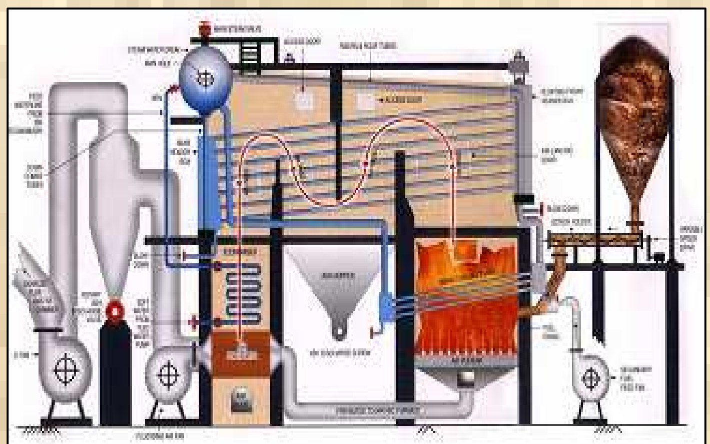
MANUAL ON ENERGY CONSERVATION MEASURES IN RICE MILLING CLUSTER WARANGAL



Bureau of Energy Efficiency (BEE)

Ministry of Power, Government of India

Prepared By

APITCO Limited, Hyderabad

Bureau of Energy Efficiency (BEE)
(Ministry of Power, Government of India)
4th Floor, Sewa Bhawan, R. K. Puram, New Delhi – 110066
Ph.: +91 – 11 – 26179699 (5 Lines), Fax: +91 – 11 – 26178352
Websites: www.bee-india.nic.in, www.energymanagertraining.com

CONTENTS

LIST OF TABLES:

LIST OF FIGURES

ACKNOWLEDGEMENT

APITCO Limited places on record its sincere gratitude to the Bureau of Energy Efficiency (BEE), Ministry of Power, Government of India for giving us this opportunity for implementation of "BEE – SME program for energy efficiency improvement at Warangal Rice Milling Cluster, Andhra Pradesh". We express our gratitude to the below mentioned BEE officials for their support and guidance for successful completion of cluster manual.

Dr. Ajay Mathur - Director General
Smt. Abha Shukla - Secretary
Shri Jitendra Sood - Energy Economist
Shri Pawan Kumar Tiwari – Advisor (SME)
Shri Gaurav Kumar - Project Engineer
Shri Rajeev Kumar Yadav – Project Economist

APITCO Limited is also thankful to "Warangal Rice Mills Association", for their valuable inputs, cooperation, support and identification of the units for Energy use and technology audit studies and in preparation of cluster manual

We take this opportunity to express our appreciation for the excellent support provided by various SME owners, LSP's and various equipment suppliers for their active involvement and their valuable inputs in making the program successful and in completion of the cluster manual.

APITCO Limited is also thankful to all the SME owners, plant in charges and all workers of the SME units for their support during the Energy Use and Technology Audit studies and in implementation of the demonstration projects.

We assure you, always, of our best services.

S. Srinivasa Rao
Managing Director

CHAPTER- I
INTRODUCTION

1.1 Preamble

Small and Medium enterprises (SMEs), in particular play an important role in creation of local employment and increasing the regional income. Efficient utilization of raw material, thermal and electrical energy becomes imperative for their sustenance as they work on low profit margins. Moreover, the production processes are based on technology concepts, which sometimes tend to become inefficient in a long run. The inefficient utilization and excessive use of raw material, fuel & energy also contribute to exceeding levels of energy intensities and environmental loads. Excessive utilization of thermal and electrical energy also impacts the regional energy balance and has a direct impact on the local power utility, as also has stress on the backward linkages of fuel resources. It also impedes the improvement of productivity of local enterprises and the economic development of communities at large.

Energy efficiency and conservation issues traditionally were dealt with addressing the issues at an individual unit level, which is a discrete approach to resolve energy problems. Most of the energy consumption is unevenly distributed and is larger in a cumulative context among small enterprises. Due to low incomes and non-availability of immediate and next to door solutions the SMEs continue to draw and use excessive energy in a business-as-usual scenario. The uneven use of energy resources have a toll on the investments and erode the competitiveness of the SMEs. The paradigm of addressing energy security issues at a local level, and in particular the SME level has now shifted to energy efficiency improvements with a “Cluster Approach”. This enables augmenting the forward and backward linkages to the SME units, developing the skill capabilities of the SMEs to go for energy efficiency improvements, technology upgradation and market development by linking the Local Service Providers (LSPs) and financial linkages with the local Banks / Financial Institutions in augmenting loans for investments in energy efficiency projects.

In this context, the Bureau of Energy Efficiency (BEE) has initiated the Small & Medium Enterprise (SME) Program in twenty-five clusters in the country to address the energy efficiency and overall productivity improvements.

1.2 The Bureau of Energy Efficiency (BEE) – SME Programme

The Government of India has set up The Bureau of Energy Efficiency (BEE) under the provisions of Energy Conservation Act, 2001. The mission of the BEE is to assist in developing policies and strategies with a thrust on self-regulation and market principles within the overall framework of the Energy Conservation Act, 2001 with the primary objective of reducing energy intensity by active participation of all stakeholders, resulting in accelerated and sustained adoption of energy efficiency in all sectors. The objective of the BEE SME Energy Efficiency program is to accelerate the adoption of Energy Efficiency (EE) technologies and practices in the chosen SME clusters through knowledge sharing, capacity building and development of innovative financing mechanisms. Further information is available at www.bee-india.nic.in.. There are 29 clusters identified under the BEE- SME's Program, these are as follows:

Table 1.1: List of Identified Clusters under BEE SME's Programme

Sr. No.	Name of Cluster/ Sector	Product
1	Jamnagar, Gujarat	Brass
2	Warangal, Andhra Pradesh	Rice Milling
3	Surat, Gujarat	Textiles
4	Pali, Rajasthan	Textiles
5	Morvi, Gujarat	Ceramics
6	Ahmedabad, Gujarat	Chemical Industries
7	Solapur, Maharashtra	Textile
8	Alwar & Sawai Madhopur, Rajasthan	Oil Mills
9	Bangalore, Karnataka	Machine Tools
10	Batala, Jalandhar & Ludhiana, Punjab	Casting & Forging
11	Bhimavaram, Andhra Pradesh	Ice Making Plants
12	Bhubaneswar, Orissa	Utensils
13	East Godavari & West Godavari, Andhra Pradesh	Refractories
14	Ganjam, Orissa	Rice Milling
15	Gujarat	Dairy
16	Howrah, West Bengal	Galvanizing /Wire Drawing
17	Jagadhri, Haryana	Brass and Aluminum Utensils
18	Jodhpur, Rajasthan	Limestone
19	Jorhat, Assam	Tea Gardens
20	Kochi, Kerala	Sea Food Processing
21	Muzaffarnagar, UP	Paper
22	Orissa	Coal based Sponge Iron
23	Vapi, Gujarat	Chemicals
24	Varanasi, UP	Brick Kilns
25	Vellore, Tamilnadu	Rice Milling
26	Tirupur,Tamilnadu	Textile
27	Mangalore, Karnataka	Tiles
28	Allepe, Kerala	Coir
29	Firozabad, Uttar Pradesh	Glass

BEE-SME program is one of the activities to improve the energy efficiency in SME clusters across the selected industrial clusters. The broad objective of the BEE-SME program is to improve the energy intensity of the Indian economy by undertaking actions in the SME sector which directly or indirectly produce 60% of the GDP. Majority of SME's in these clusters are run by the manufacturers who don't have skilled manpower and who can practice energy efficiency programs for conservation of energy. The awareness of energy conservation in these areas is minimal which also affects the manufacturing cost.

Therefore, it will be useful to build their energy efficiency awareness and through studies give energy conservation recommendations including identification of technology up-gradation opportunities and demonstration of the same. This would help to address the cluster specific problems and enhancing energy efficiency in SME Clusters.

These studies would provide information on technology status, best operating practices, gaps in skills and knowledge, energy conservation opportunities, energy saving potential, capacity building of local service providers and entrepreneurs/ managers etc for each of the sub sector in SME's. For each of the cluster an executing agency has been entrusted with this activity.

APITCO is selected as an executing agency by the BEE in Warangal Rice Milling Cluster to execute the project. The main objective of the implementing agency is to accelerate the adoption of Energy Efficiency Technologies and practices in cluster through knowledge sharing, capacity building and development of innovative financial mechanisms. The main role of the executive agency is to facilitate the implementation of project activities in the SME–BEE Rice milling cluster activities suggested by BEE.

Natural resources such as natural gas, kerosene, diesel and coal are used to generate energy. Energy here refers to electrical or thermal energy produced by both fuel and electricity. Fuel is burnt to produce thermal energy for the process requirement. Whereas, electric energy is converted to mechanical energy through electric motors for moving, blending, crushing, compressing or any form of displacement activity.

In some end-uses (electrical equipments or appliances) electricity is converted to thermal energy according to industrial process requirements. Electricity is generated by thermal energy and delivered to end-users through a transmission and distribution system. Using electricity to produce thermal energy is not a wise decision. This is because a lot of energy has already been lost during the generation, submission and distribution. Producing thermal energy using electricity will further increase the losses. More energy can be saved if fuel is used to directly produce thermal energy near to the end-use. This line of thinking relates to the phrase 'energy efficiency' in the title above.

If the term efficiency alone is used in the technical world, then the definition refers to performance of a particular machine or a system. It indicates how much quality output is obtained after deducting the losses in the system. This figure will be normally given in percentage form. When the word 'energy' is added to the word 'efficiency', then the whole perspective changes and a new definition is born.

1.3 Objectives of the Study

As we have seen the importance of the Energy Efficiency (EE), and the encouragement given by the government in urging private and government institutions towards the realization of energy security in India, it is worth to investigate the potential of implementing Energy Efficiency (EE) options in Warangal Rice Industries. In view of this, the objectives of this work were structured as below.

- To carry out energy and technology audit in the rice mills, to identify the energy efficiency measures and to provide guidelines to other industries on how to categorize the no cost EE measures, low-cost EE measures, medium-cost EE measures and high cost EE measures illustrated by a case study .
- To identify local service providers and their capacity building in technology augmentation
- To develop bankable Detailed Project Reports for Energy Efficiency Measures
- To link up financial institutions to the SMEs for implementation of EE Measures
- Capacity building of all local stakeholders in EE in Rice Milling Cluster.

1.4 Activities, Expected Outcome and Project Duration

Under this BEE SME Program, the following outcome is envisaged for Rice mill cluster:

Activity 1: Energy Use and Technology Analysis

This activity has developed information base on the status of Rice mill cluster, identification & detailing of all possible energy efficiency measures, their techno economic feasibility, overall potential to impact energy and environment scenario. Energy use and status of adaptation of technology in order to improve energy performance of the units in the cluster has been studied and analyzed. 15 technologies / energy conservation measures have been identified for preparation of Detail Project Report (DPR). This stage has been completed and findings have been presented in this manual.

Activity 2: Capacity Building of Local Service Providers (LSP's) and SME's

The Capacity Building Introductory Experts workshop will be conducted by APITCO under the guidance of the BEE. The objective of this activity is to create capacities among local services providers/technology provides in the SME clusters that would help in the uptake of the energy efficiency measures. The Local Service Providers (LSPs) and the technology providers identified during Activity 1, will be registered as experts with the SME programme of the BEE. A one-day Introductory Local Service Providers (LSPs) workshop will be organized with these experts and reprentatives from the industry/associations to share the outcome of Activity 1. The workshop will also identify issues regarding avenues for implementing energy efficiency measures, roadblocks in terms of capacities in the cluster, financing issues and carbon-market related issues. This activity will also involve the concerned SDA(s).

The output of this Activity will be a workshop proceeding which cover the entire activities of the workshop along with the outcome of the workshop on issues regarding implementation of energy efficiency measures. The activity will also enroll all the attending experts for the BEE SME Programme.

A one-day Information Dissemination Workshop will be conducted in this cluster with the help of local industry association and enrolled Local Service Providers. The main focus of the workshop will be to share with the cluster the Energy Use and Technology Analysis manual prepared for the cluster. The workshop will discuss the energy efficiency measures identified in the cluster manuals and shortlist a minimum of 5 projects for which bankable Detailed Project Reports (DPR) will be prepared across maximum three segments of capacities in each cluster.

Another important focus of the cluster workshop will be to share the best practices prevailing in the cluster. The workshop will also discuss managerial issues related to implementing energy efficiency measures. These will have mainly the financing component: how to keep books, what types of financing schemes are presently available and discuss what further can be done in this regard. State Designated Agenesis (SDA) will also be involved in order to help disseminate information. The output of this activity will be a list of 15 projects for this cluster for which bankable Detailed Project Reports (DPR) will be prepared.

Activity 3: Implementation of Energy Efficiency Measures

Scope of this activity is to facilitate the implementation of energy efficiency measures in Warangal rice mill cluster through development of ready to use DPR's to facilitate bank financing. The development of 15 DPR's is in progress.

Activity 4: Facilitation of Innovative Financing Mechanism

As the objective of this activity is to facilitate the implementation of energy efficient measures through innovative financing mechanisms without creating market distortion. Efforts are in progress to develop such mechanisms.

Complete project duration is about 2.5 years. Project has started in March 2009. Most of the activities will be completed by December 2010. This Project will be completed latest by June 2011.

1.5 Methodology

Preliminary Energy Audit

- Establish energy consumption in the organization
- Estimate the scope for saving
- Identify the most likely and the easiest areas for attention
- Identify immediate (especially no-low-cost) improvements/savings
- Set a reference point
- Identify areas for more detailed study/measurement
- Preliminary energy audit uses existing, or easily obtained data

Detailed Energy Audit

A Comprehensive audit provides a detailed energy project implementation plan for a facility, since it evaluates all major energy using systems. This type of audit offers the most accurate estimate of energy savings and cost. It considers the interactive effects of all projects, accounts for the energy use of all major equipment, and includes detailed energy cost saving calculations and project cost.

1.6 Structure of the Manual

Chapter II of the manual describes the rice milling cluster, the products, cluster actors, energy consumption patterns, current policies and initiatives of local bodies, and technology upgradation needs. The Chapter III details on energy audit and technology assessment, methodology adopted, production processes and unit operations, energy consumption in production activities, and technology gap analysis.

Chapter IV describes in detail energy conservation technologies, benefits of implementing energy efficiency measures, cost of implementation, savings and payback, barriers in implementation, availability of technology for implementation at local and regional level, identification of technologies / equipments for DPR preparation, techno-economics of technologies, barriers for implementation etc. the list of local service providers are annexed at the end.

Chapter V Introduces approach to Small Group Activity (SGA) / Total Energy Management (TEM). It details the Small Group Activity (SGA) standards for practice, TEM and further, describes the ten stage activity. The chapter concludes with the tools used for SGA for TEM.

The chapters are followed by annexure briefing the technical calculations, list of LSPs and quotations of technologies suggested.

CHAPTER II
RICE MILLING CLUSTER WARANGAL

2.1 Overview of SME Cluster

2.1.1 Introduction: Andhra Pradesh historically called as rice bowl of India has 77 % of cultivated land under paddy cultivation and produces around 17 million tonnes of rice. There are around 6000 rice milling units are established in the sate, out of which 368 registered rice mills are with in Warangal district to process the produced paddy.. Due to high concentration of many rice mills in Warangal district, the Warangal district rice milling units are considered for BEE –SME Program. The rice mill units in Warangal district are formed association namely The Warangal District Rice Milling Association and have around 275 rice millers are registered. Warangal is well known for rice milling industry and about 110 rice mills are in and around Warangal town. These rice mills owners are procured the paddy from different sources and processed in these rice mills. The final product i.e. rice from these mills is supplied to Food Corporation of India (FCI), other marketing channels for selling. These units are in operation since 10-15 years and most of rice mills are family owned. Majority of the units generally operate for one shift a day but some run for two shifts both raw rice and parboiled rice mills. Rice processing is seasonal in nature and has two main seasons in a year depending on the paddy availability. First season is during April- May and paddy available during this season is fit for the production of boiled rice whereas the paddy available during the second season (November-January) is used mainly for raw rice production. The **Fig 2.5** Cluster Map illustrates the cluster actors, stakeholders, forward and backward linkages in the cluster. The major equipments employed in a typical rice mills are rubber shellers, polishers, dryers, whiteners, boilers, elevators, air compressors, motors, etc which are operated by power from the State Electricity Board (SEB). DG sets are operated when power off situation by the SEB. The major fuel used in the cluster is rice husk which is generated in the rice mills as a waste after process the paddy. The rice husk is used in boilers as a fuel for generating the steam which is required for different process in parboiled rice mills. Surplus rice husk from these rice mills is sold to outside buyers.

2.1.2 Types of Rice Mills: A per the Warangal Rice Milling Association there are three different types of rice mills are established in the Rice mills cluster.

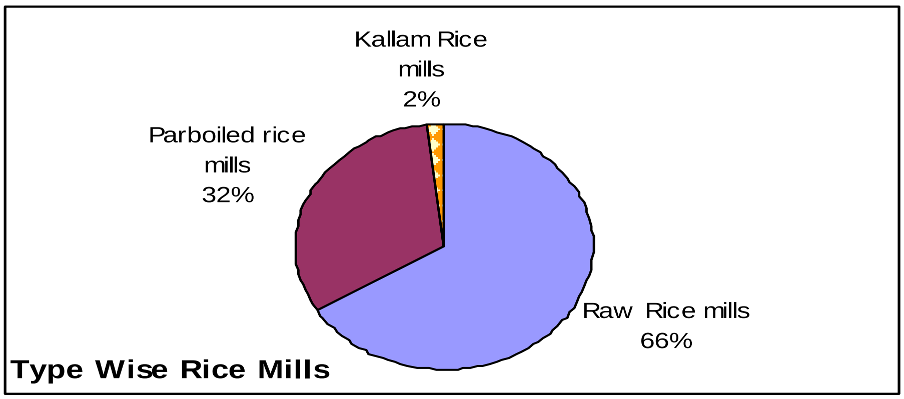
- Raw Rice Mills
- Parboiled Rice Mills
- Kallam Rice Mills

The above type of rice mills are speared all parts of Warangal District. Out of 275 rice mills in Warangal District, 110 units with three different types are exists within the Warangal town, of which 73 units are raw rice mills contributing 66.4 % followed by 35 units of parboiled rice mills (31.8 %). Only 2 rice mills have kallam rice milling method of production. **Table 2.1** below and **Fig. 2.1** illustrate the type of rice mills in Warangal Town.

Table 2.1: Type Wise Rice Mills units at Warangal & Percentage share

Type	Processing Methodologies	Units	% share
Type-1	Raw Rice mills	73	66
Type-2	Parboiled rice mills	35	32
Type-3	Kallam Rice mills	2	2
Total		110	100

Fig 2.1: Percentage Sharing of Rice Mill units in Warangal

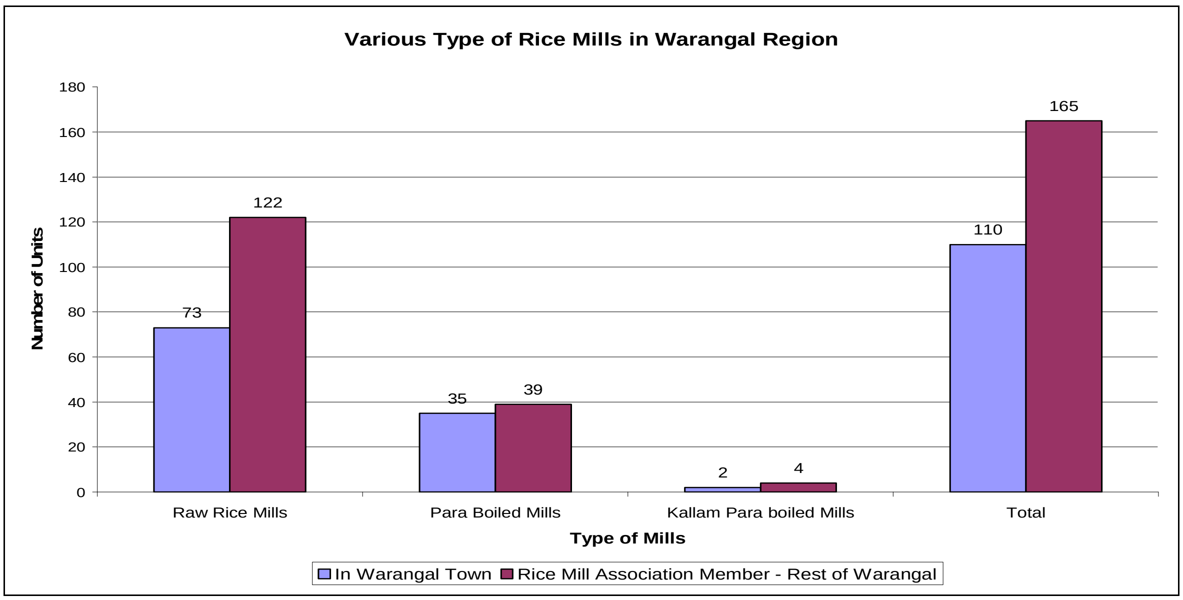


The remaining 165 rice mills are exists in other places in the district. All these units are registered with the association. Overall, from the rice mills registered with the association, it is seen that 71 % are Raw Rice Mills, 27 % are parboiled and only 2 % are based on Kallam method. **Fig. 2.2 & Table 2.2** illustrate the breakup of rice mills in Warangal town and rest of the district.

Table 2.2: Type Wise and Total Rice Mills Warangal Rice Mill Cluster

Type	Processing Methodologies	Warangal Cluster	Other places In district	Registered Rice Mills with Association
Type-1	Raw Rice Mills	73	122	195
Type-2	Parboiled Mills	35	39	74
Type-3	Kallam Parboiled Mills	2	4	6
	Total	**110**	**165**	**275**

Fig 2.2: Number of Rice Mills in Warangal Region



During the study the Kallam rice mills were not in operation and thus the study deals only with the majority of the units which use raw rice and parboiled mode of production.

The total annual production produced within Warangal town i.e.110 units is 6, 00, 000 MT and turnover was ₹ 120 Crore. The total employment generated from these units is 2160 persons (**Table 2.3**).

Table 2.3: Total Production, Turnover and Employment in Rice Mill Cluster

Sr. No.	Parameter	Value
1	Total Cluster Production (MT/Yr)	6,00,000
2	Total Cluster Turnover (Crore ₹./Yr)	120
3	Total no. of employment	2,160

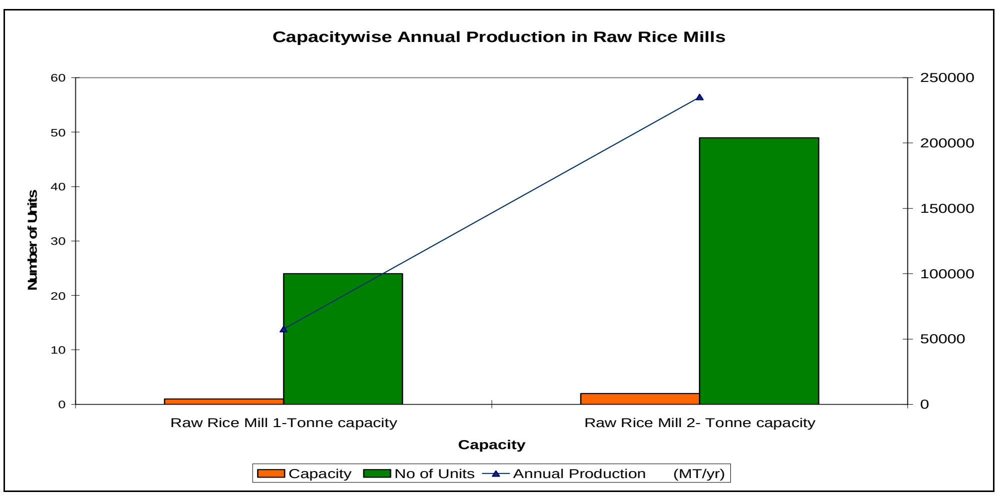
2.1.3 Rice mill Type wise Production: The annual production of raw rice and parboiled rice for various capacities is briefed here. It is clearly depicted in the **Table No 2.4 & Table No 2.5.**

Type-1: Raw Rice Milling: From the annual production in raw rice mill units for different capacities it is seen that for a 1 TPH capacity, the annual production is 57600 MT/Yr from 24 units, whereas for a 2 TPH capacity the annual production is 235200 MT/Yr form 49 units. **Table 2.4 and Fig.2.3** illustrate the annual production of raw rice mill based on capacity of production.

Table 2.4: Annual Production in Raw Rice Mill (Type 1)

Capacity (TPH)	Processing Methodologies	Number of Units	Annual Production (MT/Yr)
1	Raw Rice Mill	24	57600
2	Raw Rice Mill	49	235200

Fig 2.3: Annual Production in Raw Rice Mills (Type1)

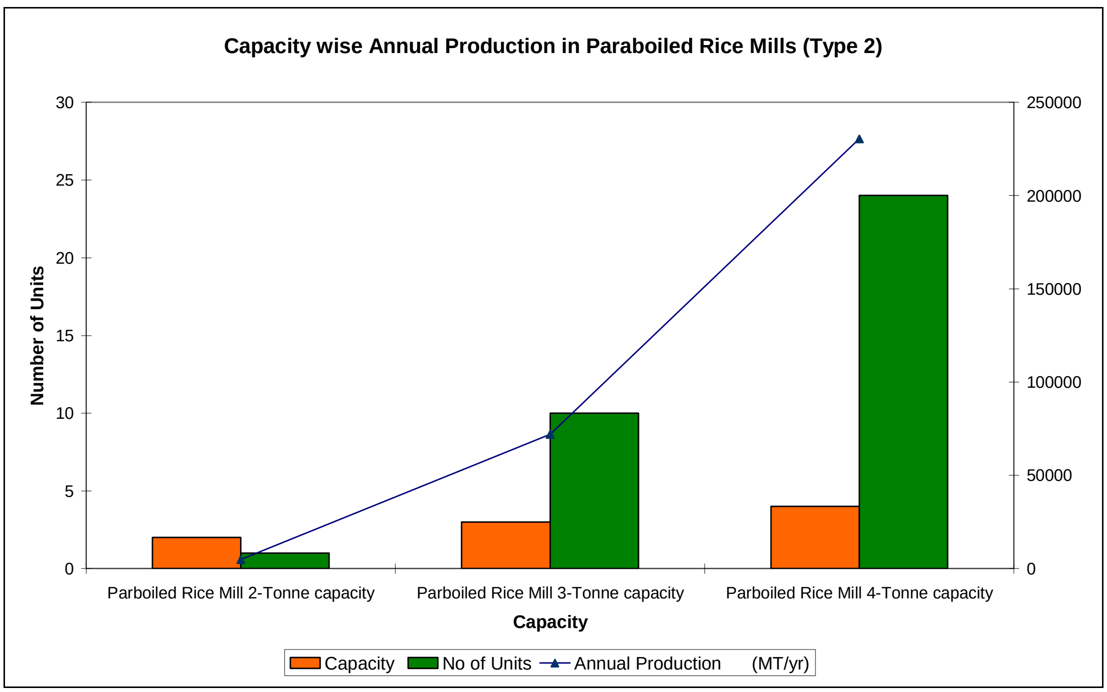


Type-2: Parboiled Rice Milling: From the annual production in parboiled rice mill units for different capacities, it is seen that for a 2 TPH capacity the annual production is 4800 MT/Yr from 1 unit, whereas for a 3 TPH capacity the annual production is 72000 MT/Yr from 10 units and 4 TPH is 230400 MT/Yr from 24 units. **Table 2.5 and Fig.2.4** illustrates the annual production details of parboiled rice mills based on capacity of production.

