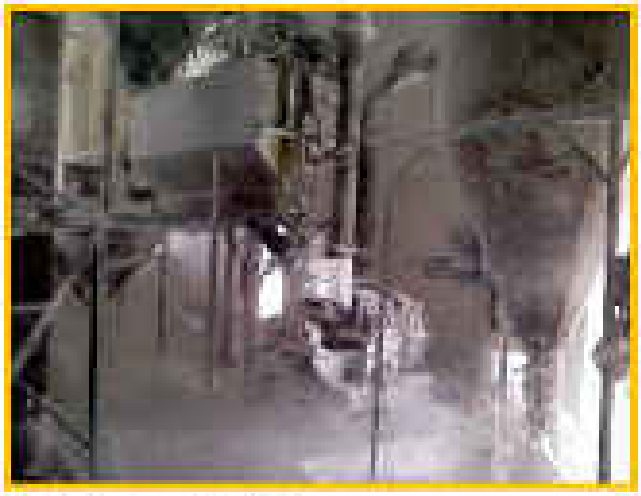
MANUAL ON ENERGY CONSERVATION MEASURES IN LIMESTONE CLUSTER JODHPUR



ENERGY IS LIFE
BEE
CONSERVE IT

Bureau of Energy Efficiency (BEE)

Ministry of Power, Government of India

Prepared By

CII
Confederation of Indian Industry
Since 1895

GHAVASTHA

MANUAL ON ENERGY CONSERVATION MEASURES IN LIMESTONE INDUSTRY

Based on findings of BEE's SME Program for Jodhpur Limestone Cluster

March, 2011

Confederation of Indian Industry
Sector 31-A, Chandigarh 160 030
Tel : 0172-2607228, 2605868, 5080784
Fax : 0172-2606259, 2614974
Email : harinder.singh@cii.in
Website: www.ciicfc.org

Bureau of Energy Efficiency (BEE),
Ministry of Power, Government of India,
New Delhi
www.bee.nic.in

DISCLAIMER

This manual has been developed by CII for BEE on the terms of engagement as Executing Agency. Contents in this report are based on observations made during the field studies at Jodhpur, data and information provided by the units and based on information generally available to the public from sources believed to be reliable. No representation is made that it is timely accurate or complete. CII has taken due care in compilation of data and information, however CII does not guarantee the accuracy adequacy or completeness of any information and it is not responsible for errors or omissions or for the results obtained from the use of such information and specially states that it has no financial liability to what so ever to the users of this manual. This manual is published with the understanding that CII is supplying information but is not attempting to render detail engineering services; if such services are required the assistance of an appropriate professional organization (Technology suppliers & LSPs) should be sought.

ACKNOWLEDGEMENT

CII – AVANTHA Centre for Competitiveness for SMEs acknowledges with thanks to the Bureau of Energy Efficiency, Ministry of Power for giving the opportunity to implement **'BEE SME Project in Jodhpur – Limestone Industry Cluster'**.

We express our sincere gratitude to all concerned officials for their support and guidance during the conduct of this exercise.

Bureau of Energy Efficiency

- Dr. Ajay Mathur- Director General
- Ms Abha Shukla - Secretary
- Mr. Jitendra Sood - Energy Economist
- Mr. Pawan Kumar Tiwari- Advisor, SME
- Mr. Rajiv Yadav – Project Economist
- Mr. Gaurav Kumar - Project Engineer

CII – AVANTHA Centre for Competitiveness for SMEs is also thankful to **"The Jodhpur Industry Association & Units"** for their valuable inputs, co-operation, support and identification of the units for Energy Use and Technology Audit studies in Jodhpur Limestone Industry Cluster.

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

CII would also like to place on record our sincere thanks to all the SME owners, plant in-charges and all workers of the unit for their support during the Energy Use & Technology Audit Studies.

Harinder Jeet Singh
Principal Counsellor & Head
CII – AVANTHA Centre for Competitiveness for SMEs
Confederation of Indian Industry

CONTENTS

Abbreviations

MSME	Micro Small and Medium Enterprises
SMEs	Small and Medium Enterprises
GOI	Government of India
BEE	Bureau of Energy Efficiency
EE	Energy Efficiency
IRR	Internal Rate of Return
DPRs	Detailed Project Reports
tpa	Tonnes Per Annum
MTOE	Metric Tonnes of Oil Equivalent
mkCal	Million Kilo Calories
kW	Kilo Watt
hp	Horsepower
kWh	Kilo Watt Hour
SDA	State Designated Agency
GHGs	Green House Gasses
LSPs	Local Service Providers

CHAPTER 1

ABOUT BEE SME PROGRAM

Worldwide the Micro, Small and Medium Enterprises (MSMEs) have been accepted as engines of economic growth to promote and accelerate equitable development. The major advantage of this sector is its enormous employment potential at significantly low capital involvement. This can be established from the simple fact that the MSMEs constitute over 90% of total enterprises in most economies and are credited with generating the highest rates of employment growth and also account for a major share of industrial production and exports. In Indian context, MSMEs play a pivotal role in the overall industrial economy. In recent years the sector has consistently registered higher growth rate as compared to the overall industrial sector. With its agility and dynamism, the sector has shown admirable innovativeness and adaptability to survive the recent economic downturn and recession.

As per available statistics (the 4th Census of MSME Sector), this sector employs an estimated 59.7 million persons spread over 26.1 million enterprises. It is estimated that in terms of value, MSMEs have a 40% share in total industrial output at a huge volume of producing over 8,000 value-added products. At the same time, MSMEs contribute nearly 35% share in Direct Export and 45% share in the Overall Export from the country. SMEs exist in almost all-major sectors in the Indian industry such as Food Processing, Agricultural Inputs, Chemicals & Pharmaceuticals, Electrical & Electronics, Medical & Surgical Equipment, Textiles and Garments, Gems and Jewellery, Leather and Leather Goods, Meat Products, Bioengineering, Sports goods, Plastics Products, Computer Software etc.

However, despite the significant contributions made to towards various aspects of the nation's socio-economic scenario, this sector too faces several critical issues that require immediate attention. One such factor that falls in the ambit of this publication is the prevalence of age old technologies across the sectors and inherent inefficiencies associated with resource utilization, including, energy. The National Mission for Enhanced Energy Efficiency in Industry under the National Action Plan for Climate Change (released by Government of India on June 30, 2008) has emphasized the need for improving Energy Efficiency (EE) in the manufacturing sector. A number of sector-specific studies have also unanimously confirmed that energy intensity in the industry can be reduced with the widespread adoption of proven and commercially available technologies which will improve EE and produce global benefits from reduced Green House Gasses (GHGs) emissions.

As a result of increasing awareness towards efficient usage of energy and other resources, there has been a visible reduction in energy intensity in comprehensive Indian industrial sector. However, focusing the observation on the MSME sector

reveals that the energy intensity per unit of production is much higher than that of the organized large scale sector. Since energy cost is significant contributor to the overall production cost of SMEs due to high and rising energy costs in current scenarios, it is required to increase the Energy Efficiency (EE) levels in order to ensure the sustenance of SMEs.

