 nos. (1,263.2 KW)	20.00	-	-	51.20	190.00
	3)	Air Ambiators for control rooms					
		a) PM-IV complex	4.50	-	-	11.52	20.0
		b) Power Plant Area	2.24	-	-	5.73	10.00
	4)	HOC Dryers for Air compressors	4.30	-	-	11.00	28.80
	5)	Incremental cost of higher efficiency in motors / pumps / compressors 583 nos. motors (21, 120 KW)	19.20	-	-	49.15	31.60
	6)	Automation and DCS Controls of PM-IV process areas.	36.00	-	-	90.00	1,100.00
	7)	Selective use of Transparent 1.60 plastic sheets in New PM-IV Building roof	1.60	-	-	4.10	1.50
		TOTAL	**159.04**			**414.84**	**1838.40**

rupees savings annually with an estimated investment of Rs. 4000 million.

ENERGY SAVINGS AREA

1. Installation of belt conveyors in place of pneumatic conveying.
2. Using variable frequency drives in place of old technology drives (PRV, Eddy current etc. on fan pumps, ID & FD fans, washers, process water pumps etc., etc.
3. Energy efficient motors whose efficiencies are 1 to 1.5% higher compared to other motors.

Year of Commissioning		Project Description	Power	Fuels		Total Rs. in	Investment incurred
			Lakh Kwh	Coal Tonnes	F.oil KL	Lakhs	(Rs. Lakhs)
	1)	Energy savings by providing VFD's a) Pulp Mill washers b) NSFT final tower	4.00	-	-	11	13.1
	2)	Energy savings in paper m/c no. 3 through replacement of inefficient vacuum pumps.	4.00	-	-	11	8
	3)	Energy saving through lighting modifications i.e. replacement of Halogen lamps, IC lamps with SV lamps, providing photocell controls, auto start-stop control, Beblec energy savers.	2.6	-	-	7.15	3
1998-99	4)	Energy savings through process modifications a. Evaporators by increasing the operating pressure of steam.	-	3900 MT of LP steam	-	12	NIL
		b. NSFTC stopping of screw conveyor 19.	0.95	-	-	2.61	0.5
		c. Pulp Mill St-2 washing process modifications	2.14	-	-	5.885	3
		d. Impellers strimming for identified pump in pulp mill and NSFT A.	6	-	-	16.5	1
		e. Replacing inefficient pumps in pulp mill with energy efficient pumps.	10.25	-	-	28.18	10
		f. By providing of auto stop/start control in process equipment.	9.16	-	-	25.19	1
		g. In NSFT A & B bypassing of disperser final chest pump and agitator by providing pneumatic valves in place of manual valves.	2.4	-	-	6.6	4.5
	5)	Reductions in line losses by installing capacitors.	2	-	-	5.5	10
	6)	Optimisation of TG II generation by paralleling with grid.	23	-	-	63.25	22
	7)	Reduction in the frequency of TG 1 from 50 Hz to 48.6 Hz.	2.66	-	-	7.315	NIL
	8)	Reduction of MVA Contract demand from 15000 KVA to 5000 KVA.	48+ 8000 KVA	-	-	333.6	NIL
	9)	Improvement of total mill power factor from 0.9 to 0.98	2.38	-	-	6.545	10
	10)	Harmonic filters for 5 nos. rectifier connected transformers.	8.64	-	-	23.76	24
	11)	Main 132/6.6 KV, 10 MVA old transformer switched off.	4.75	-	-	13.06	NIL
		***TOTAL**	**132.93**			**579.145**	**110.1**

- *In view of effective inhouse load management, ITC BPL has reduced electricity board maximum contract demand from 1500 KVA to 500 KVA which has resulted in savings of Rs. 333.6 lakhs per year.*

* *In the year 1998-1999 we have invested Rs. 110.1 lakhs and savings achieved were Rs. 579.145 lakhs.*

* *In the implementation of the Rs. 675 crores Expansion Project, several energy conservation measures have been adopted instead of the energy- prone conventional measures to achieve the production objectives. Some of them have been installed during 1996-97 and some have been incorporated during 1997-98. The entire project has been commissioned during October 1997 and the Production has been stabilised upto March 1998. National savings in energy are indicated against each measure in the above tables. Due to synergic effect of all the measures, however, the power demand of 20 MW estimated by Valmet, the Finnish Manufacturer of the Paper Machine and Vetted by the world -renowned Paper Consultants, viz Jaakko Poyry of Finland settled down for 15 MW only. Assuming a liberal estimation of 20% on the part of the consultants, the energy savings work out to a staggering 256 lakh kWh per year.*