Table 2.5: Annual Production in Parboiled Rice Mill units (Type 2)

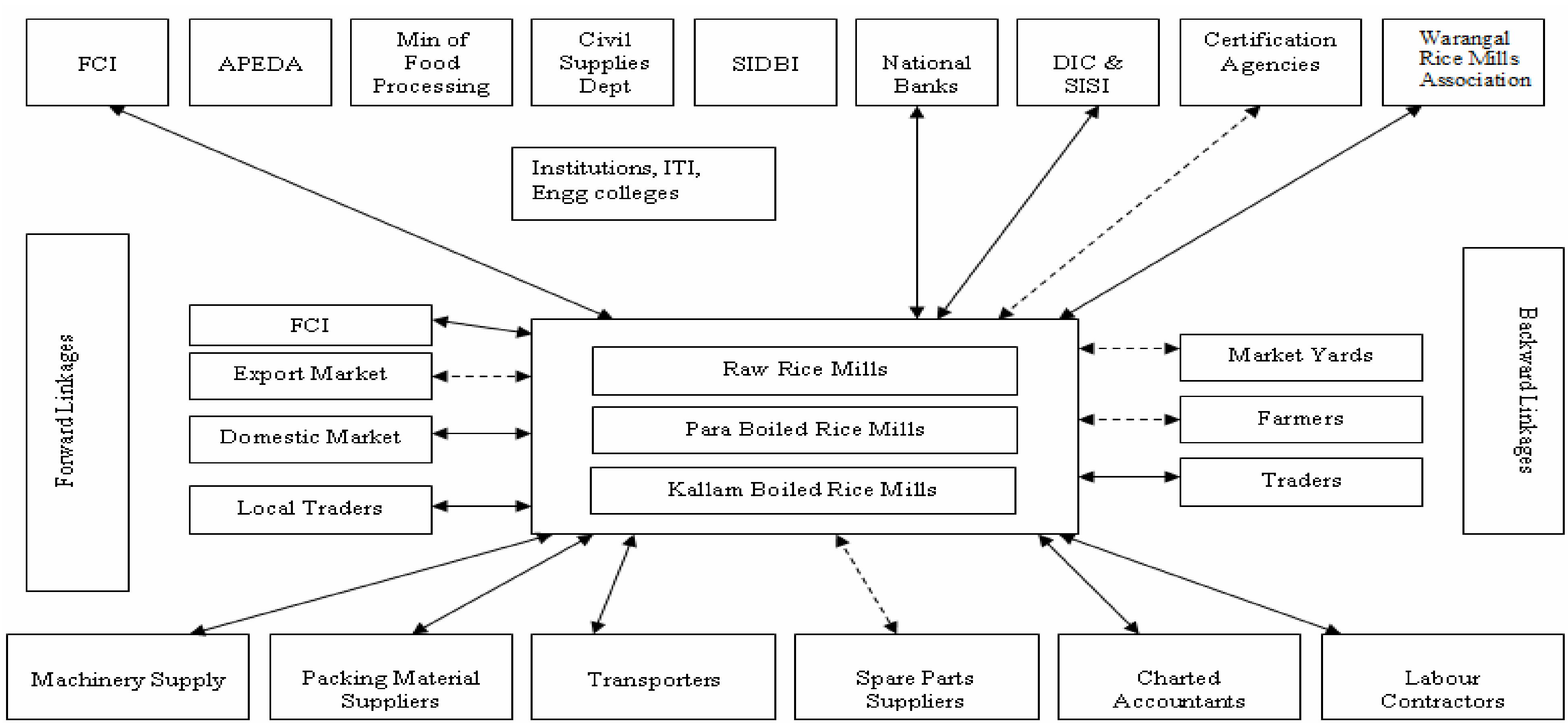
Capacity TPH	Processing Methodologies	No of Units	Annual Production (MT/Yr)
2	Parboiled Rice Mill	1	4800
3	Parboiled Rice Mill	10	72000
4	Parboiled Rice Mill	24	230400

Fig 2.4: Annual Production in Parboiled Rice Mills (Type 2)



The annual production from these rice mills is dependent on the availability of the paddy. The paddy is available during two seasons in a year i.e. First season is during April- May and paddy available during this season is fit for the production of boiled rice whereas the paddy available during the second season (November-January) is used mainly for raw rice production.

Fig.2.5 Cluster Map – Warangal Rice Milling



2.2 Energy Situation in the cluster (Energy Consumption Pattern of the cluster)

Energy consumption in the rice milling cluster is mainly of two forms i.e. Electrical and Thermal Energy. The electrical energy consumption is mainly by the motors in milling section and boiler section. In milling section the electrical energy is consumed by paddy elevators, rubber shellers, motors, coin motors, whitener motors, polisher motors, air compressors and also in lighting systems. In the boiler section the electrical energy consumption is to dryer motors, husk handling, blowers and pumps etc.

The thermal energy is used in parboiled rice mills where paddy undergone for different process. The thermal energy i.e. steam is generated from boiler where rice husk or any agro-residue is used as a fuel. The steam is used for heating the water for soaking and drying the steamed paddy

2.2.1 Type of fuel used and Tariff: The details of different types of fuel used in Rice mill cluster along with tariff and calorific value is presented in **Table 2.6**: The power tariff is ₹ 3.30 per unit **(Details of Power tariff from APNPDCL Presented in Annexure-3),** while rice husk is ₹ 1800 per tonne. The price of Diesel is ₹38.90/L.

Table 2.6: Types of Fuel Used and Price*

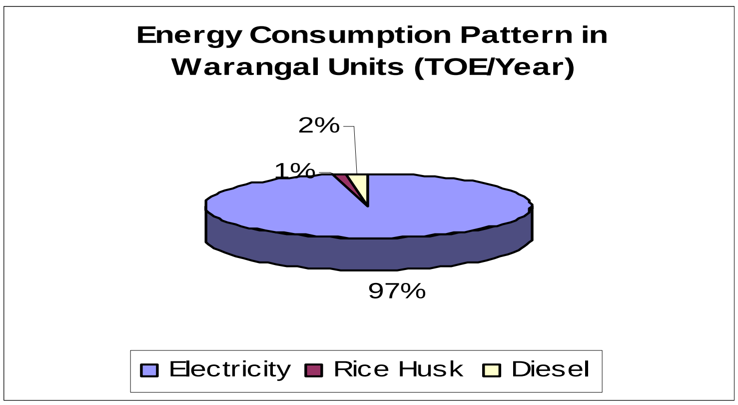
Sr.No	Type of Energy	Tariff in ₹	Calorific Value (kcal/kg)
1	Electricity (LT category)	3.30 /kWh	-
2	Rice Husk	1.8 /kg	2800 – 3600
3	Diesel	38.900 Ltr	9900

2.2.2 Fuels and Electricity Consumption in Total Units: The energy consumption in the total 110 units is 17.64 Million Units of electrical energy. The rice husk consumption for boiler in parboiled rice mills is 61800 MT /Yr and that of diesel is 35.54 kL. **Table 2.7** gives the Thermal and Electrical consumption in the cluster and **Fig.2.6** gives % of share of energy consumption in terms of TOE/year.

Table 2.7: Thermal and Electrical Energy Consumption with in Warangal Units

Sr.No	Energy Type	Unit	Quantity	TOE/year
1	Electricity	kWh/year	17646928	1517
2	Rice Husk	MT/year	61800	22
3	Diesel	Liters/year	35542	34

Fig 2.5 Shows the % share of the Energy Consumption in terms of TOE/Year



2.2.3 Specific Energy Consumption: Based on data collected and provided by the units in the cluster, specific energy consumption for thermal and electrical energy has been calculated, the same is in **Table 2.8**.

Table 2.8: Specific Energy Consumption Range in Rice mill units in Warangal Town Units

Type	Capacit (TPH)	No. of Units	Electrical Energy kWh / Yr	Production MT/Yr	Sp. Power Cons. kWh/T	Fuel Cons. MT/Yr	Sp. Fuel Cons. kg/T	Total Energy TOE
Type-1 Raw Rice Mills	1	24	2225283	57600	38.63	-	-	191.4
	2	49	5431820	235200	23.09	-	-	4671.4
	Sub-Total	**73**	**7657104**	**292800**	**26.15**	**-**	**-**	**4862.8**

Type	Capacity (TPH)	No. of Units	Electrical Energy kWh / Yr	Production MT/Yr	Sp. Power Cons. kWh/T	Fuel Cons. MT/Yr	Sp. Fuel Cons. kg/T	Total Energy TOE
Type-2 Par-boiled Rice Mills	2	1	129454	4800	26.96	1272	265	481
	3	10	2036309	72000	28.28	15600	216	5900
	4	24	7824060	230400	33.95	44928	195	16991
	Sub Total	**35**	**9989824**	**307200**	**32.51**	**61800**		**23372**
	Total	**108**	**17646928**	**600000**		**61800**		**21853.8**

From the above table It can be seen that in Type 1 units i.e. in raw rice mills with 1 TPH capacity, the electrical consumption is higher at 38 kWh / t of rice production as compared to the 2 TPH which is 23.09 kWh/t and average electrical consumption is 26.15 kWh/t. As per the studies by conducted by Waste Minimization Circles (WMC), the range of electrical energy is between 17-23 kWh/t. Thus the electrical input is on the higher side in the Type 1 units.

In case of Type 2 units i.e. the parboiled rice mills the electrical energy input is 26.96 kWh/t, 28.28 kWh/t and 33.95 kWh/t for 2 TPH, 3 TPH and 4 TPH capacities respectively. As compared with the ranges of WMC it is seen that the units are well within the range of 27 to 35 kWh/t. The thermal specific fuel consumption of rice husk it is 265 kg/t, 216 kg/t and 195 kg/t.

Note: In the above table, broad range of minimum and maximum energy consumption in a typical Rice mill units has been provided, which also depends upon the capacity of the mill

2.3 Current Policies and Initiatives of Local Bodies

The cluster SMEs are influenced by the various institutions and cluster actors viz. the District Industries Centre(DIC) under the Commissioner of Industries, Department of Agriculture, Government of Andhra Pradesh; and District Collectorate. The other Institutions those who have influence on the SMEs are Banks & FIs, Food Corporation of India (FCI) and The Warangal District Rice Millers Association etc.

The various schemes of Ministry of Micro Small and Medium Enterprises (MSME), Ministry of Food Processing Industries, Agriculture & Processed Food Products Export Development Authority (APEDA) and Small Industrial Development Bank of India (SIDBI) related to the SMEs are implemented through the DIC, Commissioner of Industries and District

Collectorate. The unit's holders are taken the benefits of various schemes from time to time.

SIDBI: SIDBI was established in 1990 as a Principal Development Financial Institution for Promotion, Financing, Development of Industries in the small scale sector and for coordinating the functions of other institutions engaged in similar activities. SIDBI has many products and schemes which can be fined tuned to meet requirements of SMEs. List of some of such products & schemes is as follows:

- **Technology Up gradation Fund**: TUFS has been launched with a view to sustaining as well as improving the competitiveness and overall long term viability of the SSI sector. The scheme intends to provide timely and adequate capital at internationally comparable rates of interest in order to upgrade the industry's technology level.
- **International Finance**: The main objective of the various International Finance schemes is to enable small-scale industries to raise finance at internationally competitive rates to fulfill their export commitments. Used for supporting import and export activities
- **Marketing Support for SMEs**: To finance corporate entities to enable them to provide support services and/or infrastructural facilities to small scale sector to improve its marketing capabilities
- **Direct Credit Scheme:** To finance SSIs & Service sector units with project cost upto Rs.25 crore, Medium Sector Enterprises (MSE) and Service sector units with project cost above Rs.25 crore and upto Rs.250 crore.
- **Bills Financing Scheme:** Bills Finance Scheme seeks to provide finance, to manufacturers of indigenous machinery, capital equipment, components sub-assemblies etc.
- **Refinancing Scheme:** SIDBI grants refinance against term loans granted by the eligible PLIs to industrial concerns for setting up industrial projects in the small scale sector as also for their expansion / modernization / diversification.
- **Scheme for Development of Industrial Infrastructure:** For the purpose of strengthening of existing industrial clusters / estates by providing increased amenities for smooth working of the industrial units. Setting up of warehousing facilities for SSI products / units. Providing support services viz., common utility centres such as convention halls, trade centres, raw material depots, warehousing, tool rooms / testing centres, housing for industrial workers, etc.

On the basis of experiences of above mentioned schemes it is advisable to devise and implement schemes of similar characteristics through SIDBI for the sustainable development of SMEs

Ministry of Small and Medium Enterprises (MSME): The ministry of Small and Medium Enterprises, Govt of India, implementing the different schemes to promote the SME sector towards the growth. The following schemes are available for implementation of Energy Efficient Technologies in SMEs.

Technology Up gradation: Government of India will provide financial support to the extent of 25% of the project cost for implementation of Energy Efficient Technologies (EET), as per the approved DPR. The maximum amount of GoI assistance from the scheme will be Rs. 10 Lakh. About 390 units will be supported for implementing EETs in MSMEs.

Quality Up gradation: Under this activity, MSME manufacturing units will be provided subsidy to the extent of 75% of actual expenditure, towards licensing of product to National/International Standards. The maximum GoI assistance allowed per MSME is Rs. 1.5 Lakh (Average Rs. 0.75 Lakh) for obtaining product licensing/marking to national standards and Rs. 2 Lakh (Average Rs. 1.50 Lakh) for obtaining product licensing/marking to international standards. One MSME unit can apply only once under the scheme. Total 3000 product certification on national standards and 1000 on international standards are proposed to be reimbursed under the scheme. This scheme will include the star rating certification by BEE. All the applications for the star rating will be reimbursed the application processing fees directly to the entrepreneur after the successfully certification from BEE.

District Industries Center (DIC): District Industries Center (DIC) at Warangal is mandated to promote industrial activity in the district. DIC will issue SSI certificates to the entrepreneurs. The DIC will issue the SSI to the Rice Mills owners based on the capacity of the unit. It has schemes and other related activities for the SSI unit’s i.e. marketing assistance etc., to promote the self-employment schemes with assistance from the local banks.

The Warangal District Rice Millers Welfare Association:

The Raw Rice and Parboiled Rice Mills owners formed a The Warangal District Rice Millers Welfare Association with 350 registered members in 1994. The main objective of the association is carry out the different activities for the welfare of the all the rice mills by coordinating with different agencies and between SMEs and Govt. Organizations. The detail of the association is presented below.

Table 2.9: Details of Associations of Rice Mill Cluster- Warangal

Sr. No	Name of the Association	Contact Details	Activity Performed
1	Warangal District Rice Milers Welfare Association Hunter Road, Warangal, 506008.	Bhupathi Omprakash President +91 9866074849	• Arranging various seminars, workshops • Inviting various agencies for promotional activities • Representing the cluster to various government bodies and business forums.

2.4 Issues in Cluster

2.4.1 Energy Availability: The units draw the electrical energy from the distribution system of APNPDCL. In case of power cut off situation the units utilize the power from DG sets. So far there have not been any issues related to long term failure of power or diesel supply. Rice husk is used as a fuel in boiler and available after the milling operation of paddy.

As the raw rice and parboiled rice mills are energy dependent, there is a vast opportunity for savings of energy in every unit operation at various capacities of connected loads. However, it is seen that the major issue and barrier is not achieving the same is primarily the awareness and secondly the linkages in technologies. Some units though have practiced which is very meager. The third major barrier is the lack of knowledge of financial linkages.

There is huge scope of Energy conservation and co-generation in this cluster, among that one of the unit is having cogeneration i.e. rice husk used as a fuel for this process. Many of the rice mill owners are interested to produce (Conflict) rice husk based Co-generation which has started picking up in the cluster and within a few months in 2010-11. It is expected that co-generation plants will be commissioned and put in use.

Utilization of the cogeneration system to meet the requirement of thermal and electrical needs specially for generating steam and or hot air for parboiling and drying of paddy will help in enhancing the energy efficiency and production capacity of rice mills. This will not only results in considerable saving but also leads to an increase in production capacity, a sustainable supply of electricity and additional revenue from the surplus electricity generated from saved rice husk.

2.4.2 Technological Issues: In rice milling cluster at Warangal, overall technical understanding on rice manufacturing is good and is rapidly increasing. Some unit's prime equipments like rubber sheller, whitener, polisher etc are imported from Japan and China.

There is no separate electrician in each unit. In case, any problem occurs in the milling section and boiler section, the plant should be shutdown for one day. However, the first change is still a challenge, upon success, later on duplication and adaptation is extremely common in the cluster. The technologies need to be demonstrated within the cluster. While carrying out the audits and presenting the energy audit reports to the units, in the discussion with the plant owners, many of them agreed with many of the identified energy saving measures and technologies but they demanded demonstration of the energy saving technologies in any plant and thereafter they have readiness to follow.

2.4.3 Financial Issues: Availing finance is not a major issue. Among the SME's, the larger units, if convinced, are capable of either financing themselves or get the finance from their banks. The smaller units will require loan at comfortable rates and other support to raise the loan. However, as most of them have been able to expand their setup and grow, there is a readiness to spend for energy efficiency technologies which have good returns. Energy Efficiency Financing Schemes such as that of SIDBI's, if focused on the cluster, will play a catalytic role in implementation of identified energy conservation projects & technologies.

The cluster has significant potential of co-generation by using biomass (rice husk) and solar technologies. However, though there are good returns, this project is highly capital intensive and requires support of policy as well as innovative financial mechanisms. Initiative has already been taken by some of the units to install rice husk based co-generation. Clean Development Mechanism (CDM) needs to be duly applied to generate additional cash flow to further improve the returns from the project.

2.4.4 Manpower Related Issues: At Warangal rice mill cluster, availability of skilled manpower is one of the limitations. Number of rice mill units has grown fast as compared to the availability of skilled manpower. Two to three local electrical persons available at Warangal takes care of about 15 to 20 Rice mill units. For major equipments like polisher, whitener, capacitors banks status checking, boiler section and remaining motors in the unit etc. Maintenance or the repair work of these equipments is take care by the equipment suppliers themselves. Local technical persons at Warangal take care of most of the matters. The units have age-old inefficient practices and well-experienced non-qualified staff in these industries. Even if the qualified staff joins for the sake of experience it jumps to other big industry after getting sufficient experience this is because of low pay packages. These are the major barriers in the technological development of the SME's.

Specialized and focused training of the local service providers on better operation and maintenance of the equipments, importance of the energy and its use and energy conservation measures will improve awareness among the unit owners and workforce. Original equipment suppliers should also participate in these programs.

2.4.5 Technology and Service Providers Related issues: Many of the new technology provider's (especially some foreign technology leaders) have not shown keen interest in implementation of their new innovative technologies. This appears to be because of fear of duplication.

The service providers for the Warangal cluster are available in the radius of 150 to 200 kms and are mainly from important cities such as Vijaywada and Hyderabad. Warangal is well connected by intercity train service and highways to both the cities. Few of the service providers have their activities in Warangal. More than fifty service providers of technologies for energy efficiency improvements are located in these cities.

CHAPTER III
ENERGY AUDIT AND TECHNOLOGY ASSESSMENT

3.1 Methodology Adopted

3.1.1 Energy Audit: Energy audit is a systematic study or survey to identify how energy is being used in a building, a plant, and identify the energy saving opportunities. Using proper audit methods and equipments, an energy audit provides essential information of energy consumption pattern in each process and how energy being used with in a plant/ industry. This will indicate the performance at the process level or overall plant. Based on information by energy audit, energy manager/ management can compare these performances against past and future levels for proper energy management. The energy audit report contains energy conservation opportunities and energy savings proposals comprising of technical and economic analysis of projects.

The viable energy conservation opportunities and energy saving proposals is then transformed into energy savings projects. It will facilitate the energy manager/management to draw up an action plan listing the projects in order of priority. He will then present it to the organizations management for approval. Providing tangible data enables the management to be at a better position to appreciate and decide on energy efficiency projects. Adopting this activity as a routine or part of the organizations culture gives life to energy management, and controlling the energy use by energy audit is what we refer to as Energy Management by facts.

Pre-Energy Audit Study: The Methodology adopted for pre - energy audit activities is as follows:

- Based on the situation analysis data provided by BEE on Warangal Rice mill cluster, the activities were evolved and planned accordingly. Three rice mill units i.e. one raw rice mill and two parboiled rice mills were visited and observed in detail to get deeper understanding of the energy issues in the industry before starting the work.
- Visited and interacted with president and members of the association and get their feedback and views.
- Based on the visit, identified high energy consuming equipments and analyzed ongoing technologies and started identifying gaps at the cluster level.
- Prepared the data collection format for energy audit and its field measurements
- Prepared a list of units to be audited taking care that all types and sizes are covered and finally classified the units to be studied as Raw rice mills and Parboiled rice mills
- Depending on visit to the three units, started identifying possible energy conservation areas.

- Exclusive allocation of team personnel (who can also speak local language) from our team to work full time to convince the plant owners/persons to get ready for conducting the energy audit Used local maps, books and information provided by association to get further details on the cluster

Preliminary Energy Audit Study: The methodology adopted for Preliminary Energy Audit study in Rice Milling Cluster as follows:

- Conducted preliminary study in 30 units
- Collection of the past six month's electrical energy consumption data
- Establishment of the energy consumption scenario at the plant
- Establishment of the benchmarks of specific energy consumption of typical equipments wherever possible
- Study and Identification of major energy consuming sections and equipments for further work on identification of energy conservation opportunities
- Detailing of no cost and low cost saving measures at the plant.
- Identification of the areas for detailed study and listing the measurements required
- Modified previous formats for data collection and measurements and finalized for detail energy audit study

Detailed Energy Audit Study: The methodology adopted for Detail Energy Audit study in Rice Milling Cluster as follows:

- Conducted detailed energy study in 30 units
- Detail observations on the equipments in terms of their functions, energy requirements
- Electrical measurements on the electrical equipments by Load Analyzer which includes the measurement of Voltage, Current, kWh, PF and harmonics percentage each major equipments such as transformer, motors, capacitors, air compressors, blowers etc.
- Performance evaluation and efficiency of Boilers and auxiliary systems conducted by taking the measurements like steam properties , feed water properties and flue gas particulars and fuel firing systems and primary and secondary air supply.
- In a dryer section the following measurements are taken for analyze the performance like air velocity, motor speed and air temperature etc
- Calculated energy balance and Specific Energy Consumption at plant level and process level
- Carried out all the required measurements to quantify specific energy consumption of electrical and thermal energy at each of the major process - i.e. kWh/MT and kg of fuel/MT of Production in Raw Rice Mills, Parboiled Rice Mills

- Identified process benchmarks focusing ongoing best practices so as to promote their repetition in the cluster
- Identification of alternative lower energy consumption or energy cost options for same process in the industry
- Analyzed the saving potential and investment required accordingly prioritized the measures and identified 15 technologies for preparation of DPR's

Benefits of Energy Audit: Detailed Energy audits in cluster indicate massive potential for energy savings in every sub-sector of industry with an average of almost ten percent of the energy usage. However, this can only materialize through replication in other factories within the respective industry sub-sector.

The results are bound to create a positive impact to the industries as well as the national economy and the environment. By saving energy in industries can reduce the emission of Green House Gases (GHG) into the atmosphere.

Technical Audits (Methodology): The following methodology has been adopted for conducting technical audit:

- Conducted technical energy study in 20 units
- Identify major equipments and technologies of the plant
- Whether the equipments installed are local make or reputed company make
- Various energy sources available in the cluster
- Energy use and specific energy consumption details
- Identify major constraints for installing energy efficient equipments
- Whether energy efficient equipment suppliers are available locally and identify the suppliers
- The strategy followed for selection of equipment suppliers by the management
- Any research or survey carried out prior to selection of the technologies adopted and available
- Discussions made with management of adopting new technologies for efficiency improvement
- Financial strength and investment that can be made for the improvement of energy efficiency by the plant management

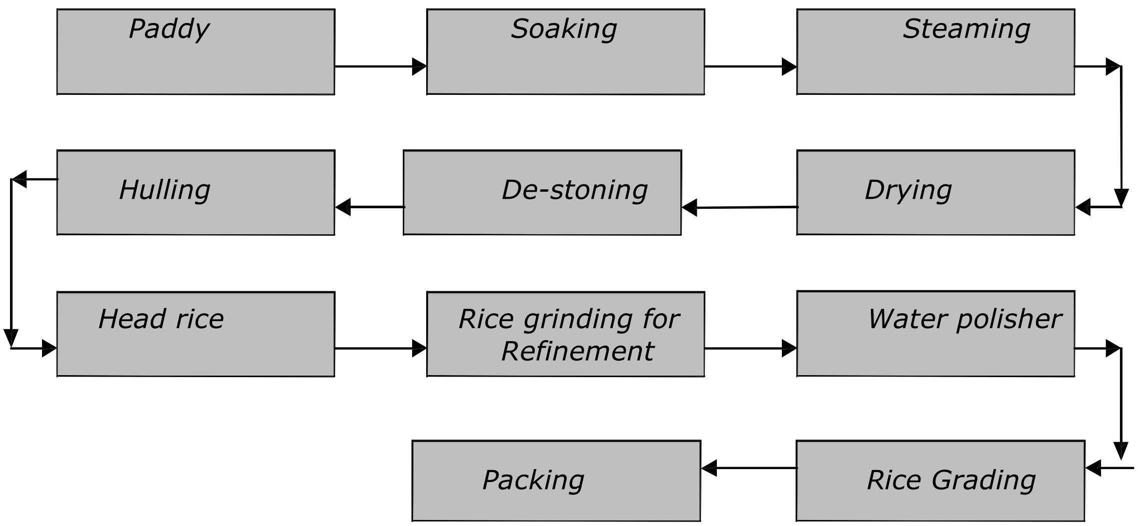
3.2 Production Process in Rice Mill cluster

The product i.e. Rice is produced by processing the paddy in mill by removing the husk. There are two types of paddy processing technologies as discussed below:

Raw Rice Mills: Paddy procured from different sources is dried & then sent for milling without any other process.