One of the ways to reduce the inefficiencies is by replacing the conventional/old/obsolete technology with feasible and adaptable energy efficient technologies. This would not only contribute towards reduction in production cost, but would also improve the quality and productivity of MSME products.

However, while knowing the way out, there are still numerous barriers (as listed below) and market failures that have prevented widespread adoption of new energy efficient technologies.

Key barriers in promotion and adoption of EE technologies in Indian SME sector:

- Lack of awareness and capability on the part of SMEs to take up energy conservation activities
- Lack of scientific approach on monitoring and verification of performance assessment of installed equipments and utilities.
- Non availability of benchmark data for various equipments/process
- Low credibility of the service providers such as equipment suppliers and their technologies
- The SME owners are more concerned on production and quality rather than energy efficiency and conservation
- The key technical personnel employed in the SME units are based on their past experience in similar industries rather than technically qualified personnel and hence, they are not aware of the latest technologies or measures which improve energy efficiency
- Lower priority to invest in improving efficiency than in expansion (this may be due to lack of knowledge on cost benefit)

Majority of SMEs are typically run by entrepreneurs and are leanly staffed with trained technical and managerial persons to deploy and capture energy efficiency practice to reduce manufacturing cost and increase competitive edge. Therefore, it will be useful to build energy efficiency awareness in the SMEs by funding/subsidizing need based studies in large number units in the

SMEs and giving energy conservation recommendations including short term energy conservation opportunities, retrofit/replacement options and technology up-gradation opportunities.

In this context, the Bureau of Energy Efficiency (BEE) has laid adequate emphasis on the SME sector as presented in the Working Group on Power for 11th Five-Year Plan (2007-2012)-Sub-Group 5. Consequently, the Bureau has initiated the Energy Efficiency Improvement program in 29 SME clusters in India.

1.1 PROJECT OBJECTIVES

The BEE SME Program is aimed to improve Energy Efficiency in SME sector by technological interventions in the various clusters of India. The EE in SMEs is intended to be enhanced by helping these industries in the 29 energy intensive SME clusters of India by:

- Technology interventions
- Sustaining the steps for successful implementation of EE measures and projects in clusters
- Capacity building for improved financial planning for SME entrepreneurs.

The program also aims at creating a platform for;

- Dissemination of the best practices and the best available technologies available in the market for energy efficiency and conservation,
- To create awareness in the clusters, and
- To demonstration the new technology interventions/ projects to stimulate adoption of similar technology/projects in the clusters.

The BEE SME program has been designed in such a way so as to address the specific needs of the industries in the SME sector for EE improvement and to overcome the common barriers in way of implementation of EE technologies in cluster through knowledge sharing, capacity building and development of innovative financing mechanisms. Major activities in the BEE SME program are listed below:

- Energy use and technology studies
- Capacity building of stake holders in cluster for building EE projects
- Implementation of energy efficiency measures

- Facilitation of Innovative financing mechanisms for implementation of energy efficiency projects

The brief objective of each of these activities is presented below:

1. Energy Use and Technology Analysis:-

An in-depth assessment of the various production processes, energy consumption pattern, technology employed and possible energy conservation potential and operational practices in cluster by means of conducting detailed energy audits and technological gap assessment studies in a cluster is presented herewith. The energy audit study includes analysis of the overall energy consumption pattern, study of production process, identification of energy intensive steps/sub-processes and associated technology gap assessment for the individual units. The study also focuses on identifying the Best Operating Practices and the EE measures already implemented in the units.

2. Capacity Building of Stakeholders

The aim of this activity is capacity building of the enrolled LSPs to equip them with the capability to carry on the implementation of the EE technology projects in cluster on a sustainable basis. The needs of the LSPs will be identified as a preparatory exercise to this activity, as to what they expect from the BEE Program in terms of technical and managerial capacity building.

3. Implementation of EE Measures

To implement the EE and technology up-gradation projects in the clusters, technology specific Detailed Project Reports (DPRs) for five different technologies for three scales of operation will be prepared. The DPRs will primarily address the following:

- Comparison of existing technology with feasible and available EE technology
- Energy, economic, environmental & social benefits of proposed technology as compared to conventional technology
- Details of technology and service providers of proposed technology
- Availability of proposed technology in local market
- Action plan for implementation of identified energy conservation measures

- Detailed financial feasibility analysis of proposed technology

4. Facilitation of Innovative Financing Mechanisms

Research and develop innovative and effective financing mechanisms for easy financing of EE measures in the SME units in the cluster. The easy financing involves following three aspects:

- Ease in financing procedure
- Availability of finance on comparatively easy terms and relaxed interest rates
- Compatibility and availing various other Central/ State Governments' incentive schemes like CLCSS, TUFF etc.

1.2 EXPECTED PROJECT OUTCOME

The outcome of BEE-SME Program will be an assessment of total energy usage, preparedness of the cluster to undertake further action and a list of units where further action is recommended along with filled in data collection formats.

Expected project outcome of BEE SME program in clusters are:

Energy Use and Technology Analysis

The outcome of the activity will include identification of the EE measures, potential of renewable energy usage, fuel switching, feasibility analysis of various options, and cost benefit analysis of various energy conservation measures including evaluation of financial returns in form of payback period, IRR and cash flows. The cost liability of each measure, including the capital and operational cost will also be indicated.

The identified EE measures will be categorized as per the following types:

- Simple housekeeping measures/ low cost measures
- Capital intensive technologies requiring major investment.

The sources of technology for each of the suitable low cost and high cost measures, including international suppliers as well as local service providers (LSPs)/ technology suppliers, in required numbers shall be identified. It is envisaged to create a knowledge bank of detailed company profile and CVs

of key personnel of these technology sources. The knowledge bank will also include the capability statements of each of these sources.

The EE measures identified in the energy audit study will be prioritized as per their energy saving potential and financial feasibility. The inventorization survey would establish details like the cluster location, details of units, production capacity, technologies employed, product range, energy conservation potential along with possible identified EE measures and respective technology suppliers.

The specific outcomes of this activity will be as follows:

- Determination of energy usage and energy consumption pattern
- Identification of EE measures for the units in cluster
- Development and preparation of case studies for already implemented EE measures and Best Operating Practices in the units
- Evaluation of technical & financial feasibility of EE measures in terms of payback period, IRR and cash flows.
- Enlisting of Local Service Providers(LSPs) for capacity building & training including creation of knowledge bank of such technology suppliers
- Capacity building modules for LSPs
- Development and preparation of cluster manuals consisting of cluster details and EE measures identified in cluster.

Implementation of EE measures

The aim of this activity is development and finalization of bankable DPRs for each of the EE projects which would presented before the SME units for facilitation of institutional financing for undertaking the EE projects in their respective units.

