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We assure you, always, of our best services.

[V Ramchander]
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 up gradation 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

S. 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	Refractory
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 Refractory Units in Rajamundry, East and West Godavari District 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 Refractory Manufacturing milling cluster activities suggested by BEE.

Natural resources such as Coal, natural gas, kerosene, diesel and coal are used to generate energy. Energy here refers to electrical or thermal energy is 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 Refractory units of Rajamundry. In view of this, the objectives of this work were structured as below.

- To carry out energy and technology audit in the Refractory Manufacturing Units,
- 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 Refractory Cluster.

1.4 Activities, Expected Outcome and Project Duration

Under this BEE SME Program, the following outcome is envisaged for Refractory Cluster:

Activity 1: Energy Use and Technology Analysis

This activity has developed information base on the status of Refractory 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 representatives 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 Rajamundry Refractory 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

The methodology of the BEE-SME program is described below.

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 Refractroy Making cluster, the products, cluster actors, energy consumption patterns, current policies and initiatives of local bodies, and technology up gradation 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 2
REFRACTORY CLUSTER, EAST AND WEST GODAWARI

2.1 Introduction

Refractory Manufacturing Cluster is spread across in East & West Godavari districts of Andhra Pradesh. The reason behind the spread is availability of raw material i.e. Clay. Majority of industries are installed near to city of Rajamundry, head quarter of East Godavari district. These industries are well connected to road, rail and air. The location of cluster is 400 km from Hyderabad, state capital Andhra Pradesh and 200 km from Vishakapatnam of Andhra Pradesh.

There are approximately 100 refractory industries with different capacities are installed in east and west Godavari District. All the units are manufacturing different refractory products in the cluster.

2.1.1 Spread of Cluster

The Refractories manufacturing cluster is spread in east and West Godavari District of Andhra Pradesh.

East Godavari District

There are approximately 25 Refractory Manufacturing industries are established for manufacturing of refractory products. These industries are engaged in manufacture of various types of products like firebricks, potteries and Ceramics. The Industries are spread over in and around Rajhamundry, Morampudi and Dhavaleswaram with in a radius of 5 km from Rajamundry.

These industries spread across the district due to availability abundant resources of raw material and skilled and unskilled man power from near by locations. All these industries fall under the category of SME sector and run by the well experienced proprietorship management.

These plants are operated through out the year and few are operating 24 hrs of operation and many are 8-10 hrs of operation.

West Godavari District

Approximately 20 refractory manufacturing Industries are installed and engaged in manufacture of various types of fire bricks in this district. These industries are spread across Chebrolu, Bhimdole, Dwarka Tirumala, Timmaya Palem Road locations in the district.

These industries spread across the district due to availability abundant resources of raw material and skilled and un skilled man power from near by locations. All these industries fall

under the category of SME sector and run by the well experienced proprietorship management.

These plants are operated through out the year and few are operating 24 hrs of operation and many are 8-10 hrs of operation.

2.1.2 Products manufacturing

All Refractory manufacturing Industries located in East & West Godavari district are manufacturing different refractory material products. The following products are manufacturing in Refractory cluster in East & West Godavari District.

- Fire bricks
- Ceramic Jars
- Potteries

Majority of industries are manufacturing refractory Fire Bricks flowed by potteries and ceramic jars.

2.1.3 Equipments in Cluster units

The equipments/machinery required for manufacturing refractory materials are

- DD kiln
- Grater
- Pug Mill
- Muller Mixer
- Hammer Press
- Electric Motors

The main part of equipment/machinery is Down Draft Kiln which is constructed in locally available suppliers. The other machinery is procured from available local service providers.

2.1.4 Raw Material

The spread of Refractories Manufacturing Industries in East & West Godavari District is availability of Raw material. The raw material required for the manufacturing Refractory products is mineral based clay. The following clay is available and suitable for manufacturing the refractory products.

- Fire Clay
- China Clay

- Vemigiri Clay
- Grog

Due to abundant raw material across the East & West Godavei District, Many Refractory manufacturing Industries are established since 5-6 decades.

2.1.5 Fuel Used

In any Industry required energy to produce the different products. The type of energy required for manufacturing the product is depends up on the requirement of the equipment/machinery.

The following energy is used for refractory manufacturing industries in East & West Godavari District of Andhra Pradesh

- Thermal Energy
- Electrical Energy
- Renewable Energy

All the industries required thermal energy as major consumption and followed by electrical energy.

Thermal Energy

Thermal energy is required in refractory manufacturing Industries to heating up the refractory material up to 1200C. The following fuels are used in refractory cluster located in East & West Godavari District.

- Coal
- Wood

All the Down draft kilns are required thermal energy for heating the refractory material up to 1200 C. The source of thermal energy is form firing the coal and Wood in kiln. None of the Industries are using other forms of energy for heating applications in Kilns. The coal is procured from the Singareni Colleries Company Limited (SCCL) and Coal India limited (CIL) and wood is from local suppliers. The required quantity of coal is procured from coal traders and suppliers.

Electrical Energy

Electrical Energy required in refractory manufacturing industries to operate the motors and prime movers installed. The source of electrical energy is from the Andhra Pradesh Eastern Power Distribution Company Limited (APEPDCL). The detail of supply and contract demand is based on the equipments installed in the Industries.

Renewable Energy

The Refractory Manufacturing in East & West Godavari Industries are not utilizing any renewable energy resources except the natural drying process of shaped refractory before kept in kiln.

2.2 Installed Capacities-Products Manufactured

Different Installed Capacities are exists in Refractories manufacturing cluster located in East & West Godavari district. All these industries are batch type production due to lengthy process operation i.e.6-10 days. The equipments and machinery is same for all the refractory products manufacturing except the process duration and raw material type. The installed capacity is depends up on the size of the kiln and type of product to be manufactured. The following table gives about the different installed capacities exists in refractory cluster in East & West Godavri District.

Table No: 2.1 Installed Capacities and Products manufactured in Cluster

S.No	Capacity range	Products
1	up to 50 TPD	• Fire Bricks • Potteries • Ceramic jars
2	50-100 TPD	• Fire Bricks • Potteries
3	100-200 TPD	• Fire Bricks • Ceramic jars
4	Above 200TPD	• Fire Bricks • Ceramic jars

2.3 Refractory Manufacturing Industries- Categorization

The installed capacities of Refractory manufacturing Industries in East & West Godavari are categorized in to four categories. All the Refractory manufacturing Industries are fall under these categories. The details of categories, Installed capacities and no of industries are presented below.

Table No: 2.2 Refractory Manufacturing Industries – Categories

S.No	Installed capacity range	Category
1	up to 50 TPD	I
2	50-100 TPD	II
3	100-200 TPD	III
4	Above 200TPD	IV

All the existing 100 Refractory Industries are fall under the above categories in the both the districts.

2.4 Installed Capacities and Its share

The installed capacities in the cluster and its % share in the Refractory manufacturing Cluster, East &West Godavari is presented below.

Table.2.3 Refractories category and its % share

S.No	Category	Installed capacity range	East Godavari District	West Godavari District	No. SMEs	% share
1	I	up to 50 TPD	13	12	25	56
2	II	50-100 TPD	5	3	8	18
3	III	100-200 TPD	5	4	9	20
4	IV	Above 200TPD	2	1	3	7
	Total		25	20	45	100

2.5 BEE-SME Program-Study Particulars

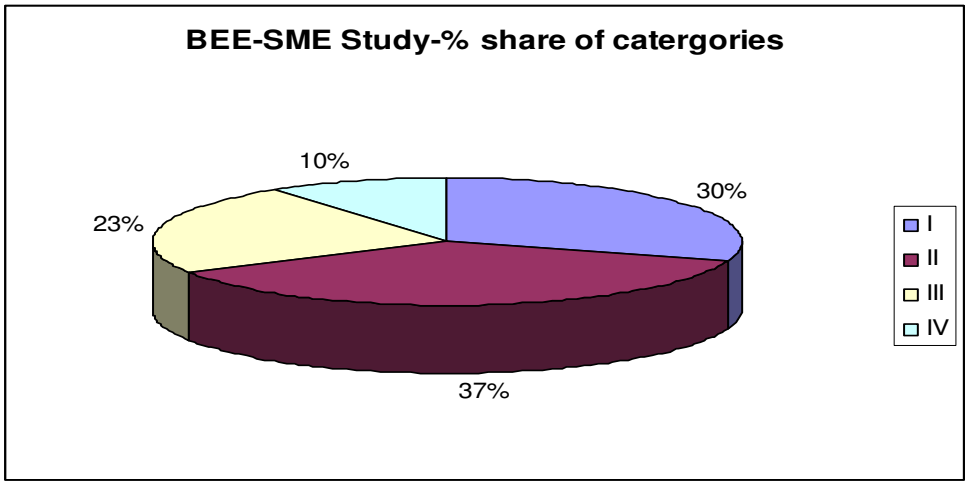
Under BEE-SME program in Refractory Manufacturing Cluster, East & West Godavari District, Energy Use and technology audit was conducted in 30 Units covered all categories and locations. The following table provides the information of study particulars covered in the cluster.

Table 2.4 Different Categories and share considered in Technology Audit

S.No	Category	Installed capacity range	No. SMEs	% share
1	I	up to 50 TPD	9	30
2	II	50-100 TPD	11	37
3	III	100-200 TPD	7	23
4	IV	Above 200TPD	3	10
	Total		**30**	**100**

The study of the Energy Use and Technology audit was conducted in 30 Refractory Manufacturing Industries out of 80 Existing Refractory Industries located in East & West Godavri District to identify the Energy Efficient Technologies. The identified Energy Efficient Technologies in 30 units represent to all the Industries in the Cluster.

Fig 2.1: Percentage Sharing of Refractoriness cluster under BEE-SME Program



These 30 units cover all the four installed categories of Refractory manufacturing Industries. Energy Use and Technology Audit was conducted in 30 % Industries in category I Type, 37% Industries in category –II Industries, 23% in category III Industries and 10% Industries in category-IV Type Industries.

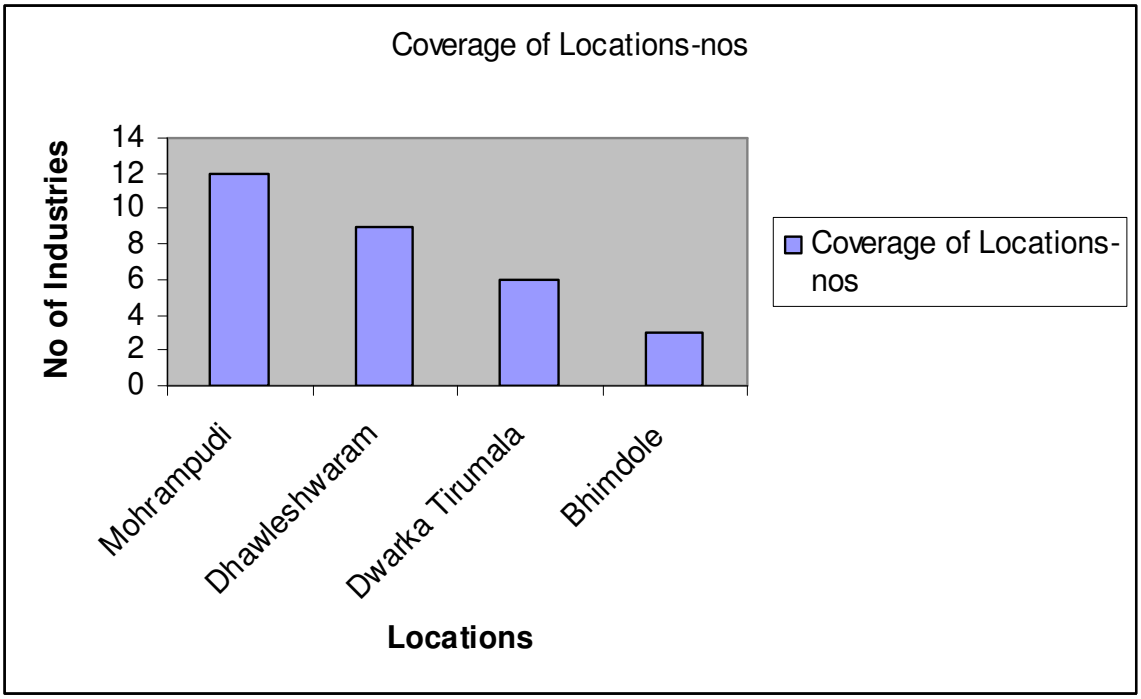
Due to spread of Industries in different locations in East & West Godavari Districts and cover all the locations in the districts, Energy Use and Technology Audit was Conducted in the following locations.

Table 2.5 BEE-SME Program- No of plants covered in all locations

S.No	Place	No of SMEs	% share
1	Mohrampudi	12	40
2	Dhawleshwaram	9	30
3	Dwarka Tirumala	6	20
4	Bhimdole	3	10
	Total	**30**	**100**

The no of Industries are studied based on the existing units and installed capacities in particular areas in the Districts.

Fig 2.2: Location Wise Industries studied for Energy Use & Technology Audit



2.6 Production

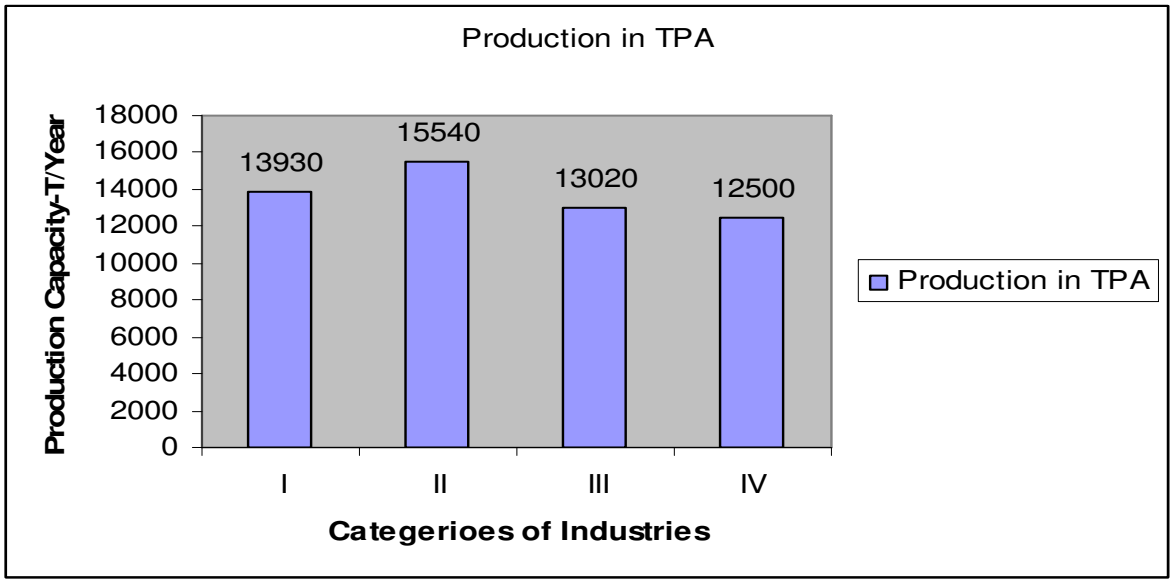
The annual Production in Identified 30 Refractories Industries are evaluated based on the % utilization and no of batches per year operating.

Table 2.6: Category wise production and % production share

S.No	Category	Installed capacity range	No. SMEs	Production in TPA	% share
1	I	up to 50 TPD	9	13930	25
2	II	50-100 TPD	11	15540	28
3	III	100-200 TPD	7	13020	24
4	IV	Above 200TPD	3	12500	23
5	**Total**		**30**	**54990**	**100**

The annual production of 30 Refractory Industries with four different capacities was evaluated and estimated as 54990 MT Tons per year.

Fig 2.3 Category wise production of BEE-SME Studied Industries



The category I (i.e 9 Industries) contribution 25%, category-II (i.e.11 Industries) contribute 28%, category-III (i.e. 7 Industries) contribute 24 %and Category-IV (i.e. 3 Industries) adds in a share of 23%.

2.7 Institutions

The any SME cluster is influenced by the various institutions and cluster actors. The Financial Institutions, Government Institutions and Associations are playing a major role followed by the Technical Institutions in the cluster.

The following institutions are influenced in the Refractory manufacturing Cluster in East & West Godavari. They are:

- Associations
- Financial Institutions i.e. Banks
- Govt Institutions i.e. District Industries Centre (DIC)

2.7.1 Associations

The refractory Manufacturing Industries are formed an association called "Refractory manufacturers Welfare Association" to solve the issues in the cluster on Technical, Financial, man power and policy related.

The details of associations exist in Refractory Manufacturing cluster, East & West Godavari District is presented below.

Table 2.7: Details of Associations in the Refractory Manufacturing cluster

S.No	Particulars	Details
1	Name of the Association	The Ceramic Manufacturers Welfare Association
2	Established Year	1983
3	Activities	• Organizing the Industry related Programs • Solving Industrial related to Industry with respect to Govt and Private
4	Association Address	C/o. Sri Ramakrisha Ceramics & Refractories, D.No.11-36, Hukumpeta post, Rajamundry-533103
5	Contact Person with details	K. Prasad Kumar, Secretary

2.7.2 Financial Institutions

In the Refractory Manufacturing Cluster, the following financial Institutions are exists to cater the financial services to SME owners and employees of industries. The following banks are exists in refractory manufacturing Cluster to provide the services line loans, working capital and salaries to SME owners, employees in the cluster.

- Andhra bank
- Syndicate Bank
- Indian Bank
- State Bank of India

The relation ship among Refractory Manufacturing Industry Owners and the financial institutions are good.

2.7.3 Govt. Institutions

The Govt. institutions play a major role in the cluster from the establishment to the operation of the installed plants. The following institutions play a vital role in the Refractory manufacturing cluster, East & West Godavari to register the Refractory Industries and avail different schemes related to the Refractory Industries.

- Industries Department (District Industries Center)
- Dept of Income Tax
- Mines
- Dept of Labor
- APNPDCL
- Factories department

2.7.4 SME Schemes

The various schemes from Ministry of Micro Small and Medium Enterprises (MSME), Government of Andhra Pradesh and Small Industrial Development Bank of India (SIDBI) are available to Install SMEs, install or upgrade Energy Efficient technologies and marketing. These schemes are availed and implemented through the District Industries Center (DIC), Commissioner of Industries and District Collector and Financial Institutions. The unit's holders are taken the benefits of various schemes from time to time.

2.7.4.1 Small Industrial Bank of India (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:

a. 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.

b. 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

c. 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

d. 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.

e. Bills Financing Scheme

Bills Finance Scheme seeks to provide finance, to manufacturers of indigenous machinery, capital equipment, components sub-assemblies etc.

f. 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.

g. 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. The scheme is to avail setting up of warehousing facilities for SSI products / units. Providing support services viz., common utility centers such as convention halls, trade centers, raw material depots, warehousing, tool rooms / testing centers, 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

2.7.4.2 Ministry of Small and Medium Enterprises (MSME)

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

a. 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.

b. 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.

2.7.4.3 Govt of Andhra Pradesh

Govt of Andhra Pradesh providing the SSI Certificated through the District Industries Center (DIC) at Eluru to promote industrial activity in the district. The DIC will issue the SSI to the Ice making Plants based on the capacity of the Plant. 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.