Parboiled Rice Mills: The procured paddy from different sources is first sent to partial cooking with the help of steam and then dried with help of air dryers. The steaming of paddy is two types: 'Once steamed paddy', and 'Twice steamed Paddy'. After steaming the paddy, it is sent to the driers for drying, then after it is sent for milling operations. The drying of paddy is of two types, Open Dryers and Closed Dryers. The dried paddy from dryer is then sent to the milling process which is similar to the raw rice processing.

Fig 3.1 Process Flow Diagram-Parboiling Units



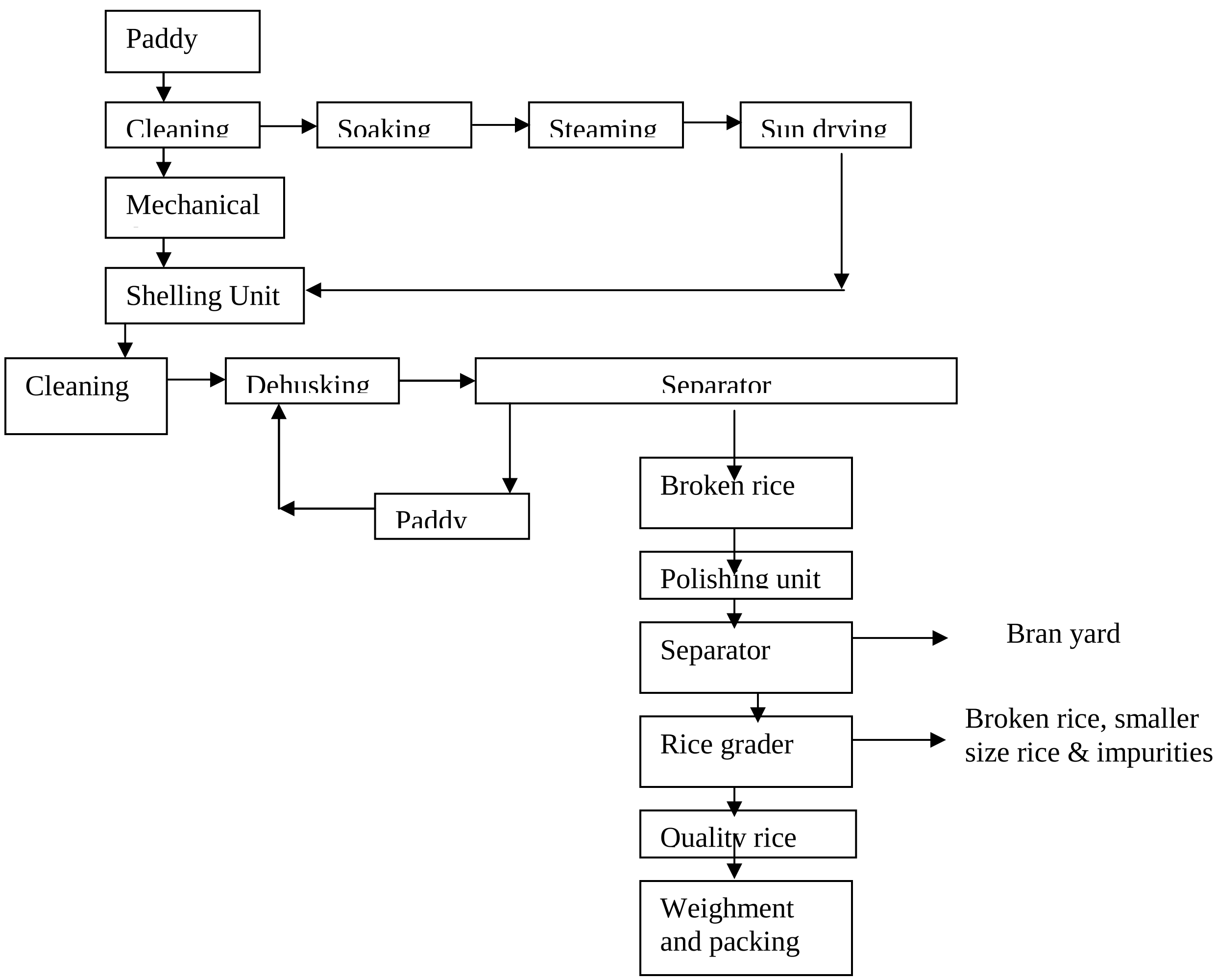
3.2.1 Process description and flow: The paddy received from the farmers contains around 20 % moisture and also contains lot of foreign matter. In order to maintain a uniform moisture level of 12 %, the paddy is passed through a cleaner cum drier to reduce moisture and remove foreign particles. Grading and cleaning operation would involve removal of moisture and foreign material. The cleaned and dried paddy is stored for milling. The dried paddy is again passed through a secondary cleaning system to remove the foreign particles; stones etc are remained in preliminary cleaning. The cleaned paddy is de husked in huller mill with the help of rubber roll hullers. The husk thus separated is either sold or sent to the boiler section for use as fuel. The de-husked paddy is passed through table separators and then to polishing section. In the polishing section the thick brown layer of the paddy is removed with polishers/whiteners. The thick brown layer thus removed by the polishers/ whitener is called bran and this will be used in the solvent extraction plant as raw material. The polished rice is then passed through sieves to remove brokens. The broken rice obtained is put for sale in packed condition. The un broken polished rice finally passes through sorters to remove discoloured rice and then sent for packing.

- Pre Cleaning: Removing all impurities and unfilled grains from paddy
- De-stoning: Separating small stones from paddy

- Parboiling (Optional): Helps in improving the nutritional quality by gelatinization of starch inside the rice grain. It improves the milling recovery percent during deshelling and polishing / whitening operation
- De-Husking: Removing husk from paddy
- Husk Aspiration: Separating the husk from brown rice/ unhusked paddy
- Paddy Separation: Separating the unhusked paddy from brown rice
- Whitening: Removing all or part of the bran layer and germ from brown rice
- Polishing: Improving the appearance of milled rice by removing the remaining bran particles and by polishing the exterior of the milled kernel
- Length Grading: Separating small and large broken from head rice
- Blending: Mixing head rice with predetermined amount of broken, as required by the customer
- Weighing and bagging: Preparing the milled rice for transport to the customer

The flow diagram of the various unit operations are as follows:

Fig 3.2: Raw Rice/Parboiled Rice processing flow chart



3.2.2 Par Boiling Process: Par-boiling is the hydrothermal treatment of paddy before milling. There are three steps involved in the parboiling process. They are

- Vacuuming of paddy
- Soaking (steeping) of paddy
- Heat-treatment of wet paddy
- Drying of paddy

Vacuming of Paddy: Vacuum is used in some machines for soaking and drying. The benefits are

- Reduced heat and electricity consumption.
- Making recycled-husk as it is the only fuel employed in the par boiling system, with no other needs of fuel.
- Even moisturizing of all paddy varieties.
- Reduced soaking and drying time (keeping the paddy warm and wet for too long time will destroy its good smell and taste due to fermentation).

Soaking: The soaking is a process in which hot water is pumped in the soaking pressure vessel and cushion of compressed air at 7.5-10 kg/cm^2 is maintained, at the top of the vessel, by means of an air compressor. Hot water is generated in a special heater in which heat is provided to the cool water by (a) the hot steam condensate returning back to the boilers hot well and (b) the direct injection of the steam. The soaking dwell time (for water uptake) and temperature of hot water differs from variety to variety. The higher the soaking temperature, the lesser the time required for saturated uptake of the grain. However, higher temperature and soaking time have their own disadvantages. Higher temperature of soaking increases the concentration of salts and vitamins in the water. This reduces the nutrient value of the rice. Secondly, the color of the Kernel changes to brown, due to the dissolving of the color pigment in the kernel.

Lengthy and low water temperature soaking of paddy will create fermentation which gives a bad smell and taste to the rice. Also certain biological changes take place which are also harmful for the rice grain. The harmful effects on rice as mentioned above could be avoided by soaking rice under pressure and de-aerating rice prior to soaking. The outcome is better product with good grain color and water soluble nutritious substances.

Heating and Drying of Soaked Rice: Rotating and pressure resistant vessel is also used for heating because it allows high heating temperatures of more than 100 ^{o}C, even exposure to heat/steam and condensate to be removed continuously. The rice grains break when they are moist and handled mechanically. Hence mechanical handling of moist grain is avoided and its conveyance by gravity is adopted. Also hot and wet rice creates blockages in mechanical handling. Such blockage may cause serious problems of unblocking, cleaning and maintenance.

Par-boiled paddy should be dried to 14% moisture for safe storage or milling. Parboiled paddy is more difficult to dry and requires more energy than field paddy because its moisture content is much higher. However, higher air temperatures help reduce the drying time. If drying is done too fast, internal stresses develop in the grain and cause breakage during milling. After drying is completed, the paddy should be allowed to stand for at least several hours - preferably for 1 or 2 days - before it is milled, to permit internal moisture differences and stresses to equalize.

Moisture reduction takes place rapidly during the first part of drying from 36 to 18% moisture level, but is slow from 18 to 14%. The drying process should be stopped at about 18% moisture to allow the paddy to temper or equalize for several hours before continuing the drying to 14%. Most par-boiled paddy is sun-dried on large drying floors close to the rice mill. A large number of workers are needed to constantly turn and mix the paddy to achieve rapid, uniform drying. For best results, paddy should be spread about 2.5 cm thick over the floor. At this thickness 500 square meters of drying floor can handle 6 tons of paddy. Depending on drying air temperature and relative humidity, sun- drying usually takes 1 or 2 days.

Sun-drying paddy from 36% to 14% moisture in a single stage causes considerable damage to its milled quality. The problem is overcome by dividing the drying periods and tempering the paddy in between.

Mechanical equipment for drying par-boiled paddy is the same as for drying field paddy. But the operation of the equipment differs. The continuous-flow dryer (LSU type) is used as a re-circulating batch dryer. Wet paddy is re-circulated in the dryer until it reaches 14% moisture.

In contrast with field paddy, par-boiled paddy requires air temperatures of up to 100°C during the first drying period. During the second period air temperature should be kept below 75°C. Maintaining higher air temperature will not decrease the drying time but will result in increased drying cost and more damage to milled rice quality. The first drying period takes about 3 hours including dryer loading and unloading time. After tempering, the second drying period takes about 2 hours. Continuous-flow dryers are available in many sizes to match the capacity of the parboiling system. A 24-5/day parboiling plant needs an 8-ton (holding capacity) dryer. In some cases, rotary dryers are used to pre-dry par-boiled paddy before it is loaded into the continuous-flow dryer. That removes large quantities of surface moisture quickly. Many parboiling plants use husk- fired boilers to supply steam and hot water for parboiling. These same boilers can supply steam to heat exchangers that are used to supply the heated air for drying. In some cases, oil-fired burners and direct husk-fired furnaces have supplied the heated air for drying.

Rice Milling: Paddy is processed to convert it into rice which is ready for consumption. The different stages of rice processing are described below. The process of removing husk, the top layer of the kernel grain is done in this unit. The process is called husking or hulling or shelling. After this process, the final product is "brown or cargo rice".

Reception & Storage: It is essential to have a system which can receive, clean and store paddy within a very short time, particularly during the harvest season. Paddy supplied in bulk is weighed and discharged into large intake pits. Paddy is cleaned from coarse impurities. Paddy is then dried to reduce the moisture content to 14% making it suitable for storage. This is achieved through several passes in vertical driers, with intervals of 8-12 hours.

Husking Unit: In the husking unit generally there are two separate lines provided. One for intake of raw paddy from the paddy storage area and the other, for the intake of par-boiled paddy from the par-boiled unit. The major components/equipments in this unit and its operations are explained as following.

Pre-Cleaner: The pre-cleaner removes the large, medium and small size impurities, including ferrous metal from the incoming metal. The large impurities such as straw, strings and stones are removed in the first stage of scalping. Then in the second stage, more impurities are removed which are of the size of the product to be cleaned. Finally in the third stage, through the lower sieve, fine impurities like weeds etc. are removed. Magnets are provided to remove ferrous metal from the clean stock. Dust is removed by an aspiration system, which is installed on the top of the cleaner. The aspirated air is led to cyclones for separation of solids from the exhaust air.

Cleaning: Paddy is cleaned from dust and foreign particles. Classifiers are used to remove straw, sand, stone and paper etc. from the paddy, while destoners remove heavy impurities such as stones and glass.

Husking: The husking machine does two things; it dehusks the paddy and then separates the kernels into fractions of large, light and mixed kernels. Husking generally cannot be done 100% and hence, will still be having the unhusked kernels. These are separated in a later process and recycled. Dehusking is achieved in this machine by passing paddy through rubber rollers and by friction. Parboiling makes the paddy lesser tough and easier to remove, with lesser broken grains. Exhaust fans (or aspiration) suck out the husk from the machine. The resulting output is brown or cargo rice.

Phak Grader: This grader separates the brown rice into grades of large, medium and small sizes. It delivers them into separate bins provided for interim storage.

Husk Separator: This machine separates husk from the kernels by application of rubber roller friction to husk.

Paddy Separator: In the dehuller, some part of the paddy (about 15%) will escape dehulling. This dehulled paddy is separated in this machine and recycled to the dehuller.

Destoner: This is a pre-cleaning machine which removes stones from the paddy through the principle of oscillating to and fro, the particles of different material densities. Pre-cleaned paddy is spread on a to and fro oscillating horizontal sieve with air blown from under the sieve. The stones of higher density descend own the sieves and are discharged as waste.

Reprocessing Unit: In this unit the brown rice, an output from the husking unit, is processed to give the final product of polished white rice or Parboiled rice fit for consumption. The reprocessing unit comprises of the following parts.

- Separator
- Grader
- Polisher
- Color Sorter (if provided)

Separator: This separator is the same as the separator in the husking unit except that the finer sieves are provided for removal of impurities remaining in the product after husking.

Combi- Cleaner: The combi-cleaner is the combination of three separate individual units i.e.

- Scalping Cylinder (optional)
- Double Stage Sieves Frame
- Strong air Flow Aspirator

This machine is capable of fulfilling the requirements of cleaning of grains and similar products.

- **Scalping Cylinder:** Through a vertical pipe equipped with an adjusting valve & gravity flap, adjustable by counter weight to ensure a uniform distribution of the stock. The scalping cylinder separates the large impurities like straw, string and stones etc. Cylinder is equipped with a rotary wiper to remove the sticked impurities. The rejections are thrown in a straw box and the stock is fed to the double screen tray.
- **Double Stage Sieves Cleaner:** After cleaning through scalping cylinder, the stock is fed to the flat sieves. Mesh sieves are used for cleaning of rice in double stage with suitable sizes according to the grains. The sieves are operated through vibrating electric motor.

  The upper sieve screens off impurities which exceed the size of the material to be cleared. These impurities are discharged through the outlet provided.

  The bottom sieve separates fine impurities such as sand, weeds etc. and the impurities are discharged through the outlet provided. Rubber balls are provided to prevent clogging of sieves.
- **Air Aspirator:** A strong fan is provided on the top of the air aspirator with the volume of of 4 cu-m of air/min suction. Four air regulatory channels with the control of shutters on the top are provided for efficient blow of light particles.
- **Magnetic Cleaning:** The magnets attract iron particles in the stock. Permanent type magnets are provided at the discharge of cleaned stock.

Silky Polisher: Shelling is the process of removing husk from the paddy. This is achieved by the gentle action of rubber rolls applied to the paddy. Next, the husk aspirator separates the husk from the rice by means of air aspiration. The brown rice then passes into the paddy separator which separates any unshelled kernels from the brown rice. The unshelled paddy is recycled back in to the Sheller while the shelled rice (brown or cargo rice) passes onto the whitener and polisher.

Whitening & Polishing: During whitening and polishing bran layers are removed from the brown rice. This not only enhances the appearance of the rice but also increases its shelf life, since the lipids contained in the embryo and the bran layers are highly susceptible to enzymatic and non enzymatic oxidation. The bran removal is best achieved in several steps to ensure evenly milled rice grains with minimum broken and optimum whiteness. The number of passes required depends upon the desired finish and variety of rice. In the whitening process bran is removed by abrasive action. Bran is removed by creating high friction forces between the rice grains. Whitening process results in smooth rice with an opaque appearance.

Grading: Grading removes brokens from head rice and sorts rice into fractions of different length. Head rice, brokens and tips are further separated by a sequence of indent cylinders into fractions of different broken sizes and head rice.

Color Sorting: Optical inspection is the final quality control and enhancement step in the rice mill. Discolored grains and optionally chalky kernels are removed to yield a first grade product.

3. 3 Observations

3.3.1 Manufacturing Process and Technology/Equipments Employed: The manufacturing processes involved in Raw Rice Mills and parboiled rice mills are same in all types of units in the cluster. The lists of the major equipments employed in rice mill units are as follows:

- Power supply from Incomer to the Mill and Boiler section
- Whitener motor
- Paddy Separator
- Elevators
- Rubber Sheller
- Boiler
- Dryer
- Polisher
- Bucket ,Conveyers and Screening

Fig 3.3: Parboiling Section Schematic Diagram

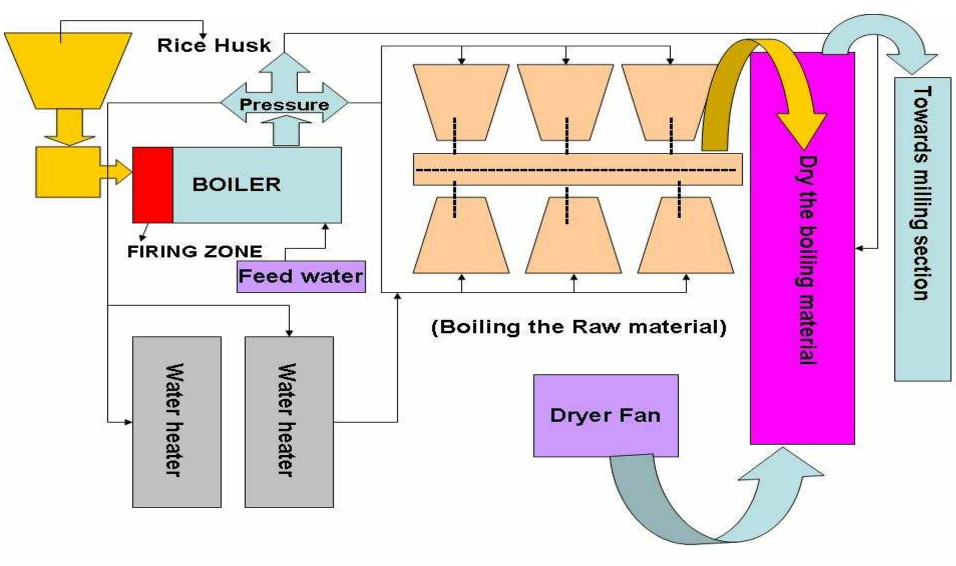
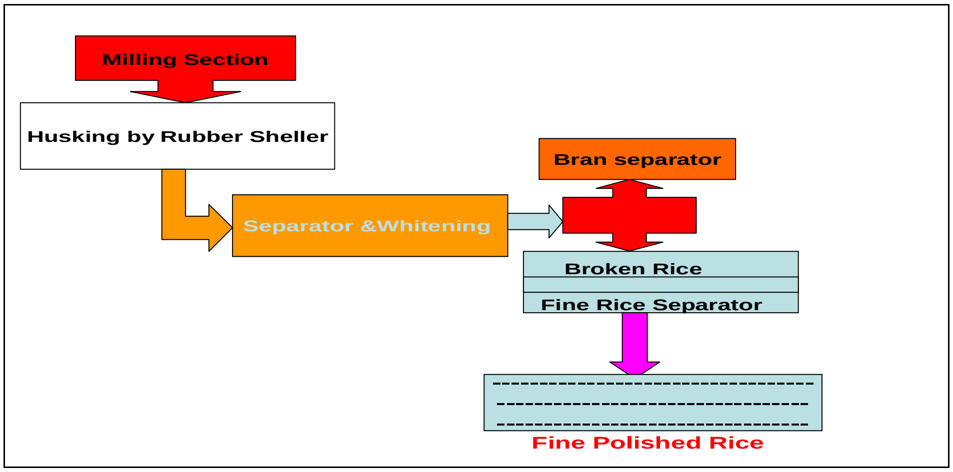


Fig 3.4: Rice Milling Section Schematic Diagram



3.3.2 Energy Consumption Profile & Availability: At the cluster level, energy consumption profile & availability of various energy sources is given in **Table 3.1**. The total Electrical energy consumption by the cluster units per annum is 17.64 Million units and the power tariff is ₹3.30 /kWh which is procured from the APNPDCL. The rice husk requirement for parboiled mills is 61,800 T/Yr and is available with in the plant and the cost of rice husk is ₹1.8 /kg. The diesel requirement is 35.54 KL and the cost is ₹38.90 /liter.

Table 3.1: Energy Consumption Scenario at Warangal Rice mill Cluster

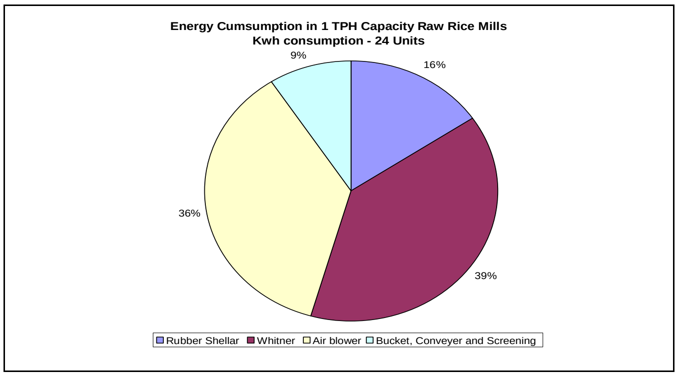
Sr. No	Type of Fuel	Units	Quantity /year	Availability
1	Electricity	kWh	17,646,928	Available in required quantity
2	Rice Husk	Tons	61800	Available in required quantity
3	Diesel	Ltrs	35542	Available in required quantity

Energy consumption Profile for 1 TPH capacity raw rice mill in 24 units: The total electrical energy consumption in 1 TPH capacity raw rice mill for 24 units 22, 25, 283 kWh/ year. The electrical energy consumption patron is shown in percentage wise **Table 3.2** and **Fig 3.5** illustrate the energy consumption by various equipments. It is seen that the whiteners, air blower consume around 39 and 36 % of electricity each followed by rubber sheller.

Table 3.2: Energy Consumption Scenario in 24 Raw Rice Mill units of 1 TPH Capacity

Sr. No.	Process Equipment	Consumption (kWh/year)	%
1	Rubber Sheller	346680	16
2	Whitener	865440	39
3	Air blower	811428	36
4	Bucket, Conveyer and Screening	201708	9
	Total	**2225256**	**100**

Fig 3.5: Energy Consumption Scenario in 24 Raw Rice Mill units of 1 TPH Capacity

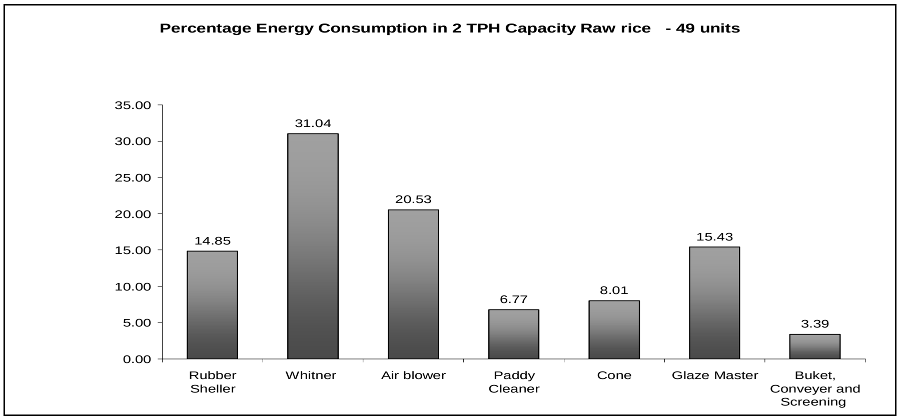


Energy consumption Profile 2-TPH Capacity raw rice mill in 49 units: The total electrical energy consumption in 2-TPH capacity raw rice mills for 49 units per annum is 54, 31,820 kwh/year. The electrical energy consumption pattern is shown in **Table 3.3** and **Fig 3.6.** It is seen that the maximum energy is consumed in the whitener, glaze master and air blowers.