The activity will ensure that there is close match between the proposed EE projects and the specific expertise of the Local Service Providers (LSPs). These DPRs will be prepared for EE, renewable energy, fuel switching and other possible proposed measures during course of previous activities. Each DPR will include the technology assessment, financial assessment, economic assessment and sustainability assessment of the EE project for which it has been developed. The technology assessment will include the details of the design of equipment/ technology along with the calculation of energy savings. The design details of the technology for EE project will include detailed

engineering drawing for the most commonly prevalent operational scale, required civil and structural work, system modification and included instrumentation and various line diagrams. The LSPs will be required to report the progress of the implementation of each such project to BEE PMC. Such implementation activities can be undertaken by the LSPs either solely or as a group of several LSPs.

Capacity Building of LSP's and Bankers

The outcome of this activity would be training and capacity building of LSPs so as to equip them with necessary capacity to undertake the implementation of proposed EE projects as per the DPRs. Various training programs, training modules and literature are proposed to be used for the said activity. However, first it is important to ascertain the needs of the LSPs engaged, as in what they expect from the program in terms of technical and managerial capacity building. Another outcome of this activity will be enhanced capacity of banking officers in the lead banks in the cluster for technological and financial feasibility analysis of EE projects that are proposed by the SME units in the cluster. This activity is intended to help bankers in understanding the importance of financing energy efficiency projects, type and size of projects and ways and means to tap huge potential in this area. Different financing models would be explained through the case studies to expose the bankers on the financial viability of energy efficiency projects and how it would expand their own business in today's competitive environment.

Concluding workshop

The outcome of this activity will be the assessment of the impact of the project as well as development of a roadmap for future activities. The workshop will be conducted for the representatives of the local industrial units, industry associations, LSPs and other stakeholders so that the experiences gained during the course of project activities including implementation activities of EE project can be shared. All the stakeholders in the project will share their experience relating to projects undertaken by them as per their respective roles. Effort from industrial units as well as LSPs to quantify energy savings thus achieved would be encouraged. This would lead to development of a roadmap for implementing similar programs in other clusters with greater efficiency and reach.

1.3 PROJECT DURATION

Activity	**Time**
Energy use & technology audit	January to April 2010
Capacity Building	Oct 2010
Introductory Service Providers Workshop	Oct 2010
Information Dissemination Workshop	Oct 2010
Implementation of EE Measures	December 2010
Preparation of DPRs	April to October 2010
Capacity building of local service providers	November 2010
Facilitation of Innovative Financing	December 2010
Financing EE	December 2010
Capacity Building of Bankers	December 2010
Concluding Service Providers Workshop	December 2010

1.4 IDENTIFIED CLUSTER UNDER THE PROGRAMME

29 most energy intensive MSME clusters across different end use sectors have been identified to implement the BEE SME program for EE improvement. The details of industrial sector and identified cluster are provided in Table 1.1 below:

Table 1.1: *List of clusters identified for BEE SME Program*

S. No.	Cluster Name	Location
1	Edible oil cluster	Alwar
2	Machine components cluster	Bangalore
3	Ice slabs cluster	Bhimavaram
4	Brass cluster	Bhubhaneswer
5	Sea food processing cluster	Cochin
6	Fire bricks cluster	East &West Godavari
7	Rice mills cluster	Ganjam
8	Milk processing cluster	Gujarat
9	Galvanizing and Wire drawing cluster	Howrah
10	Foundry cluster	Jagadhri
11	Limestone cluster	Jodhpur
12	Tea processing cluster	Jorhat
13	Foundry	Ludhiana, Batala, Jalandhar
14	Paper processing cluster	Muzzafar Nagar
15	Sponge iron cluster	Orissa
16	Dyes and chemicals cluster	Vapi
17	Bricks and tiles cluster	Varanasi
18	Rice mills cluster	Vellore
19	Dyes and chemicals cluster	Ahmedabad
20	Brass cluster	Jamnagar
21	Textile cluster	Pali
22	Textile cluster	Surat
23	Tiles cluster	Morvi
24	Textile cluster	Solapur
25	Rice mills cluster	Warangal
26	Tiles cluster	Mangalore
27	Textile cluster	Tirupur
28	Coir cluster	Alleppey
29	Glass cluster	Firozabad

As a part of BEE SME program, one of cluster identified is Jodhpur, Lime Stone Industry Cluster. It was proposed to carry out energy use and technology audit studies in around 60 units in Jodhpur Lime Stone Cluster covering all types and sizes of the industries to understand/give valuable insight into the process of developing energy efficiency solutions relevant to the SME industries in Jodhpur Lime Stone Cluster.

CHAPTER 2

JODHPUR LIME STONE CLUSTER SCENARIO

2.1 OVERVIEW OF SME CLUSTER

There are approximately 115 units, engaged in lime (hydrated & quick lime) production. These units are spread across Borunda, Gotan Road, Pipad City, Jawasia, Pullu Road, Godawat Road, Ransi & Khejedla, which are under Jodhpur district. The mines are located close by in a radius of 8/10 kms. Most of the units are operating in general shift and are non-mechanized in nature. The main energy consuming equipment used is Fire Brick Kiln locally fabricated in various capacities such as 10/12/14 tons of quick lime output per Kiln/day. On an average the daily input is 30 tons of limestone along with 2.5 – 3.0 tons of petro coke as fuel which takes 48 hrs to 72 hrs for preparing quicklime. Firewood & Petro coke are the main fuel used. The end products – granular is used in various industries for different applications whereas powder goes for white washing & other applications.

2.1.1 CLUSTER BACKGROUND

Limestone is valuable natural resource and it is used for many applications such as in cement industries, chemical industries, building constructions industrial uses, etc. Stones from different mines is collected and baked in Kilns to get granular lime. Energy is one of the major inputs in lime processing. The average energy cost is approximately 50-60 % of the total manufacturing cost and major energy consumer for making limestone granular form is fire brick Kilns where Petro coke is main energy sources.

Bureau of Energy Efficiency (BEE), Government of India in coordination with Confederation of Indian Industry (CII) has taken up initiative to enhance Energy Efficiency of Limestone Manufacturing Units across Jodhpur, Rajasthan through **"BEE - Jodhpur Limestone SME Cluster Program for Energy Efficiency"**.

The objective of the project is to accelerate the adoption of energy efficiency technologies & practices through knowledge sharing, capacity building and development of innovative financing mechanisms.

2.1.2 PRODUCT MANUFACTURED

Most of the units produce hydrated lime & quick lime as end product of different grades according to the customer requirement.

1. **Hydrated lime** (or calcium hydroxide (**Ca(OH)2)**, or slaked lime) is usually a dry powder resulting from the controlled slaking of quicklime with water. The exothermic or released heat of reaction is captured and used to evaporate the excess slaking water. Chemical composition of Hydrated Lime available in each grade.