2.8 Issues in the Cluster

The following issues are identified while interacting with Owners and employees during the Energy Use and Technology Audit.

2.8.1 Energy Issues

All refractory Manufacturing Industries requires both Thermal and electrical energy for manufacturing of refractory material. For generation of thermal energy coal and wood is used as fuel and electrical energy from APEPDCL.

All refractory Industries are mainly depend on coal which contributed higher compare to the electrical energy.

All the Refractory Industries required electrical energy to operate equipments installed in their Industries. These Industries draw electrical energy from the APEPDCL by registering with contract maximum demand. All the units in this cluster are having grid connection - commercial and power availability is not a problem except some small power cuts of 30 – 40 mins daily.

The availability of coal is one of the major problems encountered in the cluster. The Commissioner of Industries allotting the coal for the Industries from SCCL. The quality and quantity of coal is not suitable due to inferior quality and more consumption. The Owners are purchasing the good quality of coal i.e. CIL from open market through the dealers/middleman.

There is potential energy saving in both thermal as well as electrical energy by adopting the energy efficient technologies in refractory Industries. By Introducing Coal /Wood Gasification, waste heat recovery systems are two major concepts in refractory Industries will save the more than 30% of thermal energy as well as environment is saved. These two technologies are not implemented so far in the cluster due to lake of awareness on technology, energy conservation techniques and identification and approach towards implementation.

In the cluster, energy conservation awareness and conscious is required among the refractory Manufacturing Owners and Operators on how to conserve energy.

2.8.2 Technological Issues

Another major issue in Refractory manufacturing Cluster is identification of the right technology and equipments for improvement of efficiency. The efficiency of kiln is low due to high energy losses during process. To minimize energy loss in refractory manufacturing industry, it is essential to adopt energy efficient technology in process.

The identification of energy efficient equipment in refractory manufacturing industry is very difficult by the Owners except implementation by the other similar industry. This is due to lake of technology information, financial constraints to invest and skilled manpower requirement. The technology service Providers, equipment suppliers are another issue in the cluster

The major energy consumption in refractory industries are using coal in kiln. The operation and specific energy consumption and efficiency of kiln play a vital role while in operation of kiln process. The operators and owners should aware on efficiency of kiln and also specific energy consumption to find whether energy loss is there or not.

The other major issue in the cluster is even though updated technologies available in refractory manufacturing process not implemented due to lake of awareness, technology suppliers in the cluster.

The Refractory cluster owners/ operators are not fully aware of updated technologies, equipments available for manufacturing of refractory materials. To overcome the situation in the cluster it is essential to generate awareness by organize /sensitise on relevant technologies with local service/ equipment suppliers with in the cluster.

2.8.3 Financial Issues

The Industry owners have good contacts with the local banks to avail a financial service from banks i.e. loans, salaries, and working capital requirements

Among all 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 and readiness to install / invest for energy efficiency technologies which have good payback periods. If schemes like Energy Efficiency Financing provided by SIDBI's and other Govt Schemes will play a catalytic role in implementation of identified energy conservation projects & technologies.

2.8.4 Skilled and Unskilled Manpower issues

All Refractory Industries in East & West Godavari, requires skilled and unskilled manpower during the process. The skilled workers are required for the operation of kiln, motors, molding press etc for efficient operation. The available skilled manpower is not from technical back ground but experienced. The skilled man power required training on operation and maintenance of kilns, motors, molding operation for efficient use of machinery which leads to minimize the energy consumption in Industry.

In Refractory Industries in East & West Godavari, availability of skilled and trained manpower is one of the limitations. Numbers of refractory industries are grown fast as compared to the availability of skilled manpower.

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 and jump to other industry after getting sufficient experience this is because of low salaries.

Specialized and focused training by the local service providers on better operation and maintenance of the equipments, importance of the energy and its use and energy conservation measures among industry owners and workforce will result the energy savings and life of equipments.

2.8.5 Issues related to Service Providers

Many of the Energy Efficient technology providers have not shown keen interest in implementation of their new innovative technologies in the cluster due to higher price which cannot be implemented by the SMEs.

The service providers for refractory manufacturing Industry cluster are available in the radius of 400 to 200 km and are mainly from important cities such as Vijayawada, Hyderabad and Vishakhapatnam.

The Cluster locations are well connected with road, rail and air connection to reach these cities. Few of the service providers have their activities in Rajamundry which is near to the all Industries. The list of Service and Technology providers are presented in the Annexure.

CHAPTER 3
ENERGY AUDIT AND TECHNOLOGY ASSESSMENT

3.1 Energy Audit

Energy audit is a systematic study or survey to identify how energy is being used in a plant and identify the energy saving opportunities. Using proper audit methods and equipments, an energy audit provides essential information on energy consumption pattern in every process and how energy being used with in a plant/ industry. The energy audit study is classified into two types

- Preliminary Energy Audit Study
- Detailed Energy Audit Study

During the detailed energy audit the energy consumption in each process is calculated and compares with bench marks standards. The identified energy losses in each area converted into energy conservation proposal where identification of technology /equipment is proposed to save energy. The energy audit report contains energy conservation opportunities and energy savings proposals comprising of techno economic analysis of projects. These energy conservation proposals are discussed with energy management team/management in the plant and implement on priority basis. Adopting this activity as routine or part of organizations culture gives life to energy management, and controlling the energy use.

Benefits of Energy Audit in Cluster

The Industrial clusters means where similar type of industries manufacturing same products in particular region/boundary. By conducting detailed energy audits in industrial cluster, there will be massive potential for energy savings with an average of 10-15% of energy usage by the industries. The identified energy conservation proposals are implemented by one/two industries in each cluster will replicate by all the units within the cluster. These results are creating 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.

3.2 Methodology Adopted for BEE-SME Programme

The methodology adopted for the BEE-SME Cluster program in Refractory manufacturing cluster is as follows.

Pre-Energy Audit Study

The Methodology adopted for pre - energy audit activities is as follows:

- Based on situation analysis data provided by BEE on Refractory Manufacturing units in East & west Godavari district of Andhra Pradesh, two to three Refractory units are visited and observed in detail to get deeper understanding of the energy issues in the industry before starting the work
- Interacted with Association members regarding energy use and consumption and critical issues related to energy in various industries in the cluster and get their feedback and views
- Identify the high energy consuming equipments and analyzed latest technologies to modernize/ minimize energy consumption
- Prepared 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
- 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 conduct preliminary audit in the plants

Preliminary Energy Audit Study

The methodology adopted for Preliminary Energy Audit study in Refractory units Cluster as follows:

- Conducted preliminary study in 30 units
- Collection of past six month's both thermal and 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 /Technology Audit

The methodology adopted for Detail Energy Audit study in Refractory bricks manufacturing Cluster as follows:

- Conducted detailed energy study in 30 units
- Detail observations are made on all major equipments in terms of functions, energy requirements
- Thermal and electrical energy consumption is measured for one batch of production in all 30 units
- Voltage, Current, kWh and PF are measured during the operation of each equipment/machinery using portable power analyzer for evaluation of specific energy consumption and identification of energy savings.
- Coal consumption for one batch production is measured for calculation of specific energy consumption
- Estimated/calculated preset specific energy consumption both electrical and thermal and evaluated the balance sheet
- Identified the energy conservation opportunities by verifying benchmarks
- Identified the technology requirements to save the energy losses in each process
- Prepare the Techno Economic feasibility to adopt the energy conservation technologies
- The identified 15 technologies/energy conservation proposals are preoritised based on different capacities in the cluster and prepared Detailed Project Reports (DPRs)

Technical Audits

The following methodology has been adopted for conducting technical audit:

- Studied the Technologies used in 30 units and Identified major equipments and technologies of the plant
- Identified the equipment suppliers locally/with in India and made assessment of companies
- Identified the availability and accessibility of energy resources in the cluster
- Identify major constraints for installing energy efficient equipments
- Identified the energy efficient equipment suppliers available cluster locations
- Discussed with Industries management for adoption of New Technologies/Energy efficient equipments to their plants
- Discussed with the financial strength and investment to adopt the new technologies

CHAPTER 4
PRODUCTION PROCESS

4.1 Introduction

Refractory material is used to provide linings for high-temperature furnaces and other Processing units. Refractory material must be able to withstand physical wear, high temperatures (above 538℃ [1000℉]), and corrosion by chemical agents. The refectory material is manufactured by using raw material i.e. clay which having the properties of Alumina, zinc and ferrous etc. The raw material with required material properties are made into different shapes using molds and heated up to 1200 C in the furnace i.e. kiln.

4.2 Products

The product manufacturing in Refractory cluster is based on raw material used. Based on the availability and accessibility of raw materials in the cluster, the products manufacturing in the cluster is classified in to two types. They are:

- Refractory Bricks
- Ceramic jars
- Potteries

The production process and equipments required are same but only differs in process time and raw material use.

4.3 Type of Energy Used

The energy required to manufacture Refractory products is thermal energy and electrical energy. The major energy consumption in refractory cluster is Thermal energy and followed by electrical energy.

Coal is used for generate the thermal energy in the plant. The quantity of coal required is based on the production capacity and the quality of coal. The electrical energy in the cluster is used to operate the electrical motors used in the machinery. The electrical energy is drawn from the AP Transco lines available near by the plants.

4.4 Refractory Manufacturing Equipments

Any product manufacturing industry requires equipments/machinery to produce the products. Refractories are made from different raw materials depending on their type and

quality. The refractory manufacturing industries requires the following machinery/equipments to produce the products.

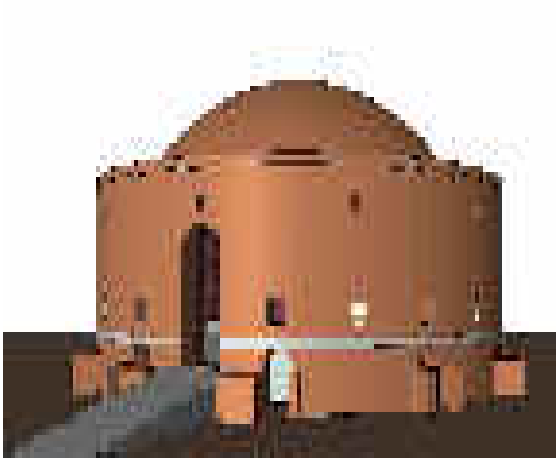
- Down Draft Kiln
- Crusher
- Pug Mill
- Clay Mixer
- Bal Mill

The brief details of each machinery/equipment use in manufacturing of refractory products located in East & west Godavari District of Andhra Pradesh are discussed below.

4.4.1 Down Draft Kiln

Down draft Kiln is a furnace used in refractory manufacturing industry to heat up the refractory material where under go chemical, physical reactions. These Down Draft kilns are used for all type of refractory including ceramic and bricks manufacturing.

The Down draft kilns are constructed using ordinary bricks, refractory bricks and clay. The shape of the kiln is round with roof mounted structure. These kilns have one or Two charging doors depending up on the requirement is provided in the structure for keep the material inside the kiln. The firing doors are provided in around the structure to supply the heat flames in side the kiln. Coal, Fire wood is used as a fuel in the DD kilns to generate heat flames. The generated heat from firing doors is spread across the kiln and heats up the material in side the kiln. The air required for the combustion of coal is drawn from natural draft circulation.



The dimensions of kiln is depends up on the production capacity of products to be manufactured. The dimensions of kilns used in East & west Godavari Refractory Cluster with different capacities are presented below.

Table 4.1 Details of DD Kiln

S.No	Particulars	Unit	Value
1	Diameter of kiln	Feet	21
2	Height up to Collar	Feet	14
3	Dom radius	Feet	7.5
4	Gate for Coal In	No	10
5	Material Gate	No	2
6	width of Wall	Feet	3
7	size of Man gate	Sq Feet	5.5*3
8	width of the Dom	Feet	1
9	Chimney	Feet	55
10	Production Capacity	Tons/Batch	200

4.4.2 Crusher

Crushers are used to reduce the size, or change the form for further use of material in production. Crushing process is one of the processes involved in refractory Manufacturing Industry. The procured raw material / other material is crushed in to required granular sizes before mixing with the other materials. For the Crushing the material Crusher is used to refine the size of raw material to required size. The Grog (Used refractory) is also crushed to small size using Crusher. The capacity of the crusher is depends upon the production capacity. These crushers are used to grain & size raw material up to 10-12mm size depending requirement of product manufactured.

The crusher is operated by motor and consumed electrical energy. The capacity of motor is depends upon crushed quantity of raw material.

4.4.3 Pug Mill

A pug mill is a machine with fast continuous mixer in which materials are simultaneously ground and mixed with a liquid. A continuous pug mill can achieve a thoroughly mixed, homogeneous mixture in a few seconds. Mixing materials at optimum moisture content requires the forced mixing action of the pug mill paddles, while soupy materials might be mixed in a drum mixer. A typical pug mill consists of a horizontal boxlike chamber with a top inlet and a bottom discharge at the other end, 2 shafts with opposing paddles, and a drive

assembly. Small quantity of water is added during the pug mill operation. The pug mill is used in Refractory bricks, ceramics and potteries manufacturing industries.

These parts are operated by electrical motors installed to operate the parts. The crushed raw material powder is fed in to pug mill along with the partial water for the proper mixing. The product from the pug mill is called unshaped refractory. The pug mill operated by electrical driven motors.

The pug mill capacity is based on the production capacity of the plant.

4.4.4 Clay Mixture

The clay mixture is also a machine where two or more material to be mixed thoroughly, homogenous. The clay mixture is operated by electrical driven motors. The crushed materials are fed into the clay mixture along with small quantity of water during the mixing. The product from the clay mixer is called unshaped refractory.

The clay mixture capacity is based on the production capacity of the plant.

4.4.5 Bal Mill

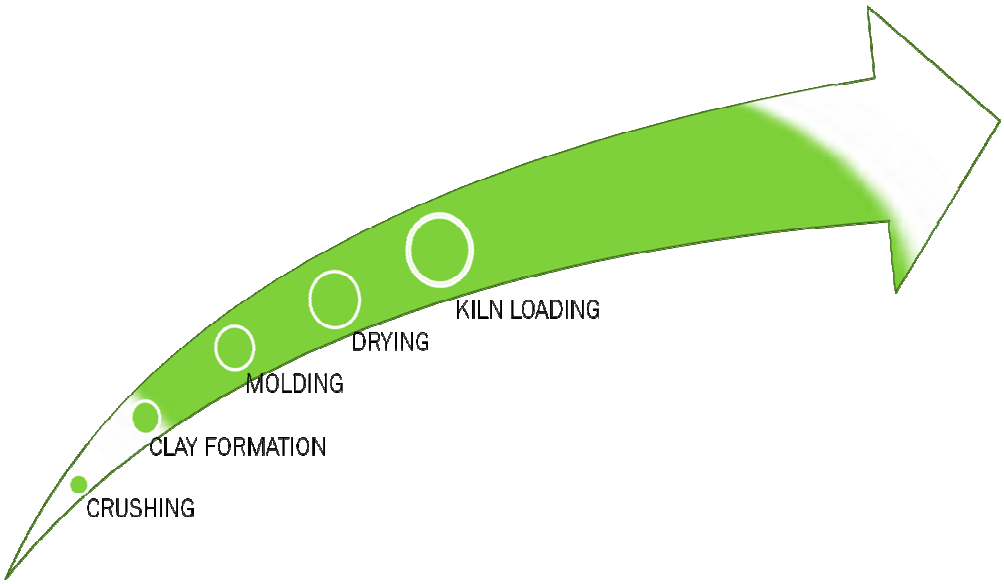
The Ball mill is also a machine where the raw material is used to crush up to 200 meshes. This machine is used in the refractory industries where the products required fine raw material up to 200 meshes. These ball mills are required in potteries, ceramics manufacturing industries which require fine powder form of material.

The ball required electrical energy to operate the motors. The capacity of Ball mill is depends up on the production capacity of the industry.

4.5 Production Process

The raw material Clay, refractory Grog and water is mixed manually and mixed by mixing machine with appropriate portion depending up on the product called unshaped refractory. The raw material Clay 60%, refractory Grog 40% and water is mixed manually and mixed by mixing machine. The refractory bricks are made from the raw material mix either prepared by manually (Hollow bricks) or in molding machines (Solid bricks). These bricks contain 4-20 % moisture content. The shaped refractory from the machines are dried with naturally sun dried or using fans for 2 to 3 days to remove the moisture content.

The less moisture content bricks are placed in to the kiln for slow firing/rapid firing. Initially slow firing done in the kiln for 4-7 days (48-72 hours) for removing the moisture content in the product. In the slow firing, for every one hour, about one shovel of coal (3.5 kgs) in each grate is burnt. The temperature is maintained between 100 – 200°C. During this period all the openings of the kiln are kept open. Damper is opened fully for 48-72 hrs operation.

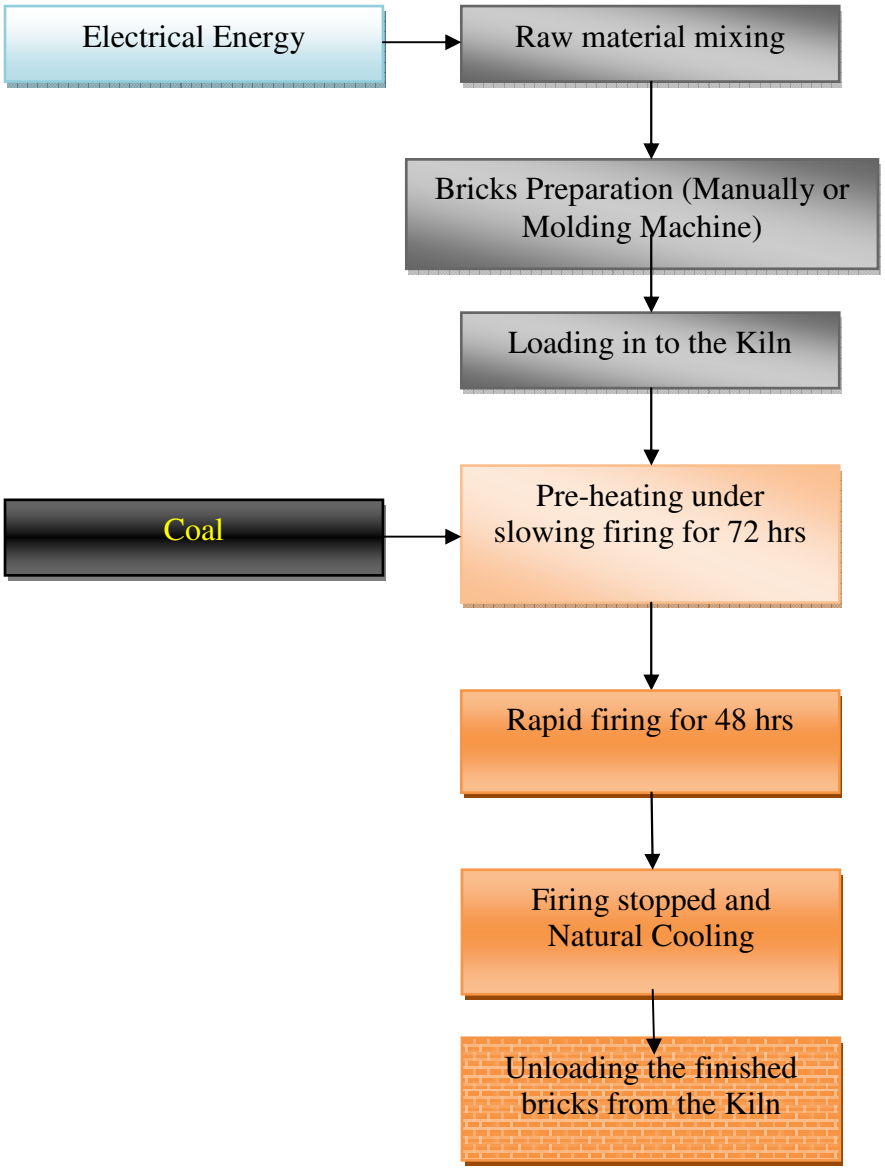


After 24 hrs operation of slow firing, firstly centre opening of kiln is closed. Subsequently 4 no's of top holes are closed after every 8 hrs. There are a total 24 no's of holes. At 48-72) hrs of preheating all the openings are closed (top and sides). After all holes are closed, 1 shovel is increased per hour. There are total 10 coal feeding points. Subsequently number of shovels is based on the temp to be maintained.