Table 3.3: Energy Consumption Scenario in 49 Raw Rice Mill units of 2 TPH Capacity

S. No	Process Equipment	Consumption (kWh/yr)	%
1	Rubber Sheller	806478	14.85
2	Whitener	1685906	31.04
3	Air blower	1114995	20.53
4	Paddy Cleaner	367500	6.77
5	Coin	435120	8.01
6	Glaze Master	837900	15.43
7	Bucket, Conveyer and Screening	183921	3.39
	Total	**5431820**	**100**

Fig 3.6: Energy Consumption Scenario in 49 Raw Rice Mill units of 2 TPH Capacity

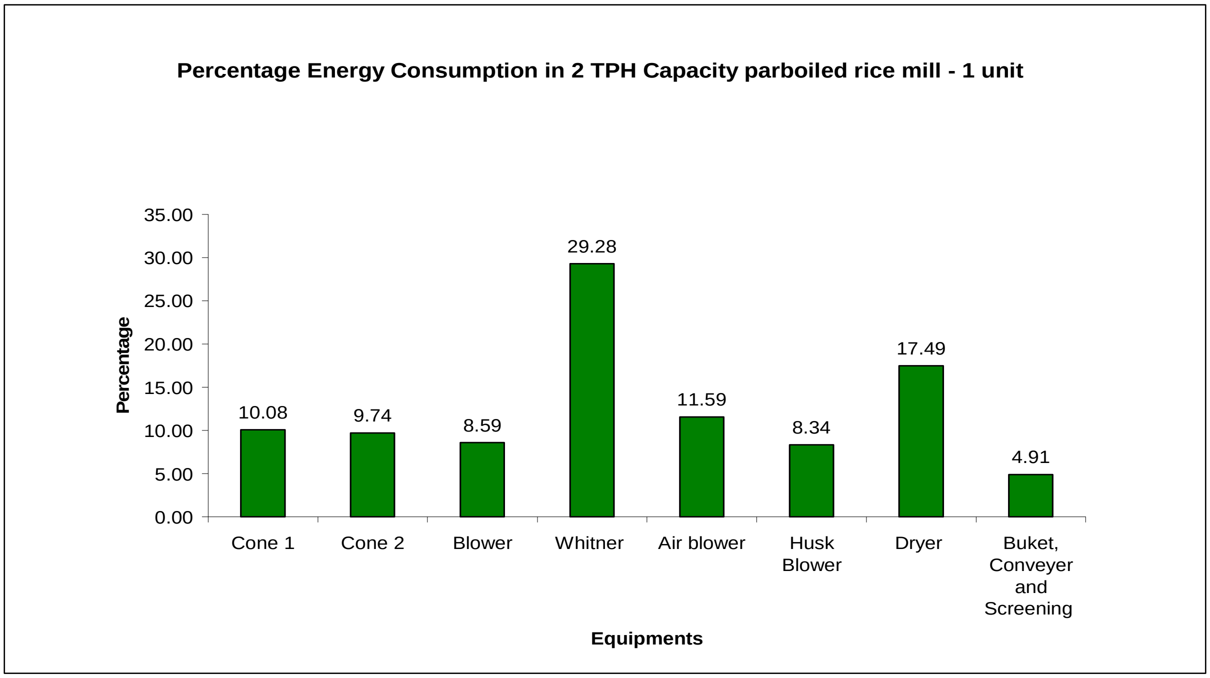


Energy consumption Profile 2-TPH Capacity parboiled rice mill in 1 unit: The total electrical energy consumption in 2-TPH capacity parboiled rice mill is 1, 29,454 kWh/year and for the thermal energy rice husk consumption to the boiler is 1272 MT/year. The electrical energy consumption pattern is shown in **Table 3.4** and **Fig 3.7.** It is seen that whiteners and dryers have 29 and 17 % energy consumption followed by air blowers and cones.

Table 3.4: Energy Consumption Scenario in 1 Parboiled Rice Mill unit of 2 TPH Capacity

S. No	Process Equipment	Consumption (kWh/yr)	%
1	Cone -1	13046	10.08
2	Cone -2	12604	9.74
3	Blower	11116	8.59
4	Whitener	37900	29.28
5	Air blower	15000	11.59
6	Husk Blower	10800	8.34
7	Dryer	22640	17.49
8	Bucket, Conveyer & Screening	6356	4.91
	Total	**129462**	**100**

Fig 3.7: Energy Consumption Scenario in 1 Parboiled Rice Mill unit of 2 TPH



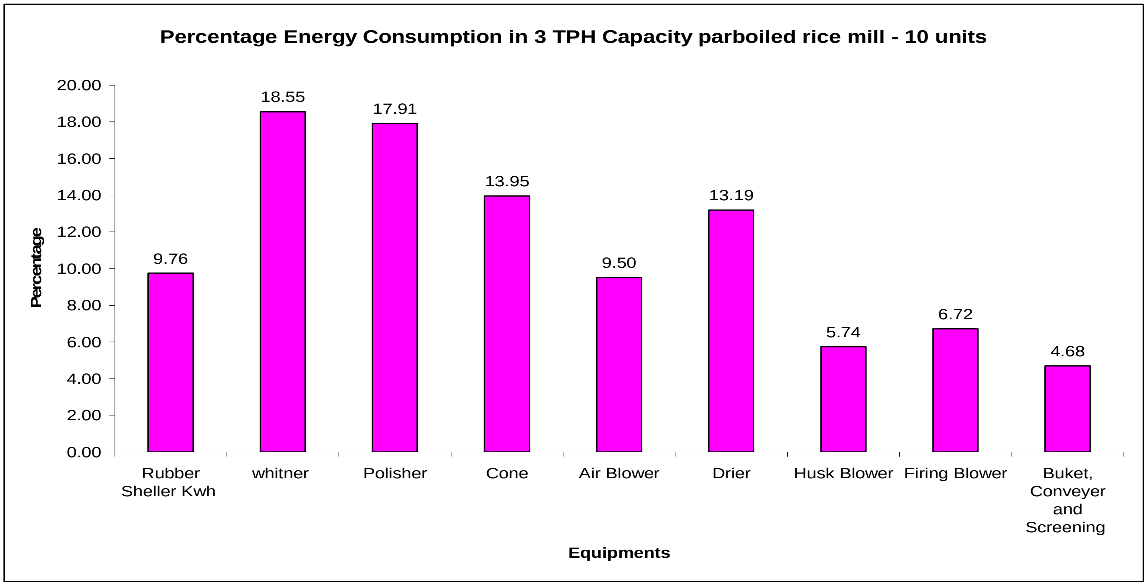
Capacity

Energy consumption Profile 3-TPH Capacity parboiled rice mill in 10 units: The total electrical energy consumption in 3-TPH capacity parboiled rice mill for 10 units per annum is 20, 36, 309 kWh/year and for the thermal energy rice husk consumption to the boilers is 15600 MT/Yr. The electrical energy consumption pattern is shown in **Table 3.5** and **Fig 3.8.** It is seen that whiteners and polishers have 18 and 17 % energy consumption followed by Cone and driers

Table 3.5: Energy consumption Profile 3-TPH Capacity parboiled rice mill in 10 units

Sr. No	Process Equipment	Consumption (kWh/year)	%
1	Rubber Sheller	198667	9.76
2	Whitener	377780	18.55
3	Polisher	364800	17.91
4	Cone	284144	13.95
5	Air Blower	193488	9.50
6	Drier	268520	13.19
7	Husk Blower	116800	5.74
8	Firing Blower	136800	6.72
9	Bucket, Conveyer and Screening	95319	4.68
	Total	**2036318**	**100**

Fig 3.8: Energy consumption Profile 3-TPH Capacity parboiled rice mill in 10 units

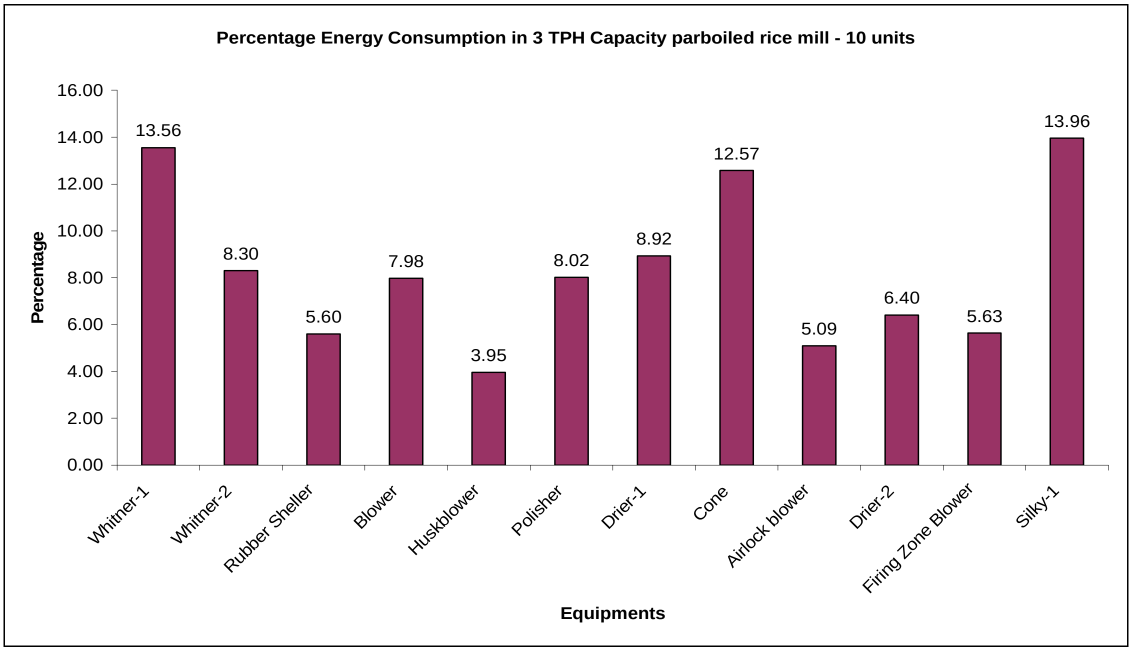


Energy consumption Profile 4-TPH Capacity parboiled rice mill in 24 units: The total electrical energy consumption in 4-TPH capacity parboiled rice mill for 24 units per annum is 78,24,060 kWh/year and for the thermal energy rice husk consumption to the boiler is 44928 MT/year. The electrical energy consumption pattern is shown in **Table 3.6** and **Fig 3.9.** The maximum energy consumed is in the whitener, silky and the cone.

Table 3.6: Energy consumption Profile 4-TPH Capacity parboiled rice mill in 24 units

Sr. no	Process Equipment	Consumption (kWh/year)	%
1	Whitner-1	1060721	13.56
2	Whitner-2	649116	8.30
3	Rubber Sheller	437937	5.60
4	Blower	624013	7.98
5	Husk blower	309120	3.95
6	Polisher	627840	8.02
7	Drier-1	698276	8.92
8	Cone	983736	12.57
9	Airlock blower	398229	5.09
10	Drier-2	501120	6.40
11	Firing Zone Blower	440640	5.63
12	Silky-1	1091980	13.96
	Total	**7822728**	**100**

Fig 3.9: Energy consumption Profile 4-TPH Capacity parboiled rice mill in 24 units



3.3.3 Capacity Utilization Factor: Capacity utilization factor at the plant level and at the equipment level is described below:

- **Plant Level:** First season of crop is during April- May and paddy available during this season is fit for the production of boiled rice whereas the paddy available during the second season (November-January) is used mainly for raw rice production. Units are shutdown due to non-availability of paddy and procurement problem from FCI (Food Corporation of India).
- **Equipments Level:** Boiler operates 10-12 hrs a day to produce continues steam pressure to the soaking zone. Dryer motor in the boiler section operates 8-10 hrs a day and motors in milling section for equipment viz. rubber sheller motors, whitener motors, silky motors, cone motors and elevators operate at full load capacity.

3.3.4 Good House Keeping & Miscellaneous Measures: Good house keeping includes:

- **Reduce Losses:** Energy losses to the atmosphere caused by surface addition, leakage of process air, product discharge temperature being too high, or exhaust temperature of flue gas being too high are to be avoided.
- **Prevent Leakage:** Leaks reduce the operation's effectiveness. Ingressive leaks dilute the air and spend valuable energy on heating up this additional air and any moisture in

it. Exfiltration results in the loss of process air and will decrease the unit's performance.

- **Maintain Utility Supply Lines**: Utilities such as steam, fuel, compressed air, etc., should be regularly maintained to control the losses. If these losses are unrecoverable and will contribute to the overall operating cost of the system. It requires measures such as avoiding steam leaks and regular steam trap checking, improving insulation efficiency of burners compartments, heat exchangers, duct work and the body of dryer itself.

Fig 3.10: Good House Keeping & Miscellaneous Measures

3.3.5 Availability of data & Information: The availability of data and information pertaining to energy procurement and consumption is available in some of the cluster units. However, the equipment wise consumption and production data is not available as it is kept confidential.

3.3.6 Any other relevant aspect: Majority of the machine operators and helpers deployed in the cluster units are non technical and illiterates and had been taken based on the past experience and do not have any technical skills and knowledge on energy conservation. This is also one of factor for the inefficiency of the process and energy losses.

3. 4 Technology Gap Analysis

3.4.1 Technology Up gradation: The existing technology for manufacturing in the existing units for some of the equipments installed is poor as compared to the technologies available in the market. Various technological gaps were identified in the units and these may be due to lack of awareness of technologies available in the market, lack of knowledge in tapping the potential from saving of energy losses and its monetary benefit, lack of awareness among the workforce.

There is a tremendous need for the industry to modernize/upgrade its technology and adopt energy efficient technologies in some of the areas. Further, as per the discussions made with the management, they are interested in improving the efficiency of the utilities rather than process equipments. The rice mills is an unorganized sector with low engineering, limited technology innovation and poor R&D base as well as low level of human resource on knowledge of technology, and operational skill. The sector also faces deficiencies such as the lack of access to technology and technology sharing and the inadequacies of strong organizational structure, professional attitude etc. There are many technologies and energy efficient equipments available in the market which can be sourced from local service providers dealing in these technologies.

Thus, the study has found small changes required to be introduced in the cluster. However, what is required is a retrofit of smaller add-ons to the existing machinery so as to make energy consuming components of the machinery efficient and also use of automatic to ensure precise process control. Some of the significant opportunities for technology upscale are discussed here.

3.4.2 Technology Gaps: The difference in existing technology and the technology as needed to improve the energy efficiency in the units is discussed here. The gap between the supply and pull of technology has to be reduced through the linkages of local service providers in terms of energy efficient systems in the units.

Energy Efficient Boilers: the boilers are installed in the cluster unit for steam generation for cooking the paddy. Based on detailed studies in the units, some of the boilers were found to be inefficient and the efficiencies were found to be in the range of 30 to 45 %. The reasons for such low efficiencies are mainly, low loading of the boilers to less than 40 %; no control over fuel firing and partial combustion leading to un-burnt carbon. Very old boilers and damaged heat exchanger tubes contribute to the inefficiency of the boiler leading to low throughput. The boilers with 70 – 80 % efficiency are available in the market and the equipment suppliers are locally available. The technology gaps are Hearth area redesign, FD fans optimization and installation of VFD.

Rice Husk Based Cogeneration systems: In view of optimizing the power consumption and thermal requirement of the plants and secondly reducing the dependability of power from grid and reducing the use of DG sets, it is advisable to go for cogeneration systems as the rice husk is locally available. The rice mill cluster units require significant quantity of heat and electricity in the production processes. The major technology gaps in the present system is the overall efficiency which is less than 55 % , while the cogeneration system efficiency when deployed would give an overall efficiency above 85 %. The cogeneration system would deliver both the thermal and electrical energy, while the import of electricity could be reduced, and would be free of cost for internal consumption. The cogeneration system would also help at a broader level to curtail the T&D losses in the grid. An efficient and sustained cogeneration system enables the plant to isolate itself from the difficulties and barriers in seeking grid power.

Preheating of boiler feed water by using solar hot water systems: The Warangal rice milling cluster units require significant quantities of hot water and steam. Few of the advantages of the use of hot water system are: reduction in the consumption of fuel for boiling; use of preheated water from solar energy directly in the boiler thus improving the efficiency and time required for steam generation. The present requirement of the water heating is around 8 -32 KL for use in a 1-4 TPH boiler. The application of such a system will benefit the units in a long run and would be effective in non-monsoon seasons effectively.

Energy Efficient Motors: The motors in the different unit operations are inefficient. Ideal capacities of motors are required i.e. proper sized motors are required as per the electric load application. It is appropriate to use Variable Speed Drive (VSD) with the motor, if the load is variable in nature such as that of pumps, fans, and mixers. VSD matches the motor speed as per the load and results in saving. All new replacements should be done with energy efficient motors having 3 – 5 % higher efficiencies. This results into significant energy savings for every rewinding.

Air compressors: The efficiency of the compressed air system from generation to end-use, is less than 10 %.Thus it must be used judiciously in the plant. The air intake to the compressor should be clean, cool and drawn from a place, which is away from the heat sources. Air intake filters should be cleaned at regular intervals to facilitate clean air intake of compressor and low pressure drop across it. The compressor should keep near by the utilities to reduce the pressure loss. Increase of 1 kg/cm^2 air discharge pressure from the compressor would result in about 4 % to 5 % increase in input power. This will also increase compressed air leakage rates roughly by 10 %.

Drying system: The utilization of hot water after soaking, low dryer blower efficiency and heat loss from condensate are typical technology gaps. A solar drying system can be utilized in parboiled rice milling process. When used the advantages of the solar drying system would reduce the fuel consumption, hot air readily available. As per the estimates, about 2 – 53 % of fuel consumption can be saved in the cluster units.

Fans and blowers: The fans and blowers used to supply the air to the process. The required air is controlled by the dampers. The regulation of required air if not proper leads to increased power consumption. The low power factor is another major issue. The fans and blower efficiency improvements and use of capacitor banks is appropriately needed. The frequent failures of the machine can be arrested by installing variable frequency drives, by which it is possible to operate the motor as per speed requirement and also to achieve wide speed variation and smooth startup as well as energy savings due to running the motor at low speeds. The VFDs were installed in about 50 % of the units surveyed. The variable frequency drives can be installed for ID and FD fans, water circulation pumps etc. About 15 to 20 % of the total energy consumption for above equipments can be reduced by installing VFDs.

Waste Heat recovery from Flue Gas: The flue gas generated by the boilers is at 120 to 180^{O}C and exhausted through the chimney for all the cluster units. This is a common practice in cluster units. No single unit is recovering heat from flue gas. The advantages of installing waste heat recovery systems are reducing fuel consumption, increase in efficiency of the system, where in hot water and air are readily available and hence reduces the time for steam generation. As per estimates, about 2- 4 % of fuel can be saved in the cluster units.

Automatic boiler blow down control system: The blow down is monitored manually for maintaining the TDS in boiler feed water. The boiler operators do not have knowledge of TDS to be maintained and quantity of blow down to be drained. High quantity of blow down than the required levels leads to high fuel consumption, increased consumption and chemicals in water. An automatic boiler blow down control system can be deployed to curtail the losses.

CHAPTER IV
ENERGY CONSERVATION TECHNOLOGIES

4.1 Introduction

The following energy conservation technologies are identified after the technology audit in the cluster.

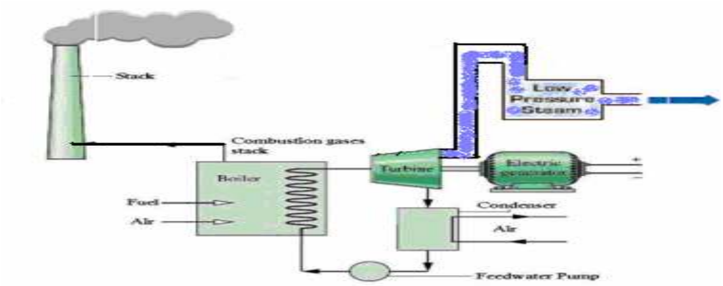
4.1.1 Installation of Rice Husk Based Co-generation System:

Installation of Rice Husk based co generation system in parboiled rice mills are one of the energy savings option identified during the Technology audit. The small portion of power can be produced by installing the energy efficient boiler and also turbo generator. The out put steam from the turbine can be used for the paddy processing in the parboiled rice mills at required operating conditions. The system is the environmentally –friendly, economical and sensible way to produce power simultaneously and significant amount of money is saves as well as reducing green house gas emissions.

4.1.1.1 Background:

With the rising energy cost and unreliable grid power, there is a good potential for industries to opt for energy efficient techniques, as a cost reduction measure. Rice mill clusters require electricity as well as heat in the form of steam or hot water for their operations. These requirements are normally met through different energy sources. The steam pressure required for operation in parboiled rice mills is 2-3.5 $kg/cm^{2,}$ however the units in Warangal are utilizing the steam pressure thrice of the actual pressure (i.e. about 10.5 kg/cm^2) .So, in order to boost energy efficiency in rice mill units, Co-Generation is a buzz word being advocated as the most beneficial technology. It is one of the most efficient energy conversion processes with large cost-saving potential which boasts competitiveness of these units. The power generated from co-generation projects could be utilized for other operations.

Fig 4.1: Rice husk based Cogeneration System



The higher energy conversion efficiencies will contribute to lower emission in particular CO_2, the main green house gas. The cogeneration plant consists of high pressure boiler, extraction cum back pressure turbine and alternator of required capacity, through which steam of required pressure could be extracted without any energy wastage .This, will greatly improve the system efficiency. The schematic diagram of a co-generation system is furnished below (**Fig. 4.1)**.

4.1.1.2 Recommendations:

The present production process system in the parboiled rice mill is a single batch process. To install Co-Generation system in the plant requires two batch productions in the parboiled rice mill instead of one batch for maximum utilization of steam. The proposed Co generation system is suitable for the existing parboiled mills with installed capacity of 2 TPH and above.

4.1.1.3 Energy Conservation Potential:

Every parboiled rice mills requires a steam for the process of paddy before milling operation. But the steam generation by the boiler not utilized efficiently and produces the loss. The rice husk cogeneration system is effective utilization of steam both in process and also generation of at same time. By implementation and installation of cogeneration in parboiled rice mills, the steam generation by the boiler is used to generate the power and also used for process the paddy. All parboiled rice mill in Warangal cluster requires steam at 3.5 kg/cm^2 pressure and 110^{o}C to process the paddy. By the cogeneration system the generated steam from boiler is used initially for generating the power and thereby utilizing the low pressure steam for process the paddy. The proposed Co generation system for typical 4TPH parboiled rice mills can generates 280 kW power. This power can be used for internal consumption of the parboiled rice mills for their operation where grid power consumption reduces and remaining for sale to others.

Technical Specifications and Availability:

The Technical Specifications of the proposed Rice Husk Based Co generation system for the parboiled rice mills is presented below.

Boiler:

Boiler Capacity	: 4TPH
Type of Fuel Used	: Rice Husk
Overall Efficiency of Boiler	: 70%
Steam Flow rate to Turbine	: 4000 kg/hr
Steam Pressure and pressure at turbine inlet	: 32 kg/cm^2 and 350^{o}C
Steam pressure and Temperature at Turbine out Let	: 3.5 kg/cm^2 and 110 ^{o}C
Steam Pressure and Temperature to parboiled process	: 3.5 kg/cm^2 and 110 ^{o}C
Boiler Feed Water Temperature	: 80 ^{o}C

Flue Gas Temperature from boiler : 160 °C

Calorific Value of Fuel : 3600 kcal/kg

Turbo generator:

Steam Turbine Capacity : 280kW

Turbine Efficiency : 90%

Total Power Out put from the System : 280kW

Improvement of the boiler efficiency : 4- 5%

4.1.1.5 Life Cycle Analysis:

The life cycle of the proposed rice husk based co generation is estimated from the technical parameters and cost options.

Cost Benefit Analysis: The cost benefit analysis of the Co Generation system is calculated based on expected savings achieved by installing the proposed Co generation system with existing boiler for the same process and operating parameters of the mill.

Table 4.1: Cost Benefit Analysis of Rice Husk based Co generation System

S. No	Parameter	Unit	Existing System	Proposed CO GEN
1	Process Steam Requirement (ms)	kg/h	4000	4000
2	Process Steam Pressure (P2) / Back Pressure	kg/cm^2	10.5	3.5
3	Steam Pressure (P1)	kg/cm^2	10.5	32
4	Steam temperature (T2)	^0C	110	350
5	Steam Enthalpy at steam turbine inlet(h1)	kcal/kg	644	744
6	Steam Enthalpy at Turbine extraction (h2) @210 °C	kcal/kg		689
7	Feed water temperature (T)	^0C	60	80
8	Enthalpy of feed water (h)	kcal/kg	60	80
9	Fuel Consumption (Rice Husk @3600 kcal/kg)	kg/h	958	1054
10	Boiler efficiency (η_{b})		0.68	0.70
11	Average Power generated (P)	kW /hr	280	
12	No of days operation (assumption)	days/Yr	350	
13	Working hours	hours/day	24	
14	Total Power generation	kWh/yr	2352000	
15	Power Tariff	₹ /kWh	3.30	
16	Total generated Power Cost	₹ /year	7761600	
17	Additional Fuel Consumption due to Power Generation	kg/h	96	
18	Additional Fuel Consumption due to Power Generation	kg/yr	806400	
19	Cost of Fuel	₹/kg	1.8	
20	Additional fuel Cost for power generation	₹./yr	1445500	
21	Operational & maintenance Cost	₹/Yr	240000	
22	Total Cost for Power generation by CO Gen	₹/yr	1685500	
23	Total Savings	₹/yr	6076100	
24	Initial Investment	₹	20000000	
25	Simple Payback period	Years	3.2	

Life Cycle Cost: The estimated Lifecycle Cost for the proposed 280 kW rice husk based Co generation system is analysis for the parboiled rice mill and presented below.

Table 4.2: Life Cycle Cost of Rice Husk Based Co generation System

S.No	Particulars	Units	Value
1	Boiler Capacity	TPH	4
2	Steam Pressure	kg/cm^2	32
3	Steam Temperature	^oC	350
4	Process Steam Pressure	kg/cm^2	3.5
5	Operating Hours	Hours/day	24
6	No of Days	days/year	350
7	Power output from turbine	kW	280
8	Capital Cost	₹	20000000
9	Cost for Replacing of boiler tubes , turbine Auxiliary etc each 5 Years	₹	500000
10	Annual maintenance cost for annum	₹	500000
11	Life of COGEN system	Years	30
12	Interest rate	%	12
13	LCC at the end of life	₹	24783989

Implementation Cost: The implementation cost of the Co Generation system in parboiled rice mills estimated and presented below.