Grades of Hydrated Lime;

Name of Chemical Composition	Special Pharma Grade	A+	A	B	C	D	E	F
Ca (OH) 2 (%)	+93	+92	+90	+85	+80	+75	+70	+65
Active CaO	70	69	68-72	63-68	58-63	55-58	50-55	47-50
Acid Insoluble (Silica) (Max) %	0.5	0.7	1.0	1.5	2.0	3.0	4.0	6.0
Iron & Alumina as Fe2O3 & Al2O3	<0.4	<0.4	<0.5	0.5-1	0.5-1	0.5-1	0.5-1	0.5-1
Megnetia as MgO (Max) %	0.6	0.8	1.0	1.5	2.0	2.0	2.5	2.5
Carbonate (Max) %	0.5	0.5	1.0	1.5	2.0	3.0	3.0	4.0
Mesh Size	300	300	250	200	200	100	100	100

2. **Quick Lime**: Quicklime (or calcium oxide (CaO), or burnt lime, or un-slaked lime), is obtained by calcining (controlled heating - time and temperature) limestone at temperatures above 900°C. This highly reactive product is essential to many industrial processes.

2.1.3 CLASSIFICATION OF UNITS

Broadly units are classified with respect to production capacity.

1) Large Scale Units
2) Medium Scale Units
3) Small Scale Units

Large Scale Units

Units which are having annual quicklime production above 15000 Metric Tonnes can be categorised as large scale units. There are very few units (around 10) of such large capacity in Jodhpur Lime Stone Cluster.

Medium Scale Units

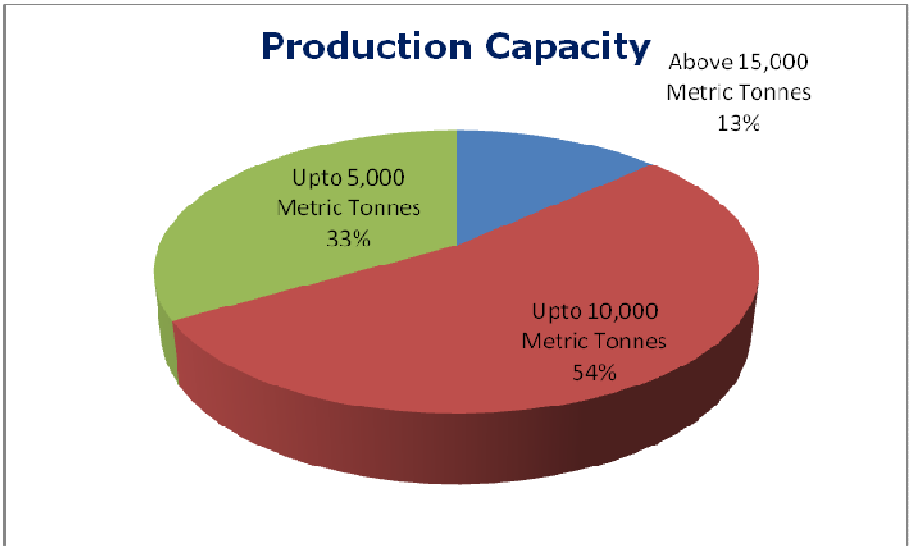
Units with a capacity range of 3000-15000 Metric Tonnes/annum can be categorised as medium scale units. Most of the limestone units (more than 40) fall under this category.

Small Scale Units

These are units with capacity less than 5000 Metric Tonnes per annum.

2.1.4 PRODUCTION CAPACITY

The total production capacity can be estimated around 6,00,000 MT / annum of quicklime.



2.1.5 RAW MATERIALS USED

Limestone is use as raw material. The main source of lime stone is mines near Jodhpur regions. These mines are located in range of 8 – 10 km diameter.

2.2 ENERGY SITUATION IN THE CLUSTER

Energy used for Lime production is Petcoke & Electricity. Main source of pet coke is Reliance Refinery, Jamnagar. Market dependent cost of pet coke is a major issue for lime units. Electricity is purchased from RSEB. Most of the units are having

connected load in the range of 100 kVA – 200 kVA.

2.2.1 TYPES OF FUEL (FOSSILS, BIOMASS, WASTE, BYPRODUCTS, ETC)

The following are the commonly used fuels & their prices are given herein;

S. No.	Fuel Used	Price Rs/ Kg
1.	Pet Coke	6.5 - 7.5
2.	Coal	4 - 6
3.	Fire Wood	4 - 5

2.2.2 FUELS AND ELECTRICITY CONSUMPTION

In this cluster pet coke & electricity are the main form of energy used. Pet coke is mainly used in Kilns & electricity is mainly used in crushing & hydration of quicklime to get hydrated lime. Fuel & electricity consumption for a typical unit is shown below;

Energy Use in Kiln:

Types of Kiln	Types of Fuel Used	Running hr/Day	Production Capacity	Fuel Consumption/Day	Specific Energy Consumption/Ton molten material	Specific energy Consumption in rupees
Vertical Shaft	Pet coke	Cont.	15 Metric Tonnes Quicklime output/day	2.5 – 3.0 Metric Tonnes Petcoke	0.2 Metric Ton Pet coke/T quicklime	Rs. 1.44/Kg Quicklime

Electricity Used for Crushing & Hydration:

Types of Process	Types of Fuel Use	Running hr/Day	Production Capacity	Electricity Consumption	Specific Energy Consumption/Ton Hydrated Lime	Specific energy Consumption in rupees
Crushing & Hydration	Electricity	8 - 10	18 T hydrated lime/day	250 -270 kWh electricity	14 - 16 kWh electricity	Rs. 75

* Assuming electricity Rs 5.0/kWh

2.2.3 SPECIFIC ENERGY CONSUMPTION

Specific energy consumption of Lime stone units depends upon the production capacity & their corresponding power consumption. Units of Jodhpur are having Specific energy consumption in range of **14-16 kWh/MT** of hydrated lime produced.

Pet coke consumption in Kiln is in the range of 2.5 – 3.0 Tonnes to produce around 15 Tonnes of quick lime. So, based on the lime output from Kiln, Specific energy consumption is coming around 0.2 Tonnes of Reliance pet coke (@ 7400 Kcal/kg)/T of quick lime produced.

2.3 MANUFACTURING PROCESS/TECHNOLOGY OVERVIEW IN A TYPICAL UNIT

Lime is the high-temperature product of the calcination of limestone. Although limestone deposits are found in every state, only a small portion is pure enough for industrial lime manufacturing. To be classified as limestone, the rock must contain at least 50 percent Calcium Carbonate. When the rock contains 30 to 45 percent magnesium carbonate, it is referred to as dolomite, or dolomite limestone. Lime can also be produced from aragonite, chalk, coral, marble, and sea shells.

In some lime plants, the resulting lime is reacted (slaked) with water to form hydrated lime. The basic processes in the production of lime are;

(1) Quarrying raw limestone
(2) Preparing limestone for the kilns by crushing & sizing
(3) Calcining limestone
(4) Processing the lime further by hydrating
(5) And miscellaneous transfer, storage, and handling operations.