After 72 hours, the rapid/ full firing period is carried out for 48 hours and the temperature of the kiln is increased from 200 oC to 1050 oC. The coal is supply is around 7 to 9 shovels of coal per each grate for every one hour. Damper position is kept opened for about 25%. After completion of rapid / full firing, all the coal feeding points /grates are closed and firing is stopped subsequently damper also fully closed. Then the kiln is left for maintain the temperature (soaking) for 24 hours and then the kiln is taken for natural cooling and the bricks are unloaded after 24 hours of natural cooling.

The Process Flow diagram of Bricks manufacturing industry is as follows:

Figure4.1: Process Flow diagram Refractory Industry



The Refractory Bricks manufacturing process consists of following process involved to complete the one batch production.

- Crushing of Clay
- Crushing of Grog
- Unshaped refractory material formation
- Molding
- Drying
- Kiln Loading
- Slow firing
- Cooling
- Unloading of product from kiln

The details of process involved in manufacturing of refractory bricks /products are presented below:

4.5.1 Crushing

In the crushing process, the procured clay or Grog from the mines/ other sources is crushed in to required sizes by using crushers installed in the plant. This refractory material/ clay are used for preparation of unshaped refractory by using the clay mixer/ball mill. The used refractory material i.e. grog is also used for manufacturing of the refractory material which contains the material properties.

4.5.2 Unshaped Refractory Material formation

The crushed raw material i.e. Clay, crushed Grog is mixed with small portion of water in clay mixture/ ball mill for uniform mixture. The raw material is thoroughly mixed in the clay mixture/ ball mill. The product from the clay mixture/ ball mill is called unshaped refractory. This unshaped refractory material is used to prepare product by using molding press/ annual press for required shape.

4.5.3 Molding

The unshaped refractory material is then used in molding press /press/ manual to form required shape of product. The finished products from molds have moisture content. The shape of products are varies depending up on the requirement of client.

Drying

The shaped refractory contains moisture content. The moisture content in the shaped refractory is removed by natural drying i.e. sun drying or using fan. The drying process will take 2-3 days from the formation of shaped refractory.

4.5.4 Loading in to Kiln

The dried refractory material is placed into empty kiln by manually through the charging doors provided in kiln in order to heat flames are passing through it. The charging doors are closed after refractory material kept in the kiln by using refractory bricks, clay.

4.5.5 Slow firing

In the slow firing process, the heat is passed through the kiln using wood initially from the firing zones located in the kiln. After wood, coal is used for slow firing process to increase the inside temperature of the kiln. During the process the moisture content in the refractory material is removed completely by passing the heat. The slow firing process kept for 2-3 days depending up on moisture content and capacity of the products in refractory material.

4.5.6 Rapid Firing

After removal of moisture during the slow firing process, rapid firing process starts by supplying more coal to the firing gates in the kiln. During the rapid firing process, the refractory material undergoes physical and chemical changes. The final temperature

required during the process is up to 1200 C. During this temperature the refractory material heated up and formed finished product. This process required 48-36 hrs of operation depending upon the quantity of material inside the kiln.

4.5.7 Cooling

In the Cooling process the fired refractory material is kept for cooling to reduce the refractory material temperature from 1100 -1200 C to 50 C. This cooling process is done naturally or by forced air circulation. In the cooling process the cooling of the brick is done by supplying the air either naturally/ forced draft. Due to natural air circulation the cooling process will be more than 2 days depending up on the material inside the kiln and temperature of the material.

In all the kilns, the cooling process are done by circulating the air naturally i.e. holes provided in the kiln surface /forced draft air circulation.

4.5.8 Unloading

The cooled refractory product then withdrawn from the kiln by manually and kept for outside. This material then packed and marketed. The finished product is checked manually during the unloading. Any un burn/ cracks material is removed and finished refractory product sent for packing.

CHAPTER 5
ANALYSIS OF ENERGY USE AND OBSERVATIONS

5.1 Types of Energy Used

The following types of energy is used for refractory manufacturing industries in East & West Godavari District of Andhra Pradesh

- Thermal Energy
- Electrical Energy

The type of energy required for manufacturing the product is depends up on the requirement of the equipment/machinery. All the industries required thermal energy as major consumption and followed by electrical energy.

5.2 Energy Resources and Sources

The details of energy required in refractory manufacturing cluster in East & West Godavari District discussed below.

Thermal Energy

Thermal energy is required in refractory manufacturing Industries to heating up the refractory material up to 1200C. The following fuels are used in refractory cluster located in East & West Godavari District.

- Coal
- Wood

All the Down draft kilns are required thermal energy for heating the refractory material up to 1200 C. The source of thermal energy is form firing the coal and Wood in kiln. The details of fuel used and the specifications are presented below.

Table No: 5.1 Details of Thermal Energy Used in Refractories Cluster

S.No	Particulars	Unit	Coal	Wood
1	State of fuel	Solid/Liquid/gas	Solid	Solid
2	Type of Fuel	Name	Coal	Wood
3	Fuel Source	Name of Company	SCCL/CIL	Local suppliers
4	Calorific Value	Kcal/kg	3500	2000
5	Price of Fuel	Rs../Ton	3000	2000

None of the Industries are using other forms of energy for heating applications in Kilns. The coal is procured from the Singareni Colleries Company Limited (SCCL) and Coal India limited (CIL) and wood is from local suppliers. The required quantity of coal is procured from coal traders and suppliers.

Electrical Energy

Electrical Energy required in refractory manufacturing industries to operate the motors and prime movers installed. The source of electrical energy is from the Andhra Pradesh Eastern Power Distribution Company Limited (APEPDCL). The detail of supply and contract demand is based on the equipments installed in the Industries and presented below.

Table No: 5.2 Details of Electrical Energy Used in Refractories Cluster

S.No	Particulars	Details	
1	Type of Energy	Electrical	Diesel
2	Source of Energy	APNPDCL	Open Market
3	Type of Connection	LT	LT
4	Category	Type-1	-
5	Tariff	₹3.75/kWh	₹38.90/L

The power tariff from the APEPDCL is ₹ 3.75 per unit and the price of Diesel in open market is ₹38.90/L which is fluctuated time to time by the central govt.

5.3 Energy use & consumption analysis of Refractory Manufacturing Industries

The energy use & consumption analysis of different categories of refractory Industries are presented below. The categorization of refractory manufacturing industries in East & West Godavari is presented below.

Table No: 5.3 Categorization Refractory Plants

S.No	Installed capacity range	Category
1	Up to 50 Tones per Batch	I
2	50-100 Tones per Batch	II
3	100-200 Tones per Batch	III
4	Above 200 Tones per Batch	IV

5.3.1 Analysis of Energy use in Category –I Refractory Industries

The energy use and consumption of Category –I refractory Industries located in East & West Godavari mainly by coal, wood and electrical energy consumption. The following table gives about the energy consumption for Category-I refractory Industries.

Table No: 5.4 Energy Consumption & Profile of Category-I Refractory Industries

S.No	Particulars	Units	Total
1	No of refractory industries	No	9
2	Avg. production per batch	T/batch	44
3	Avg. Yearly Production per Industry	TPY	573
4	Total Production by Cat-I Industries	TPY	5160
5	Avg. Electrical Energy consumption by a Plant	kWh/Year	26015
6	Total Energy Consumption By cat-I Plants	kWh/Year	234135
7	Avg Coal consumption per Industry	T/Year	816
8	Total Coal Consumption by Cat-I Industries	T/Year	7346
9	Sp. Electricity consumption	kWh/Ton	45.37
10	Sp. Coal Consumption	Ton Coal/Ton Product	1.42

The average total electrical energy consumption by 9 refractory industries in Category –I (Up to 50 Tones per Batch) consumes 234,135 kWh/ year and sp. electricity consumption is calculated by above Industries is 45.37 kWh/Ton of product.

Where as the average total coal consumption by 9 refractory Industries in category-I type consumes 7,346 T/Year and sp. coal consumption is worked out to be 1.42 Ton of Coal/Ton of Product.

5.3.2 Analysis of Energy use in Category –II Refractory Industries

The energy use and consumption of Category –II refractory Industries located in East & West Godavari mainly by coal, wood and electrical energy consumption. The following table gives about the energy consumption for Category-II refractory Industries.

Table No: 5.5 Energy Consumption & Profile of Category-II Refractory Industries

S.No	Particulars	Units	Total
1	No of refractory industries	No	11
2	Avg. production per batch	T/batch	85
3	Avg. Yearly Production per Industry	TPY	737
4	Total Production by Cat-II Industries	TPY	8,110
5	Avg. Electrical Energy consumption by a Plant	kWh/Year	25,567
6	Total Energy Consumption By cat-II Plants	kWh/Year	281,235
7	Avg. Coal consumption per Industry	T/Year	962
8	Total Coal Consumption by Cat-II Industries	T/Year	10,585
9	Sp. Electricity consumption	kWh/Ton	34.6776
10	Sp. Coal Consumption	Ton of Coal/Ton of Product	1.31

The average total electrical energy consumption by 11 refractory industries in Category –II (from 50 to 100 Tones per Batch) consumes 281235 kWh/ year and sp. electricity consumption is calculated by above Industries is 34.68 kWh/Ton of product.

Where as the average total coal consumption by 11 refractory Industries in category-II type consumes 10585 T/Year and sp. coal consumption is worked out to be 1.31 Ton of Coal/Ton of Product.

5.3.3 Analysis of Energy use in Category –III Refractory Industries

The energy use and consumption of Category –III refractory Industries located in East & West Godavari mainly by coal, wood and electrical energy consumption. The following table gives about the energy consumption for Category-III refractory Industries.

Table No: 5.6 Energy Consumption & Profile of Category-III Refractory Industries

S.No	Particulars	Units	Total
1	No of refractory industries	No	7
2	Avg. production per batch	T/batch	134.29
3	Avg. Yearly Production per Industry	TPY	1860.00
4	Total Production by Cat-III Industries	TPY	13020.00
5	Avg. Electrical Energy consumption by a Plant	kWh/Year	27838.52
6	Total Energy Consumption By cat-III Plants	kWh/Year	194869.67
7	Avg Coal consumption per Industry	T/Year	1046.43
8	Total Coal Consumption by Cat-III Industries	T/Year	7325.00
9	Sp. Electricity consumption	kWh/Ton	14.97
10	Sp. Coal Consumption	Ton of Coal/Ton of Product	0.56

The average total electrical energy consumption by 7 refractory industries in Category –III (from 100 to 200 Tones per Batch) consumes 194870 kWh/ year and sp. electricity consumption is calculated by above Industries is 14.97 kWh/Ton of product.

Where as the average total coal consumption by 7 refractory Industries in category-III type consumes 7325 T/Year and sp. coal consumption is worked out to be 0.56 Ton of Coal/Ton of Product.

5.3.4 Analysis of Energy use in Category –IV Refractory Industries

The energy use and consumption of Category –IV refractory Industries located in East & West Godavari mainly by coal, wood and electrical energy consumption. The following table gives about the energy consumption for Category-IV refractory Industries.

Table No: 5.7 Energy Consumption & Profile of Category-IV Refractory Industries

S.No	Particulars	Units	Total
1	No of refractory industries	No	3
2	Avg. production per batch	T/batch	330
3	Avg. Yearly Production per Industry	TPY	6,250
4	Total Production by Cat-IV Industries	TPY	12,500
5	Avg. Electrical Energy consumption by a Plant	kWh/Year	30,954
6	Total Energy Consumption By cat-IV Plants	kWh/Year	61,908
7	Avg Coal consumption per Industry	T/Year	1,775
8	Total Coal Consumption by Cat-IV Industries	T/Year	3,550
9	Sp. Electricity consumption	kWh/Ton	4.95264
10	Sp. Coal Consumption	Ton of Coal/Ton of Product	0.28

The average total electrical energy consumption by 3 refractory industries in Category –IV (more than 200 Tones per Batch) consumes 61908 kWh/ year and sp. electricity consumption is calculated by above Industries is 4.95 kWh/Ton of product.

Where as the average total coal consumption by 3 refractory Industries in category-IV type consumes 3550 T/Year and sp. coal consumption is worked out to be 0.28 Ton of Coal/Ton of Product.

Note: The specific coal consumption in refractory industries mainly depends on type of DD kiln, efficiency and % utilization.

The Specific Electrical consumption is depends upon efficiency of equipment, environment, operating parameters and % utilization.

5.4 Summary of Energy Consumption

The summary of energy consumption for 30 refractory units studied during BEE-SME Program in Refractory Units are presented below based on data collected

Table 5.8 Summary of Electrical and Diesel Consumption in 30 Ice Plants

S. No	Cate-gory	No	Plant Wise Details (Yearly)			Total Plants Details (Yearly)			Specific Energy Consumption (ton of Product)	
			Produ-ction(T)	Coal (T)	Electr-icity (kWh)	Produ-ction(T)	Coal (T)	Electr-icity (kWh)	Coal (Tons)	Electr-icity(kWh)
1	I	9	573	816	26015	5160	7346	234135	1.42	45.38
2	II	11	737	962	25567	8110	10585	281235	1.31	34.68
3	III	7	1860	1046	27839	13020	7325	194870	0.56	14.97
4	III	3	6250	1775	30954	18750	5325	92862	0.28	4.95
	Total	**30**	**9420**	**4599**	**110375**	**45040**	**30581**	**803102**		