Table 4.3: Implementation Cost of Rice Husk Based Co generation System

S.No	Details	Rice Husk Based Co generation System Co Generation System In ₹ Lakhs		
	Capacity of System	**1 MW**	**0.360 MW**	**0.280 MW**
1	Plant and Machinery	350	200	135
2	Civil Works	50	35	25
3	Electrical works	50	25	15
4	Erection and Commissioning	40	30	15
5	Miscellaneous costs	10	10	10
6	**Total Cost**	**500**	**300**	**200**

4.1.1.6 Benefits and Limitations: The Rice Husk based co generation system in parboiled rice mills will have the following benefits.

- Power generation with using available steam
- Improving the efficiency of the boiler

- Reduction in fuel consumption
- Environment free
- Pay back period is 3.2 years

Limitations:

The adoption of rice husk based co-generation technology is high capital investment and requires technical issues related to grid synchronization, technological constraints and fluctuating steam synchronization, technological constraints and fluctuating steam demand. A well designed system can tackle all such hurdles. The cost involved in engineering will get paid back as COGEN yields good returns apart from undisturbed power supply.

Subsidy from Govt of India:

The Ministry of New and Renewable Energy (MNRE), Govt.of India, provides the subsidy towards the installation of Biomass based Co generation (Non Bagasse Project). The subsidy component is ₹20.00 lakhs/MW up to max of 5MW for Non Bagasse Projects.

4.1.2 Installation of Solar Hot Water System for Boiler feed water/Soaking of Paddy:

Parboiled rice mills require steam for heat the boiler feed water, drying and soaking of paddy. The steam consumption for heating feed water and hot water required for soaking can be reduced / eliminated by installing solar hot water system. A solar water system can heat the water up to 70-75 ^{o}C.

4.1.2.1 Background:

In order to reduce the steam consumption to heat for boiler feed water and water for soaking, one of the energy savings proposal is solar hot water systems. The energy from solar can be used to heat the water at required temperature to feed water and soaking process.

4.1. 2.2 Recommendations:

The proposed solar hot water system can be implement in the rice mill cluster where the sufficient area and climatic conditions in that area. The proposed system brings the environment is free, less maintenance cost, and high investment cost involved.

4.1.2.3 Energy Conservation Potential:

Solar hot water system technology used in the parboiled rice mills to reduce the steam consumption for to heat up the water required for different process. The solar hot water system generates the required hot water for paddy soaking and other process requirement without the conventional energy consumption. By installing the solar hot water system in parboiled rice mill saves 72kg/hr rice husk in a mill.

4.1.2.4 Technical Specifications and Availability:

The Technical Specifications of the proposed solar hot water system for the parboiled rice mills is presented below.

Capacity of Solar Hot Water System	: 50 KLD
Type of Solar Hot Water System	: Concentric/Tube type
Feed Water Temperature to Solar System	: 30 °C
Specific heat of water	: 4.18 kJ/ kg °C
Final Temperature of water from System	: 70-75 °C

4.1.2.5 Life Cycle Analysis:

The life cycle analysis for the implementation of solar hot water system is tabulated and presented below.

Cost Benefit Analysis: The cost benefit analysis of the Solar Hot Water System is calculated based on expected savings achieved by installing the proposed Solar Water System with existing boiler hot water system for the same process and operating parameters of the mill.

Table 4.4: Cost Benefit Analysis of Solar hot water system

S.No	Parameter	Unit	Using steam	Solar Hot Water System
1	Boiler Capacity	kg/hr	4000	4000
2	Hot Water Requirement	ltrs/h	4800	6400
3	Hot Water Temperature	°C	80	70
4	Cost of Equipment	₹		5000000
5	No of days operation (assumption)	days/yr	280	280
6	Working hours per days	Hours/day	12	9
7	Fuel Consumption (Rice Husk@ 3600 kcal/kg)	kg/h	72	
8	Cost of Fuel	₹/kg	1.8	
9	Fuel Cost	₹/hr	130	
10	Fuel Cost	₹/day	1555	
11	Net Saving Potential	₹/year	435456	
12	MNRE Subsidy	₹	2000000	
13	Initial Investment	₹	3000000	
14	Simple Payback period	Years	6.9	

Life Cycle Cost: The analysis of estimated Lifecycle Cost for the proposed Solar Hot water System with 50KLPD for the parboiled rice mill was presented below.

Table 4.5: Life Cycle Cost of Solar hot water system

S.No	Particulars	Units	Value
1	Solar hot water Capacity (SHW)	KLD	50
2	No of hours	Hours/day	9
3	No of Days	days/yr	280
4	Capital Cost	₹	3000000
5	Component replacement each 10 years.	₹	200000
6	Annual maintenance cost for annum	₹	50000
7	Life of SHW system	Years	30
8	Interest rate	%	12
9	LCC at the end of life	₹	3501824

Implementation Cost: The implementation cost of the proposed solar water system in parboiled rice mills is presented below.

Table 4.6: Implementation Cost of Solar hot water system

S. No	Details	Solar Hot Water system in ₹ Lakhs		
	Capacity of System	**20 KLD**	**30 KLD**	**50 KLD**
1	Plant and Machinery	20	25	30
2	Civil Works	5	5	5
3	Electrical works	5	5	5
4	Erection and Commissioning	2.5	3	5
5	Miscellaneous costs	2.5	3	5
6	**Total Cost**	**35**	**41**	**50**

4.1.2.6 Benefits and Limitations:

The benefits for implementation of the solar hot water system are mainly reducing the rice husk consumption in boiler. The proposed installation of this system will save the fuel consumption in the boiler. By dismantling the primitive way of heating and adoption of this technology will bring a net saving potential of ₹. 4.35 per annum, and investment is ₹ 30.00 lakhs and payback period is 7 years.

Subsidy from Govt of India:

The Ministry of New and Renewable Energy (MNRE), Govt.of India, provides the subsidy towards the installation of Solar Water heating System. The subsidy component is ₹1100 per Square meter of solar collector area.

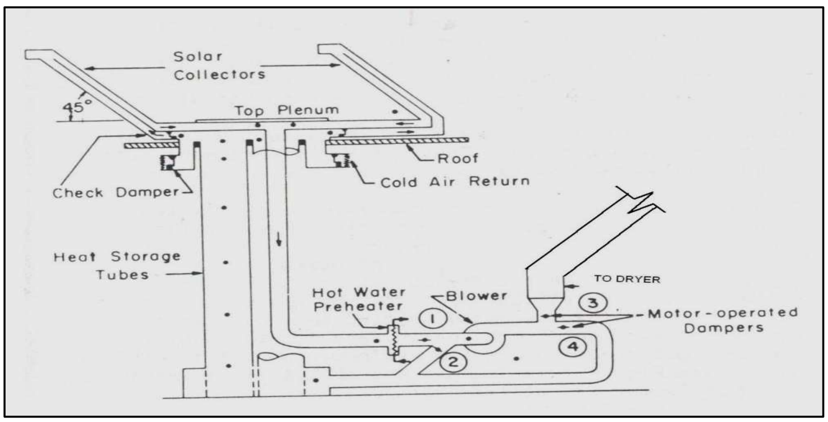
4.1.3 Installation of Solar Air –Water Dryers for paddy drying:

In parboiled rice mill, the steam is required for drying the soaked paddy and also for heat the water. The quantity of steam required for this purposes depends upon the paddy and quality of steam.

4.1.3.1 Background:

It was observed during the detailed study that the best drying conditions for 1 Tone of paddy is required 650m^3 /min of hot air at 60^0C. The amount of steam required for heat the air is 350-450 kg. In drying process, the steam is used to attain desired air temperature. So, this technology of solar air -water heat exchanger system (**Fig 4.2**) will simultaneously heat the air as well as boiler feed water at idle time. The solar energy is utilized for hot water heating by an air-water heat exchanger system serving as a pre heater.

Fig 4.2: Solar air-water heat exchanger



4.1.3.2 Recommendation

The proposed solar air-hot water system can be implement in the rice mill cluster where the sufficient area and climatic conditions in that area. The proposed system brings the environment is pollution free, less maintenance cost, and high investment cost involved.

4.1.3.3 Energy Conservation Potential:

The solar Air Water Drying system is useful in parboiled rice mills where hot water and air required for soaking and drying i.e. removing the moisture level of the paddy. In parboiled rice mills the amount of steam required for heat the air is 350-450 kgs. Steam is generated by using the conventional energy in boiler. In typical parboiled rice mills, the quantity of steam required for this operation of dryer is 350-450 kgs and the rice husk required to generate the steam is 140 kg/hr. By implementing/installing the solar Air-Water system in parboiled rice mills can meet the requirement of the hot water for different process.

4.1.3.4 Technical Specification and Availability:

The Technical Specifications of the proposed solar Air-Water Drying system for the parboiled rice mills is presented below.

Solar Hot Air-Water System Capacity	: 48400 m^3/hr
Density of Air	: 1.067 kg/m^3
Sp. Heat of air	: 1.005 kJ/kg ^oC
Hot air Temperature from Solar Air-Water Dryer	: 60 ^oC
Air Inlet Temperature to the System	: 25-30 ^oC

4.1.3.5 Life Cycle Analysis:

The life cycle and cost benefit analysis is discussed in below along with the implementation of the Technologies also discussed

Table 4.7: Cost Benefit Analysis of Solar Air – Water Dryer system

S. No	Parameter	Unit	Drying	
			Steam	Solar
1	Hot Air Requirement	kg/h	38732	51643
2	Hot Air Temperature	^oC	60	60
3	Cost of Equipment	₹		7500000
4	No of days operation (assumption)	days/yr	280	280
5	Working hours	Hours/day	12	9
6	Fuel Consumption (Rice Husk@ 3600 kcal/kg)	kg/h	140	
7	Cost of Fuel	₹/kg	1.8	
8	Net Saving Potential	₹/year	844819	
9	MNRE Subsidy	₹	2000000	
10	Initial Investment	₹	5500000	
11	Simple Payback period	years	6.5	

Life Cycle Cost: The analysis of estimated Lifecycle Cost for proposed Solar Air- dryers 51643 kg/hr system for the parboiled rice mill is presented below:

Table 4.8: Life Cycle Cost of Solar Air – Water Dryer system

S.No	Particulars	Units	Value
1	Solar drying Capacity	kg/hr	51643
3	No of hours	Hours/day	9
4	No of days	days/year	280
5	Capital Cost	₹	3000000
6	Component replacement each 10 years.	₹	200000

S.No	Particulars	Units	Value
7	Annual maintenance cost for annum	₹	5000
8	Life of SHW system	Years	30
9	Interest rate	%	12
10	LCC at the end of life	₹	3106090

Implementation Cost: The implementation cost of the proposed Solar Air- dryers with 51643kg/hr in parboiled rice mills is presented below.

Table 4.9: Implementation Cost of Solar Air – Water Dryer system

S.No	Details	Solar Air- dryers (₹ Lakhs)		
	Air Flow Capacity m3/hr	**25821**	**38732**	**51643**
1	Plant and Machinery	45	55	65
2	Civil Works	5.0	5.0	5.0
3	Electrical works	5.0	5.0	5.0
4	Erection and Commissioning	5.0	5.0	5.0
5	Miscellaneous costs	5.0	5.0	5.0
6	**Total Cost**	**65**	**75**	**85**

4.1.3.6 Benefits and Limitations:

The proposed system makes economic sense to think beyond the initial purchase price & consider life time energy cost. Solar Air- Water heating system is a long term investment that saves money and energy for many years, the technology minimizes the environmental effects and provides insurance against energy price increase, helps reduce our dependence on conventional form of energy. The pay back period is 6.5 years.

Subsidy from Govt:

The Ministry of New and Renewable Energy (MNRE), Govt. of India, provides the subsidy towards the installation of Solar Water heating System. The subsidy component is ₹ 1100 per Square meter of solar collector area.

4.1.4 Installation of Waste Heat Recovery from Flue Gas:

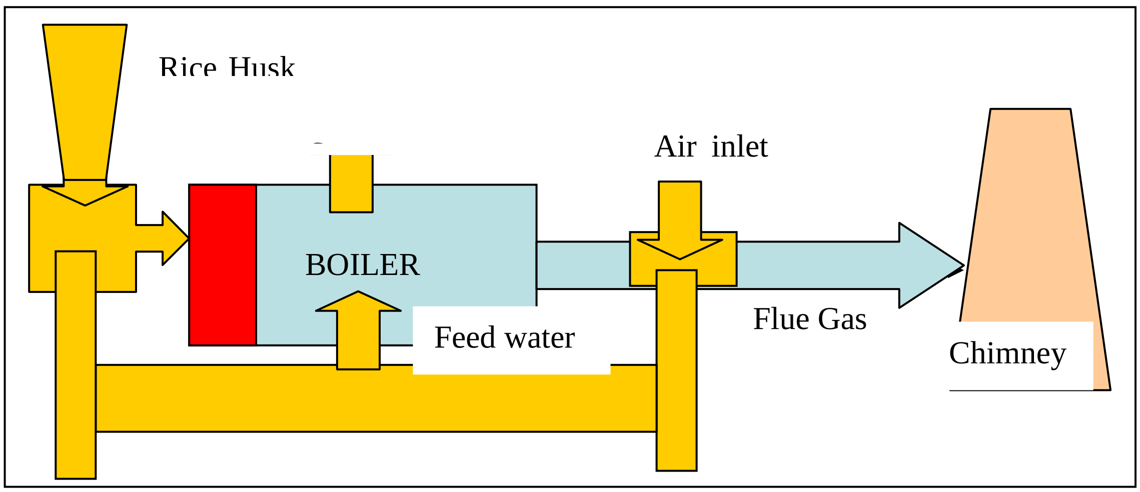
All parboiled rice mills are using boilers for generating the steam. The flue gas generated during the combustion process is sent through the chimney. The flue gas contains the heat content which is considerable to recover by adopting the proper heat recovery system.

4.1.4.1 Background:

All parboiled rice mills in Warangal Cluster not installed any waste heat recovery system from the flue gas. It was observed that the flue gas from the boiler out let was leaving at temperature of 160 °C - 180 °C. This temperature can be recovered by installing the waste heat recovery system/air pre heater.

The sensible heat of the flue gases can be recovered to an extent. Complete recovery of waste heat is neither theoretically possible nor economically viable and hence only optimum quantity of the heat is recovered during this process. **Fig 4.3** illustrates the waste heat recovery system.

Fig 4.3: Boiler with Pre Heating combustion Air



4.1.4.2 Recommendation:

The waste heat recovery system can be installed to all parboiled rice mills irrespective of capacities. Proper design and implementation of the WHR system in the parboiled rice mills improve the overall plant efficiency and reduction in flue consumption and environment.

4.1.4.3 Energy Conservation Potential:

Based on the energy audit it was found that there is considerable energy savings possible by adopting the waste heat recovery system to the boiler. The flue gas temperature from combustion chamber having around 120-170°C temperature which is sending as a waste with out recovering the heat.

4.1.4.4 Technical Specifications and Availability:

The Technical Specifications of the proposed Waste heat recovery System for the parboiled rice mills was presented below.

Capacity of proposed Waste Heat recovery System : 6700 m^3/hr

Density of Flue gas from boiler : 1.19 kg/m^3

Sp. Heat of Flue gas : 0.04 kcal/kg ^oC

Flue gas Temp at inlet and outlet of WHR : 170 ^oC and 120 ^oC

4.1.4.5 Life Cycle Analysis:

The life cycle and cost benefit analysis is discussed in below along with the implementation of the Technologies also discussed.**Cost Benefit Analysis:** The cost benefit analysis of the Air Pre Heater system (WHR) is calculated based on expected savings achieved by installing the proposed WHR in existing flue gas path in mill.

Table 4. 10: Cost Benefit Analysis of Air Pre heater

S. No	Particulars	Unit	Existing System	With Air Pre heater
1	Flue gas flow rate of the :Vf	m^3/hr	6677	6677
2	Combustion air flow rate :Va	m^3/hr	5719	5719
3	Inlet Combustion air temperature :Ti	^oC	35	80
4	Outlet Flue gas Temperature :To	^oC	170	120
5	Heat Load :Q	kcal/hr	220512	57879
6	Overall Heat transfer coefficient	kcal/m^2 hr^oC	38	
7	Logarithmic Mean Temperature Diff	^oC	87.5	
8	Heat transfer area of Air Pre heater	m^2	17	
9	No of days operation (assumption)	Days/year	280	
10	Working hours	Hours/day	12	
11	Fuel Savings	kg/day	16	
12	Fuel Savings	kg/year	54020	
13	Net Saving Potential	₹/year	97237	
14	Cost of air Pre heater	₹	200000	
15	Pay back Period	year	2	

Life Cycle Cost: The analysis of estimated Lifecycle Cost for the proposed Air Pre heater system for the parboiled rice mill was presented below:

Table 4. 11: Life Cycle Cost of Air Pre heater

S.No	Particulars	Units	Value
1	Capacity of Flue gas flow	m^3/hr	6677
2	Air Pre-heater heat transfer rate	kcal/hr	57879
3	No of hours operation	Hours/day	12
4	No of days	Days/year	280
5	Capital Cost	₹	200000
6	Component replacement each 5 years.	₹	50000
7	Annual maintenance cost for annum	₹	25000
8	Life of Air Pre-heater	Years	30
9	Interest rate	%	12
10	LCC at the end of life	₹	470092

Implementation Cost: The implementation cost of the proposed Air Pre heater system in parboiled rice mills is presented below.

Table 4. 12: Implementation Cost of Air Pre heater

S.No	Details	WHR System cost in ₹ Lakhs		
	Boiler Capacity	**3 TPH**	**4TPH**	**6TPH**
1	Plant and Machinery	1.5	2	2.5
2	Civil Works	-	-	-
3	Electrical works	-	-	-
4	Erection and Commissioning	0.5	0.5	0.5
5	Miscellaneous costs	0.5	0.5	0.5
6	Total Cost	2.5	3.0	3.5

4.1.4.6 Benefits and Limitations:

The heat loss through flue gases can be recovered by the installation of the waste e heat recovery system. This recovered heat is utilized for heating of combustion air/increasing the feed water temperature.

Subsidy from Govt of India:

The Development commissioner , Ministry of Small and Medium Enterprises ,Govt of India providing a subsidy for implementation of Energy Efficient technologies in under a scheme of National Manufacturing Competitiveness Program (NMCP) Under XI Plan. The subsidy component will be 25% of project cost and up to ₹10.00 laks per project.

4.1.5 Replacing the existing inefficient boiler with Energy Efficient Boilers:

The following methods can be adopted for existing boilers to increase the boiler efficiency and decrease fuel consumption.

- Reduction in excess air and flue gas temperature
- Reduction in un burnt flue gas by increase in excess air
- Blow down heat recovery by raising the feed water temperature
- Replacing the boiler with energy efficient boiler

4.1.5.1 Background:

Based on detailed studies carried out in Rice Mill cluster, Warangal , some of the boilers were found to be inefficient due to inferior design like single pass system, high flue gas losses, and high radiation losses. The efficiencies are found to be around 40-65%. The low efficiency is due to low loading, inferior design, old boilers, structural and scale losses etc.

4.1.5.2 Recommendations

All inefficient existing boilers having 65% of boiler efficiency in parboiled rice mills are suggested to implement the energy efficient boilers to attain the maximum energy savings.

4.1.5.3 Energy Conservation Potential:

Boilers are one of the areas to concentrate for energy conservation. Lower Energy efficiency boiler leads the higher fuel consumption and also the quality of the steam. By improving or replacing with Low energy Efficiency Boilers with High Energy efficient boiler result the lesser fuel consumption and their by reduction in heat loss. In Rice Milling Sector, especially in par boiled rice mill where low energy efficient boilers existing have great scope for energy conservation by installing the new energy efficiency boiler. By replacing the energy efficient boiler typical parboiled rice mill with capacity of 4TPH will save conservation potential 215 kg/hr fuel i.e. rice husk.

4.1.5.4 Technical Specifications and Availability:

The Technical Specifications of the proposed Co generation system for the parboiled rice mills was presented below.

Boiler Capacity	: 4TPH
Over all Efficiency of Boiler	: 80 %
Boiler Steam Pressure and temperature out put	: 10.5 kg/cm^2
Boiler Steam temperature out put	: 110 ^oC

4.1.5.5 Life Cycle Analysis:

The life cycle and cost benefit analysis is discussed in below along with the implementation of the Technologies also discussed

Cost Benefit Analysis: The cost benefit analysis of the Energy Efficient Boiler is calculated based on expected savings achieved by installing the proposed Energy Efficient Boiler with existing in efficient boiler for the same process and operating parameters of the mill.

Table 4.13: Cost Benefit Analysis of Energy Efficient Boiler:

S.No	Parameter	Unit	Existing Boiler	EE Boiler
1	Boiler Capacity	TPH	4	4
2	Mass Flow rate of steam (ms)	kg/h	4000	4000
3	Feed water temperature (T1)	^{0}C	60	80
4	Enthalpy of feed water(h2)	kcal/kg	60	80
5	Process steam pressure (P)	kg/cm^2	10.5	10.5
6	Inlet steam temperature (T2)	^{0}C	110	110
7	Steam Enthalpy at steam turbine inlet(h1)	kcal/kg	643.9	643.9
8	Mass Flow rate of fuel (mf)	kg/h	998	783.2
9	Boiler efficiency (η_{b})		0.68	0.8
10	Cost of Equipment	₹		5000000
11	No of days operation (assumption)	Days/year	280	280
12	Working hours	Hours/day	12	12
13	Rice Husk Consumption (@ 3600 kcal/kg)	kg/h	998	783.2
14	Extra Fuel Consumption for inefficiency boiler	kg/h	215	
15	Cost of Fuel	₹/kg	1.8	
16	Net Saving Potential	₹/year	1299148	
17	Initial Investment	₹	5000000	
18	Simple Payback period	years	4	

Life Cycle Cost: The analysis of estimated Lifecycle Cost for the proposed Energy Efficient Boiler for the parboiled rice mill was presented below.

Table 4.14: Life Cycle Cost of Energy Efficient Boiler:

S.No	Particulars	Units	Value
1	Boiler Capacity	TPH	4
2	Steam Pressure	kg/cm^2	10.5
3	Steam Temperature	^{o}C	110
4	No of hours operation	hours/day	12
5	No of days	days/year	280

S.No	Particulars	Units	Value
6	Capital Cost	₹	3500000
7	Cost for Replacing of boiler tubes etc each 5 Years	₹	250000
8	Maintenance cost	₹ /Year	400000
9	Life of boiler system	Years	30
10	Interest rate	%	12
11	LCC at the end of life	₹	7142009

Implementation Cost: The implementation cost of the Energy Efficient Boiler in parboiled rice mills is presented below.

Table 4.15: Implementation Cost of Energy Efficient Boiler:

S.No	Details	Energy Efficient Boilers in ₹Lakhs		
	Boiler Capacity	**3 TPH**	**4TPH**	**6TPH**
1	Plant and Machinery	30	40	50
2	Civil Works	1.0	1.0	1.0
3	Electrical works	0.5	0.5	0.5
4	Erection and Commissioning	0.5	0.5	0.5
5	Miscellaneous costs	0.5	0.5	0.5
6	Total Cost	32.5	42.5	52.5

4.1.5.6Benifits and Limitations:

Benefits: The benefits of the installing the Energy Efficient Boiler is to attain the maximum overall efficiency of the boiler there decrease in fuel consumption.

Subsidy from Govt of India:

The Development commissioner , Ministry of Small and Medium Enterprises ,Govt of India providing a subsidy for implementation of Energy Efficient technologies in under a scheme of National Manufacturing Competitiveness Program (NMCP) Under XI Plan. The subsidy component will be 25% of project cost and up to ₹10.00 laks per project.

4.1.6 Replacing the existing inefficient Motors with Energy Efficient Motors (EFF1):

The efficiency of a motor is determined by intrinsic losses which can be reduced only by change in motor design. Intrinsic losses are of two types: fixed losses- independent of motor load, and variable losses - dependent on load.

Fixed losses consist of magnetic core losses and friction and windage losses. Magnetic core losses (sometimes called iron losses) consist of eddy current and hysteresis losses in the stator. They vary with the core material and geometry and with input voltage.

Friction and windage losses are caused by friction in the bearings of the motor and aerodynamic losses associated with the ventilation fan and other rotating parts.

Variable losses consist of resistance losses in the stator and in the rotor and miscellaneous stray losses. The Resistance to current flow in the stator and rotor result in heat generation that is proportional to the resistance of the material and the square of the current (I^2R). Stray losses arise from a variety of sources and are difficult to either measure directly or to calculate, but are generally proportional to the square of the rotor current.

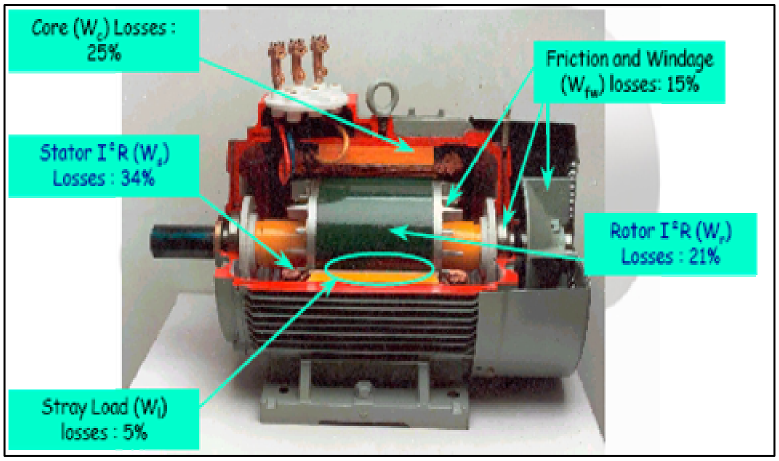
Table 4.16: Various loss in Motors

S.No	Parameter	Unit	Value
1	Motor Loss Core (Wc)Losses	%	25
2	Friction and windage (W_{fn}) losses	%	15
3	Stator I^2R losses	%	34
4	Rotor I^2R losses(Wr)	%	21
5	Stator load (W_L) losses	%	5

4.1.6.1 Background:

During the energy audit, rice mills in the cluster were observed, using motors which had been rewound many times in the past. Some of them are reported to be rewound more than 5 times. It was suggested to replace the existing motors which were already rewound more than 3 times, with EFF1 labeled motors to reduce electrical consumption and losses significantly while in operation. The energy loss due to each rewinding is about 3-5% and could vary depending on the quality of work. **Table 4.17** illustrates the energy savings in motors**. Fig 4.4** illustrates the parts of motor and the losses.