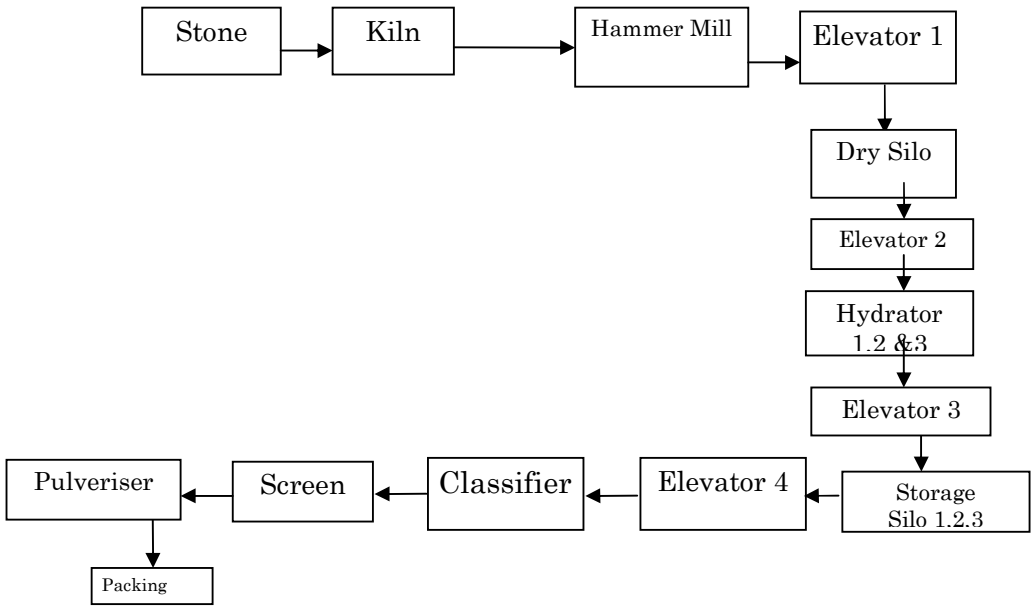
2.3.1 PROCESS TECHNOLOGY

In lime industry, kiln is major consumer of energy. Conventionally it is done in direct flame to fire the products. Kiln is batch type kiln, where raw material is fed from top side and at bottom after 12-13 hrs finished product (quick lime) is taken out.

Raw product undergoes loading section, combustion zone, cooling zone and then under loading section. Material movement is by gravity. Kiln is constructed with refractory and insulating bricks. Lime Stone cluster units in Jodhpur region produce quick lime and hydrated lime. The kiln lining is made of refractory material bricks, and in between the refractory material bricks and the fire brick, there is a layer of high strength heat insulating yellow sand.

In traditional Kiln there is no insulation and only fire bricks lining is done. 1000℃ temp is maintained in burning zone the heat losses from fire bricks lining is around 40 to 45% which can be reduced through insulation having thickness 2" and heat losses can be minimized from 40% to10% only. With the technical support of experts in insulating materials, the Team suggested trying new refractory bricks/castables at zones of kiln system to reduce heat loss. For example, Insulation Bricks, Insulation castables i.e Monoline-7, Insulite-7, Magnesia 85% castable, Ceramic Fibre Blanket/wool, Insulate (Mixture of Quartz and Mica) is insulating material which is new technology for kiln insulation. This option gives saving potential at least 4% in petcoke because it reduces the batch time from 13 hrs to 11 or 12 hrs. In addition to that extra heat availability after doing insulation, the unburn petcock contents is approximately nil.

2.3.2 Process Flow Diagram



2.4 CURRENT POLICIES AND INITIATIVES OF LOCAL BODY

Many good initiatives are being initiated by local body/ Jodhpur Industry association for improving manufacturing practices in industries.

- Organising programs & awareness sessions on different subjects
- Association people involve themselves in increasing energy efficiency of plant.
- Shares good practices for plant and benefits achieved
- Workers safety
- Implementation of Automated Material handling practices.

2.5 ISSUES RELATED TO ENERGY USAGE AND CONSERVATION AND BARRIER IN TECHNOLOGY UP GRADATION

Energy usage and conservation issues

- No Monitoring of pet coke consumption
- Heat losses from the Kiln (Improper Insulation)
- Low Power factor operation

- Re-winded motor operation
- Utilization of energy inefficient lamps
- Lack of monitoring of energy consumption

Barrier in technology up gradation

- Lack of information/availability of latest technology
- Lack of technology provider in near area

2.5.1 TECHNOLOGICAL BARRIER

- There is lack of cost effective energy efficient technology in Kiln
- In most of the unit's material handling is manual which results in non uniform production this can be rectified by automated material (Conveyor Belt) system. Another benefit will be reduced labour cost.
- Units are using quite old and rewinded motors which lead to increase in power consumption, which can be reduced by energy efficient motors.
- Units are maintaining power factor less than 0.90, which can be improved to 0.99 to get rebate from SEB

2.5.2 FINANCIAL BARRIER

Finance is one of the major issues in energy efficiency. There is need to develop attractive financing mechanism in order to create interest among industry for technology adoption.

2.5.3 MANPOWER

Skilled workers are locally available to operate kiln/. Specialized training with local service providers for better operation and maintenance of equipments, importance of the energy and its use will create awareness among workforce. These programs should be organized with equipment suppliers.

CHAPTER 3

ENERGY USE AND TECHNOLOGY ASSESSMENT IN CLUSTER

Energy Audit team have assessed the energy productivity of unit through a detailed study and discussed the various energy issues.

3.1 METHODOLOGY ADOPTED FOR ENERGY USE & TECHNOLOGY AUDIT STUDIES

A well planned methodology was adopted to execute the energy use and technology audit studies and to achieve the desired project objectives. Major steps which were followed during the energy use & technology studies of the project are mentioned below:

- Data Collection
- Measurements
- Analysis
- Technical discussion
- Conclusion

The primary objective of the energy audits is to quantify the existing electricity consumption pattern and to determine the operating efficiencies of existing systems. The key points targeted through energy audits were determination of specific fuel consumption, various losses, operating practices. Pre-planned methodology was followed to conduct the energy audits. The following sections describe details of methodology adopted in energy use and technology audits in Jodhpur Lime Stone Cluster.

At site team has collected all relevant information related to energy with respect to production. At all required places measurement being taken with involvement of plant people. Analysis of all the data captured being done and then on basis of measurement discussion was held on with plant.

3.1.1.1 PRE ENERGY AUDIT ACTIVITIES

Energy Audit team have assessed the energy productivity of unit through a study and discussed the various energy issues. At first energy audit team have taken plant round to have feel of plant and to understand plant team's expectation through energy audit. Plant management assigned one technical person as coordinator, who has given all kind of details of energy and in his presence data measurement being taken. Finally at end of audit, there was discussion with all plant team regarding findings of energy saving in plant.