Fig 5.1 Energy consumption Details-Plant Wise for Different Categories

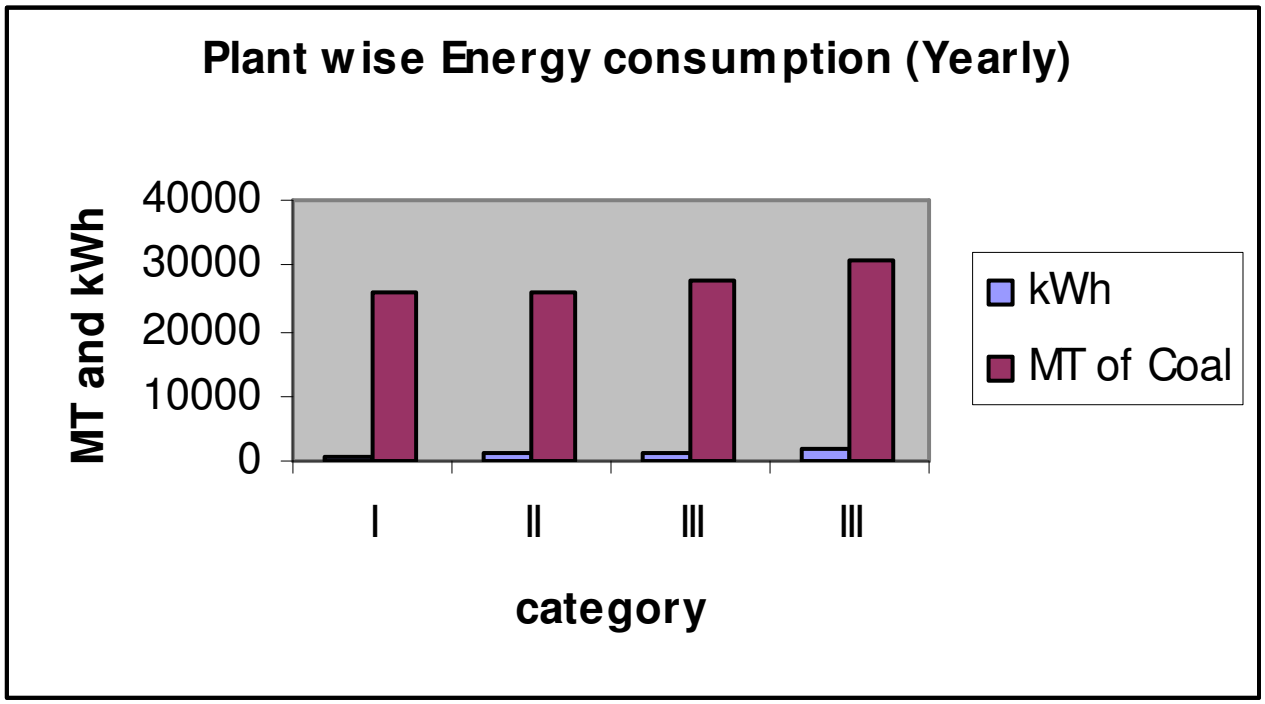


Fig 5.2 Production details of Category Wise plants

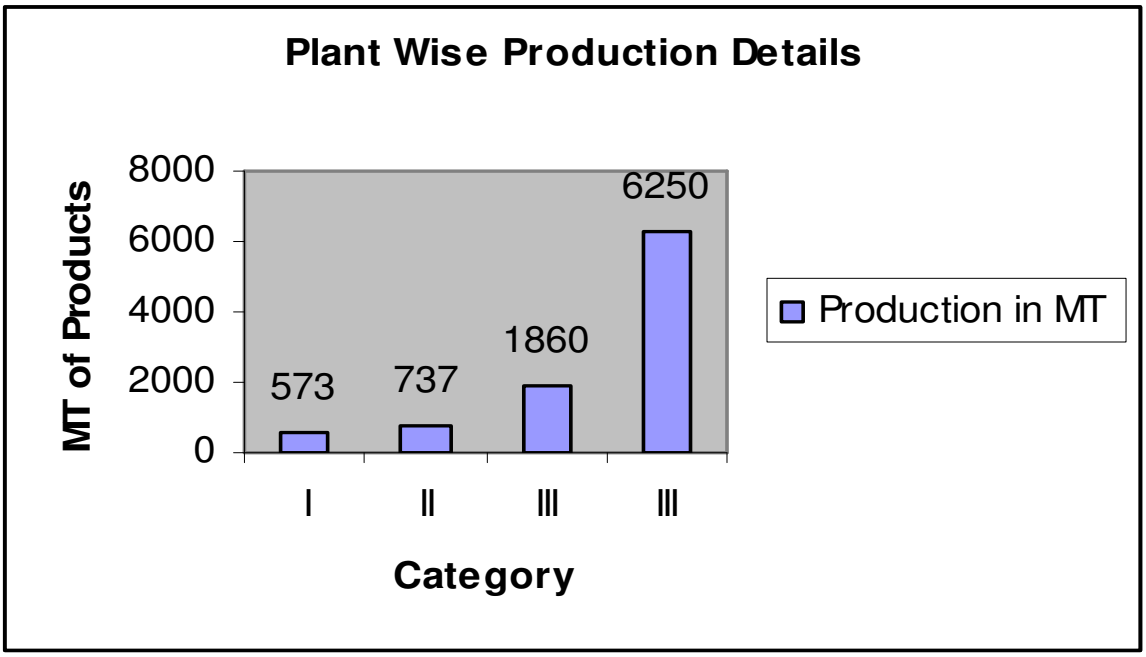


Fig 5.3 Total consumption Details -Category Wise for 30 Industries

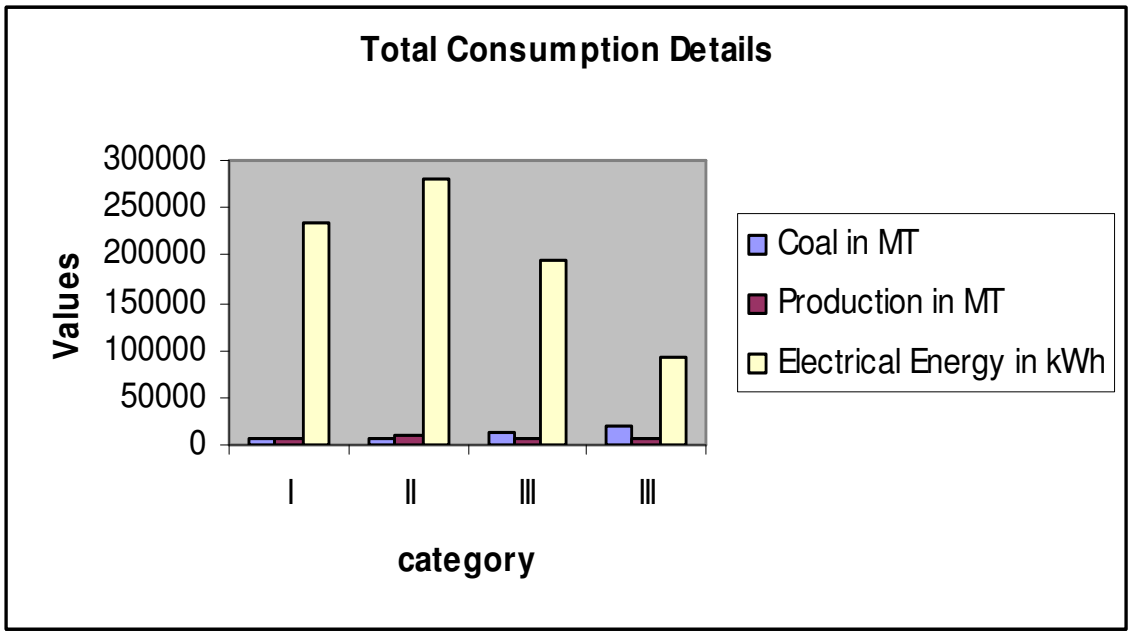
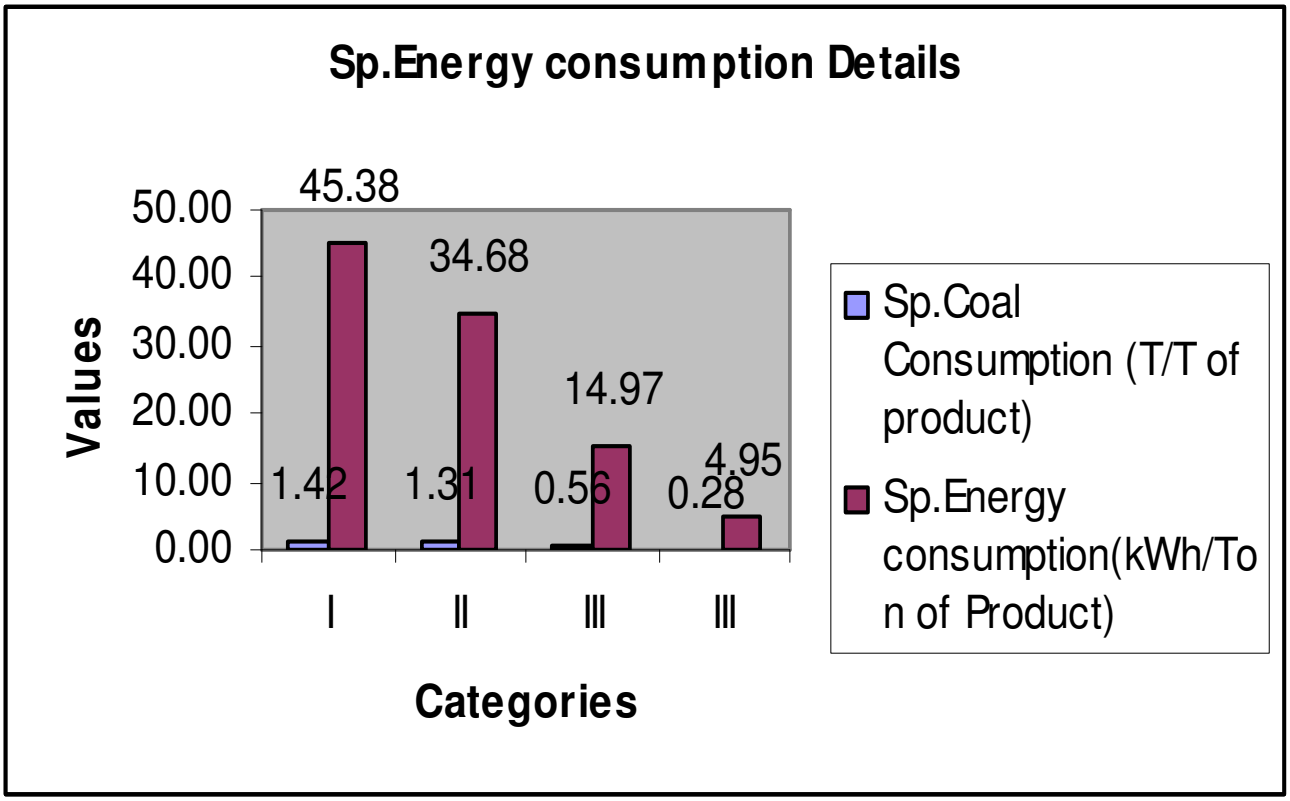


Fig 5.4 Specific Energy Consumption Details in different Categories



The total electrical energy consumption by 30 refractory Industries is about 8 lakhs kWh/ year, coal consumption is about 30581 MT/ year and total production is 45040 MT.

Note: The energy consumption in the refractory Industries depends up on DD kiln efficiency, % utilization and type of products manufactured.

5.5 Availability of Energy resources

The availability of energy resources in cluster level is assed based on the information collected from different sources and suppliers in the cluster. **Table5.9**. give about the energy consumption details of various energy sources is provided.

Table 5.9: Energy Consumption and Availability in Cluster

S. No	Type of Fuel	Units	Quantity/year	Availability
1	Electricity	kWh	8 lakhs kWh	Available from DISCOMS
2	Coal	MT	30581	Available form SCCL and CIL and Traders

The total Electrical energy consumption in 30 Industries in the cluster is 8 lakhs kWh/ year and power tariff is ₹3.75 /kWh. The power is supplied from APEPDCL through DISCOMs. The coal consumption by 30 Industries in the cluster is 30581 MT per year and coal is procured from SCCL by allotting the licenses from the Industries department and also open market and traders available in Rajamundry.

5.6 Factors Effecting in Energy Consumption

The following factors effects in Industries for higher energy consumption.

Efficiency of Kiln

The efficiency of kiln in refractory industries plays a vital role in coal consumption. All refractory industries are age old construction and consumption more coal for the same out put of product. The reason behind high energy /coal consumption is due to heat loss from surfaces, incomplete combustion, inferior quality of raw material and operating parameter. Normally the DD kiln efficiency is around 45% which is higher side. But during the observation the kiln efficiencies are in between 20-25 % in all 30 units. This will effect the higher energy consumption.

Capacity utilization

The capacity utilization is one of the factors for high energy consumption in refractory Industries. The refractory Industries located in East & West Godavari is depends upon the market requirements. Based on market requirements the refractory industries are producing 30-36 Batch of product and remaining days in between the operations are kept ideal. Due to this reason the heat in kiln is wasted and consumes more coal wile in fresh operation

Electrical Equipments

The electrical equipments in refractory Industries are mainly crusher's followed by ball mill, clay mixture and pug mill. The environment in refractory industries are dusty in nature due to operation of crushers, clay etc. the efficiency of motors in above equipments decrease in dusty operation.

Another factor of equipments for higher energy consumption is efficiency of motors operated in those equipments. The old and re winded motors consumes high energy consumption.

Skilled and UN Skilled Man Power

Majority of the equipment operators and helpers deployed in cluster units are non technical and illiterates and had been taken based on 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.

5.7 Technology Gap Analysis

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.

All refractory manufacturing Industries required kiln for heating of refractory material. The design and construction of kiln is manufactured locally. The sp. coal consumption depends on mainly by kiln efficiency.

There is a tremendous need for the industry to modernize/upgrade its technology and adopt energy efficient technologies in some of the areas. There are many technologies and energy efficient equipments available in the market which can be sourced from local service providers dealing in these technologies. Further, as per the discussions made with the management, they are interested to adopt the energy efficient motors in their refractory Industries.

During the study of Energy use and technology audit in refractory industries, energy efficient motors, waste heat recovery systems and gasification are found to be feasible and energy efficient in the cluster. It requires only a retrofit of equipments 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.

The following Technology Gaps are identified during the energy use and Technology Audit.

5.7.1 Energy Efficient Motors

The Motors installed in refractory Industries for the operation of crushing, pressing and ball mill are in efficient motors which found between 75-90% operating Efficiency and few motors are several times re winded. The reasons for such low efficiencies are mainly due to dusty environment, re winded and low efficiency of motors.

Now a days energy efficient motors are available at least 95 % of efficiency in the market with latest technology. By implementing the energy efficient motors in crushers, ball mill, clay mixture, pug mill and mold pres, there will be tremendous energy savings in Refractory industries.

5.7.2 Gasification Process

The operating thermal efficiency of the present traditional down draft kiln is only 10.1%, due to poor combustion efficiency, no proper air circulation, and high un burnt coal. Further, the heat treatment of the refractory bricks with coal is costly and the efficiency is also low. The biomass is available in plenty in the area and also easily available. As a long term option, it is recommended to install biomass gasifier system for supplying heat to the down draft kiln.

Biomass Gasification

Gasification is the process of converting solid fuels to gaseous fuel. It is not simply pyrolysis; pyrolysis is only one of the steps in the conversion process and is combusted with air (partial supply of air) and reduction of the product of combustion, (water vapour and carbon dioxide) into combustible gases, (carbon monoxide, hydrogen, methane, some higher hydrocarbons) and inerts, (carbon dioxide and nitrogen). The process produces gas with some fine dust and condensable compounds such as tar.

The producer gas generated is used for thermal application and heat generated by combustion of biogas is used for various heating purposes. Like other gaseous fuels, producer gas can also controlled critically. This also paves way for more efficient and cleaner operation. The producer gas can be conveniently used in number of applications as mentioned below.

Wood Gasifier

This system is meant for biomass having density in excess of 250 kg/m3. Theoretically, the ratio of air-to-fuel required for the complete combustion of the wood, defined as theoretical air required for combustion is 6:1 to 6.5:1, with the end products being CO2 and H2O.

Whereas in gasification system, the combustion is carried out at sub-stoichiometric conditions with air-to-fuel ratio of 1.5:1 to 1.8:1. The product gas thus generated during the gasification process is combustible. This process is made possible in a device called gasifier with limited supply of air. A gasifier system basically comprises of a reactor where the gas is generated, and is cooled, cleaned and is burned. The clean combustible gas generated can be used for power generation in diesel-generators or for thermal use by directly supplying to the combustor through an ejector.

It is estimated that a minimum of 25% to 30% of the present coal consumption savings can be reduced due to the following reasons:

- Improved combustion
- Better control of the kiln temperature and reduces over heating
- Less radiation losses from the grate
- The fuel feeding can be critically controlled
- Less flue gas losses

5.7.3 Waste Heat Recovery system

The waste heat recovery system is one utilize generated flue gas during the operation of Industry. The flue gas from chimney has high temperature which can be used for heating of the stocks and raw material.

So, it is recommended to install waste heat recovery system for pre-heating the refractory bricks for removing moisture content by using heat in waste flue gases. The ambient air is supplied to the heat exchanger by blowers and heat is recovered from the flue gases. The heated air is used for pre-heating of the refractory bricks.

CHAPTER 6
ENERGY CONSERVATION TECHNOLOGIES

6.1 Introduction

In Refractory manufacturing cluster, it is essential to adopt energy efficient technologies that can be minimize energy consumption both electrical and coal consumption. During the energy use and technology audit in 30 refractory Industries located in East & West Godavari, the following energy efficient technologies are identified to reduce energy consumption in Refractory Industries both Electrical and Thermal energy. They are

1. Waste Heat recovery System for Raw material Heating
2. Biomass Gasification process
3. Energy Efficient motor for Crushers
4. Energy Efficient motor for Clay Mixture
5. Energy Efficient motor for Pug Mill
6. Energy Efficient motors for Mold press
7. Energy Efficient motor for Ball Mill

6.1.1 Install Waste Heat Recovery from Flue gas for raw material Heating

Installation of Waste heat recovery system to recover the heat from flue gas generated during kiln operation. All Refractory Industries are using kilns for the process of refractory material. During the slow and rapid firing process involved in kiln operation by consuming coal as fuel, the flue gas is generated during the operation. The temperature of flue gas is 700 to 800C which can be recovered and reuse in industry for heating of raw bricks.

The details of Technical and Financial viability of installing Waste Heat recovery System in Refractory industries in East& West Godavari is discussed below.

Background

All Refractory manufacturing Industries located in East & west Godavari installed DD Kilns for production of Refractory Bricks, ceramic jars, potteries etc. These kilns are in operation throughout the year based on production requirements. The major energy consumption in refractory Industries are thermal energy which is produced using coal. During the operation kiln at slow firing and rapid firing, flue gases are generated which has higher temperature is passed through the chimney with out use.

The higher temperature flue gas is not using for any other applications in industries. This high temperature gas is recovered the heat by using waste heat recovery system in industries which can be used for heating applications. By using waste heat recovery system, the efficiency of the kiln will increase and energy is saved.

Energy Conservation Potential

By installing the Waste Heat recovery system in Refractory industries, heat is recovered from 700-800C to 200C. This heat can be used for raw material heating application which has moisture content. The capacity of Waste Heat recovery system is depends up on the flue gas generation and Installed capacity of kiln.

Technical Specifications

The Technical Specification of proposed Waste heat Recovery System with 1000 kg/hr capacity is presented below.

Table: 6.1 Technical Specifications of Waste Heat Recovery System

S. No	Parameter	Unit	Value
1	Type of WHR		Heat Exchanger
2	Quantity of Flue gas Flow	Kg/hr	1000
3	Temperature of Flue gas (In)	C	690
4	Temperature of Flue Gas(Out)	C	210
5	Blower capacity	HP	5

Fig No 6.1 Waste Heat Recovery system form Flue gas

Availability of Technology /Equipment

Waste Heat Recovery Systems are available for various applications in India. The waste Heat Recovery systems for recovery of heat from flue gas was installed various industries in Indian industries.

The Waste Heat Recovery Systems are available and manufacturing in India by the few major companies. These companies are marketing their products through directly in India and Andhra Pradesh. Majority suppliers for these equipments are located in capital cities in India. Refractory Manufacturers can avail these equipments by ordering.

The details of manufacturers and suppliers of waste Heat recovery systems in India presented in Annexure-1.

Cost Benefit Analysis

Any Energy conservation/Efficient Improvement proposal/project requires cost benefit analysis before implement in industries. Based on observations and measurements taken from refractory Industries during Energy Use and Technology Audit the cost benefit analysis was calculated for implementation of Waste Heat Recovery System in refractory Industries.

Table 6.2 Cost Benefit Analysis for Waste Heat Recovery System

S.No	Particulars	Units	Value
1	Quantity of Coal Consumption	kgs/batch	13000
2	Excess air measured	%	30
3	Theoretical Air required	kg/kg	8.5
4	Actual air quantity supplied	kg/kg	11.05
5	Total Quantity of flue gases	kgs/batch	156650
6	Average temperature of flue gases	oC	690
7	Temperature of flue Gas after WHR	oC	210
8	Specific heat of flue gases	Kcal/kg oC	0.29
9	Waste heat recovery potential	Kcal/batch	21805680
10	Equivalent coal savings	kgs/batch	5192
11	No. of batches per annum	No	24
12	Coal savings per annum	Kgs/annum	124604
13	Coal savings per annum	Tons/annum	124.6
14	Coal cost	Rs./ton	3500
15	Monetary savings	Rs. lakhs/annum	4.4
16	Investment required for WHR	Rs. lakhs	5
17	Electricity consumption of the blower	kWh	10656
18	Electricity bill	Rs./year	0.43
19	Net monetary savings	Rs. Lakhs/year	3.9
20	Payback period	Years	1.27

From the above table, Installing Waste Heat Recovery System in Refractory Industries with capacity of handling 156650 kg/Bach flue gas, total energy savings due to WHR is 21805680 kcal /Batch which is equivalent of 124 ton of coal per year. The total investment required to implement for Installing WHR is Rs.5 Lakhs and Payback period is observed 1.27 Years if the plant produce 24 batches in year.

Life Cycle Cost

The Life Cycle Cost of Waste Heat Recovery system is calculated based on operating cost, equipment life and maintenance etc. The following table provides details of life cycle cost of Waste Heat Recovery System in Refractory Industries.

Table 6.3 Life Cycle Cost of Waste Heat Recovery system

S.No	Particulars	Units	Value
1	Waste heat recovery potential	Tons/batch	21805
2	No. of Batches per year	No	24
3	Quantity of flue gas	Tons/batch	393
4	Capital Cost	Rs	500000
5	Replacement of components for 5 years	Rs	50000
6	Annual Maintenance	Rs	15000
7	Life of WHR	Years	15
8	Interest rate	%	10
9	LCC at the end of life	Rs	653380

The life cycle cost of Waste Heat Recovery system for Installing in Refractory Industry is estimated at Rs.6.53lakhs

Implementation Cost

Another parameter for implementation of Energy conservation proposals/project is implementation cost. The implementation cost of the energy conservation project will be depending up on erection, civil works, retrofitting costs etc.

The implementation cost for installing waste Heat recovery system with capacity of 2000 m3/hr flue gas in refractory Industry is calculated based on civil, mechanical, erecting, and replacement cost . The implementation cost of Installing Waste Heat Recovery System in Refractory Industry is presented below.

Table 6.4 Implementation Cost for Waste Heat Recovery system

S.No	parameter	Cost in Rs.lakhs
1	Plant and Machinery	5
2	Civil Works	0.5
3	Electrical works	0.1
4	Erection and Commissioning	0.75
5	Miscellaneous costs	0.5
6	Total Cost	6.85

The Implementation cost for installing Waste Heat recovery System in Refractory Industry is estimated at Rs.6.85 Lakhs.