** *Investment was made during 1996-97 for a 10 MW share of the 172 MW Expansion Project of the AP Gas Power Corporation which is effectively a Captive Power Plant of about 25 industries including the Electricity Board. The 112 MW Gas Turbo-Generator was commissioned on 31/3/1997. The heat recovery steam Turbo-Generator of 60 MW was commissioned during December, 1997. Achievement of annual energy recovery of 250 lakh kWh due to the 3.5 MW shareholding of ITC Bhadrachalam commenced during 1997-98.*

*** *In view of APGPCL power shareholding we hav[illegible]oaded all energy drawn from electricity board on APGPCL keeping minimum energy on Elec[illegible]icity board to reduce the bills as APGPCL energy is 80 paise cheaper compared to elect[illegible]ity board. In the process we have gained Rs. 172 lakhs in 1998-99.*

Technology Innovation/In-House R & D effort under-tak[illegible] in the plant to reduce energy consumption during the last thre[illegible] years.

Year of Commiss-ioning		Technology Innovation/ In-House R & D effort undertaken	Saving Achieved		Investment in lakhs
			Energy kWH Lakhs	Value Rs. Lakhs	
1996-97	i)	Use of super-magnets on fuel- injection pipes of 2270 KVA SKODA Diesel Generators	30 KL of Diesel oil	2.22	0.72
	ii)	Replacement of two feed water pumps by a single higher capacity pumps by innovative circuit modifications to ensure reliability.	5.73	10.50	9.00
1997-98	i)	Hybrid (AC & DC) Drive for Paper Machine with DC for main drive motors and AC for paper carrying rolls (Total 111 nos. motors)	37.40	95.74	440.00
	ii)	Air ambiator, an energy efficient evaporative cooling equipment with an innovative heat exchanger comprising microporous pads suitably designed to eliminate air-conditioning of control rooms.	6.74	17.25	30.00
	iii)	Novel Tie Transformer to parallel high rupturing capacity 11 KV system and low rupturing capacity 6.6 KV system together and with the grid.	3.50	8.96	25.00

Year of Commissioning		Technology Innovation/ In-House R & D effort undertaken	Saving Achieved		Investment in lakhs
			Energy kWH Lakhs	Value Rs. Lakhs	
	i)	Parallel operation of TG-2 with grid having load controller for generating fixed MW	Yielded extra generation 2376 kWh	63.25	22
	ii)	Switching OFF of two 152/6.6 KV old transformers of old mill.	4.75	13.06	NIL
	iii)	Reduction of purchased power Demand from 15000 KVA to 5000 KVA.	48+8000 KVA	333.6	NIL
1998-99	iv)	Reduction of oversized pump capacities by trimming the impellers in pulp mill centricleaners pumps.	6	16.5	1
	v)	Evaporates by increasing the operating pressure of steam.	-	12	NIL
	vi)	Hormonic filters for 5 nos. rectifier connected transformers.	8.64	23.76	24
	vii)	Auto start/stop of electrical equipment	9.16	25.19	1
	viii)	TG-1 operating frequency reduced from 50 to 48.5 Hz	2.66	7.315	NIL

Note: These measures are unique, innovatively conceived, judiciously engineered, meticulously executed and solidly stabilised through a lot of in-house effort.

Energy Conservation measures planned for the future, investment planned and expected savings. (Year 1999-2000)

	Savings		Investment
	kWh Lacs	Rs. Lacs	Rs. Lacs
1) Replacing of inefficient pumps at power block	1	2.75	3
2) Replacement of inefficient pumps with energy efficient pumps in pulp mill PM 1 and 2	5.71	15.70	9
3) Replacement of reciprocating air compressors with centrifugal compressors	28.57	78.56	140
4) Replacement of TG 1 & 2 rotary excitation with static excitations	1.43	3.93	15
5) Auto running of PM 1 & 2 condensate pumps	1.07	2.94	0.5
6) CFB IV FD fans 1 & 2, SRB 2 FD fan impellers modifications.	5	13.75	4
7) Providing IGV damper for SRB 1 FD fan	0.36	0.99	0.5
8) Providing VFD's for specified stock pumps	3.57	9.81	12
9) Installing smaller heater mixers inplace of bigger heater mixers in pulp mill.	1.96	5.39	6
10) Replacement of inefficient vacuum pumps in PM-1	13	35.75	142
11) In PM-IV capacity utilisation of big chiller cooling tower and stopping of small chiller cooling water pumps.	2.14	6	2
12) Replacement of defective steam traps	Saving in LP steam	7	5
Total	**63.81**	**182.57**	**339**