3.1.1.2 PRELIMINARY ENERGY STUDY

40 Preliminary energy audit studies are conducted in Jodhpur Lime Stone Cluster. Methodology followed in preliminary energy audit study is presented below:

- Collection of past energy consumption details and energy bill
- List out major energy consuming areas of the plant
- Existing technology of various processes and utilities (latest or old, local or reputed company make etc)
- Identification of the areas for special attention for low cost measures with quick payback period
- Understanding the detailed process with energy and material balance
- Establish specific energy consumption, if possible for the each typical equipment/process
- Identify the areas for detailed energy audit study and measurements required

3.1.1.3 DETAILED ENERGY STUDY

Detailed energy study being done at plants which are having annual capacity of lime stone production more than 500 MT. Kiln was studied for its energy performance. Actual running power factor is recorded from the current month's electricity bills. On site measurement of all big size motors i.e. hydrator, hammer mill, classifier is taken, survey of lighting system is also done with plant team all the suggested measures with the plant team with techno-economic measures & their corresponding investment.

30 Detailed energy audit studies are conducted in Jodhpur Lime Stone Cluster. The methodology followed in detailed energy audit study is presented below:

- Collection of past energy consumption details and energy bill
- Listing of major energy consuming areas of the plant
- Identifying existing technology of various processes and utilities (latest or old,

crude or efficient, local or reputed company make etc)

- Status of instruments installed in the plant and necessary instrumentation required for the detailed study
- Identification of the areas for special attention for low cost measures with nominal investment.
- Understanding the detailed process with energy and material balance
- Monitoring & measuring of different parameters of various equipment / machines to evaluate performance
- Collection of operational data from various measuring instruments / gauges installed in the plant
- Compilation of design data/name plate details of various equipment from design manuals and brochures
- Discussions with concerned plant personnel to take note of operating practices and shop-floor practices being followed in the plant and to identify specific problem areas and bottlenecks if any with respect to energy consumption
- Critical analysis of data collected and parameters monitored
- Identification of energy wastage areas and quantification of energy losses
- Identification of suitable energy conservation measures for reducing energy consumption

3.2 OBSERVATIONS MADE DURING THE ENERGY USE AND TECHNOLOGY STUDIES CARRIED OUT IN THE CLUSTER

Energy audit team made many observations during visit, that includes Kiln, material handling process, technology or equipment employed, energy availability, utility energy consumption and many more which are listed below

3.2.1 MANUFACTURING PROCESS AND TECHNOLOGY/ EQUIPMENT EMPLOYED

Manufacturing process involves size reduction of raw stone in the kiln. size reduction is made on the basis of regular production practices Raw product undergoes loading section, combustion zone, cooling zone and then under loading section. Material movement is by gravity. Raw stone is coming from local mines. The output material from Kiln goes to the hammer mill & lime is crushed in to small pieces. These fine lime particles are further divided by classifiers according to that different grade of lime. Finally lime is packed in bags of 20/40/60 kgs & send to different places across the world.

Equipment employed:

1) Kiln
2) Manual Hammer
3) Hammer mill
4) Hydrator

5) Classifier

3.2.2 ENERGY CONSUMPTION PROFILE AND AVAILABILITY

Energy consumption profile varies from starting to end of process. Highest energy consuming equipments are Kiln followed by Hammer mill, Pulverisor, Classifier & hydrator. Pet coke as fuel is used in Kiln.

3.2.3 CAPACITY UTILIZATION FACTOR

This factor can be divided into two parts:

1) Equipment capacity utilization factor
2) Plant capacity utilization factor

As far as equipment capacity utilization is concerned, it varies. Loading of the motors is directly proportional to the plant capacity. Loading of Transformer is also having the same variation pattern proportional to plant production. Petcoke consumption is almost uniform throughout the production. Plant capacity utilization is also having the same pattern some plants are running 340 days per annum but some are running only 200-150 days per annum only depending upon the market requirement of lime.

3.2.4 HOUSEKEEPING PRACTICES

Operational practices in majority of the plant are not very good. There is good possibility to improve the same. There are no specific procedures followed for any particular operation & maintenance of equipments/machines. Knowledge on energy conservation is not much.

By improving the operational practices alone, there is possibility to reduce energy consumption by 2 – 3%. Some of the suggested housekeeping practices are presented below;

- ✓ Monitor charging time in Kiln
- ✓ Planning for scheduling Kiln operation should be done
- ✓ Idle running of equipments should be avoided
- ✓ Training programs & awareness session may be organised to showcase benefits of better housekeeping practices.
- ✓ There is need to create sufficient space & process for storage of raw material, coke. Also proper flouring & covering of the coal storage yard is required which can reduce unwanted dust & carpet losses.
- ✓ Unwanted stone, other residues get mixed in pet coke, which consume the additional heat during the combustion which results in non uniform heating of lime stones & increased fuel consumption for same production

3.2.5 AVAILABILITY OF DATA INFORMATION

As plant persons are very cautious about the end products quality, almost every plant is recording & monitoring data. They have keen observation of the products according to the client's requirement. Audit team had taken all the required data to analyse specific energy consumption of the plant.

3.3 TECHNOLOGY GAP ANALYSIS

Lime Stone units in unorganized sector has these characteristics; low engineering, limited technology innovation, poor R&D base, low level of human resource on knowledge of technology and operational skill etc. This sector also faces deficiencies such as the lack of access to technology, technology sharing, lack of strong organizational structure, professional attitude etc.

Majority of Lime Stone units in Jodhpur Lime Stone Cluster are using low end technologies in their processes and utilities. There are various technological gaps which were identified in units as under:

- Lack awareness on the technologies available
- Lack of awareness among the workforce etc.

There is a tremendous need for this industry to modernize/upgrade its technology and adopt energy efficient technologies in some of the areas. Further, as per the discussions made with the some of the progressive managements, they are interested in improving efficiency of their units by replacing the conventional technology with energy efficient technologies in market.

From technology audit studies conducted in Jodhpur Limestone Cluster, below mentioned areas were identified for technology up gradations;

- Kiln
- Material handling
- Surface Insulation for reducing heat loss of Kiln
- Electrical Motors
- Plant Lightning System

3.3.1 TECHNOLOGY UP-GRADATION

Now a day, there are various new technologies available in market for above said equipments which are not only energy efficient but are also having good productivity. Technology up gradation can be done in every equipments and utilities which are installed. Kiln is one of the major area where much improvement is required.

Equipments which are installed are very old such as almost all the motors are re-winded many times, Hydrator, Classifier, Pulveriser, Hammer Mills are having motors in the range of 10-50 h.p. contribute to more power consumption. Energy efficient lamps are available in market which is very competitive with other incandescent lamps.

Equipments	Old Technologies	New Technologies	Saving Potential
Kiln	Improper insulation	Energy saving insulation	4 – 5%
Pulverisor,Hydrator,Classifier,Hammer Mill	Old In-efficient motors	Energy efficient motors	5 - 10 %
Energy Efficient Kiln	Kiln with improper insulation	Energy efficient Kiln with proper insulation	4 - 5% improvement in productivity
Classifier	V – belt drive	Flat belts	3-5 % Longer Life
Pet coke storage	Improper storage	Cemented floor to avoid carpet loss	2%
HPSV lamps	250 W	FTL of (24 x 4) W	60%
HPSV lamps	150 W	FTL of (14 X 4) W	60%

3.3.2 PROCESS UP-GRADATION

Regenerative type Kiln is one of the energy efficient Kiln but requires higher investment & also technology is not available locally. Conveyor belt for material handling can be other option for better material flow and better loading of equipments. This arrangement reduces the dependency of the plants on the labours which are difficult to get. Such type of arrangement reduces the plant dependency on labours and production becomes smooth.