Fig 4.4: Typical motor losses



4.1.6.2 Recommendations:

All re winded motors more than 2 to 3 times and under loaded motors can be replace with EE motors (EFF1) for energy savings. The application of these motors found in all the rice processing industries including the par boiled rice mills.

4.1.6.3 Life Cycle Analysis:

Cost Benefit Analysis: The cost benefit analysis of EE motors (EFF1) is calculated based on expected savings achieved by installing the EE motors (EFF1) with existing inefficient and under loaded motors in both the rice mills.

Table 4.17: Cost benefit analysis for Energy Efficient Motors

S.No	Parameter	Unit	Whitener Motor (EFF1)	Cone Motor(EFF1)
1	Present installed capacity	kW	45	18.5
2	Present power consumption	kW	30.6	14.6
3	Motor load factor		0.6	0.65
4	Estimated efficiency at present operating Conditions	%	87.76	82.36
5	Proposed capacity of New Motor	kW	45	18.5
6	Proposed efficiency of energy efficiency motor	%	93.9	92.2
7	Expected Power Consumption of New Motor	kW	28.6	13.0
8	Reduction power consumption	kW	2.0	1.6
9	No of days operation (assumption)	days/year	280	280
10	Working hours	Hours/day	12	12.0
11	Energy Charges	₹/kWh	3.3	3.3
12	Estimated savings potential	kWh/year	6717.9	5233.9
13	Estimated cost savings	₹/year	22168.9	17271.8
14	Initial Investment	₹	100000	42000
15	Payback Period	Years	5	2

4.1.6.4 Benefits and Limitations:

An "energy efficient" motor (EFF1) produces the same shaft output power (HP), but uses less input power (kW) than a standard-efficiency motor

Subsidy from Govt of India:

The Development commissioner , Ministry of Small and Medium Enterprises ,Govt of India providing a subsidy for implementation of Energy Efficient technologies in under a scheme of National Manufacturing Competitiveness Program (NMCP) Under XI Plan. The subsidy component will be 25% of project cost and up to ₹10.00 laks per project.

4.1.7 Power Factor improvement by Installing Capacitors:

Andhra Pradesh electricity board provides the incentives for good power factor (PF >0.95) and penalty if the PF is less than 0.9. In case power factor is maintained at unity, incentives of 2.5% on energy demand charges are provided. Most of the units have scope for improving this incentive percentage from 0.5% to 1.5%. Power factor can be improved by the installation of capacitors and replacement of the de-rated existing capacitors. **Table 4.16** illustrates the CBA of improving the PF.

Cost Benefit Analysis: The cost benefit analysis of the implementation of Capacitors in rice milling units is calculated for the same process and operating parameters of the mill.

Table 4.18: Cost Benefit Analysis of improving PF

S.No	Parameter	Unit	Value
1	Total Connected load	kW	140
2	Measure Power Factor	$P.F_1$	0.9
3	Desired Power Factor	$P.F_2$	1
4	KVAR Required	KVAR	Load kW* [tan (Cos-1(PF1)) – tan (Cos-1(PF2)]
5	Required KVAR	KVAR	67.76
6	Annual Saving	₹	2,39,000
7	Approximate Investment	₹	50000
8	Pay back Period	Months	3

4.2 Other Identified Energy Conservation Proposals:

The other identified energy conservation proposals in Warangal Rice Milling Cluster are discussed below.

4.2.1 Variable Frequency Drives

The variable frequency drives are used to drive the equipments according to speed by varying the frequency supply. The following advantages can be achieved by implementing the Variable frequency drives in both rice mills.

- Reduction in energy consumption in motors and pumps. This is possible according to the to the load conditions
- Attain 95% efficiency during the full load conditions
- Maintain good PF
- Motors and equipments when overloaded gets protected and also power quality will maintain
- Protection over over and under voltage, over temperature and other faults are protected by the VFD
- Reduction in maintenance cost due to frequent failures

- Maximize Power Distribution System
- Eliminates Mechanical Shock and Stress on Power Trains (couplings, belts, drive shafts, gear boxes, etc.)

4.2.2 Steam traps and its monitoring system

One of the energy saving proposal in parboiled rice mills is to implement the steam straps and steam monitoring system. The main advantage of the steam straps is the steam from the steam straps is used in the boiler feed water .

- Reduces steam wastages and consumption
- Improves condensate recovery by steam traps
- Faster heat supply
- Reduces water and water treatment chemicals
- Reduces fuel consumption and there by GHG emissions

4.2.3 Automatic Blow down Control System

The impurities found in boiler water due to untreated feed water to the boiler. This causes to form a scaling in boiler tubes which is hazardous in nature. This can be avoided by blowing down process. In this certain portion of water is blow off from the boiler and immediately replace with feed water. The replaced water is during the blow down will maintain the TDS in boiler water.

Excess blow down causes the energy loss. To avoid the excess blow down it is necessary to operate by installing the automatic blow down.

Warangal Rice milling Units, the monetary savings have been estimated for each proposal and the details are furnished in **Table 4.19** gives the techno-economics of the technologies.

Table 4.19: Summary of Energy savings proposals and the savings

Sr. No	Energy Conservation Measures	Capacity	Energy Saving Potential/Unit			Implementation Cost (Lakhs)	Expected No. of units to be adopted	Total Energy Saving Potential			Simple Payback Period (Years)
			Electricity kWh/Yr	Rise husk Tones/yr	TOE / Year			Electricity kWh/Yr	Rise husk Tones/yr	TOE/ Year	
1	Rice Husk Based co-generation system	0.280 MW	2352000	-	202	200.00	7	16464000	0	1414	3.4
2	Rice Husk Based co-generation system	0.360 MW	3024000	-	260	300	5	15120000	0	1298	3.8
3	Rice Husk Based co-generation system	1.00 MW	8400000	-	721	550	3	25200000	0	2164	2.5
4	Energy Efficient Motor for Whitener (EEF1)	45kW	336000	-	29	1.50	20	6720000	0	580	5
5	Energy Efficient Motor for Cone (EEF1)	18.5kW	268800	-	23	1.00	50	13440000	0	1150	2
6	Water Heat Recovery From Flue Gas by Air Pre heater	3TPH	0	54	66	2.5	35	0	1890	2310	2
7	Water Heat Recovery From Flue Gas by Air Pre heater	4	0	72	88	3.5	25	0	1800	2200	2.5

Sr. No	Energy Conservation Measures	Capacity	Energy Saving Potential/Unit			Implementation Cost (Lakhs)	Expected No. of units to be adopted	Total Energy Saving Potential			Simple Payback Period (Years)
			Electricity kWh/Yr	Rise husk Tones/yr	TOE / Year			Electricity kWh/Yr	Rise husk Tones/yr	TOE/ Year	
8	Water Heat Recovery From Flue Gas by Air Pre heater	5	0	90	110	4.25	20	0	1800	2200	4.25
9	Energy Efficient Boiler	3	0	540	195	35	15	0	8100	2925	4.5
10	Energy Efficient Boiler	4	0	722	259	42.5	10	0	7220	2590	3.8
11	Energy Efficient Boiler	6	0	1083	390	60	10	0	10830	3900	3.4
12	Solar hot water system	20 KLD	0	242	87	35	15	0	3630	1305	8.7
13	Solar hot water system	40	0	484	174	65	10	0	4840	1740	8.1
14	Solar drying system	40000m3/ hr	0	470	169	75	15	0	7050	2535	9.3
15	Solar drying system	50000 m3/hr	0	580	210	90	10	0	5800	2100	9
	Total		**14380800**	**4337**	**2983**	**1465.25**	**250**	**76944000**	**52960**	**30411**	

4.3 Issues/barrier for implementation of proposals

The following are the major barriers identified for implementation of the energy savings proposals in the cluster units. They are:

- One of major barrier is lack of awareness and information among cluster owners on the energy losses, EE technologies and energy efficiency. However a few demonstration projects may motivate to take up the projects in cluster.
- About 40 to 60% of the cluster unit owners doesn't have financial strength for implementation of high cost technologies like waste neat recovery systems, Co-generation system, etc. Moreover, the owners are interested to implement low cost measures having quick payback periods of less than 2 years.
- Though, local service providers are available in the cluster, the LSP's don't have technical strengths for supply of efficient equipments.
- Production loss during implementation of the energy saving proposals

Table no:4. 20 Barriers for Energy Saving Proposals

Sr. No	Energy saving proposal	Identified Barriers
1	Rice Husk based Co-generation system	• Initial investment is high • high payback period
2	Waste Heat recovery from flue gases-Air Pre heater	• Lack of Technology source • High initial investment
3	Solar hot water system	• High initial investment • High payback period and low returns • Auxiliary system is required Intermittently
4	Solar air dryers	• High initial investment • High payback period and low returns
5	Energy efficient boilers	• High initial investment • low returns and payback period over 4/5 years
6	Energy Efficient Motors	• No knowledge of EE motors • High returns • Pay back period is high
7	Variable frequency drives	• No Local Service Provider to supply • Financially not attractive for SME owners due to subsidized electricity cost and low operational hours • Operation and maintenance problems
8	Automatic blow down control system	• No Local Service Provider to supply • Operation and maintenance problems

4.4 Availability of Technology/Product in Local /National / International Market

For majority of the technologies and proposals identified, the equipments suppliers/dealers/branch offices are available locally in Warangal. The high investment technologies like solar systems, Co-generation system and energy efficient products like boilers, motors are to be procured from other places in the country. Among the technologies/equipments identified for implementation for Warangal rice milling cluster units, some of the measures can be implemented by the local service providers and the balance equipments can be procured at nearest city i.e., Vijaywada or Hyderabad. The detail of equipment which can be implemented by LSPs and those needs to be procured from other cities is furnished below in **Table 4.21**

Table 4.21: Details of technology/equipments available for various with in India Warangal

Equipment Details	LSPs	India
Co-generation system	Not Available	Available
Heat exchanger	Available	Available
Energy Efficient Boiler	Available	Available
Variable frequency drive	Not Available	Available
Solar hot water system	Available	Available
Solar drying system	Available	Available
Automatic blow down control system	Available	Available

4.5 Availability of Local Service Providers for Implementation of above -mentioned Proposals:

The details of availability of local service providers for implementation of energy saving proposals identified are furnished below:

Table 4.22: Details of LSP's available for implementation of Energy savings Proposals in Warangal and India

Equipment Details	LSPs	India
Co-generation system	Not available	Available
Heat exchanger	Available	Available
Energy Efficient Boiler	Available	Available
Variable frequency drive	Not Available	Available
Energy efficient motors	Available	Available
Automatic blow down control system	Available	Available
Solar hot water system	Available	Available
Solar drying system	Not Available	Available

4.6 Identification of Technologies / Equipments for DPR Preparation

The Justification for technologies/equipments identified for DPR preparation (e.g. potential, reliability, etc. in the cluster) is based on the detailed studies carried out and considerable potential in all cluster units for energy conservation and efficiency.

As the process and equipments are more or less similar in all cluster units, all the technologies/equipments identified can be replicated as per the requirement and detailed project reports for the specific technologies prepared also can be replicated for different units as per the capacity requirement. The following technologies/equipments were considered for preparation of detailed project report:

Table 4.23: List of Proposed Technologies for preparation of Detailed Project Report:

S. No	Proposed Technology/ equipment	Proposed capacity	No. of DPR's
1	Rice Husk Based Co-generation system	280 kW	1
2	Rice Husk Based Co generation system	360 kW	1
3	Rice Husk Based Co generation system	1000 kW	1
4	Waste heat recovery system (Air Pre heater)	3TPH	1
5	Waste heat recovery system (Air Pre heater)	4TPH	1
6	Waste heat recovery system (Air Pre heater)	5TPH	1
7	Solar drying system	25821	1
8	Solar drying system	38732	1
9	Solar hot water system	20KLD	1
10	Solar hot water system	50KLD	1
11	Energy Efficient Boiler	3TPH	1
12	Energy Efficient Boiler	4TPH	1
13	Energy Efficient Boiler	6TPH	1
14	Energy Efficient Motors	45kW	1
15	Energy Efficient Motors	18.5kW	1
	Total		**15**

4.7 Awareness on Energy Savings and Technologies in Warangal Cluster

The level of awareness on energy efficiency is poor in the cluster. Out of 110 units surveyed, only 10 industry owners have knowledge on energy efficiency and EE products. The other unit owner doesn't have awareness on either on energy efficiency or EE products. Though, the owners have interest on EE, due to non availability of LSP's or equipment suppliers. Though the clusters units are in operation since last 5 decades, no single program on energy efficiency either from the local bodies or central government had been implemented in the cluster. The cluster unit owners could not implement the EE technologies, as the units are more concerned for uninterrupted production and low investment options.

CHAPTER V
SMALL GROUP ACTIVITIES / TOTAL ENERGY MANAGEMENT

5.1 Systematic Approach for Energy Conservation by TEM/SGA

5.1.1 Introduction:

Energy is one of the most important resources to sustain our lives. At present we still depend a lot on fossil fuels and other kinds of non-renewable energy. The extensive use of renewable energy including solar energy needs more time for technology development.

In this situation Energy Conservation (EC) is the critical needs in any countries in the world. Of special importance of Energy Conservation are the following two aspects:

1. Economic factors
2. Environmental impacts

5.1.1.1 Economic factors of Energy Conservation: Energy saving is important and effective at all levels of human organizations – in the whole world, as a nation, as companies or individuals. Energy Conservation reduces the energy costs and improves the profitability.

Notably, the wave of energy conservation had struck the Indian intelligentia 3 years earlier when a Fuel Policy Committee was set up by the Government of India in 1970, which finally bore fruits three decades hence in the form of enactment of the much awaited Energy Conservation Act, 2001 by the Government of India. This Act made provisions for setting up of the Bureau of Energy Efficiency, a body corporate incorporated under the Act, for supervising and monitoring the efforts on energy conservation in India.

Brief History of energy efficiency movement in India and associated major milestones are as follows

- 1974: setting up of fuel efficiency team by IOC, NPC and DGTD (focus still on industry)
- 1975: setting up of PCAG (NPC main support provider) : focus expanded to include agriculture, domestic and transport
- 1978: Energy Policy Report of GOI: for the first time, EE as an integral part of national energy policy – provided detailed investigation into options for promoting EE
- Post 1980, several organizations started working in EC area on specific programs (conduct of audits, training, promotion, awareness creation, demonstration projects, films, booklets, awareness campaigns, consultant/product directories)
- Some line Ministries and organizations like BICP, BIS, NPC, PCRA, REC, Ministry of Agriculture, TERI, IGIDR, CSIR, PETS (NPTI)

- State energy development agencies
- Industry associations
- All India financial institutions

The Government of India set up Bureau of Energy Efficiency (BEE) on 1st March 2002 under the provisions of the Energy Conservation Act, 2001. The mission of the Bureau of Energy Efficiency is to assist in developing policies and strategies with a thrust on self-regulation and market principles, within the overall framework of the Energy Conservation Act, 2001 with the primary objective of reducing energy intensity of the Indian economy. This will be achieved with active participation of all stakeholders, resulting in accelerated and sustained adoption of energy efficiency in all sectors

Private companies are also sensitive to energy costs, which directly affects their profitability and even their viability in many cases. Especially factories in the industrial sectors are of much concern, because reduced costs by Energy Conservation mean the more competitive product prices in the world markets and that is good for the national trade balance, too.

5.1.1.2 Environmental impacts of Energy Conservation: Energy Conservation is closely related also to the environmental issues. The problem of global warming or climate change is caused by emission of carbon dioxide and other Green House Gases (GHG). Energy Conservation, especially saving use of fossil fuels, shall be the first among the various countermeasures of the problem, with due considerations of the aforementioned economic factors.

5.2 Total Energy Management (TEM)

Every point in factories has potential for Energy Conservation. Total Energy Management is implemented, by all the people's participation, step by step utilizing "Key Step Approach" in a systematic manner, as shown below:

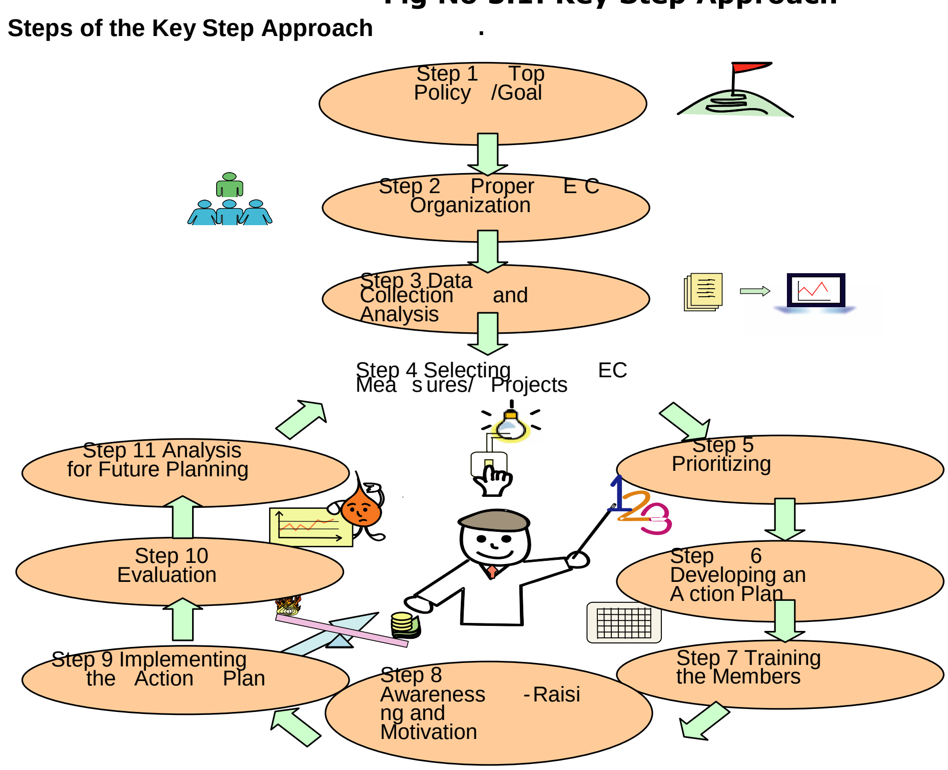
1. Top management policy/Goal
   - Develop a policy statement
   - Set targets
2. Proper EC Organization including Assignment of Energy Manager
   - Establish proper EC organization (utilizing SGA)
   - Assignment of Energy Manager
3. Data collection and Analysis
   - Collect data on current energy use
   - Analyze the collected data
   - Identify management strength and weakness

- Analyze stakeholders' needs
- Anticipate barriers to implement
- Estimate the future trend

4. Selecting EC Measures/Projects
   - Selecting EC Measures
   - Selecting EC Projects
   - Make out a plan/program
5. Prioritizing
6. Developing an Action Plan
7. Training the related members
8. Awareness-raising and Motivation
9. Implementing the Action Plan (including monitoring and controlling)
10. Evaluation (Management review)
11. Analysis for future planning (Standardization and Dissemination)

The following figure shows these Key Steps for implementing Energy Conservation activities.

Fig No 5.1: Key Step Approach



Each step is explained in this order as below:

Step 1: Top Management policy/Goal

It is the most important for the success of Energy Conservation activities within companies or factories to have clear and official commitment of top management – either the corporate top (senior) management or factory managers. The top (senior) management shall announce explicit commitment to the Energy Management (or Energy Conservation) and behave along this line – for example, participate in EC (Energy Conservation) events and encourage the people there for EC promotion.

This Handbook is primarily meant for Energy Managers for the use of EC promotion within factories, on the assumption that top management has already committed to that. However, there may be cases where top management would learn about Energy Management (or Energy Conservation) by this Handbook, or Energy Managers would make efforts to persuade top management to support or commit to Energy Management (or Energy Conservation) with the help of this Handbook.

1. **Develop a policy statement**

   It is desired that the top (senior) management announces the "Energy Policy Statement". This is very effective to let people inside and outside the company clearly knows the management's commitment to Energy Management (or Energy Conservation). The format of the energy policy statement is various, but it usually includes the goal or objective of the company and the more concrete targets in the field of Energy Management (or Energy Conservation). It often shows the major measures and timetables. The statement shall match the company's mission statement or overall management strategy plan.

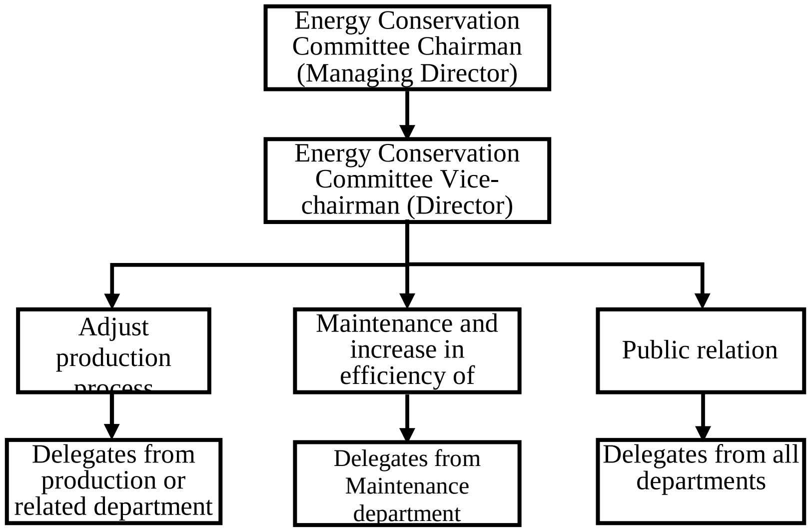
2. **Set targets**

   The targets shall be concrete and specific so that everyone can understand it.

Step 2 : Proper EC Organization including Assignment of Energy Manager

In some countries, where the EC Promotion Act is in force, the designated factories have obligation of assigning Energy Managers. In relation to Energy Management, however, the word "Energy Managers" is here used as a Manager or a Coordinator, separate from the above-said legal obligation, who works exclusively for Energy Management (or Energy Conservation) purposes, ranging from gathering energy-related information to drafting EC plans/programs and promoting or coordinating during implementation. To the proper Energy Management, this type of Energy Manager is indispensable. How to position this Energy Manager within the company organization is also an important issue and needs careful decision. In some cases, Energy Committee, with members from the major departments, may be formed to assure the company-wide or factory-wide cooperation, as shown in the following figure.

Fig No. 5.2: Example of energy conservation committee's Organization



Actually there are many ways of forming EC organization, depending on the situation of factories or institutions, such as the size, kind of business, etc. In any case, it is very effective to utilize SGA (Small Group Activities) and there are also many ways to do that. The important thing is to design and make out the organization carefully to meet the purpose. In practical sense to do that, there may be the following five widely applicable ways of establishing the organization.

1. Utilize Line (Formal) Job-related Organization for TEM purpose
2. Use TPM Organization for TEM purpose
3. Use TQM Organization for TEM purpose
4. Add Employee Suggestion System to Energy Conservation Organization for TEM purpose
5. Utilize another organization for TEM purpose

The easy and practical way may be starting from easy form of TQM, or QCC (Quality Control Circle) activities.

Furthermore, because TPM is closely related to job-related organization, (1) and (2) may be often give the same kind of results. (An example of this form is shown in Part 3, 2 "How is SGA related to Energy Conservation?" (page 21).

Step 3 : Data collection and Analysis

Before trying to make out any future programs or action plans, it is essential for the company or factory management to understand the current situation in a proper and accurate manner. This includes not only the status of their own operation but also other relevant information such as competitors' operation, circumstances around the company and their trend in future, positioning the company itself in the local and global markets, and so on.

The key steps for this purpose are shown below:

1. Collect data on current energy use and analyze them

The current data of energy consumption shall be obtained by measurement, calculation or estimation for the individual operation units (energy cost centers) with classification of kinds of energy (fuels types, utility types, etc.). The data shall be gathered regularly and arranged/summarized daily, weekly, monthly, by seasons or annually. Then the data shall be checked for the past historical trend and interpreted with relation to operational modes and production scales. That shall also be utilized for the forecast of future trends.

2. Identify Management Strength and Weakness

Then the data shall be compared with the best practice data or benchmarks in the industry. If such reference data are hardly available, the historical data of their own operation and estimated data for the competitors would be utilized for this purpose. At the same time, the strength and the weakness of the company shall be evaluated considering the competitors' situations in the local and global markets. This would serve the purpose of making out a realistic Energy Management plan later.

3. Analyze stakeholders' needs

Stakeholders are top (and senior) management, middle managers, staff/engineers and workers/operators. Other stakeholders in the normal business sense, such as the shareholders and lenders, need not be considered here for the moment. The needs and intention of those stakeholders shall be summarized and taken into consideration.

4. Anticipate barriers to implement

Making out a realistic and practical program also needs consideration of anticipated barriers for the implementation of Energy Management program or action plan. Some possible examples of such barriers are:

- Insufficient understanding and support by top management
- Insufficient understanding and cooperation of managers within factories
- Insufficient awareness of people to get successful results
- Insufficient capability of people due to lack of training
- Insufficient available technology due to lack of information
- Insufficient availability of manpower for EC activities within factories
- Insufficient budget for EC activities due to the company's financial status

5. Estimate the future trend

The future trend of energy supply-demand balance is estimated based on checking and analysis of the historical data. That data of future trend would also be a basis of the program of excellent Energy Management.

In analyzing the collected data and developing ideas of Energy Conservation, it is very often useful to think of the following techniques of finding problems and solutions:

Suppress	- Using during the time in which it is not necessary to use. Examples include using electricity before or after working hours or when there is no one working.
Stop	- Using equipment when it is not necessary. Examples include using all lightings during break time.
Reduce	- Amount, pressure, temperature, speed, or brightness, or quality that exceed requirement. Examples include reducing intensity of lighting if not necessary.
Prevent	- Prevent leakage or loss of energy. Examples include reducing space that leads to outside in order to prevent the leakage of heat into air.
Improve	- Improve or repair machines to increase efficiency or modify manufacturing process to the one which enables us to conserve energy more. Examples include changing transparent sheet over the roof.
Store	- Re-use the discarded energy. Examples include re-using heat from exhaust fume in order to reduce use of electric heater to warm heavy oil.
Change	- Change how to use, type of energy, or energy sources to a suitable one from technical or economic point of view. Examples include changing the grade of heavy oil to an appropriate one or changing furnace systems or welding machines to the ones that use gas.