4. Use of DC and AC drives for sectional drives.

5. Installation of Falling Film Evaporator in place of conventional evaporators.

6. Conversion of Spreader Stoker Boilers to Fluidised Bed Boilers.

7. Conversion of MP steam users to LP steam user to maximise co -generation.

8. Utilisation bamboo dust along with coal firing in the Coal Fired Boilers.

9. Installation of centralised Compressed Air System.

10. Installation of Vapour Absorption Heat Pump in place of Vapour Compression System.

11. Installation of Heat of Compression (HOC) in dryers.

12. Optimisation of plant operating voltage.

13. Control of Maximum Demand pertaining to purchased power.

14. Synchronisation of inhouse co-generators with purchased power.

ITC Bhadrachalam Paperboards has capitalised all above areas by incorporating Energy efficient equipments and the savings achieved in last 3 years is tabulated and is shown earlier in Annexure-1.

CORPORATE STRATEGY ADOPTED AT ITC BHADRACHALAM IN REAPING ENERGY EFFICIENCY BENEFITS.

STRATEGY FROM START

A study of the location of ITC Bhadrachalam's Mill at Sarapaka in the Khammam Dist. of Andhra Pradesh reveals the strategy of the Corporate planners in the area of energy efficiency. After the Mill was comissioned and commercial production commenced in 1979, energy conservation activities were indicated in all spheres of the operation.

Within one year of the commencement of its commercial production, the Mill was awarded the "Certificate of Merit in recognition of outstanding achievements in the field of energy conservation" by the Indian Paper Makers' Association. The Mill received 16 awards for energy conservation at the State and National levels with a life span of 19 years. Corporate Conviction at ITC Bhadrachalam confirm that efficient use of energy leads to a culture of efficient technology management, improved productivity, reduced cost of production, waste minimisation and cleaner environment.

CULTURE AT WORK

The culture of conservation is sustained by constant monitoring on daily and monthly basis. Energy consumption, unit wise, are discussed at the daily production meetings held by the Resident Director (Mill Operations), Interaction between the consumers and suppliers of energy at these meetings results in objective analysis of the energy at these meetings result in objective analysis of the energy wastage and the possible measures to arrest it. Monthly Review Meetings presided over by the Managing Director of the company bring out the variance between the actual monthly specific energy consumption in different units of the Mill. These meetings, generally held alternately at the Mill and Corporate Office, are invariably attended by the Top Management besides the heads of all departments. At the end of the year, special plan meetings are held to crystallise a 3 year perspective plan of business activities including the energy conservation. Energy consumption/ conservation, thus receives, as much attention as the production itself. The Process Manager is accountable for energy. However, the attitude of the Top Management of the company is one of constructive motivation for good performance rather than vindictive punishment for any short-fall.

ENCON STRATEGY

"Use energy, but efficiently" epitomises the energy conservation strategy followed at ITC Bhadrachalam Paperhoards Ltd. Wastage of energy shall be reduced to the minimum. After the Mill was originally commissioned in 1979, a critical look was taken at energy consumption of all equipment, as stabilised in full-load operation. Motors were rearranged to work at near full - load to ensure better efficiency and power factor. Marginal process modifications were also effected to optimise motor loads. Metering equipment were installed on all transformer and motor feeders. Periodical reviews of performance of individual equipment led to improvements in their energy performance. A system of efficient energy management has come to stay at the Mill.

ENERGY AUDITS

While inhouse efforts at energy conservation were nearly exhausted, an experienced external resource was inducted in 1990 to carry out the detailed energy audit and depth study. Detailed proposals made by the consultant have been critically analysed. Those involving no or nominal investment were implemented forthwith. The proposals with short gestation and quick pay back were also implemented, thereafter implementation of the remaining proposals was selectively done on merits. Altogether 60% of anticipated annual energy savings were achieved in about 5 years. It is worthy of mention that ITC Bhadrachalam paid to the consultant 10% of the cost of annual energy saved as and when a proposal was implemented. By this strategy of linking consultant's payment to the actual savings achieved, involvement of the consultant was ensured till the proposal yielded results, in actual practice.