3.4 ENERGY CONSERVATION MEASURES IDENTIFIED

Various energy conservation proposals are identified for Jodhpur Limestone Cluster. Details of identified energy conservation proposals along with its cost benefit analysis and issues in implementation of each proposal are presented in following sections.

1. Insulation of Kiln
2. Energy efficient Kiln with insulation

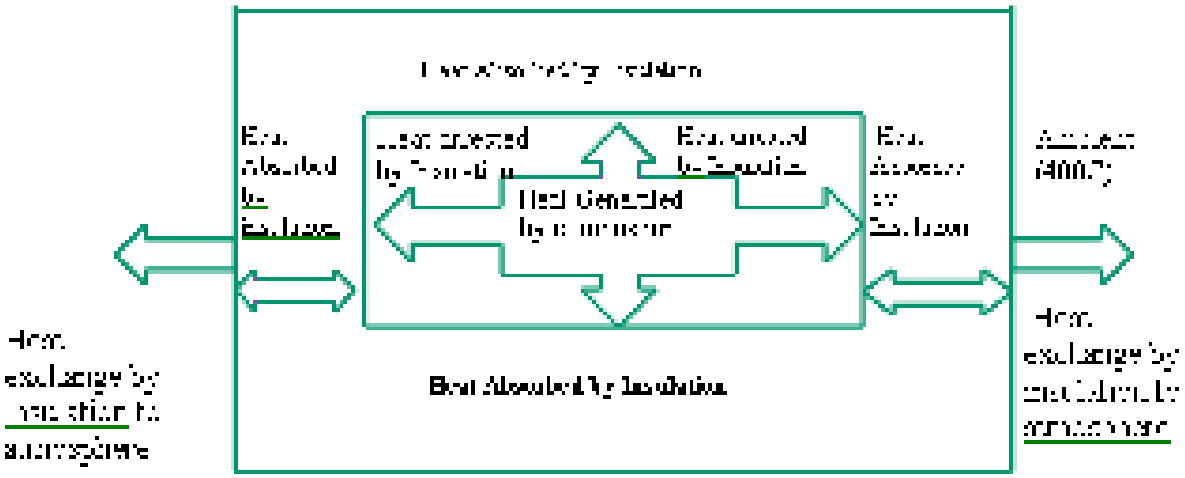
3. Energy efficient motors for different equipments
4. Install APFC to maintain close to unity power factor
5. Coal storage to avoid carpet loss
6. Replace 40 W Light by T5, 28 W Light
7. Replace 100 W GLS bulb by 20 W CFL

3.4.1 PROPOSAL FOR ENERGY CONSERVATION INCLUDING TECHNOLOGY UP GRADATION

Various energy conservation proposals are identified for Lime Stone units Jodhpur Lime Stone Cluster. Details of identified energy conservation proposals along with its cost benefit analysis and issues in implementation of each proposal are presented in following sections.

A) 3.4.1.1 Install Energy Efficient Kiln/Improve Insulation

CII and plant team jointly studied the Kiln during the energy audit. Pet coke is being used Kiln for treating lime stone to get quick lime. Heat distribution in surface heat loss is explained in figure given below.



Ideally, skin temperature should not be more than Ambient +100℃. Higher skin temperature means more surface heat loss into the atmosphere. During our study we found that insulation of kiln was weak. Locations identified are;

1. Surface of kiln / brick lining

Heat loss from fire brick lining is around 40% which can be minimized to 10% by providing insulation

Types of Insulation

- Insulation bricks
- Ceramic fibre blanket
- Insulation castables
- Monoline-7
- Insulite-7
- Magnesia 85% castable

3.4.1.2 Benefits

1. It will result in reduced pet coke feeding by 4%.
2. Improving insulation will also result in reduction of batch time from 13 hours to 12 hours
3. It will also result in reduction of unburned pet coke.
4. Added advantage will be in achieving core calcinations.

3.4.1.3 Cost of New Energy Efficient Kiln/Insulating Existing Kiln

The Cost of a new Kiln with high insulation would be around Rs. 7.5 Lakhs. And the cost of insulating existing Kiln would be around Rs. 3.0 Lakhs.

3.4.1.4 Saving

Around 4% savings in fuel consumption can be achieved by installing new energy efficient Kiln. Saving would be around Rs. 12.0 Lakhs/annum/Kiln, considering fuel cost Rs. 7200/T & annual consumption 15 T/day.

Simlarly, around 2% savings in fuel consumption can be achieved by providing insulation to existing Kiln. Saving would be around Rs. 6.0 Lakhs/annum/Kiln, considering fuel cost Rs. 7200/T & annual consumption 15 T/day.

3.4.1.6 Simple Payback Period

Simple payback period would be around 6 - 12 months.

3.4.1.7 Issues / barrier in implementing

This proposal requires some capital for implementation, so could be implemented as per priority of plant.

Other barriers are as follows

1. The main barrier in implementation of this proposal is the absence of monitoring system of Kiln temperature which is important for temperature loss reduction.
2. There is no maintenance schedule for insulation improvement which has to be maintained. Insulation should be provided at regular intervals.
3. High class insulation bricks are not provided because of that temperature losses are more so high class insulation to be utilized.

3.4.1.8 Availability of Technology

As far as technology is concerned it is available in local/ national market. Energy efficient Kiln manufacturer is available in Jodhpur also.

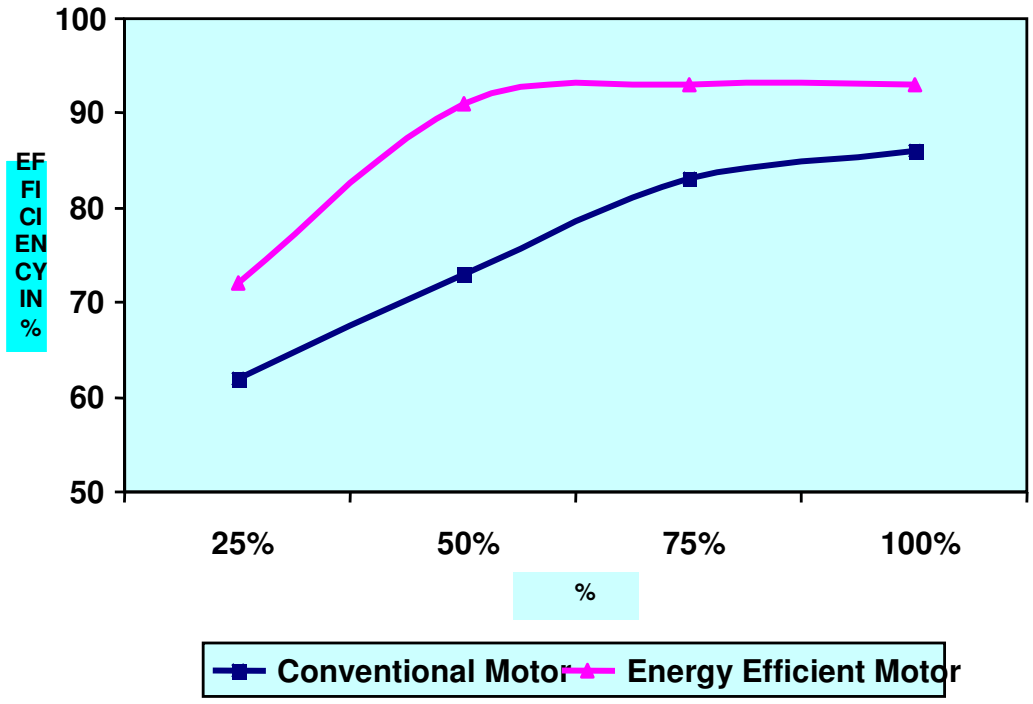
B) 3.4.1.2 Replacement of Re-winded/Old Motors by Energy Efficient Motors