Increase production - Examples include improving production process. This will lead to the reduction of energy usage per production amount.

Step 4 : Selecting EC Measures/Projects

Based on the aforesaid understanding of the current status and position of the company (factory), various EC measures are studied and many EC Projects are proposed. Comparison among these measures and projects are made with consideration of a lot of factors, such as technical, economic, intangible, and so on.

Then a plan/program is developed based on these study results. To do this, it is very important to consider the following issues:

The plan/program shall be realistic, practical and attainable with due consideration of many related elements and management resources of the company or factory. It also shall be expressed in terms of the measurable or quantifiable parameters, including Fuel Usage Index, Electricity Usage Index, Energy Usage Index, etc. It usually includes a lot of managerial measures of Energy Management (or Energy Conservation) promotion activities such as motivation techniques, means to improve awareness, training, and so on. In other words, the following items are often useful in comparing and selecting alternative plans:

1. Effects of energy conservation: Activities that can conserve energy more than others are more promising.

2. Investment amount: Activities that require less investment are more promising.
3. Pay-back period: Activities with short pay-back period for investment amount in equipment are more promising because all energy conservation will be profits after pay-back period.
4. Length of implementation: Activities that can be performed in a short period are more promising because they do not influence production process of the factory.
5. Number of personnel required: Activities that require a large number of personnel tend to be burdensome.
6. Importance to executives and reputation of the company: Some activities provide little financial benefit but cause good image or reputation.
7. Risk of the project: Some activities bring about big financial benefits but involve high risk from various factors. In this case projects have less importance.

Step 5 : Prioritizing

Many EC measures and projects are prioritized based on the internal studies including comparison among their alternatives, in the manner explained in the above.

Step 6 : Developing an Action Plan

The priority consideration then gives birth to the Action Plan. The plan shall be clear, practical and comprehensive with proper schedule and budgeting.

Shown below is an example of such a plan.

Table No 5.1: Example of energy saving plan

S. No	Detail of the plan	Length (Months)						Person in charge	Budget	Inspected by
		1	2	3	4	5	6			
1	Turn off electricity when there is no one around	◄	─	─	─	─	►	Mr.Prayat		
2	Turn off air-conditioner 30 minutes before stop working	◄	─	─	─	─	►	Miss Aom		
3	Reduce welding machine's current according to the specification of the metal used for welding	◄	─	─	─	─	►	Mr. Matthayas		
4	Close welding machine after working	◄	─	─	─	─	►	Miss Thanom		

Step 7 : Training the related members

This issue is very important to secure the success of project Implementation, because the people are the most important resources that determine the success of the plan.

Step 8: Awareness-raising and Motivation

To have the total power of "all members' participation" combined together, it is also very crucial how to raise awareness and motivation of related people within the company (or factory). Shown below is an example of awareness raising plan.

Table No 5.2: Example of awareness raising campaign

S.No	Detail of the plan	Length (Months)						Person in charge	Budget	Inspected by
		1	2	3	4	5	6			
1	Display the results of energy conservation every month	*	*	*	*	*	*	Mr.Prayat	-	Mr. Laaied
2	Evaluate every month	*	*	*	*	*		Miss Aom	-	Mr. Laaied
3	Perform energy conservation activity every 6 months	*					*	Mr. Matthayas	-	Mr. Laaied
4	Perform "Finding measures" activity in order to make energy conservation plan	*					*	Miss Thanom	-	Mr. Laaied
5	Provide rewards to sections that have achieved high efficiency						*		-	

Step 9: Implementing the Action Plan (including monitoring and controlling)

The organizational force established in the said planning step shall be utilized fully to ensure smooth implementation of the program. Energy Manager and/or the committee shall continue working to promote the activities and report to top management on the status quo.

The actual records of implementation shall be closely watched and monitored.

If some problems arise, or some variance between the planned figures and the actual record is observed, then necessary actions shall be taken immediately.

Step 10: Evaluation (Management Review)

After the program is completed, the report shall be submitted to the top (senior) management. The results shall be assessed and analyzed for any good and bad points. The lesson shall be utilized as a feedback in the subsequent plan/program.

Thus the activities are repeated to form a cyclic movement.

The result of evaluation must be announced on the board in order to inform employees, so that they will be given motivation for the next activities. Evaluation can be divided into 2 types as follows.

- Short-term evaluation for the follow-up of the performance

- Long-term evaluation for the evaluation of the whole project that will be used for the future planning

Evaluation can be made in the following 3 levels.

1. Self Audit: Self evaluation that is made in a small group or a department based on the predefined form. (Inspection may be made every month.)
2. Upper Manager Audit: Evaluation that is made by the section/department manager intended to raise performance of the activity. (Inspection may be made every 3 month.)
3. Top Management Audit: Evaluation made by the executives of the organization that will be used for the evaluation of annual bonus. (Inspection may be made every 6 month.)

In some cases, top management could think of adopting external people (outside consultants) to evaluate the results of Energy Conservation activities. Even in those cases, internal evaluation should be made to gain the fruits as much as possible.

Step 11: Analysis for future planning (Standardization and Dissemination)

The successful results and the lessons learned are to be analyzed and arranged into the standard form which can be easily utilized by anyone in the factory. The standardized documents or information are to be disseminated all over the company.

Moreover, Energy Conservation should be incorporated as a part of daily jobs and performed continuously in a systematic manner. For this purpose, activities for energy conservation must be incorporated as a part of company's basic or business plan. If a problem is found as a result of evaluation, improvement or modification will be done and the objectives will be achieved. If the results reach or exceed the objective, information must be gathered in order to set it as a "Work Standard," which will be used in setting a new activity plan.

5.3 Small Group Activities (SGA)

Small Group Activity (SGA) gives employees the problem solving tools they need to eliminate obstacles to Total Productivity, the cumination of zero break-downs, zero defects, and zero waste. Enterprising employees identify the problem, be it in "man, material, method, or machine," and develop cost-effective and practical methods for solving the problem.

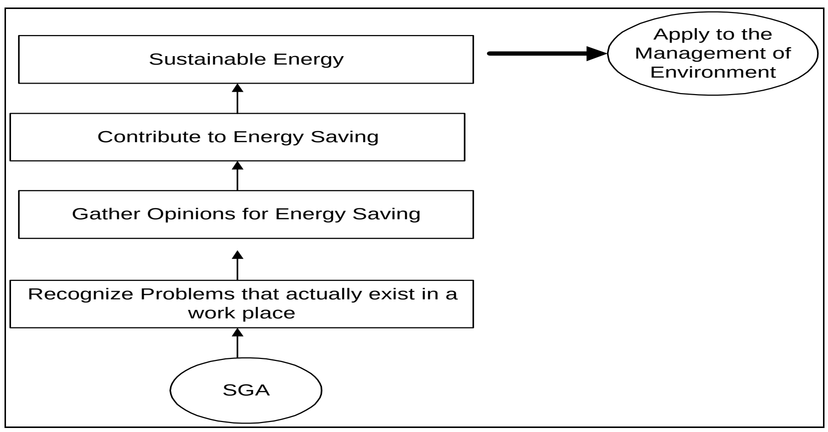
5.3.1 Importance of SGA:

SGA are activities by group of employees at operator (working Group) level. They aim to solve problems that occur at the place taken care of by each employee and put emphasis on participation and team work. Factories can apply small group activities to many kinds of work along with normal work or other measures that are already underway. The burden on employees will not increase because of small group activities. They are not only bringing benefits to factories but also boosting the knowledge and ability in performing jobs of employees, improving communication among employees, increasing creativity, and make it possible to express their own proposal with less hesitation to management. As a result, employees will start to think "This is our problem." This SGA can be applied to Energy Conservation, too, with successful results, as shown in Figure 13.

5.3.2 How SGA leads to Energy Conservation? :

An excellent example of organizational structure that promotes energy management emphasizing participation is that they form overlapping small groups as in figure 14. The feature of this structure is that a small group for energy management is distributed to various sections as in figure 15, which is a recipe for success of Total Energy Management (TEM) and makes various communications and management of activities more efficient and effective.

Fig.No 5.3 Relationship of SGA and Energy savings



Small group activities for total energy management (TEM) are the activities in which employees of all levels in production or management, starting from the top to the bottom, participate in order to reduce loss related to their own job by improving their job. In order for the activities to succeed, management of all levels must provide support in necessary training and equipment, communication of policies, and the setting of problems to solve.

Small group activities for TEM can be divided into 4 or 5 levels depending on the scale of the organization. This division is in order to emphasize the fact that everyone must improve in their job under the responsibility to each other. It also enables us to make improvement without overlapping. The following example shows utilizing the existing job-related organization as much as possible.

Fig. No 5.4 Example of Organizational Structure with Overlapping

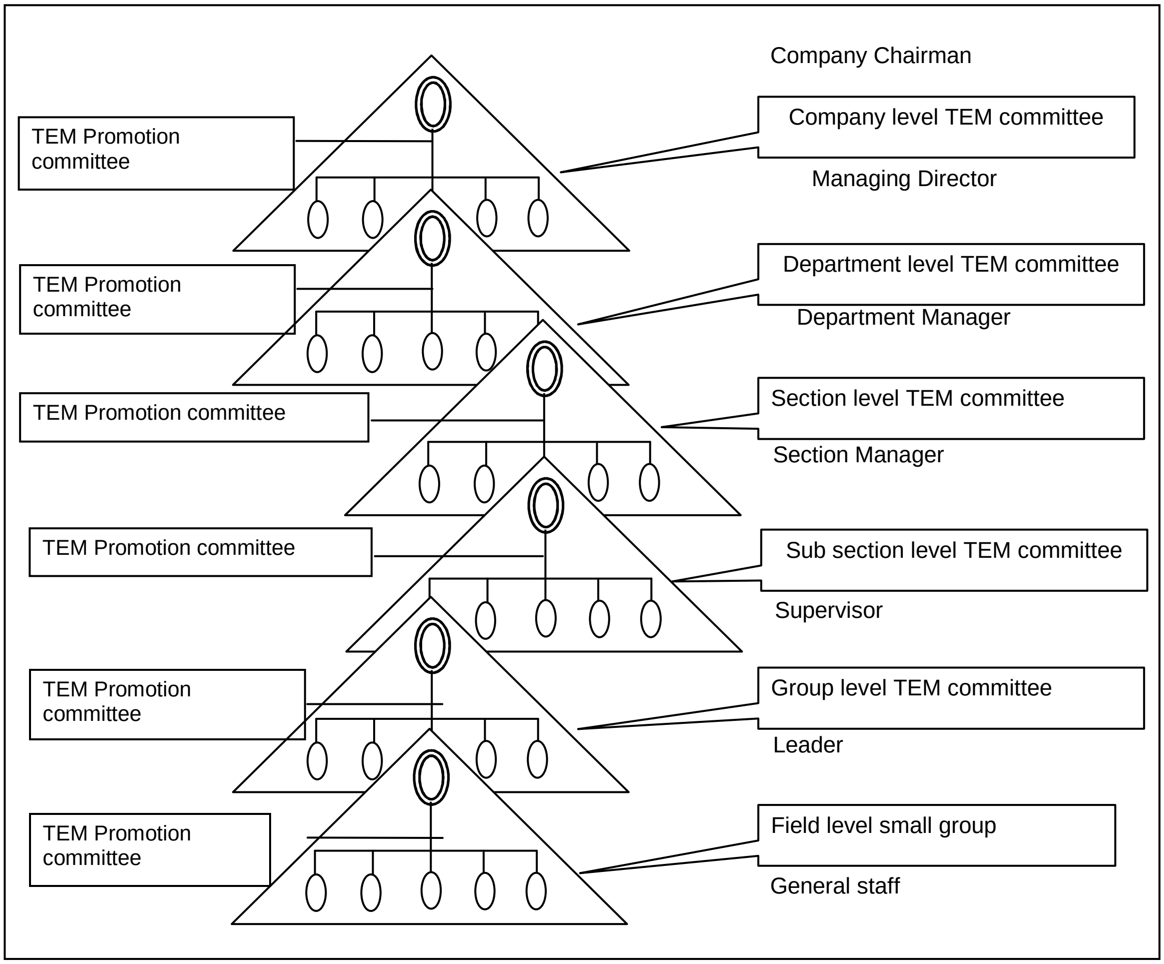
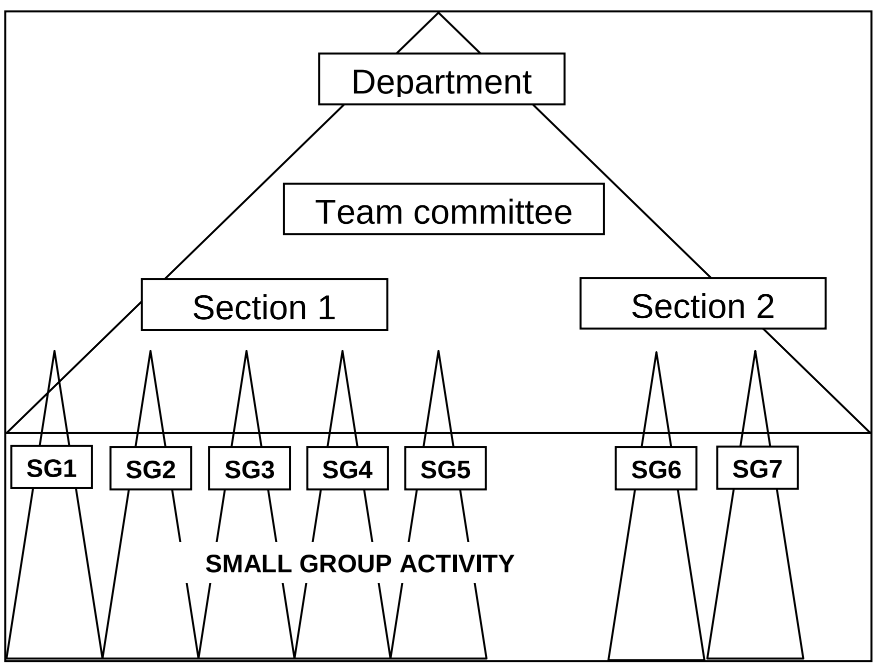


Fig.No 5.5 Positioning of SGA in Main Job Structure



5.3.2.1 Executives level

- Define the policy and target for Total Energy Management
- Follow-up and manage activities to make sure that activities are implemented according to the policy
- Consider opinions and suggestions from the promotion office
- Consider reports from promotion committee from various levels

5.3.2.2 Level of Total Energy Management promotion office

- Make sure that whole activities are done in the correct direction, without delay and smoothly
- Find a suitable method that makes it possible to implement activities continuously and without slowdown
- Listen to opinions and suggestions from small groups in order to use for improving
- Provide advice for Total Energy Management to various groups
- Persons in charge of the office must be those with good personal relationship, friendly, and with spirit of good service

5.3.2.3 Medium level

- Define the policies of each department that are consistent with the policy of the Total Energy Management and the target of the company
- Define numerical targets to sub-groups apart from the target of the company as a whole
- Follow-up the progress in order to provide to sub-groups
- Report the progress along with suggestions and opinions to upper level committee periodically

5.3.2.4 Workers/Operators level

- Implement small group activities with various themes and achieve target
- Report progress and problems encountered during implementation to upper level committee periodically
- Ask for support, suggestions, and opinions from upper level committee

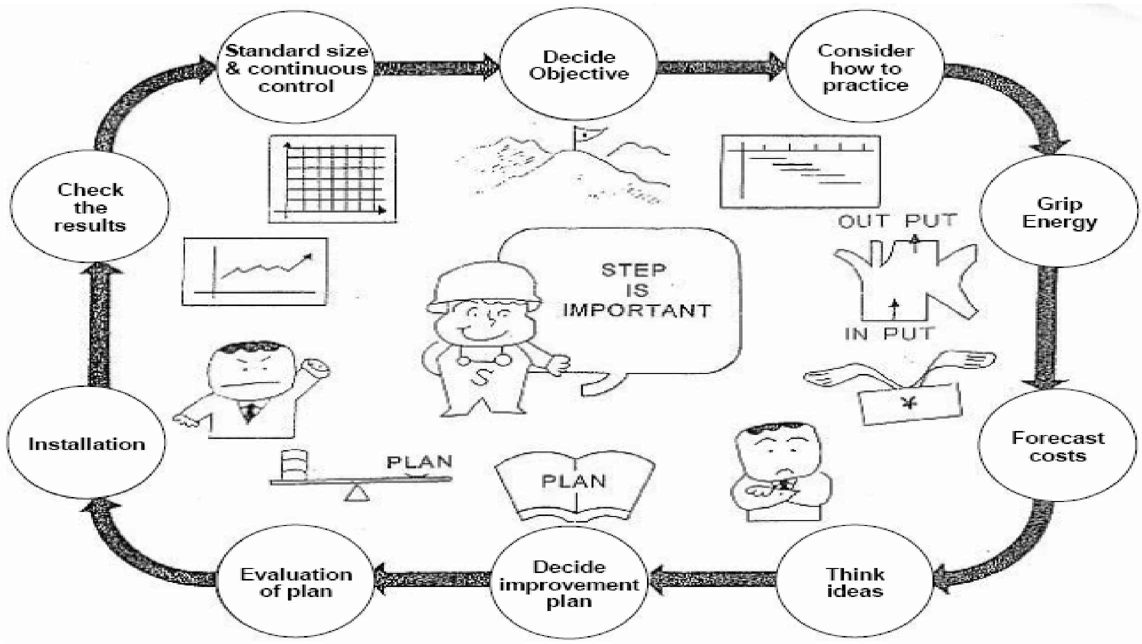
5.3.2.5 Responsibility of Energy Conservation committee

- Gather and analyze information on costs related to energy every month
- Analyze and solve problems related to energy
- Find a method for energy conservation
- Prepare energy conservation plan
- Follow-up the result of implementing the plan
- Perform activities such as public relationship for encouraging employees to participate
- Offer training to small group in each department

5.4Steps of Small Group Activities for Energy Conservation

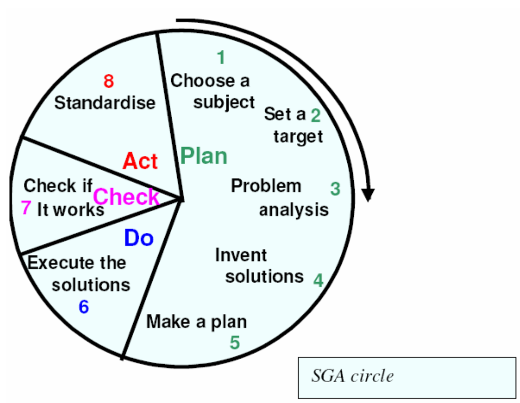
Small group activities for Energy Conservation can be done by using "10 Stages for Success", based on "PDCA Management Cycle", as shown below and in pictorial forms

Fig.No:5.6 PDCA Management Cycle



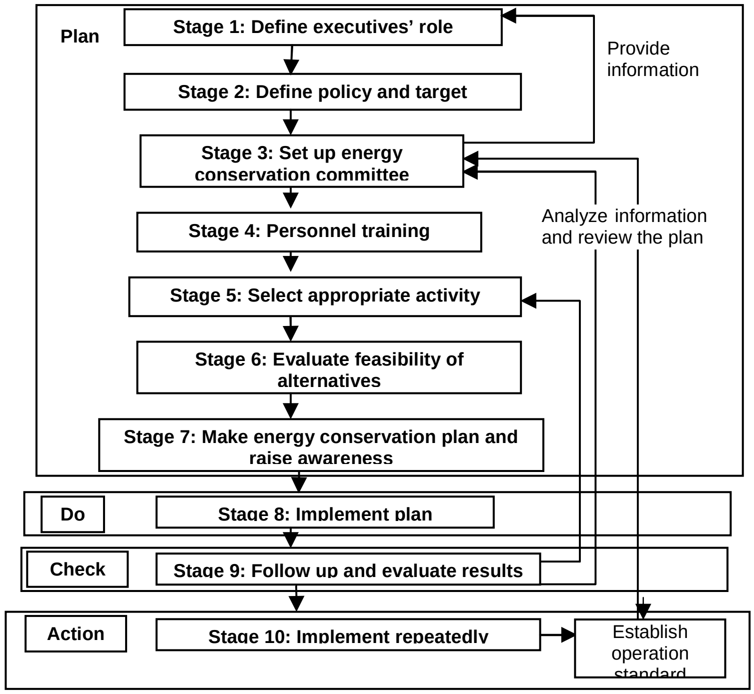
- Plan: Make an efficient plan in order to improve operation
- Do: Implement according to the plan
- Check: Check if implementation was according to the plan
- Act: Judge what to improve, what to learn and what to do from what we have checked

Fig No: 5.7 SGA Circle



Please note that these stages are substantially the same as "Key Steps" explained earlier, but put more stress on utilization of SGA. So readers could read and use either method up to their preference.

o:5.8 10 Stages for Success



5.4.2 Stage 1: Define Executive's Role:

In promoting small group activities, support must be provided such as basic environmental support. Therefore, executives must provide follow up support to employees of their companies.

- Establish a special unit that provides support to small group activities
- Prepare a system for managing small group activities in the company
- Prepare annual plan for small group activities
- Prepare a venue for meeting, consultation, advice or suggestion
- Establish a system for giving rewards to high achieving employees
- Establish a reporting system starting from informing what to do until reporting of the results
- Establish a fair system for evaluating results
- Establish a system for providing support and training to employees

5.3.2 Stage 2: Define Policy and Target

- Executives must announce a policy of supporting small group activities.
- Energy conservation committee must act as an advisor in order to set a numerical target that is consistent with total energy management (TEM) policy and the target of the organization. Specific targets must be set for each group.

We can see that responsibilities in stages 1 and 2 are mainly those of executives and committee. Responsibility of employees will become clearer from stage 3 and afterwards.

5.3.3 Stage 3: Set up Energy Conservation Committee: The principle of small group activities (SGA) is to divide into groups based on the scope of responsibility. The size of the group will depend on the size of organization. However, size of the group should not be too large. Usually a size of 5 to 10 persons is considered appropriate. It is important to define responsibilities clearly so that every member of the group can have their responsibility and participate in the activities.

5.3.4 Stage 4: Personnel Training: This stage will help employees to have more knowledge and understanding, have new ideas, and have more belief in their own responsibility.

5.3.5 Stage 5: Select Appropriate Activity: In doing small group activities, each member must be able to think, express their own ideas, and make decisions based on reality and by investigating electrical equipment, machines, and office equipment that exist in the area of their responsibility. Items to consider include size, number, where to use, situation of usage, current situation, and the number of hours usage per day. By this we can evaluate the current situation of energy usage. Also by judging if there are more machines than needed, we can choose suitable activities and real problems for the organization.

5.3.6 Stage 6: Evaluate feasibility of alternatives (Analyze problems and decide on the measures and activities in each point): Each group will gather ideas on the reasons for the problems, obstacles, and how to solve problems in order to decide on the problems, measures, and importance of activities and thus evaluate on the feasibility of activities to do based on advice from department manager. Basically, the following activities are not suitable for small group activities.

- Highly technical issues
- Issues that require a long time or many people to implement

We have identified the following problems through small group activities.

- Issues on material quality or production that influence energy usage
- Behavior on energy usage
- Efficiency of machines or equipment that uses energy
- Awareness toward environment and energy usage
- Safety costs for energy conservation

5.3.7 Stage 7: Make Energy Conservation Plan and Raise Awareness: Each group must prepare its activity plan. Generally, implementation for small group activities takes 6 months to 1 year. Activities to be implemented should correspond to the objectives of each group. Besides, it might help to listen to opinions of all organizations in order to receive support from all other organizations.

5.3.8 Stage 8: Implement Plan: Implement according to the plan of each group.

5.3.9 Stage 9: Follow Up and Evaluate Results: After implementing the plan, each member of small groups will follow up and evaluate the result by analyzing result, search for strong and weak points of activities, find a way to improve the activities and report on general achievement.

5.3.10Stage 10: Implement Repeatedly: Energy conservation is an activity that must be implemented repeatedly. Therefore, it is necessary to implement each activity repeated and make improvement to each activity. If we are satisfied with the results, by achieving the objectives of activities, we should provide rewards in order to give motivation for continuing the small group activities and implement creative activities.

Dos and Don’ts in Energy Conservation

- ✓ Don’t Emphasize the mistakes in the past. It is better to talk about the present.
- ✓ Don’t be worried about the theory or principles. Don’t spend too much time in discussion or analysis of problems in meeting rooms.
- ✓ Don’t Think that an activity can be done perfectly from the beginning. It is necessary to do the job continuously by having experiences and judging by ourselves.
- ✓ Do Start with an activity that requires small amount of investment.
- ✓ Do Raise awareness so that all employees understand the necessity and importance of energy conservation and participate in it.
- ✓ Do Start the activity now without postponing to tomorrow.

5.5Tools that are Used Often for Small Group Activities for Energy Conservation

5.5.1 5S: 5S is a contraction derived from the Japanese words **Seiri, Seito, Seiso, Seiketsu,** and **Shitsuke**. It is simple methodology that is also extremely useful in practical and realistic life. 5S is a set of actions to be followed through every day activities to advance the operational surroundings and circumstances. 5S is made in order to provide fortification to every personage in diverse profitable and industrialized fields. 5S is an extremely practical contrivance and skill set for anyone who wants to generate a more prolific environment within the workplace or who wants to make it their profession to make other people's businesses more proficient and productive. 5S occupy a list of products including eyewear, ear protectors and safety gears. Look into these different products that make up the significance of an industrialized security supply. Lean Six Sigma experts promise or guarantee for the efficiency of 5S as an enlightening enhancement to better working surroundings in an association. If you dig up Six Sigma guidance that is paid for by your company, you will be in a position to work for your company and make things better for you as well as for everyone. 5S is very useful in lots of industries and job markets, but can often fail simply because of the lack of recognition concerning changes in the office.