EN-EFF IN DESIGN

Building energy efficiency into design of any installation is by far the most effective and economical. Investment for standard equipment and processes having been provided in the project estimates, energy efficiency could be incorporated at marginal costs that could be easily funded. ITC Bhadrachalam took meticulous care to practice all possible energy conservation concepts in their massive expansion project designed and executed during 1995-98. Energy efficiency has been the principal criterion and life cycle costs including energy consumption have been the governing factors in the matter of selecting electrical and process equipment for the project. Significantly, a marginal increase of 5 to 10% on cost due to energy efficiency reduced the power demand of the project by about 30%. A brief note on **MACRO LEVEL APPROACH FOR ENCON** to be made at design stage is enclosed.

NON CONVENTIONAL ENERGY

The biggest source of non-conventional energy in a paper mill is the lignin content of the black liquor released from pulp digesters. This source is exploited at ITC Bhadrachalam by the installation of two recovery boilers together with the associated evaporators to raise steam power generation and process. Chip dust generated in the chipper house of ITC Bhadrachalam is fired in the AFBC boiler to augment steam generation. Solar energy is, however, utilised in a small way. Hot water system in Guest Houses and few residences and a few solar lanterns are in use. At ITC Bhadrachalam, solar equipment are considered on par with any other energy saving equipment and their use was based on energy savings and economic viability.

TRANSPARENCY

AT ITC Bhadrachalam, the activity of energy conservation/management is transparent. Interested parties are liberally permitted to witness the operation of the various measures, in general and the pioneering measures such as AFBC boilers, cleated belt conveyors etc., in particular. Case studies were presented by representatives of the company at various national and state level seminars/ workshops. Pit-falls were especially highlighted at these forums and positive experiences were constructively shared with the engineering fraternity.

General awareness of all strata of employees and their families about energy conservation is sustained by the observation of National Energy Conservation Day on December 14, every year. Besides popular, participative energy oriented competitions, classroom training is imparted to employees, specific to their area. Efforts are also made to encourage neighbouring industries to celebrate the national event.

IMPLEMENTATION

At ITC Bhadrachalam it is firmly believed that energy conservation is the concern of every one. The activity could be successful only with the involvement of the Top Management through the bottom most employee. Energy conservation is a line function and cannot be segregated from the main function of production. It has been the experience at the Mill that when a dedicated Energy Manager positioned to coordinate the energy conservation activity, the line Managers tended to pass the burden of execution also on to the former. A dedicated Energy Manager is considered useful to give periodical thrust to the activity of energy conservation. With a view to accelerate the pace of implementation of proposals brought to surface an Energy Manager is earmarked for co-ordination. This Energy Manager will also organise an inhouse energy audit of the massive expansion project just stabilised.

CONCLUSIONS

The strateg by adopted at ITC Bhadrachalam is one of maximisation of inhouse economic generation

of energy and minimisation of its consumption through its efficient utilisation and, by their combination, achievement of energy synergy. Commitment of Top Management is complete and constrtuctive. Energy Mangement is as much a process function as is the production. Inhouse energy audits are punctuated by depth studies by experiences external consultants. At ITC Bhadrachalam there is no constraint on funds for economically viable' measures for energy conservation. Exploitation of non conventional energy is also considered on economic merits. By and large ITC Bhadrachalam, strategically energy management is a production culture rather than an activity isolated from the process function. Results of this strategy are rewarding.

MACRO LEVEL APPROACH FOR ENCON AT DESIGN STAGE

A three pronged approach as detailed below is advocated for successfully achieving energy conservation at the design stage.

APPROACH

ENERGY EFFICIENT TECHNOLOGY: For achieving quantum jumps in energy efficiency, the application of an energy efficient technology is vital. The adoption of this is quite easy at the design stage. The retrofitting can be utmost only a compromise. The retrofitting involves many hidden costs, such as loss of production, stabilisation time etc. The retrofit also has to tackle the resistance of the cultural change. All these disadvantages can be best overcome by adoption of the latest energy efficient technology, at the design stage itself. The additional costs involved are only marginal, in comparison to the benefits that ensure. Hence the choice of technology should be the best available, at that point of time and place. For example, vertical roller mill (VRM) for cement grinding, extended delignification pulping in paper industry, etc.