Recommendations

All Refractory Industries uses kilns of manufacturing different refractory material products. During the operation of kilns by consuming coal as fuel, waste heat gases are generated. This gas having high calorific value of heat and can be reuse for heating applications. So, all refractory industries located in East & West Godavari can implement Waste Heat Recovery system for reuse of flue gas heat.

The capacity of Waste Heat Recovery System is based on the flue gas generation from Chimney which is depends up on the capacity of kiln and quantity of coal consumed during the operation of kiln.

Benefits

The following benefits can be expected by Installing Waste Heat Recovery system in Refractory Industries.

- Waste Heat Gas Is used for Heating of Raw material
- Reduction in environment Pollution
- Coal Savings due to removing from raw material before kiln operation
- Reduction in Energy consumption
- Reduction in Coal consumption leads to reduce the GHG emissions

Limitations

There is no limitation for Installing Waste Heat Recovery System in refractory Industries located in East & West Godavari

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.

6.1.2 Installing Biomass Gasifiers in Refractory Industry

The Refractory Manufacturing Industries required thermal energy for heating of raw material. At present the supply of heat by consuming coal in kiln. By using inferior quality of coal and heat loss due to fuel, bio mass Gasification is one of the best option for refractory Industries. Using Bio Mass gasifiers in refractory industries same temperature will supply to kiln operation with little modifications/installations.

Background

All Refractory manufacturing Industries located in East & west Godavari installed DD Kilns for production of Refractory Products. These kilns are in operation throughout the year and coal is used as a fuel. No other forms of energy used in operations.

The fuel is supplied for generation of thermal energy to kiln during slow and rapid firing process. During the slow firing process, limited coal, wood is supplied and in rapid firing more quantity coal is supplied with out identification of temperature. The control of fuel supply is difficult to the operator time to time operation of kiln during slow and rapid firing. Wood gasifiers are one of the Technologies available and implemented in several industries in India.

Energy Conservation Potential

Wood gasifiers are one technology in implementation in refractory industries to conserve energy and environment. The cost of Biomass is cheaper than coal cost. The biomass gasifier is required briquettes made by any waste i.e. stacks, saw dust, coco nut sells, and municipal waste etc.

The Biomass gasifiers having higher efficiency and clean energy , to saving due to implementation in refractory industries are as below.

Technical Specifications

Table: 6.5 Technical Specifications of Wood gasifiers

S. No	Parameter	Unit	Value
1	Capacity of Gasifier	Ton/Day	5
2	Fuel		Biomass
3	Temperature of Producer gas	C	1200-1500
4	Calorific Value of Wood	Kcal/kg	2000
5	Power Requirement	HP	5

Fig.6.2 Wood gasifiers

Availability of technology /equipment

Wood gasifiers are available for various applications in India. The waste Heat Recovery systems for recovery of heat from flue gas was installed various industries in Indian industries. The Bio mass Gasifiers are available and manufacturing in India and Andhra Pradesh by the few major companies. These companies are marketing their products through directly in India and Andhra Pradesh. Majority suppliers for these equipments are located in cities in India. Refractory Manufacturers can avail these equipments by ordering.

The details of manufacturers and suppliers of waste Heat recovery systems in India presented in Annexure-1.

Cost Benefit Analysis

Another factor for any implementing Energy Conservation proposal is Cost benefit analysis. The cost benefit analysis of installing Bio mass gasifier in refractory manufacturing Industries are presented below.

Table 6.6 Cost Benefit Analysis of Bio mass gasifier

S.No	Parameter	Unit	Value
1	Installed Capacity	Tons/batch	50
2	Coal consumption during rapid firing	Tons/batch	17
3	Cost of coal	Rs./Ton	3600
4	Fuel cost	Rs/batch	61200
5	Wood consumption in gasifier	tons/batch	22.95
6	Cost of wood	Rs./batch	2000
7	Wood cost	Rs/batch	45900
8	Electricity cost for Operation of gasifier	Rs./batch	710.4
9	Total energy cost	Rs./batch	46610
10	Savings due to gasifier System	Rs/batch	14590
11	No. of batches	batchs/year	24
12	Total Energy Savings cost	Rs.lakhs/Year	3.5
13	Investment	Rs.lakhs	18.0
14	Payback period	years	5.1

From the above table it is observed that Installing biomass Gasifer System in refractory Industries, The total savings due to Fuel is Rs. 3.5 lakhs/Year for 24 batchs /year production. The Investment required for gasifier system is Rs. 18.00 lakhs and pay back period is 5.1 Years.

Life Cycle Cost

The Life Cycle Cost of Bio mass gasifier is estimated based on the life, maintenance cost, and operating parameters. The following table provides details of life cycle cost of Biomass gasifier.

Table 6.7 Life Cycle Cost of Biomass gasifier

S.No	Particulars	Units	Value
1	Installed capacity of Industry	Tons/batch	50

S.No	Particulars	Units	Value
2	No. of Batches per year	No	24
3	Coal Consumption	Tons/batch	17
4	Wood Consumption in gasifier	Tons/batch	23
5	Capital Cost	Rs	18.0
6	Operation cost	Rs	0.1
7	Annual Maintenance	Rs	0.54
8	Life of Gasifier	Years	15
9	Interest rate	%	10
10	LCC at the end of life	Rs	27

It is observed that life cycle cost of Biomass gasifier for Refractory Industry is estimated at Rs.27.00 Laks.

Implementation Cost

Another major parameter for implementation of Energy conservation proposals/project is implementation cost. The implementation cost of Biomass gasifier is estimated based on erection, civil works and retrofitting cost etc.

Table 6.8 Implementation Cost of Biomass gasifier

S.No	Parameter	Cost in Rs.lakhs
1	Plant and Machinery	18.0
2	Civil Works	1.8
3	Electrical works	0.36
4	Erection and Commissioning	1.44
5	Miscellaneous costs	0.36
6	Total Cost	22.0

The implementation cost for installing Biomass gasifier is estimated at Rs.22.00 Lakhs

Recommendations

All Refractory Industries uses kilns of manufacturing different refractory material products by using coal as fuel. To biomass is substitute for coal which is cheaper than coal and other environmental benefits.

The capacity of Biomass Gasifier is depends up on the capacity of kiln and heat required at Installed capacity of products.

Benefits

The following benefits can be expected by installing Biomass Gasifier systems in Refractory Manufacturing Industries located in East & west Godavari. They are

- Cheaper Fuel Cost
- Higher Efficiency
- Clean Fuel
- Easily Control of temperature in kiln
- Reduce energy consumption
- Reduction in GHG emissions

Limitations

There is no limitation to Install Biomass gasifier systems in Refractory Manufacturing Industries irrespective of Installed Capacities existing.

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.

6.1.3 Install Energy Efficient Motor in Crushers

Installation of Energy Efficient Motor in Crushers is one of the Technology/equipment identified in Refractory manufacturing Industries located in East & West Godavari Districts of Andhra Pradesh to reduce energy consumption.

The details of Technical and Financial viability of replacing energy efficient motor in crusher with existing inefficient motor in Refractory Manufacturing cluster at East & West Godavari is discussed below.

Background

All refractory Manufacturing Industries using Crushers for preparation of unshaped Refractory material. Crushers are operation in refractory Industries to crush the raw material like clay, Grog etc to make the products. The crushers are operated by inbuilt motors to rotate the blades. The crusher operations in refractory Industries are daily about 10-12 hrs for making unshaped refractory material. The environment in crusher area is dusty which will affect the efficiency of motors and other parts in machinery. If the Crusher motor is inefficient the power consumption will be high.

To conserve electrical energy during crusher operations, install energy efficient motor to crusher motor which has higher efficiency and withstand even dusty operation.

During the energy use and technology audit in Refractory Manufacturing Industries all Crusher motors are normal efficiency compare to energy efficient motors. To reduce the power consumption, it is essential to replace energy efficient motor.

Energy Conservation Potential

The Energy Efficient Motor (EEF1) has higher efficiency while operating in part & full load and dusty operating conditions comparing with inefficient or EEF2 motor. The efficiency of EEF1 i.e.95% is more than that of normal motor i.e.85-90%. If efficiency of motor increases, power consumption will reduce at both part and full load conditions. By replacing energy efficient motor in Crusher motor in Refractory Industries at least 8-10% energy savings is possible.

Technical Specifications

The Technical Specification of 10 HP energy efficient motor is presented below.

Table: 6.9 Technical Specifications of Energy Efficient Motor for Crusher

S.No	Parameter	Unit	Value	Value
1	Capacity of Motor	HP	10	20
2	Type of Motor	Name	Induction	Induction
3	Motor power	kW	7.7	15
4	Rated Current	A	13.8	26.5
5	Voltage	V	415	415
6	PF	%	0.84	0.86
7	Frequency	Hz	50	50
8	Efficiency at ½ Load	%	88.5	91
9	Efficiency at ¾ Load	%	90.1	91.8
10	Efficiency at full load	%	90.1	91.8

Fig 6.3 Energy Efficient Motors for Crushers

It is observed that the efficiency of the energy efficient motor has higher efficiency compared to the existing motor in Crusher motors.

Availability of Technology /Equipment

The Energy Efficient Motors are available and manufacturing in India by the many companies. These companies are marketing their products through directly or dealers with in Andhra Pradesh. Majority dealers/ suppliers for these equipments are located in Hyderabad, Vijayawada and few in Rajamundry. Owners from Refractory Industries can avail these equipments by placing order from near by places i.e. Vijayawada / Hyderabad / Rajamundry.

The details of manufacturers and suppliers marketing these energy efficient motors are presented in Annexure-1.

Cost Benefit Analysis

The Cost benefit analysis for replacing energy efficient motor in crusher is presented below. Based on observations and measurements taken from refractory Industries, the cost benefit analysis for replacing energy efficient motor with existing inefficient / re winded motor in crushers are calculated and presented below.

Table 6.10 Cost Benefit Analysis of Energy Efficient Motor for Crushers

S.No	Parameter	Unit	Existing Motor	EEF1 Motor	Existing Motor	EEF1 Motor
1	Connected Load	HP	10	10	20	20
2	Connected Load	kW	7.46	7.46	15	15
3	motor Efficiency	%	80	90	80	92
4	Loading	%	85	85	85	85
5	Working hours	hr/Day	10	10	10	10
6	Working Days	Days/year	200	200	200	200
7	Measured power	kW	7.93	7.05	15.85	13.78
8	Annual Power consumption	kWh	15853	14091	31705	27570
9	Power tariff	Rs./kWh	3.75	3.75	3.75	3.75
10	Total Energy cost	Rs	59447	52842	118894	103386
11	Energy Savings Due to EE Motor	kWh/Year	1761		4135	
12	Cost of Energy savings	Rs./Year	6605		15508	
13	Investment Cost	Rs	20168		45671	
14	Payback Period	Years	3.05		2.95	

From the above table in case of

- Replacing 10 HP energy efficient Crusher motor with existing 10 HP inefficient/ re winded motor, total energy savings is 1761 kWh/ year and savings in power bill will be Rs. 6605 /year. The total investment required to implement the EEF1 motor is Rs. 20,168 and pay back period will be with in 3.05 years.
- Replacing 20 HP energy efficient crusher motor with existing 20 HP inefficient/ re winded motor, total energy savings is 4135 kWh/ year and savings in power bill will be Rs.15508 /year. The total investment required to implement the EEF1 motor is Rs.45,671 and pay back period will be with in 2.95 years.

Life Cycle Cost

The Life Cycle Cost of Energy Efficient Motor (EEF1) is estimated based on the life, maintenance cost, and operating parameters of crushers. The following table provides details of life cycle cost of Energy Efficient Motor (EEF1).

Table 6.11 Life Cycle Cost of Energy Efficient Motor for Crusher

S No	Particulars	Units	Value	Value
1	Motor Rating	HP	10	20
2	Rated power	kW	7.5	14.9
3	Capital Cost	Rs	20168	45671
4	Annual Maintenance	Rs	1008	2284
5	Motor life	Years	20	20
6	Interest rate	%	10	10
7	LCC at the end of life	Rs	28580	64709

From the above table it is observed that:-

- The life cycle cost of 10 HP energy efficient motors for replacing in crushers is estimated at Rs.28,580.
- The life cycle cost of 20 HP energy efficient motors for replacing in crushers is estimated at Rs.64,709.

Implementation Cost

Another major parameter for implementation of Energy conservation proposals/project is implementation cost. The implementation cost of replacing energy efficient motors in crushers is estimated based on erection, civil works and retrofitting cost etc.

The implementation cost of replacing EEF1 motor with inefficient and re winded Motor are presented below.

Table 6.12 Implementation Cost of Energy Efficient Motor for Crushers

S.No	Parameter	Cost in Rs.	Cost in Rs.
1	Capacity of motor	10HP	20HP
2	Plant and Machinery	20168	45671
3	Civil Works	2017	4567
4	Electrical works	1008	2284
5	Erection and Commissioning	3025	6851
6	Miscellaneous costs	403	913
7	**Total Cost**	**26622**	**60286**

From the above table it is observed that:-

- The implementation cost of 10 HP energy efficient motors for replacing in crushers is estimated at Rs.26,622.
- The implementation cost of 20 HP energy efficient motors for replacing in crushers is estimated at Rs.60,286

Recommendations

All Refractory Manufacturers in East & West Godavari Districts required and utilizing Crushers for raw material crushing.

All most all refractory Industries are installed inefficient Motor at the time of erection and some are using several time re winded motors. In such Industries can opt for install energy efficient motor for Crushers. The time required to replace EEF1 motor with existing motor requires one week and energy savings starts from the time of operation.

The identified Energy Efficient Motor (EEF1) can be use in different categories refractory Industries in the cluster depending upon motor capacity.

Benefits

The following benefits can be expected while installing Energy Efficient Motor with the existing the normal efficient motor /re winded motor.

- Less Maintenance Cost
- Low Running Cost
- Reduction in Energy consumption
- Less break downs
- Reduction in energy consumption leads to reduce the GHG emissions

Limitations

There is no limitation for replacing Energy Efficient Motor s (EEF1) with the existing inefficient and re winded 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.

6.1.4 Install Energy Efficient Motor in Clay Mixtures

Installation of Energy Efficient Motor in Clay Mixtures is one of the Technology/equipment identified in Refractory manufacturing Industries located in East & West Godavari Districts of Andhra Pradesh to reduce energy consumption.

The details of Technical and Financial viability of replacing energy efficient motor in Clay Mixtures with existing inefficient motor in Refractory Manufacturing cluster at East & West Godavari is discussed below.

Background

All refractory Manufacturing Industries using Clay Mixtures for preparation of unshaped Refractory material. Clay Mixtures are operation in refractory Industries to mix the different clays with required quantity along with small quantity of water. The Clay Mixtures parts are operated by inbuilt motors to rotate the rotors. The operating hours of Clay Mixtures in refractory Industries are daily about 10-12 hrs for making clay mixtures. The environment in crusher area is dusty which will affect the efficiency of motors and other parts in equipments. If the Clay Mixtures motor is inefficient the power consumption will be high.

To conserve electrical energy during Clay Mixtures operations, install energy efficient motor to Clay Mixtures motor which has higher efficiency and withstand even dusty operation.

During the energy use and technology audit in Refractory Manufacturing Industries all Clay Mixtures motors are normal efficiency compare to energy efficient motors. To reduce the power consumption, it is essential to replace energy efficient motor.

Energy Conservation Potential

The Energy Efficient Motor (EEF1) has higher efficiency while operating in part & full load and dusty operating conditions comparing with inefficient or EEF2 motor. The efficiency of

EEF1 i.e.95% is more than that of normal motor i.e.85-90%. If efficiency of motor increases, power consumption will reduce at both part and full load conditions. By replacing energy efficient motor in mixtures motor in Refractory Industries at least 8-10% energy savings is possible.

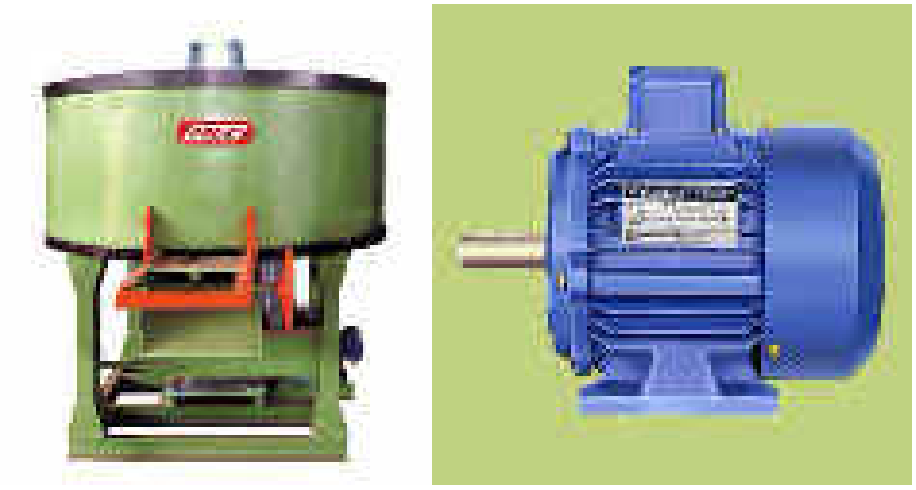
Technical Specifications

The Technical Specification of 7.5 and 10 HP energy efficient motor is presented below.

Table: 6.13 Technical Specifications of Energy Efficient Motor for Clay Mixtures

S.No	Parameter	Unit	Value	Value
1	Capacity of Motor	HP	7.5	10
2	Type of Motor	Name	Induction	Induction
3	Motor power	kW	5.5	7.7
4	Rated Current	A	10.2	13.8
5	Voltage	V	415	415
6	PF	%	0.84	0.84
7	Frequency	Hz	50	50
8	Efficiency at ½ Load	%	88	88.5
9	Efficiency at ¾ Load	%	89.2	90.1
10	Efficiency at full load	%	89.2	90.1

Fig:6.4 Clay mixture EE Motors



It is observed that the efficiency of the energy efficient motor has higher efficiency compared to the existing motor in Clay Mixtures motors.

Availability of Technology /Equipment

The Energy Efficient Motors are available and manufacturing in India by the many companies. These companies are marketing their products through directly or dealers with in Andhra Pradesh. Majority dealers/ suppliers for these equipments are located in

Hyderabad, Vijayawada and few in Rajamundry. Owners from Refractory Industries can avail these equipments by placing order from near by places i.e. Vijayawada / Hyderabad / Rajamundry.The details of manufacturers and suppliers marketing these energy efficient motors are presented in Annexure-1.

Cost Benefit Analysis

The Cost benefit analysis for replacing energy efficient motor in Clay Mixtures is presented below. Based on observations and measurements taken from refractory Industries, the cost benefit analysis for replacing energy efficient motor with existing inefficient / re winded motor in Clay Mixtures are calculated and presented below.