Fig No:5.9 Five S's

5S consists of five steps that are crucial for the completion of 5S. The 5S steps are described as follows-

1. Seiri / Sort- This is very logical term in, which identification of the contents take place, data base of the products have been created and, then any kind of sorting take place just to arrange the products and removal of unwanted items. Classification of the products is necessary, which is called Red Tagging. It is important just to identify factors, right from whether it is needed, existing amount obligatory amount, occurrence of necessity, and so on.

2. Seito / Systemize- This step in 5S process consists of removal of unwanted items permanently and one more task that to be take place is decision that means you have to decide that what is required to be in what place. Place the items in such manner that you could retrieve them within 30 seconds of requirement.

3. Seiso / Brush away/ Sweep- Examine al the items on the daily basis. The process is not that much time consuming, but essential to clean up your workplace and most required in 5S. The conscientiousness to keep the office clean should be circulated between everyone in the group.

4. Seiketsu / Homogenize- This important step of 5S involves the visual control, which is important to keep your organization well- organized and clean. It is a complete evaluation to improve the working conditions.

5. Shitsuke / Self Control- This step is quite essential, but critical because it involves all the discipline to ensure the 5S standards, it also takes charge of dedication and commitment.

5.5.2 QCC (Quality control circle): QCC (Quality control circle) means controlling quality through group activities. For this, it is necessary to work hand in hand and achieve objective quality or customers' request. With this, we can find weak points, find the cause of problems, gather ideas for problem solving and systematically prepare quality and thus, solve problems such as material loss, production costs, working hours, or productivity. This is also a very useful tool to tackle with Energy Conservation problem. So many factories or institutions are encouraged to utilize this tool.

Annexure 1: Technical Calculations

1. Calculations for Steam Turbine Cogeneration System:

Step 1: Calculate the actual heat extraction by the turbine at each stage

Steam Enthalpy at turbine inlet : h1 kcal / kg

Steam Enthalpy at 1st extraction : h2 kcal / kg

Heat extraction from inlet : h1 – h2 kcal / kg

Step 2: Calculate the Efficiency of Turbine, ηt

Efficiency of the turbo alternator $=\eta_{ta}$

Efficiency of Alternator $=\eta_{a}$

Efficiency of gear transmission $=\eta_{gt}$

$$\text{Efficiency of Turbine} = \frac{\text{Power generation efficiency of turbo alternator}}{\text{Efficiency of gear transmission} * \text{Efficiency of Alternator}}$$

Step 3: Calculate plant heat rate

Mass flow rate of steam =m kg/hr

Enthalpy of inlet steam = hs kcal/kg

Enthalpy of feed water = hw kcal/kg

Average Power generated =P kW

$$\text{Overall plant heat rate, kcal/kWh} = \frac{m\,(hs - hw)}{P}$$

Parameter	Unit	Value
Boiler Capacity	TPH	4
Mass Flow rate of steam (m)	kg/h	4000
Enthalpy of feed water(h)	kcal/kg	80
Inlet steam pressure (P1)	kg/cm2	32
Inlet steam temperature (T1)	0 C	350
Steam Enthalpy at steam turbine inlet(h1)	kcal/kg	744
Process steam Pressure (P2)	kg/cm2	3.5
Steam Enthalpy at 1st extraction turbine inlet(h2)	kcal/kg	656
Theoretical heat extraction from turbine inlet to 1st extraction(h1-h2)	kcal/kg	88
Average Power generated (P)	kW	280
Power generation efficiency of the turbo alternator =(Energy output/Energy input)		0.68
Efficiency of the turbo alternator(ηta)		0.68
Efficiency of alternator(η_a)		0.92
Parameter	**Unit**	**Value**
Efficiency of gear transmission(η_{gt})		0.98

Efficiency of turbine = $\eta ta * \eta_{a*}\eta_g$		0.76
Overall plant heat rate =m(hs-hw)/P	kcal/kWh	8853
Heat value of rice husk	kcal/kg	3600
Boiler efficiency ($\eta_{b)}$		0.7
Mass of Fuel comsuption(mf)	kg/h	1054
Power Output during normal operation (En)	kW	280
Power generated per day (E)	Units	6720

2. Solar Air-Water System

Hot water system:

Mass flow rate of water : m, kg/h

Inlet temperature of water : Ti, °C

Temperature of hot water : To,°C

Specific heat of water : Cp, kcal/kg

Total Heat energy in solar hot water system : m * Cp*(To- Ti)

Hot Air system:

Volume Mass flow rate of air : V, $m^{3/}$ hr

Density of hot air : ρ, kg/ m^3

Inlet temperature of air : Tai ,°C

Temperature of hot air : Tao ,°C

Specific heat of air : Ca, kcal/kg

Total Heat energy in solar hot air system : V * ρ* Ca*(Tao- Tai)

3. Waste heat Recovery System:

Heat loses from boiler flue gases: $Q = V * \rho * C_p * \Delta T$

Where,

Q - Heat content in kcal

V - Flow rate of the substance in m^3/hr

ρ - Density of the flue gas in kg/m^3

C_p - specific heat of the substance in kcal/kg °C

ΔT - temperature difference in °C

Heat gain by Combustion air: $Qa = m * C_a * \Delta T$

Where,

Qa - heat gain by combustion air in kcal /hr m - Flow rate of the water in kg/hr

C_a - specific heat of the combustion air in kcal/kg ^oC

ΔT - temperature difference in ^oC

4. Energy efficient motors:

kW saved = hp * L * 0.746 * ((E_{std}/100)-(E_{HE} /100))

Where:
hp = Motor nameplate rating

L = Load factor or percentage of full operating load

E_{std} = Standard motor efficiency under actual load conditions

E_{HE} = Energy-efficient motor efficiency under actual load conditions

kWh savings = kWsaved x Annual Operating Hours

$$\text{Percent slip} = \frac{(\text{Synchronous speed-Actual speed}) \times 100}{\text{Synchronous speed}}$$

Slip = RPMsync - RPMmeasured

$$\text{Motor load} = \frac{\text{Slip}}{RPM_{sync} - RPM_{fullload(nameplate)}}$$

Approximate Output hp = Motor Load * Nameplate hp

$$\text{Motor efficiency} = \frac{(0.746 * \text{Output hp})}{\text{Measured input kW}}$$

Annexure 2 :List of Local Service Providers

Machinery	Name of the Company /Supplier	Address	TELEPHONE	REMARKS
Co-generation	**SS Renewable Cogen Pvt. Ltd**	No. 36, First floor Srinivasamurthy Avenue Adyar, Chennai - 600 02		feedback@rcogenasia.com
	Tapsi Engineering Company	A-57/4, Okhla Industrial Area Phase-Ii, New Delhi-110020	011-26385323/30882042	
	Cogeneration Association of India (COGEN INDIA)	C/o. Maharashtra State Federation of Co-operative Suqar Factories **(Sakhar Sangh)**, Sakhar Sankul, First Floor, PUNE - 411 005	Tel.: 020-25511404/ 25511446. Telefax: 020 - 25511467. Mobile : +91-9890532178	cogenindia@dataone.in cogenindia.pune@gmail.com
	Cheema Boilers Limited	H.No.7-1414/19, Flat :301B ,Naga Sai Nivas, Sreenivasa Nagar(E), S.R. Nager ,Hyderabad-500 038	040-66821160	cheemahyd@cheemaoilers.com
	M/s. Veesons Energy Systems Pvt.Ltd	406,Vijaasree Apartments, Nagarjuna Nagar,Ameerpet, Hyderabad-500 073	9390927854 9848027854	hyderabad@veesons.com
Motors	**Crompton Greaves Limited**	4th Floor, Minerva House,94 P B 1670 Sarojini Devi Road Secunderabad-500003	9703151133 +91-40-40002308	anil.maniktala@cgglobal.com
	Agarwal Engineering Sales & Services	Shop No 12 2nd Floor,Maitri Arcade,2-3-52/1/42/52, M G Road, Secunderabad-3	+91-40-27721615	agarwlr_hyd@dataone.in
	Shree Enterprises	5-4-187/6 1st Floor,Modi Complex MG Road, Karbala Maidan, Secunderabad-500003	+91-40-27541472	shreeenterprises_nk@yahoo.com
	Srinivasa Enterprises	126/A 2nd Floor,Tirumala Complex, Secunderabad-3	91-40-27894858	srinivasaengg@sify.com

	Kirloskar Brothers Limited	403,Jade Arcade,126, M G Road, Nr Paradise Circle, Secunderabad-500003	+91-40-23311578	jvn@hyd.vrkec.com
	Concorde Motors (India) Limited	Ground Floor, Golden Ediffice,Circle,Khairatabad, Opp Visweswarayya Statue Hyderabad-500004	+91-40-66410220	infohyd@concordenotors.com
	International Combustion India Limited	Flat No - 204, Bhanu Enclave, 6- 1 - 638 To 643, Sunder Nagar, Hyderabad-500018	+91-40-23810546	hyderabadoffice@internationalcombustion.in
	Sri Krishna Electrical & Mechanical Engg Works	Plot No 38b,Road No 7,I D A,Ida Mallapur, Opp Bl Main Gate Hyderabad-500076	+91-40-27248142	skemew040@yahoo.co.in
	V J Marcons Private Limited	F - 111, Ram's Enclave, Opposite Allwyn Bhavan, Erragadda Hyderabad-500018	+91-40-23801987	marcons@sancharnet.in / sales@vjmarcons.com
	Kaypee Enterprises	5-1-33,Rashtrapathi Road Opp Public Library Secunderabad-500003	+91-40-27710247	kaypeeenterprises@yahoo.com
Boilers	**M/s. Veesons Energy Systems Pvt.Ltd**	406,Vijaasree Apartments, Nagarjuna Nagar,Ameerpet, Hyderabad-500 073	9390927854 9848027854	hyderabad@veesons.com
	Thermax Ltd.,	6-3-649, Nalanda Complex, Somajiguda, Hyderabad-500082	040-23310254	
	Cheema Boilers Limied	H.No.7-1414/19, Flat :301B ,Naga Sai Nivas, Sreenivasa Nagar(E) S.R. Nager , Hyderabad-500 038	040-66821160	cheemahyd@cheemaoilers.com
	Thernodyne Technologies Private Limited	No.16-11-1-5-A,Saleem Nagar, Malakpet, Hyderabad-500	9177340222	thermodyne@thermodyne.in

		036		
	Pie Boilers	33/ C, Near B. K. Guda Park S. R. Nagar, Hyderabad	040 - 23708774	
	Thermal Systems (Hyderabad) Pvt.Ltd	Plot No-1,Apuroopa Township,I D A Jeedimetla, Hyderabad-500055	040 -23091801	info@thermalindia.com
Solar hot water/ Solar Dryers	**Best Engineering Technologies**	H. NO: 5-9-285/13, PLOT NO:- 69/A, Rajiv Gandhi Nagar, Near Andhra Jyothi Press, Industrial Estate Prashanti Nagar, Kukatpally Hyderabad - 500037,	91-40-65909498 +919391057812	
	Balaji Industrial & Agricultural Castings	16, I.D.A., BALANAGAR, Hyderabad - 500037	91-40-27711183 /23078614 /23079248	
	Hyderabad Met Chem. Private Limited	Fact 34, C. I. E., Phase-ll, Gandhinagar, Opp site I. D. P., L. Colony Hyderabad - 500 037	**Phone:** +(91)-(40)-23086351 **Fax:** +(91)-(40)-23086350 **Mobile:** +(91)-9000002656	**Email:** info@hyderabadmetchem.com
	Planet Energy Technologies Ltd.	H.No. 5-5-35/73/B3, Plot 6,1st Floor Prasanthi Nagar, Kukatpally I.E., Hyderabad-500072	(040) 2372093	
	Aditya Energy Systems	Unit 19, Mount View Enclave, Road No12 Banjara Hills **Hyderabad-** 500004		
	Anu Solar Power Private Limited	H.No 1-2-288/23/4 Domalguda,R.k .Mutt Marg Hyderabad	91-40-66682992 9346997197	

Blowers / Compressor	**Deraz Engineer's** 00016	Begampet Hyderabad – 5	9948353616	
	Reitz Turbovent Ltd / Reitz India Ltd	Serene Towers 8-2-623/A, Road No 10, Banjara Hills, Hyderabad – 500034	+(91)-(40)-23301888, 23301889	
	Mcclellad Engineers	7-1-25, Green Land, Ameerpet Hyderabad – 500016	+(91)-(40)-23730124	
	Thermax Ltd	6-3-649 Nalanda Complex 2nd Floor, Behind Medinova Hospital, Somajiguda Hyderabad - 500082	(91)-(40)-23310254, 23312013, 23396820	
	Turbo Engineering Services	22/95 2nd Floor Reddy Complex, Near Bhel Main GATE, Beside LIC Building, Ramachandra Puram, Hyderabad – 500032	+(91)-(40)-65911463	
	S V Pollution Controls	S 30 & 31, Ramireddy Nagar, IDA, Jeedimetla, Hyderabad – 500855	+(91)-(40)-23778352	
	Trivsons Systems	5-5-18, Ranigunj Secunderabad Hyderabad – 500003	+(91)-(40)-27715334, 27718209	
	Envirovent Air Systems	39-55, Sanjay Gandhi Nagar, Balanagar, Hyderabad – 500037	+(91)-(40)-23412073, 23085507	
	Trivsons Systems	5-5-18, Ranigunj Secunderabad Hyderabad – 500003	+(91)-(40)-27715334, 27718209	
Capacitor Banks, Harmonic filters and APFC	**Mr. Ahamad ,** M/s. Edge Technologies	Masabtank	9866070876	
	Amit Capacitors Ltd	A 8, Near Post Office Lane, Co Operative Indl Estate, Bala Nagar, Hyderabad – 500037	+(91)-(40)-23879990, 23879991, 23879992, 23879993	

	Viz Technologies Pvt Ltd	D 143, Phase 3, IDA, Phase 3, Jeedimetla Hyderabad – 500855	+(91)-(40)-23097015	
	Dada Capacitors Manufacturing Co Pvt Ltd	4-1-119, Mahan kali Street, Secunderabad Hyderabad – 500003	+(91)-(40)-23468335, 23468334, 23468443	
	Auric Engineering Pvt Ltd	8-4-368/A, Near Meter Factory, Sanat Nagar Hyderabad – 500018	+(91)-(40)-23814035, 23811829, 23814634	
	Bagwati Electric Company	4-2-151, Hill Street, Old Bhoiguda, Hyderabad – 500003	+(91)-(40)-27841697, 66322950, 27705940	
	Ikon Capacitor Industries	B-6, Ida, Phase 1, Jeedimetla, Hyderabad – 500855	+(91)-(40)-23194154	
	Asian Capacitors	221 Kabra Complex, M G Road, Secunderabad Hyderabad – 500003	+(91)-(40)-27745578	
	Garg Enterprises	3/131/35, Narsapur X Road, Bala Nagar, Hyderabad – 500037	+(91)-(40)-23709939, 23709929, 24617419, 24524233	
	R K Power Electronics	Flat No 212, 2nd Floor, Anjaiah Complex, Hill Street, Hyderabad – 500003	+(91)-9395312449, 9963107554	
	Rama Marketing	6-3-609/1, Anandnagar Colony, Khairatabad, Hyderabad – 500004	+(91)-(40)-23397368, 23320053, 23392814, 23544521	
	Tibrewala Electronics	Ashok Nagar, BHEL, Hyderabad – 500032	+(91)-(40)-23027399, 23775351	
	Electrical Power Equipments	109 Trt Quarters, Opp Sudarshan Cinema Hall, Jawahar Nagar, RTC X Roads, Hyderabad – 500020	(91)-(40)-27611703, 66685435	

	Trinity Energy Systems Pvt. Ltd	366/A/12,G.I.D.C.Estate, Makarpura, Vadaodara-390 010	91-8142238930	
	DCiEra	Plot # 247,Ground Floor Road # 78,Jubilee Hills Hyderabad 500 037	91-40-23554579	
D.G Sets	**Prime Power Generators**	10-2-233, First Floor, Above Food World, Sreerama Bhavanamu, West Marredpally, Hyderabad – 26	+(91)-(40)-67113093	
	Prakash Maketing	Plot No-77, Beside ESI Hospital, Divya Complex, Nacharam, Hyderabad – 500001	+(91)-(40)-66049099	
	Kirloskar Electric Co Ltd	6-3-666/B 2nd Floor Deccan Chambers, Somajiguda, Hyderabad – 500082	(91)-(40)-23302994, 23311578	
	Alstom Projects India Ltd	101/3, Behind Annapurna Studio, Near Natco House, Road No 9, Jubilee Hills, Hyderabad – 500034	+(91)-(40)-23608967	
	Jakson Generators Pvt Ltd	5-4-57 To 62/1 1st Floor SRI Krishna Govinda Building, Distillery Road, Ranigunj Hyderabad – 500003	(91)-(40)-27535223, 2753522	
	Kirloskar Oil Engines Ltd	5-2-220 To 222 2nd Floor Padmavathi Towers, Opp Andhra Bank, Hyderbasti, Ranigunj, Hyderabad – 500003	+(91)-(40)-27534170, 27534197	
Rice mill Machinery	M/s. Sri Venkateshwara Engineering, Service and Machinery	VIJAYAWADA	08662842771 08662843876	

	M/s. Circars Laxmi Mill Store	VIJAYAWADA	9848125020	
	M/s. Sai Krishna Engineering works	VIJAYAWADA	9959123666	
Local Rice Mill Machinery Suppliers	M/s.Ganesh Mill stores Trading Co. Mr. Mohit k. desai	WARANGAL	9866769611	
	M/s.Badhrakalli mill Stores Mr. Amarnath	WARANGAL	9299105236	
	M/s.Adhivenkateshwarao Mill stores	WARANGAL	9849111252	
	M/s.Venkateshwara Mill stores Mr. Kanaya	WARANGAL	9908398910	
	Mr.Ranjith	WARANGAL	9640241278	
	M/s.VINOD Engineering Works	WARANGAL	9397328057	

Annexure 3: Quotations

Ref: CBL/HYD/2010-11 28th August, 2010

M/s.APITCO Limited,
8th Floor, Parisrama Bhavan,
Bhasheerbagh,
Hyderabad – 500 004

Kind Attn: Mr.D.Gopala Rao, Sr.Consultant

Dear Sir,

Sub: - Efficient steam boilers in Parboiling Rice Mills.
Ref: - Our discussions in your office on 26/8/10.

Thank you for the kind courtesy extended to us during our recent visit referred above. During our discussions we apprised you of various co-gen packages that can be recommended to small rice mills. We also discussed the need to upgrade the existing boiler systems with an energy boosting equipment like Air pre heater (APH). Accordingly we now attach here with the following documents for your kind perusal and further action.

Annexure – I : Co-gen systems with saturated or superheated turbines.

Annexure – II : Our offer for APH suitable to 4 TPH capacity boiler.

Annexure – III : Proposal for a co-generation system developing 4 TPH steam and 240 units of power with a saturated turbine.

Annexure – IV : Proposal for a co-generation system developing 6 TPH steam and 540 units of power with a super heated turbine.

Please revert to us with any points to be clarified on our above referred data.

Yours faithfully,
For CHEEMA BOILERS LIMITED

NARASIMHAM GANTI
GENERAL MANAGER

Budget for APH suitable to 4TPH Capacity Boiler:-

Boiler Capacity	: 4TPH
Boiler Pressure	: 10.54kg/cm2
APH Heat Transfer Area	: 43 m2

Cost of APH : Rs 2 Lacs

Improvement in the Efficiency of the Boiler : 4% to 5%

Pay Back period for the above is : 2-3 months

Note:- F.D fan and I.D fan Motor H.Ps to be increased suitably

Proposal for a co-generation system developing 4 TPH steam and 240 units of power with a saturated turbine.

Boiler capacity :- 4TPH

Boiler pressure :- 21kg/cm2 (saturated)

Specific steam consumption to produce 1kw is : 14.46 kg/kw

Power produced by turbine is : 240kw

Cost of the project : 146lacs (Approx)(It includes Boiler package ,turbine ,water treatment ,miscellaneous)

Saving on account of power produced : 60Lacs
(240kwxRs3.50x24hrsx300days)

Pay back period : 2 1/2 years

Boiler capacity : 6TPH
Pressure : 45kg/cm2
Temperature : 440degC (super heated)

Power produced from the above configuration is :540kw

Extra fuel consumption on account of super steam produced is - 160kg/hr

Cost of the co-genaration system : 257Lacs (Approx)

Saving on account of power produced : 136Lacs
(540kwxRs 3.50 x24hr x300days)

Less expenses on account of extra fuel consumed : 17.5Lacs

Net saving = 136-17.5=120 Lacs (Approx)

Pay back period : 2 ½ years

Dear Sir,

Please find our offer for Efficiency Level - 1 Motors as below:

Compton Greaves make, TEFC Squirrel Cage Induction Motor (NFLP),Enclosure confirming to Protection IP 55 Foot mounted (B3), continuously rated (S1) suitable for operation on 415 +/-10 % V, 3 phase 50HZ +/- 5% with an ambient of 50 deg. class F insulation with temperature rise limited to Class B and altitude less than 1000m above m.s.l confirming to IS325.

S.No	HP	kW	RPM	ALP	Net
1	25	18.5	1440	85820	36902.6
2	30	22	1440	91420	39310.6
3	60	45	1440	192240	82663.2

NOTE:
1. THE ABOVE PRICE IS EXCLUSIVE OF TAXES AND DUTIES.
2. THE ABOVE PRICE IS EXCLUSIVE OF TESTING CHARGES & OTHER FEATURES.

Thanks & Regards,

Prashant Reddy
Senior Executive - Sales, LT Motors

Crompton Greaves Limited
Secunderabad Branch
94, Sarojini Devi Rd, Secunderabad 500 003
T: +91 40 4000 2324 M: +91 9966007488 W: www.cgglobal.com

DEEPAK ELECTRICALS & ELECTRONICS

5-2-27, HYDER BASTI, R.P.ROAD, SECUNDERABAD – 500003
PH: 09533564104 / 09912550190 TELE FAX: 040 – 66323959
EMAIL: deepakelectric2010@yahoo.in / deepakelectric19@gmail.com

****
QUOTATION
****

TO,
SANKALP SHARMA
CONSULTANT-ENERGY
APITCO LIMITED,
8TH FLOOR, PARISHRAMA BHAWAN
BASHEERBAGH, HYDERABAD-04

REF : DEE-PB-52R/10-11
DATE: 27/08/2010

Cell: +91-9618427019
Ph: 040-2323-7333/2323-7981

Dear Sir,
We thank you very much for your enquiry no.__VERBAL_____ dt.___
As desired, we have the pleasure in quoting our prices as under, subject to the terms & condition of sale.

DESCRIPTION

ABB make AC 3 Phase, 415v +/- 10%, 50 Hz +/- 5% Combined Variation Class 'F' Insulation IP-55 Protection, S1 DUTY,EFF – 1, induction motor, FOOT TYPE, SSE.

S.No	HP	POLE	QTY	FRAME	PRICE PER UNIT
1	25	1475	1	180M	40945.00
2	30	1475	1	180L	43650.00
3	60	1475	1	225M	91770.00
4	25	975	1	200L	55620.00
5	30	975	1	200L	60370.00
6	60	975	1	280S	162130.00
3	60	1475	1	225M	91770.00

Terms & Conditions
Delivery : 10-12 WEEKS FROM DATE OF ORDER.
Excise : EXTRA AT THE TIME OF DELIVERY.
Tax : SALES TAX EXTRA AS APPLICABLE.
Payment : 30% ALONG WITH ORDER AND BALANCE BEFORE DESPATCH OF MATERIAL.
Validity : 15 Days
Guarantee : One year Mfg. Warranty
Price : Firm, FOR Ex. SECUNDERABAD
Freight : TO-PAY BASIS, ON YOUR ACCOUNT (IF ANY)
NOTE : YOU HAVE TO COLLECT THE GOODS FROM OUR OFFICE.
Should we be given an opportunity we shall be too glad to serve you.

Truly Yours,
For DEEPAK ELECTRICALS & ELECTRONICS
PRAMOD
+91-9912550190

Annexure-4: Power Tariff by Andhra Pradesh Northern Power Distribution Corporation Limited (APNPDCL)

H.T Loads						
S. No	**Type of Connection**	**Category**	**Type of Consumers**	**Contract Demand**	**Demand Charges**	**Energy Charges**
1	HT	Category -1	Hotels, Hospitals, Restaurants, Clubs, Theaters, Cinemas Railway Stations	Up to 70 KVA	Rs. 170 Per KVA	• up to One Lakh376 paise per Unit • One Lakh above376 paise per Uni
2	HT	Category-2	Commercial Consumers	Above 70 kVA	Rs. 170 Per KVA	• 450 Paise Per unit
3	HT	Category-4	Irrigation & Agricultural		Rs.400 Per HP	• 35 Paise Per unit
4	HT	Category-5	Railway Traction	Up to 220 KV	No Demand Charges	• 460Paise Per unit

L.T Loads					
S. No	**Type of Connection**	**Category**	**Type of Consumers**	**Demand Charges**	**Energy Charges**
1	LT	Category -1	Domestically Consumers	• Up to 250W Rs. 25/ Month • Above 250WRs.50/ Month • Three Phase Rs.150/ Month	• Up to 50 Units 135 Paise per unit • 51-200 Units 295 Paise per Unit • 201-400Units 450 Paise per Unit • > 400Units 525 paise per Unit
2	LT	Category -2	Commercial Consumers	• Single Phase Rs.65/ Month • Three Phase Rs.200/ Month	• Up to 100 Units 340 Paise per unit • Next100 Units 665 Paise per Unit • Balance Units 745 Paise per Unit
3	LT	Category - 3(A)	Poultry Forms & Rabbit Forms	• Rs.15 Per HP	• Up to 1000 Units 385 Paise per unit • Balance Units 430 Paise per Unit
4	LT	Category - 3(B)	Small & Medium Scale Industries	• Rs.15 Per HP	All Units 430 Paise Per Unit
5	LT	Category -4	Cottage Industries	• Rs.10 Per HP	All Units 174 Paise Per Unit
6	LT	Category -5	Irrigation & Agricultural	• Up to 3 HP Rs. 250/Year • Above 3 HP Rs.400/ Year • Above 5 HP Rs.500/ Year • 10 HP Above Rs.600/ year	Not Available