ENERGY SAVING DEVICES: The energy saving devices ensure energy efficiency of the individual equipment. In this case also, the addition investment involved is only marginal. In some of the cases, the retrofitting of an energy saving device, may even call for replacement of the original major equipment which necessitates higher investments. Hence, it is advantageous to incorporate saving devices at the design stage itself. For example automatic star-delta -star convertors, soft starters, variable speed drives, etc.

System Flexibility: The flexibility of the system does not have a direct bearing on the energy efficiency. However, this can go a long way in ensuring sustained and increased runnability of the plant, which indirectly reduces the specific energy consumption. For example the installation of OLTC for transformers, with correct OLTC range, can enable operation of the plant. even under low grid voltages.

Conflicts encountered during design: Many conflicts are encountered by the designer during design stage and these need to be resolved for ensuring energy efficiency later. The typical conflicts are:

Life Cycle Cost Vs. Initial Investment: The detailed life cycle cost analysis reveal that energy accounts for nearly 75%, while the intial investment accounts for only 10-15%. Hence the life cycle cost comprising of the energy cost, maintenance cost along with the initial investment, should be taken as the basis for evaluation.

Impact of Over Design: The over design of the equipment, has a major impact on the energy consumption during operation and hence needs to be considered at the design stage. The equipment which are over designed needs to be clearly communicated to the ultimate user and provision has to be made (at design) for easier correction after stabilisation of plant operation. For example the installation of VSD for a fan can greatly minimise, the detrimental effects of over design.

Standardisation Vs. Non-Standardisation: In many plant the over standardisation has led to increased consumption of energy in many areas. Hence a holistic approach of evaluation, including all the costs i.e. investment, maintenance, inventory , energy consumption, should be taken before standardisation.

Utilisation Vs. Multiple Equipment: This is yet another conflict of 'many Vs. single' encountered during the design stage. In many of the cases, it is profitable to go in for one single large equipment rather than multiple small equipment. In the present context of better manufacturing techniques and improved process control, it is advisable to unitise equipment, as far as possible.

MAJOR ACHIEVEMENTS

S. No.	Description	Power Saved/Year Lakhs kWhr	Saved Rs. Lakhs	Investment Rs. Lakhs
1.	High Efficiency Feed Water Pump	5.73	19.50	9.00
2.	Vapour absorption Heat Pump for Power Plant	4.64	15.78	20.50
3.	Installation of VFD in Process Water Pump	6.00	15.00	16.50
4.	Incremental Cost of Higher efficiency motors/	19.20	49.15	31.60
5.	Optimisation of TG Generati By Paralleing with grid	23.00	63.25	22.00
6.	Harmonic Filters	8.64	23.76	24.00
7.	Operating Mill Power Factor to 0.98	2.38	6.55	10.00
8.	Tie Trafo to Parallel old 6.6 KV to New 11 KV	3.50	8.96	25.00
9.	Switching 'OFF' of old 132/6.6 KV Trafos	4.75	13.06	NIL
10.	Selection of Hybrid Drive Op	37.40	95.74	NIL

Note: At our plant site we have one number VFD in ratings of 250 KW, 90 KW, 45 KW, 30 KW, 15 KW, 5.5 KW. These units are under the control of ENCON HEAD who will practically assess the pay back by connecting the equipment to one of the VFD and conclude for action plan.

Yearly Achievements/ Savings Per Year

1996-1997	Energy Saved	336.85 Lakh Units
	Total Amount Saved	Rs. 1052.13 Lakhs
	Total Investment	Rs. 4735.72 Lakhs
	Investment Includes Cost of Project Equipment	
1997-1998	Energy Saved	159.04 Lakh Units
	Total Amount saved	Rs. 414.84 Lakhs
	Total Investment	Rs. 1838.40 Lakhs
	Investment includes Cost of Project Equipment	
1998-1999	Energy saved	132.93 Lakh Units.
	Total Amount saved	Rs. 579.145 Lakhs
	Total Investment	Rs. 110.1 Lakhs
1999-2000	Energy Saved	51.57 Lakhs Units
	Total Amount Saves	Rs. 147 Lakhs
	Total Investment	Rs. 45 Lakhs