Table 6.14 Cost Benefit Analysis of Energy Efficient Motor for Clay mixtures

S.No	Parameter	Unit	Existing Motor	EEF1 Motor	Existing Motor	EEF1 Motor
1	Connected Load	HP	7.5	7.5	10	10
2	Connected Load	kW	5.60	5.60	7.46	7.46
3	Motor Efficiency	%	80	90	80	90
4	Loading	%	85	85	85	85
5	Working hours	hr/Day	10	10	10	10
6	Working Days	Days/year	200	200	200	200
7	Measured power	kW	5.94	5.28	7.93	7.05
8	Annual Power consumption	kWh	11889	10568	15853	14091
9	Power tariff	Rs./kWh	3.75	3.75	3.75	3.75
10	Total Energy cost	Rs	44585	39631	59447	52842
11	Energy Savings Due to EE Motor	kWh/Year	1321		1761	
12	Cost of Energy savings	Rs./Year	4954		6605	
13	Investment Cost	Rs	17331		20168	
14	Payback Period	Years	3.50		3.05	

From the above table in case of

- Replacing 7.5 HP energy efficient Clay Mixture motor with existing 7.5 HP inefficient/ re winded motor, the total energy savings is 1321 kWh/ year and savings in power bill will be Rs. 4954 /year. The total investment required to implement the EEF1 motor is Rs. 17,331 and pay back period will be with in 3.50 years.
- Replacing 10 HP energy efficient clay mixture motor with existing 10 HP inefficient/ re winded motor, the total energy savings is 1761 kWh/ year and savings in power

bill will be Rs. 6605 /year. The total investment required to implement the EEF1 motor is Rs.20,168 and pay back period will be with in 3.05 years.

Life Cycle Cost

The Life Cycle Cost of Energy Efficient Motor (EEF1) is estimated based on the life, maintenance cost, and operating parameters of Clay Mixtures. The following table provides details of life cycle cost of Energy Efficient Motor (EEF1).

Table 6.15 Life Cycle Cost of Energy Efficient Motor for Clay Mixtures

S. No	Particulars	Units	Value	Value
1	Motor Rating	HP	7.5	10
2	Rated power	kW	5.6	7.5
3	Capital Cost	Rs	17331	20168
4	Annual Maintenance	Rs	867	1008
5	Motor life	Years	20	20
6	Interest rate	%	10	10
7	LCC at the end of life	Rs	17340	20177

From the above table it is observed that:-

- The life cycle cost of 7.5 HP energy efficient motors for replacing in Clay Mixture is estimated at Rs.17,340.
- The life cycle cost of 10 HP energy efficient motors for replacing in clay mixture is estimated at Rs.20,177.

Implementation Cost

Another major parameter for implementation of Energy conservation proposals/project is implementation cost. The implementation cost of replacing energy efficient motors in Clay Mixtures is estimated based on erection, civil works and retrofitting cost etc.

The implementation cost of replacing EEF1 motor with inefficient and re winded Motor are presented below.

Table 6.16 Implementation Cost of Energy Efficient Motor for Clay Mixtures

S.No	Parameter	Cost in Rs.	Cost in Rs.
1	Capacity of Motor	7.5 HP	10HP
2	Plant and Machinery	17331	20168
3	Civil Works	1733	2017
4	Electrical works	867	1008
5	Erection and Commissioning	2600	3025

6	Miscellaneous costs	347	403
7	Total Cost	22877	26622

From the above table it is observed that:-

- The implementation cost of 7.5 HP energy efficient motors for replacing in Clay Mixtures is estimated at Rs.22,877.
- The implementation cost of 10 HP energy efficient motors for replacing in Clay mixture is estimated at Rs.26,622.

Recommendations

All Refractory Manufacturers in East & West Godavari Districts required and utilizing Clay Mixtures for unshaped Refractory material.

All most all refractory Industries are installed inefficient Motor at the time of erection and some are using several time re winded motors. In such Industries can opt for install energy efficient motor for Clay Mixtures. The time required to replace EEF1 motor with existing motor requires one week and energy savings starts from the time of operation.

The identified Energy Efficient Motor (EEF1) can be use in different categories refractory Industries in the cluster depending upon motor capacity.

Benefits

The following benefits can be expected while installing Energy Efficient Motor with the existing the normal efficient motor /re winded motor in Clay Mixtures.

- Less Maintenance Cost
- Low Running Cost
- Reduction in Energy consumption
- Less break downs
- Reduction in energy consumption leads to reduce the GHG emissions

Limitations

There is no limitation for replacing Energy Efficient Motor s (EEF1) with the existing inefficient and re winded Motor in Clay Mixtures.

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.

6.1.5 Install Energy Efficient Motor in Pug Mill

Installation of Energy Efficient Motor in Pug Mills is one of the Technology/equipment identified in Refractory manufacturing Industries located in East & West Godavari Districts of Andhra Pradesh to reduce energy consumption.
The details of Technical and Financial viability of replacing energy efficient motor in Pug Mills with existing inefficient motor in Refractory Manufacturing cluster at East & West Godavari is discussed below.

Background

Few refractory Manufacturing Industries using Pug Mills for preparation of refractory material past for manufacturing Ceramic Jars, Bricks and potteries. The Pug Mills are operation in these product manufacturing Industries to prepare a paste required for making the unfinished product.

The Pug Mills are operated by inbuilt motors. The operating hours of Pug Mills in refractory Industries are about 8-10 hrs in daily for making unfinished product. The environment in Pug Mills area is dusty which will affect the efficiency of motors and other parts in equipments. If the Pug Mills motor is inefficient the power consumption will be high.

To conserve electrical energy during Pug Mills operations, install energy efficient motor to Pug Mills motor which has higher efficiency and withstand even in dusty operation.

During the energy use and technology audit in Refractory Manufacturing Industries all Pug Mills motors are normal efficiency compare to energy efficient motors. To reduce the power consumption, it is essential to replace energy efficient motor.

Energy Conservation Potential

The Energy Efficient Motor (EEF1) has higher efficiency while operating in part & full load and dusty operating conditions comparing with inefficient or EEF2 motor. The efficiency of EEF1 i.e.95% is more than that of normal motor i.e.85-90%. If efficiency of motor increases, power consumption will reduce at both part and full load conditions. By replacing energy efficient motor in Pug Mills in Refractory Industries at least 8-10% energy savings is possible.

Technical Specifications

The Technical Specification of 10 HP energy efficient motor is presented below.

Table: 6.17 Technical Specifications of Energy Efficient Motor in Pug Mill

S.No	Parameter	Unit	Value
1	Capacity of Motor	HP	10
2	Type of Motor	Name	Induction
3	Motor power	kW	7.7
4	Rated Current	A	13.8
5	Voltage	V	415
6	PF	%	0.84
7	Frequency	Hz	50
8	Efficiency at ½ Load	%	88.5
9	Efficiency at ¾ Load	%	90.1
10	Efficiency at full load	%	90.1

Fig: 6.5 EE-Motors in Pug Mill

It is observed that the efficiency of the energy efficient motor has higher efficiency compared to the existing motor in Pug Mills motors.

Availability of Technology /Equipment

The Energy Efficient Motors are available and manufacturing in India by the many companies. These companies are marketing their products through directly or dealers with in Andhra Pradesh. Majority dealers/ suppliers for these equipments are located in Hyderabad, Vijayawada and few in Rajamundry. Owners from Refractory Industries can avail these equipments by placing order from near by places i.e. Vijayawada / Hyderabad / Rajamundry.

The details of manufacturers and suppliers marketing these energy efficient motors are presented in Annexure-1.

Cost Benefit Analysis

The Cost benefit analysis for replacing energy efficient motor in Pug Mills is presented below. Based on observations and measurements taken from refractory Industries, the cost benefit analysis for replacing energy efficient motor with existing inefficient / re winded motor in Pug Mills are calculated and presented below.

Table 6.18 Cost Benefit Analysis of Energy Efficient Motor for Pug Mills

S.No	Parameter	Unit	Existing Motor	EEF1 Motor
1	Connected Load	HP	10	10
2	Connected Load	kW	7.46	7.46
3	motor Efficiency	%	76	90
4	Loading	%	80	80
5	Working hours	hr/Day	8	8
6	Working Days	Days/year	170	170
7	Measured power	kW	7.85	6.63
8	Annual Power consumption	kWh	10680	9018
9	Power tariff	Rs./kWh	3.75	3.75
10	Total Energy cost	Rs	40048	33819
11	Energy Savings Due to EE Motor	kWh/Year	1661	
12	Cost of Energy savings	Rs./Year	6230	
13	Investment Cost	Rs	20168	
14	Payback Period	Years	3.24	

From the above table it is observed that, by replacing 10 HP energy efficient motor with existing 10 HP inefficient/ re winded motor in Pug Mill, the total energy savings is 1661 kWh/ year and savings in power bill will be Rs. 6,230 /year. The total investment required to implement the EEF1 motor is Rs. 20,168 and pay back period will be with in 3.24 years.

Life Cycle Cost

The Life Cycle Cost of Energy Efficient Motor (EEF1) is estimated based on the life, maintenance cost, and operating parameters of Pug Mills. The following table provides details of life cycle cost of Energy Efficient Motor (EEF1).

Table 6.19 Life Cycle Cost of Energy Efficient Motor for Pug Mills

S. No	Particulars	Units	Value
1	Motor Rating	HP	10
2	Rated power	kW	7.5
3	Capital Cost	Rs	20168
4	Annual Maintenance	Rs	1008
5	Motor life	Years	20
6	Interest rate	%	10
7	LCC at the end of life	Rs	28580

From the above table it is observed that, the life cycle cost of 10 HP energy efficient motors for replacing in pug mill is estimated at Rs.28, 580.

Implementation Cost

Another major parameter for implementation of Energy conservation proposals/project is implementation cost. The implementation cost of replacing energy efficient motors in Pug Mills is estimated based on erection, civil works and retrofitting cost etc.

The implementation cost of replacing EEF1 motor with inefficient and re winded Motor are presented below.

Table 6.20 Implementation Cost of Energy Efficient Motor for Pug Mills

S.No	Parameter	Cost in Rs.
1	Capacity of motor	10HP
2	Plant and Machinery	20168
3	Civil Works	2017
4	Electrical works	1008
5	Erection and Commissioning	3025
6	Miscellaneous costs	403
7	Total Cost	26622

From the above table it is observed that, the implementation cost of 10 HP energy efficient motors for replacing in Pug Mill is estimated at Rs.28,580.

Recommendations

The industries where products like Potteries, acid rain Bricks, ceramic Jars manufacturing uses pug mills in East & West Godavari Districts. These industries can implement the EEF1 Motors in their machinery.

The identified Energy Efficient Motor (EEF1) can be use in different categories refractory Industries in the cluster depending upon motor capacity in pug mills.

Benefits

The following benefits can be expected while installing Energy Efficient Motor with the existing the normal efficient motor /re winded motor in Pug Mills.

- Less Maintenance Cost
- Low Running Cost
- Reduction in Energy consumption
- Less break downs
- Reduction in energy consumption leads to reduce the GHG emissions

Limitations

There is no limitation for replacing Energy Efficient Motor s (EEF1) with the existing inefficient and re winded Motor in Pug Mills.

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.

6.1.6 Install Energy Efficient Motor in Mold Press

Installation of Energy Efficient Motor in Mold Press is one of the Technology/equipment identified in Refractory manufacturing Industries located in East & West Godavari Districts of Andhra Pradesh to reduce energy consumption.

The details of Technical and Financial viability of replacing energy efficient motor in Mold Press with existing inefficient motor in Refractory Manufacturing cluster at East & West Godavari is discussed below.

Background

All refractory Bricks Manufacturing Industries using Mold Press for preparation of Bricks. Using Mold press the strength of the brick will uniform. It required electrical energy for

operate the press motors. The operating hours of press in industries varies from 8-10. The motors used in press are inefficient and efficiency will be in the range of 80-90 %. Due to lower efficiency of motor and loading and unloading conditions, the power consumption is high.

To conserve electrical energy during press operations, install energy efficient motor which has higher efficiency.

During the energy use and technology audit in Refractory Manufacturing Industries, majority of Mold Press motors are normal efficiency compare to energy efficient motors. To reduce the power consumption, it is essential to replace energy efficient motor in Mold Press.

Energy Conservation Potential

The Energy Efficient Motor (EEF1) has higher efficiency while operating in part & full load and dusty operating conditions comparing with inefficient or EEF2 motor. The efficiency of EEF1 i.e.95% is more than that of normal motor i.e.85-90%. If efficiency of motor increases, power consumption will reduce at both part and full load conditions. By replacing energy efficient motor in Mold Press motor in Refractory Industries at least 8-10% energy savings is possible.

Technical Specifications

The Technical Specification of 10 HP energy efficient motor is presented below.

Table: 6.21 Technical Specifications of Energy Efficient Motor –Mold Press

S.No	Parameter	Unit	Value
1	Capacity of Motor	HP	10
2	Type of Motor	Name	Induction
3	Motor power	kW	7.7
4	Rated Current	A	13.8
5	Voltage	V	415
6	PF	%	0.84
7	Frequency	Hz	50
8	Efficiency at ½ Load	%	88.5
9	Efficiency at ¾ Load	%	90.1
10	Efficiency at full load	%	90.1

Fig: 6.6 EE-Motors-Mold Press

It is observed that the efficiency of the energy efficient motor has higher efficiency compared to the existing motor in Mold Press motors.

Availability of Technology /Equipment

The Energy Efficient Motors are available and manufacturing in India by the many companies. These companies are marketing their products through directly or dealers with in Andhra Pradesh. Majority dealers/ suppliers for these equipments are located in Hyderabad, Vijayawada and few in Rajamundry. Owners from Refractory Industries can avail these equipments by placing order from near by places i.e. Vijayawada / Hyderabad / Rajamundry.

The details of manufacturers and suppliers marketing these energy efficient motors are presented in Annexure-1.

Cost Benefit Analysis

The Cost benefit analysis for replacing energy efficient motor in Mold Press is presented below. Based on observations and measurements taken during the press operations in refractory Industries, the cost benefit analysis for replacing energy efficient motor with existing inefficient / re winded motor in Mold Press are calculated and presented below.

Table 6.22 Cost Benefit Analysis of Energy Efficient Motor for Mold Press

S.No	Parameter	Unit	Existing Motor	EEF1 Motor
1	Connected Load	HP	10	10
2	Connected Load	kW	7.46	7.46
3	Motor Efficiency	%	75	90
4	Loading	%	80	80
5	Working hours	Hr/Day	8	8
6	Working Days	Days/year	150	150
7	Measured power	kW	7.96	6.63
8	Annual Power consumption	kWh	9549	7957
9	Power tariff	Rs./kWh	3.75	3.75
10	Total Energy cost	Rs	35808	29840
11	Energy Savings Due to EE Motor	kWh/Year	1591	
12	Cost of Energy savings	Rs./Year	5968	
13	Investment Cost	Rs	20168	
14	Payback Period	Years	3.38	

From the above table, it is observed that by Replacing 10 HP energy efficient motor with existing 10 HP inefficient/ re winded motor in mold press, total energy savings is 1591 kWh/ year and savings in power bill will be Rs. 5,968 /year. The total investment required to implement the EEF1 motor is Rs. 20,168 and pay back period will be with in 3.38 years.

Life Cycle Cost

The Life Cycle Cost of Energy Efficient Motor (EEF1) is estimated based on the life, maintenance cost, and operating parameters of Mold Press. The following table provides details of life cycle cost of Energy Efficient Motor (EEF1).

Table 6.23 Life Cycle Cost of Energy Efficient Motor for Mold Press

S. No	Particulars	Units	Value
1	Motor Rating	HP	10
2	Rated power	kW	7.5
3	Capital Cost	Rs	20168
4	Annual Maintenance	Rs	1008
5	Motor life	Years	20
6	Interest rate	%	10
7	LCC at the end of life	Rs	28580

From the above table it is observed that the life cycle cost of 10 HP energy efficient motor for replacing in Mold Press is estimated at Rs.28,580.

Implementation Cost

Another major parameter for implementation of Energy conservation proposals/project is implementation cost. The implementation cost of replacing energy efficient motors in Mold Press is estimated based on erection, civil works and retrofitting cost etc.

The implementation cost of replacing EEF1 motor with inefficient and re winded Motor are presented below.

Table 6.24 Implementation Cost of Energy Efficient Motor for Mold Press

S.No	Parameter	Cost in Rs.
1	Capacity of Motor	10HP
2	Plant and Machinery	20168
3	Civil Works	2017
4	Electrical works	1008
5	Erection and Commissioning	3025
6	Miscellaneous costs	403
7	Total Cost	26622

From the above table it is observed that, the implementation cost of 10 HP energy efficient motors for replacing in Mold Press is estimated at Rs.26,622.

Recommendations

All Mold press existing Industries in East & West Godavari Districts can utilize energy efficient motors in press. The time required to replace EEF1 motor with existing motor requires one week and energy savings starts from the time of operation.

The identified Energy Efficient Motor (EEF1) can be use in different categories refractory Industries in the cluster depending upon motor capacity.

Benefits

The following benefits can be expected while installing Energy Efficient Motor with the existing the normal efficient motor /re winded motor in Mold Press.

- Less Maintenance Cost
- Low Running Cost
- Reduction in Energy consumption
- Less break downs
- Reduction in energy consumption leads to reduce the GHG emissions

Limitations

There is no limitation for replacing Energy Efficient Motor s (EEF1) with the existing

inefficient and re winded Motor in Mold Press.

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.

6.1.7 Install Energy Efficient Motor in Ball Mills

Installation of Energy Efficient Motor in Ball mills is one of the Technology/equipment identified in Refractory manufacturing Industries located in East & West Godavari Districts of Andhra Pradesh to reduce energy consumption.

The details of Technical and Financial viability of replacing energy efficient motor in Ball mills with existing inefficient motor in Refractory Manufacturing cluster at East & West Godavari is discussed below.

Background

In refractory Manufacturing Cluster, East & West Godavari, few Industries are manufacturing Ceramic Jars, Acid rain Bricks and potteries. For manufacturing of these products required fine clay material for product. The fine clay is prepared by using Ball Mills. These ball mills are operated by using motor for running the machinery. The energy consumption in ball mills depends on motor efficiency and operation parameters like hrs of operation, loading pattern. If the motors are efficient in no load and full load conditions the power consumption will be low. The operating hours of Ball mill is based on Installed capacity of kilns and normally the ball mill operates 8-10 hrs of duration in a day. The motors used in Ball mills are inefficient and the efficiency range will be 80-90 %. Due to lower efficiency of motor and load and unload conditions, the power consumption is high.

To minimize electrical energy during Ball mill operations, install energy efficient motor which has higher efficiency.

During the energy use and technology audit in Refractory Manufacturing Industries it is observed that many industries are using normal efficiency motors compare to energy efficient motors. To reduce the power consumption in ball mills, it is essential to replace energy efficient motor in Ball mills.

Energy Conservation Potential

The Energy Efficient Motor (EEF1) has higher efficiency while operating in part & full load and dusty operating conditions comparing with inefficient or EEF2 motor. The efficiency of EEF1 i.e.95% is more than that of normal motor i.e.80-90%. If efficiency of motor increases, power consumption will reduce at both part and full load conditions. By replacing energy efficient motor in Mold Press motor in Refractory Indutries at least 8-10% energy savings is possible.

Technical Specifications

The Technical Specification of 20 HP energy efficient motor is presented below.

Table: 6.25 Technical Specifications of Energy Efficient Motor for Ball Mill

S.No	Parameter	Unit	Value
1	Capacity of Motor	HP	20
2	Type of Motor	Name	Induction
3	Motor power	kW	15
4	Rated Current	A	26.5
5	Voltage	V	415
6	PF	%	0.86
7	Frequency	Hz	50
8	Efficiency at ½ Load	%	91
9	Efficiency at ¾ Load	%	91.8
10	Efficiency at full load	%	91.8

Fig 6.7 Energy Efficient Motors-Ball-Mill

It is observed that the efficiency of the energy efficient motor has higher efficiency compared to the existing motor in Ball mills.

Availability of Technology /Equipment

The Energy Efficient Motors are available and manufacturing in India by many companies. These companies are marketing their products through directly or dealers with in Andhra Pradesh. Majority dealers/ suppliers for these equipments are located in Hyderabad, Vijayawada and few in Rajamundry. Owners from Refractory Industries can avail these equipments by placing order from near by places i.e. Vijayawada / Hyderabad / Rajamundry.

The details of manufacturers and suppliers marketing these energy efficient motors are presented in Annexure-1.

Cost Benefit Analysis

The Cost benefit analysis for replacing energy efficient motor in Ball mills is presented below. Based on observations and measurements taken during the Ball mills operations in refractory Industries, the cost benefit analysis for replacing energy efficient motor with existing inefficient / re winded motor in Ball mills are calculated and presented below.

Table 6.26 Cost Benefit Analysis of Energy Efficient Motor for Ball mills

S.No	Parameter	Unit	Existing Motor	EEF1 Motor
1	Connected Load	HP	20	20
2	Connected Load	kW	14.92	14.92
3	motor Efficiency	%	78	92
4	Loading	%	80	80
5	Working hours	hr/Day	8	8
6	Working Days	Days/year	170	170
7	Measured power	kW	15.30	12.97
8	Annual Power consumption	kWh	20811	17645
9	Power tariff	Rs./kWh	3.75	3.75
10	Total Energy cost	Rs	78043	66167
11	Energy Savings Due to EE Motor	kWh/Year	3167	
12	Cost of Energy savings	Rs./Year	11876	
13	Investment Cost	Rs	45671	
14	Payback Period	Years	3.85	

From the above table it is observed that by replacing 20 HP energy efficient motor with existing 20 HP inefficient/ re winded motor in Ball Mill, the total energy savings is 1661 kWh/ year and savings in power bill will be Rs. 11,876 /year. The total investment required to implement the EEF1 motor is Rs.45,671 and pay back period will be with in 3.85 years.

Life Cycle Cost

The Life Cycle Cost of Energy Efficient Motor (EEF1) is estimated based on the life, maintenance cost, and operating parameters of Ball mills. The following table provides details of life cycle cost of Energy Efficient Motor (EEF1).

Table 6.27 Life Cycle Cost of Energy Efficient Motor for Ball mills

Sl. No	Particulars	Units	Value
1	Motor Rating	HP	20
2	Rated power	kW	14.9
3	Capital Cost	Rs	45671
4	Annual Maintenance	Rs	2284
5	Motor life	Years	20
6	Interest rate	%	10
7	LCC at the end of life	Rs	64709

From the above table it is observed, the life cycle cost of 20 HP energy efficient motors for replacing in ball mill is estimated at Rs.64,709.

Implementation Cost

Another major parameter for implementation of Energy conservation proposals/project is implementation cost. The implementation cost of replacing energy efficient motors in Ball mills is estimated based on erection, civil works and retrofitting cost etc.

The implementation cost of replacing EEF1 motor with inefficient and re winded Motor are presented below.

Table 6.28 Implementation Cost of Energy Efficient Motor for Ball mills

S.No	Parameter	Ball Mill Cost in Rs.
1	Capacity of Motor	20HP
2	Plant and Machinery	45671
3	Civil Works	4567
4	Electrical works	2284
5	Erection and Commissioning	6851
6	Miscellaneous costs	913
7	Total Cost	60286

From the above table it is observed that the implementation cost of 20 HP energy efficient motors for replacing in ball mill is estimated at Rs.60,286.

Recommendations

The Existing installed Ball Mill in refractory Manufacturing industries in East & West Godavari Districts can utilize to implement energy efficient motors. The time required to replace EEF1 motor with existing motor requires one week and energy savings starts from the time of operation.

The identified Energy Efficient Motor (EEF1) can be use in different categories refractory Industries in the cluster depending upon motor capacity.

Benefits

The following benefits can be expected while installing Energy Efficient Motor with the existing the normal efficient motor /re winded motor in Ball mills.

- Less Maintenance Cost
- Low Running Cost
- Reduction in Energy consumption
- Less break downs
- Reduction in energy consumption leads to reduce the GHG emissions

Limitations

There is no limitation for replacing Energy Efficient Motor s (EEF1) with the existing inefficient and re winded Motor in Ball mills.

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.

6.2 Summary of Energy savings proposals and the savings

The summary of energy saving proposal for Refractory Manufacturing Cluster for different technology options are presented below.

Table 6.32 Summary of Energy savings proposals and the savings

S. No	Name of DPR	Industry Level Energy Savings			Expected Industries	Cluster Level Energy Savings				Pay Back Period (Years)
		kWh/ Year	Coal in Tons/Year	Investment cost in Rs.Laks		Total Investment in Laks	kWh/ Year	Coal/ Year	Savings Rs.Laks/ Year	
1	10HP EE motor for Crusher with existing 10HP motor capacity	1761	0	0.20	10	2.02	17610	0	0.66	3.05
2	20 HP EE motor for Crusher with existing 20 HP motor capacity	4135	0	0.46	10	4.57	41350	0	1.55	2.95
3	7.5HP EE motor for Clay Mixture with existing 7.5HP motor capacity	1321	0	0.17	5	0.87	6605	0	0.25	3.50
4	10HP EE motor for Clay Mixture with existing 10HP motor capacity	1761	0	0.20	5	1.01	8805	0	0.33	3.05
5	10HP EE motor for Brick Pres with existing 10HP motor capacity	1591	0	0.20	3	0.61	4773	0	0.18	3.38
6	10HP EE motor for Pug Mill with existing 10HP motor capacity	1661	0	0.20	5	1.01	8305	0	0.31	3.24
7	20HP EE motor for Ball Mill with existing 20HP motor capacity	3167	0	0.46	5	2.28	15835	0	0.59	3.85
8	WHR at category 1efractory plant	0	22	6.00	10	60.00	0	215	7.53	7.97

9	WHR at category 2 refractory plant	0	24	6.50	5	32.50	0	121.5	4.25	7.64
10	WHR at category 3 refractory plant	0	41	7.50	5	37.50	0	207	7.25	5.18
11	WHR at category 4 refractory plant	0	96	8.00	5	40.00	0	481.25	16.84	2.37
12	Installing bio mass gasifier system in category 1 refractory plant	0	260	18.00	5	90.00	0	1300	45.50	1.98
13	Installing bio mass gasifier system in category 2 refractory plant	0	563	20.00	5	100.00	0	2812.5	98.44	1.02
14	Installing bio mass gasifier system in category 3 refractory plant	0	1020	22.00	10	220.00	0	10200	357.00	0.62
15	Installing bio mass gasifier system in category 4 refractory plant	0	1350	25.00	10	250.00	0	13500	472.50	0.53

6.3 Issues/barrier for implementation of proposals

The following major barriers identified for implementation of the energy savings proposals in Refractory Manufacturing cluster in East & West Godavari Districts of Andhra Pradesh. They are:

1. Lack of awareness and information among cluster owners on the energy losses, EE technologies and energy conservation measuring in refractory manufacturing Industries.
2. Majority of SMEs and doesn't have financial linkages to implement the energy savings proposals to their industries
3. The SMEs Owners of refractory Cluster, interested to implement on Gasifier systems to their plants
4. The local service providers in East & West Godavari are basically experience background in nature but not in technical sound knowledge of efficiency, losses. The LSPs required technology up gradation skills related to the ice making equipments.

6.4 Availability of LSPs for Implementation Energy Conservation Proposals

The availability of Local Service Providers for implementation of identified energy saving proposals is furnished below:

Table 4.22: Availability of LSP's for implementation of Energy Savings Proposals

S.No	Technology	Local Service Providers	
		East & West Godavari	India
1	Energy Efficient Motors	Available	Available
2	Biomass gasifiers	Not Available	Available
3	Waste Heat recovery system	Not Available	Available

6.5 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 Efficiency Improvement and conservation.

All the refractory Industries the product and equipments in their industries are similar, due to the reason if any identified technology/equipment can be replicated in other industries also.

The following technologies/equipments were considered for preparation of detailed project report:

Table 4.23: Proposed Technologies/Equipments for preparation of Detailed Project Report:

S.No	Name of DPR
1	10HP EE motor for Crusher with existing 10HP motor capacity
2	20 HP EE motor for Crusher with existing 20 HP motor capacity
3	7.5HP EE motor for Clay Mixture with existing 7.5HP motor capacity
4	10HP EE motor for Clay Mixture with existing 10HP motor capacity
5	10HP EE motor for Brick Pres with existing 10HP motor capacity
6	10HP EE motor for Pug Mill with existing 10HP motor capacity
7	20HP EE motor for Ball Mill with existing 20HP motor capacity
8	WHR at category 1efractory plant
9	WHR at category 2 refractory plant
10	WHR at category 3 refractory plant
11	WHR at category 4 refractory plant
12	Installing bio mass gasifier system in category 1 refractory plant
13	Installing bio mass gasifier system in category 2 refractory plant
14	Installing bio mass gasifier system in category 3 refractory plant
15	Installing bio mass gasifier system in category 4 refractory plant

6.6 Awareness on Energy Conservation and Energy Efficiency technologies in Refractory manufacturing Cluster –East & West Godavari

Owners and operators doesn't have awareness on energy conservation concepts and energy efficiency improvement towards reduction in energy consumption in refractory manufacturing cluster.

Though the clusters units are in operation since last 4 decades, awareness programs on Energy conservation and efficiency improvement in Refractory Industries are not conducted either from local bodies or central government in the cluster.

CHAPTER 7
SMALL GROUP ACTIVITIES / TOTAL ENERGY MANAGEMENT

7.1 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.

7.2 Systematic Approach for Energy Conservation by TEM/SGA

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

7.2.1 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 intelligentsia 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.

7.2.2 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.

7.3 Total Energy Management (TEM)

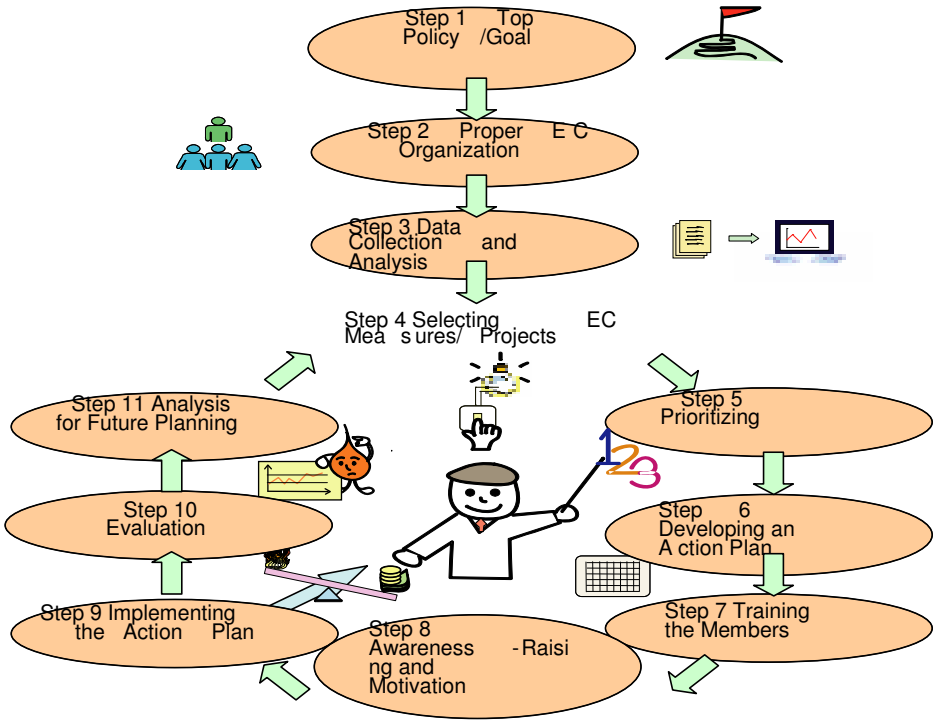
Every point in factories has potential for Energy Conservation. Total Energy Management is implemented, by all the people's participation, step by step utilizing "Key Step Approach" in a systematic manner, as shown below:

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 7.1: Key Step Approach

Steps of the 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.

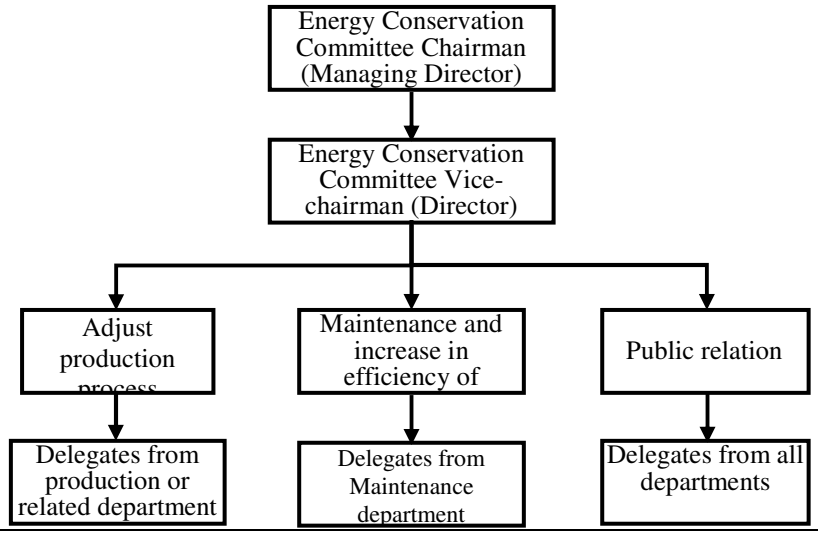
2. Set targets

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. 7.2: 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.

- Utilize Line (Formal) Job-related Organization for TEM purpose
- Use TPM Organization for TEM purpose
- Use TQM Organization for TEM purpose
- Add Employee Suggestion System to Energy Conservation Organization for TEM purpose
- 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 7.1: Example of energy saving plan

S. No	Detail of the plan	Length (Months)						Person in charge	Budget	Inspect by
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 7.2: Example of awareness raising campaign

S. No	Detail of the plan	Length (Months)						Person in charge	Budget	Inspected by
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.

7.3.1 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.

7.3.1.1 Importance of SGA:

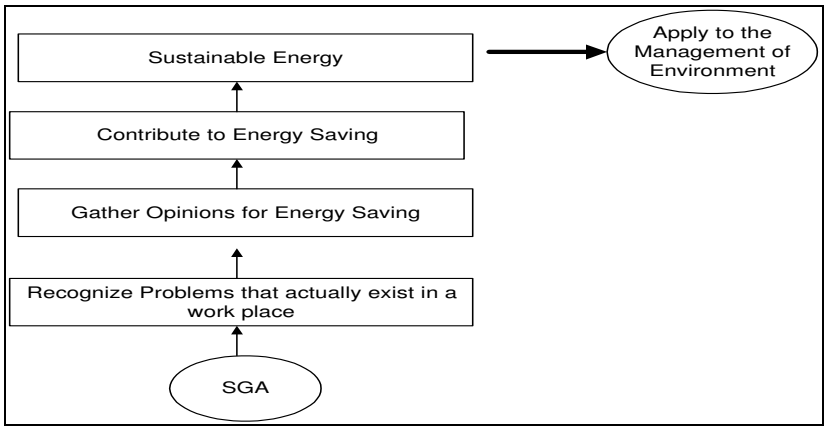
SGA are activities by group of employees at operator (working Group) level. They aim to solve problems that occur at the place taken care of by each employee and put emphasis on participation and team work. Factories can apply small group activities to many kinds of work along with normal work or other 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.

7.3.1.2 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 7.3 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 7.4 Example of Organizational Structure with Overlapping

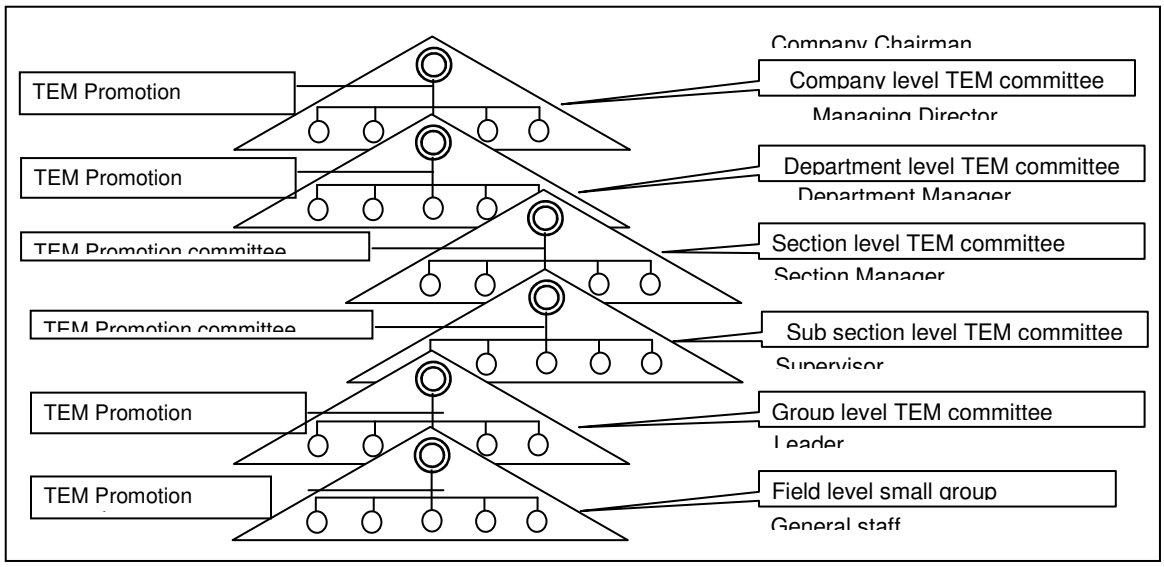
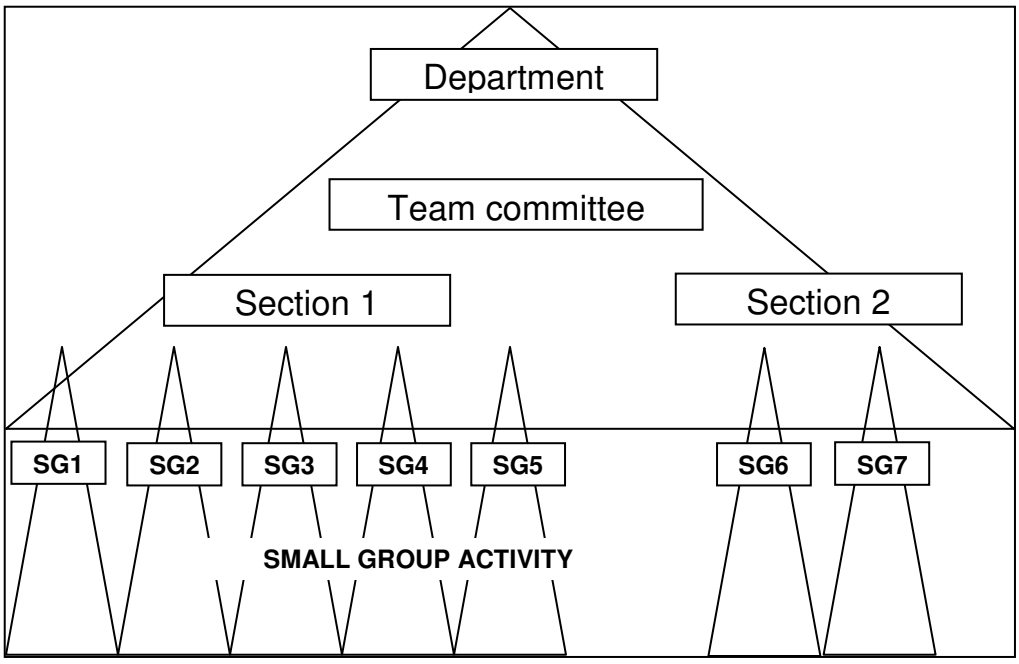


Fig.No 7.5 Positioning of SGA in Main Job Structure



7.3.1.1 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

7.3.1.2 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

7.3.1.3 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

7.3.1.4 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

7.3.1.5 Responsibility of Energy Conservation committee

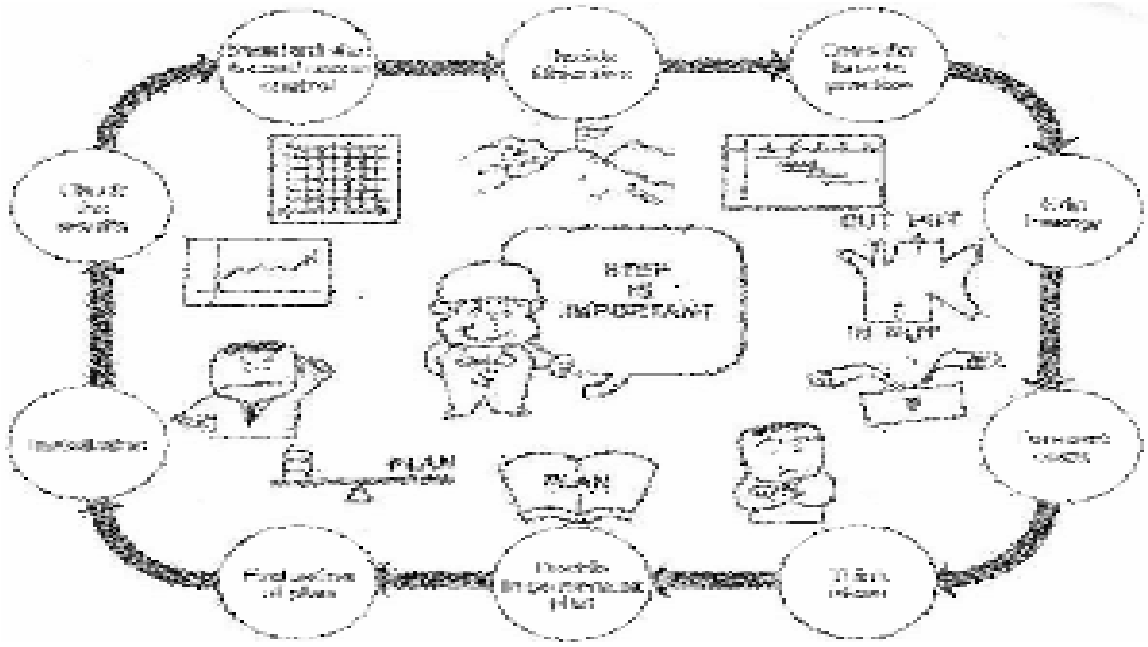
- Gather and analyze information on costs related to energy every month
- Analyze and solve problems related to energy
- Find a method for energy conservation

- 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

7.4 Steps of Small Group Activities for Energy Conservation

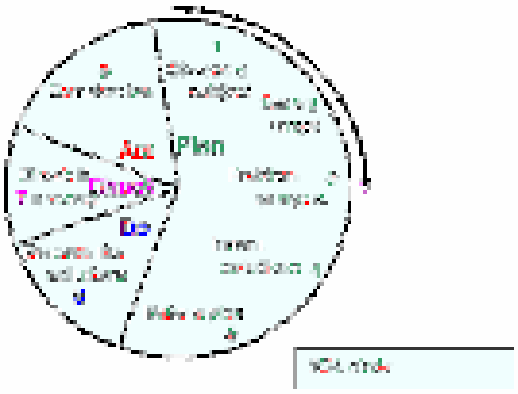
Small group activities for Energy Conservation can be done by using "10 Stages for Success", based on "PDCA Management Cycle", as shown below and in pictorial forms

Fig.No:7.6 PDCA Management Cycle



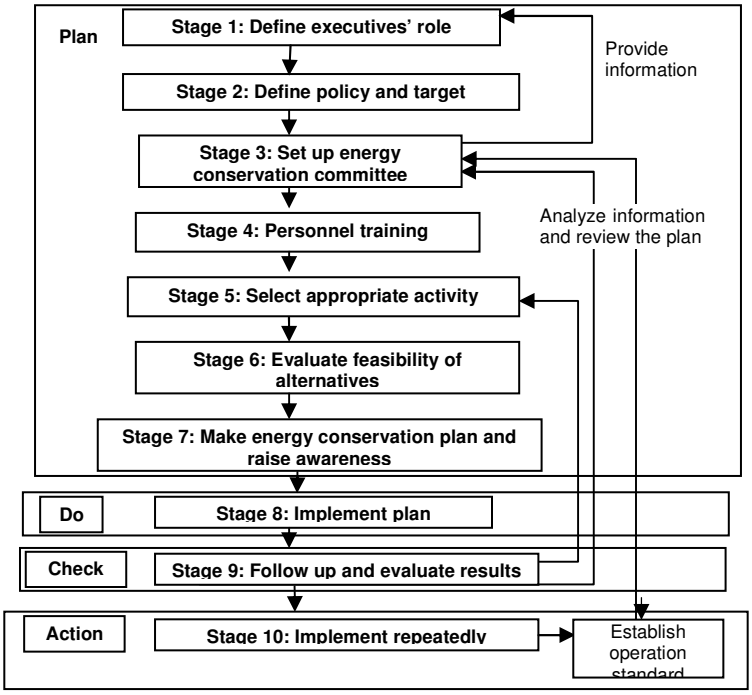
- Plan: Make an efficient plan in order to improve operation
- Do: Implement according to the plan
- Check: Check if implementation was according to the plan
- Act: Judge what to improve, what to learn and what to do from what we have checked

Fig No: 7.7 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.

Fig:7.8 Ten Stages for Success



7.4.1 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

7.4.2 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.

7.4.3 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.

7.4.4 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.

7.4.5 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.

7.4.6 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

7.4.7 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.

7.4.8 Stage 8: Implement Plan

Implement according to the plan of each group.

7.4.9 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.

7.4.10 Stage 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.

7.6 Tools that are Used Often for Small Group Activities for Energy Connservation

7.4.11 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:7.9 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.

7.4.12 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 MOTOR:

Step1: Calculation of Motor Loading.

Rated power of the motor = P'_m hp
Rated power of motor = P'_m x 0.746
= P_m kW
Rated Efficiency of motor = $\eta_{\text{motor rated}}$
Rated Input Power of the motor = P_m kW ÷ $\eta_{\text{motor rated}}$
= $P_{m\ input}$ kW
Measured input power = $P_{m\ measured}$ kW

Percentage loading of motor $L_M = \frac{Pm\ measured}{Pm\ input}$ %

Step 2: Calculation of motor efficiency.

Approximate Output hp = % loading x Rated hp
= L_M x P'_m hp

Motor efficiency $\eta_{\text{motor measured}}$ $= \frac{\text{\% Loading x P'm hp}}{\text{Pm measured kW}}$

Step3: Saving Calculation by replacing EE motor.

Measured input power of old motor = $P_{\text{oldm measured}}$ kW
Rated power of EE Motor = P'new motor hp
Rated power in kW = P' new motor x 0.746
= P new motor kW
Rated Efficiency = η new motor rated
Rated Input power of the EE motor = Pi/p new motor
= P new motor kW ÷ η new motor rated
Actual input power of EE motor = Pi/p new motor x loading%
= PA i/p new motor

Annual saving in kWh
= ($P_{\text{oldm measured}}$ kW - PA i/p new motor) working Hr x no.of working days

Annexure 2
List of Local Service Providers

S.No	Machinery /equipment	Name of the Manufacturer / Supplier	Contact Address	Telephone
1	MOTORS	Siemens India LTD	5-9-19 4TH Floor Laxmi Narasignh Estate, Opp.Secretariat, Saifabad, Hyderabad – 500004	(040)-23482500, 23482501
2		Beekay Electrical	S No 6-3-131/4, Opp Sbh Narsapur X Roads, Bala Nagar, Hyderabad – 500037	(040)-64506800 , 9848507027
3		Laxmi Traders	G M Complex, Opp RTC Colony Bus Stop, Main Road, Hayat Nagar, Hyderabad – 500036	9346936977, 9948696021, 9177607477
4		Deccan Electricals	7-2-629 & 630, 1ST Floor, Opp To Bharat Petrol Bump, R P Road, Hyderabad – 500003	
5		Sri Gurudatta Electricals	Shop No 10, Pb No 165 Opp Gandhi Park, Convent Street, Vijaywada – 520001	(0866)-2563811, 2561932
6		Lakshmi Sainadh Engineering Co	12-15-25, Opp Tpet Goods Shed 1, Main Bazar, Vijaywada – 520001	(0866)-6569370

7		Sabari Marketing Services	St Pauls Complex, Nirmala Convent Road, Convent Street, Vijaywada - 520001	(0866)-2482733
8	**COAL GASIFIERS**	Perfect Mechanical Systems	8-A, National Highway, Akhdhirpur Road, Opp. Saheb Ceramics, Morbi - 363642, Gujarat	09825230692
9		URJA Thermal Solutions	703-4, Garnet bldg. Nirmal Residency, behind nirmal lifestyle mall, Off. Ibs road, Mulund (W), Mumbai-- 400080	(022)-25903300 09819882270
10		Jay Khodiyar Machine Tools	Samrat Industrial Area no.-2, Near Atul Gas Agency, Opposite Kaneriya Oil Industries, Rajkot – 360004	(0281)-2388115 2367594
11		Ronak Engineering	3, Galaxy Indl. Estate, Survey no. 275, NR. Grevity Casting, Shaper (Veraval), Shapar - 360034, Gujarat	(02827)-252300
12		NSS Industries	NSS Industries Roorkee Road, Opp. 33 KVA Electricity Board, Muzaffarnagar Uttar Pradesh	(0131)-2441382
13		Jyoti Green Energy Transmission	"Shrimad Bhavan" Office no. Sf 95, Third Floor, Opp. Kanta Stree Vikas Gruh,	(0281)-2224941

			Rajkot – 360002	
14		New Tech Engineering Works	Rainbow Lane, Near 66 KVA Power House, Meerut Road, Muzaffarnagar - 251003, Uttar Pradesh	(0131)-2621372
15		Plantec Engineers	E-21, 3rd Crescent Road, Sanikpuri Hyderabad	(040)-64589243
16		Spac Power Engineering India Private Limited	No. 73-A Block, 5th Street, Anna Nagar East Chennai-600 040	(044)-26261660
15	**BIO MASS GASIFIERS**	Jaihind Agro Services	A-656, Market Yard Shopping Complex.2nd Floor, Opp.Panchavat, i Police Station, Dindiri Road, Pnchavati Nashik-422 005	(0253)-2510940
16		Bharti Bio-Fuel	A-11, Sector-25 Electronic G.I.D.C. Gandhinagar, Gujarat-382025	(079)-23234634
17		Jyoti Green Energy Transmission	Office No. SF-95,Third Floor, Shree Mad Bhavan, Opp. Kanta Stree Vikas Grugh, Near Dhebar Road Rajkot, Gujarat - 360 001	(0281)-2375436
18		Agni Net Bio Fuels (P) Ltd.	No. 149, Saint Therese Street Pondicherry	(0413)-2229566/ 2229567
19		A.V.U Engineers Pvt. Ltd.	Survey No. 53, Bahadurpally, Quthbullapur Mandal, R.R. Dist.	(040)-3092343, 23097391

20	**Waste Heat Recovery System**	Thermal Systems Hyderabad Private Limited	Plot No - 1, Apurupa Colony, IDA Jeedimetla Hyderabad-500037	(40)-23091801 23091802
21		Daack Vessels Private Limited	No. 21/3-A, Swaraj Building, MES Ring Road, Muthyalnagar Bangalore -560 054	(080)-23458333
22		Enersys	T/3/380, Gat No.78, Jyotibanagar, Talawade Pune-412 114	(020)-20275281
23		Fuel Save Systems & Devices	Plot No. 65, Crossing Road, 3 & 6, Saroorpur Industrial Area, Near Shona Road Faridabad	(0129)-2230398
24	**LOCAL SERVICE PROVIDERS**	A.R. Engg. Refractory	Rajamundhry East Godavari	(08883)- 2467357
25		Gerranjali Engg. Refractory	8, Morampudi, East Godavari	(08829)- 222273
26		Heat Flow Engineering	Polasanpalli Elure, West Godavari	(08829)- 222273
27		Shri Laxmi Clay Mines	Dwarka Tirumala West Godavari	09393262301
28		Vijay Laxmi Minerals	Dwarka Tirumala West Godavari	(08829)- 271213
29		Shri Satya Sai Clay Mines	Dwarka Tirumala West Godavari	(08829) - 271545
30		Godavari Clay Mines	East Godavari	09392064444

Annexure – 3
Quotations

QUOTATION

SLR ENTERPRISES

AUTHORISED DEALER FOR :
FINOLEX CABLES LTD, ROTOMOTIVE - MOTORS & WORM GEAR BOXES

M/s. APITCO LTD.

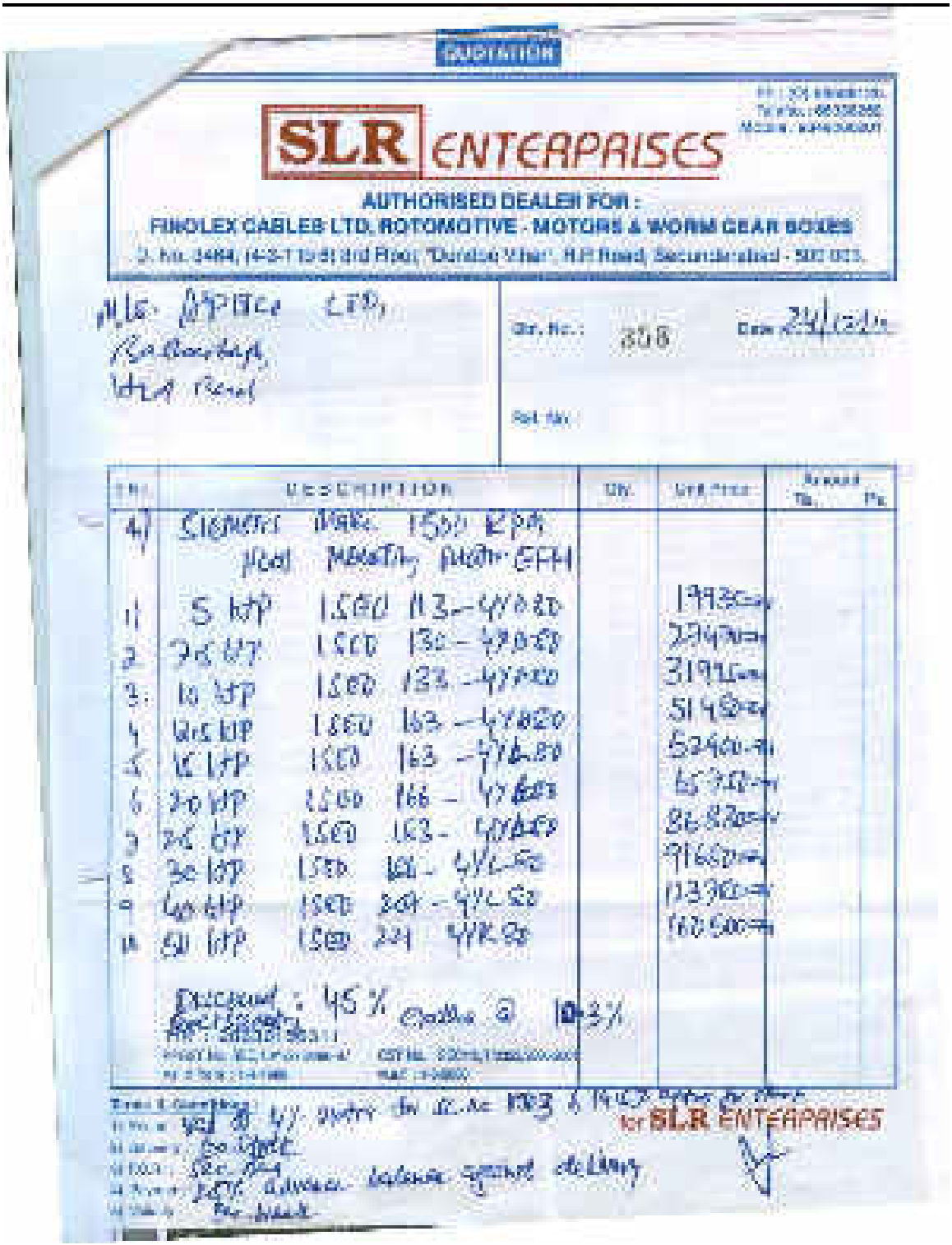
Qtn. No. : 359 Date : [illegible]

Ref. No. :

Sl.No.	DESCRIPTION	Qty.	Unit Price	Amount Rs.	Ps.
	Re: CG make Energy Efficient 1500 RPM Foot Mounting Model				
1	60 HP 1500 223		198400/-		
2	75 HP 1500 224		242500/-		
3	100 HP 1500 281		323340/-		
4	120 HP 1500 284		374910/-		
5	150 HP 1500 31		423900/-		
	Less Discount : 45%				
	Excise Duty : Extra @ 10.3%				

Terms & Conditions:
a) Prices : Vat @ 14.5% Extra
b) Delivery : Ex-Stock
c) Payment : 25% Advance, Balance against delivery
d) Validity : One Week

for **SLR ENTERPRISES**



QUOTATION

SLR ENTERPRISES

AUTHORISED DEALER FOR :
FINOLEX CABLES LTD. ROTOMOTIVE - MOTORS & WORM GEAR BOXES

M/s. [illegible]

Qtr. No.: 808 Date: 24/12/11

Ref. No.

SNO.	DESCRIPTION	QTY.	UNIT PRICE	AMOUNT Rs.	Ps.
4)	SIEMENS MAKE 1500 RPM HEAD MOUNTING FOOT MTR EFFI				
1	5 HP 1500 113-4YA2D			19930	
2	7.5 HP 1500 132-4YA2D			23470	
3	10 HP 1500 132-4YA2D			31910	
4	12.5 HP 1500 160-4YA2D			51480	
5	15 HP 1500 160-4YA2D			52900	
6	20 HP 1500 160-4YA2D			65310	
7	25 HP 1500 180-4YA2D			86820	
8	30 HP 1500 180-4YA2D			91660	
9	40 HP 1500 200-4YA2D			123900	
10	50 HP 1500 225 4YA2D			160500	

Discount : 45 % Extra @ 10.3 %

for SLR ENTERPRISES