Background

During the audit it was observed that the maximum of motors are re-winded more than 5 times which leads to approx 2.5 times more power consumption and lower operating efficiency. These motors must be replaced by the Energy Efficient Motors which leads to higher working efficiency up to 4 % for the same working condition Energy-efficient motors (EEM) are the ones in which, design improvements are incorporated specifically to increase operating efficiency over motors of standard design. Design improvements focus on reducing intrinsic motor losses. Improvements include the use of lower-loss silicon steel, a longer core (to increase active material), thicker wires (to reduce resistance), thinner laminations, smaller air gap between stator and rotor, copper instead of aluminum bars in the rotor, superior bearings and a smaller fan, etc. Energy-efficient motors now available in India operate with efficiencies that are typically 3 to 4 percentage points higher than standard motors. In keeping with the stipulations of the BIS, energy-efficient motors are designed to operate without loss in efficiency at loads between 75 % and 100 % of rated capacity. This may result in major benefits in varying load applications. The power factor is about the same or may be higher than for standard motors.

Standard vs High Efficiency Motors

Efficient motors have lower operating temperatures and noise levels, greater ability to accelerate higher-inertia loads, and are less affected by supply voltage fluctuations.



3.4.1.2 Benefits

- Reduced power consumption
- High efficiency
- Less losses
- Wide range with good efficiency
- Less starting torque

3.4.1.3 Lifecycle Analysis

Installation of Energy efficient motors in place of re-winded motors will save the power, as Energy efficient motors (EEF1) have 4-5 % efficiency higher than standard motor.

Equipment	Power consumption
Standard / Rewinded motor	32 kW
Energy efficient motor	30 kW
Saving potential	2 kW

Comparison of energy consumption between Standard and energy efficient motor

Saving	2 kW

Running Hours	10 hrs/day 7000 hrs/year
Energy Saving	= 2 kW/Motor x 7000 hrs/yr x Rs. 4.8 / kWh = **Rs. 0.67 Lakh/ year/motor**

3.4.1.4 Cost of Implementing

Cost of implementing this proposal varies in plant as per capacity and size of plant. For a motor size of 30 kW, investment would be **Rs. 1.2 Lakhs**.

3.4.1.5 Saving

Savings would be around Rs. 0.67 Lakh/motor.

3.4.1.6 Simple Payback Period

Installation of energy efficient motors in place of standard motors has payback of only 29 Months

3.4.1.7 Issues / Barrier

Major issue in implementing this proposal is cost of implementation. All the technical and commercial aspects have been discussed with unit people. It is advisable to use Energy efficient motors at place of re-winded motors. One of the barriers in implementing this proposal is vendors. Because of remote location very few suppliers of energy efficient motors are available.

3.4.2 Availability of Technology / Product

Now days when energy cost is high, it is poor practice to use re-winded motors. As far as technology is concerned Energy efficient motors are available in local/ national market. It is well proven technology which is adopted in many of the other similar and dissimilar units. Local vendors can arrange energy efficient motors at order.

C) 3.4.1.3 Installation of Automatic Power Factor Controller to maintain unity power factor

Background

During the audit of Jodhpur units, electrical distribution system survey was jointly carried out by the CII and the plant team for energy saving possibility. The state electricity board gives a flat rebate of 1.0 % of the monthly electricity bill for every 1 % improvement in the power factor above if the power factor (PF) is maintained above 0.95. The average PF maintained in the plant is low due to which units are not getting any incentives by the State Electricity Board. Improve power factor till 0.99 or unity to get maximum benefits in reduction in electricity consumption.

Theory

In a purely resistive AC circuit, voltage and current waveforms are in step (or in phase), changing polarity at the same instant in each cycle. All the power entering the loads is consumed where reactive loads are present, such as with capacitors or inductors, energy storage in the loads result in a time difference between the current and voltage waveforms. During each cycle of the AC voltage, extra energy, in addition to any energy consumed in the load, is temporarily stored in the load in electric or magnetic fields, and then returned to the power grid a fraction of a second later in the cycle. The "ebb and flow" of this nonproductive power increases the current in the line. Thus, a circuit with a low power factor will use higher currents to transfer a given quantity of real power than a circuit with a high power factor. A linear load does not change the shape of the waveform of the current, but may change the relative timing (phase) between voltage and current.

Circuits containing purely resistive heating elements (filament lamps, strip heaters, cooking stoves, etc.) have a power factor of 1.0. Circuits containing inductive or capacitive elements (electric motors, solenoid valves, lamp ballasts, and others) often have a power factor below 1

Power factor is the ratio of actual power (kW) to the apparent power (kVA). The apparent power (kVA) is defined by the following formula;

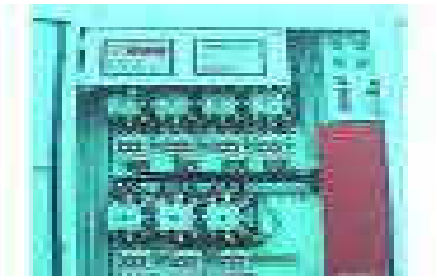
Apparent power = Sqrt (kW2 + kVAR2)

kVAR is the reactive power; from the above formula if less power factor indicates that supply of the reactive power is high compared to active power, which contributes useful work of the system. High reactive power indicates that higher reactive current and increases the I2R losses of the network. Capacitor is a device that generates reactive current and consumes very less power. Installing capacitor will improve the power factor and will also reduce the KVA demand of the system and will increase

the capacity of the network that is the network cables can be loaded further. Reduction in reactive current will result in reduction of I2R losses and efficiency of the system will improve.

Required KVAR = Load (kW) x [{tan (cos-1 PFi)} – {tan (cos-1 PFf)}]

1. Reactive Power Control Relay
2. Network connection points
3. Slow-blow Fuses
4. Inrush Limiting Contactors
5. Capacitors (single-phase or three-phase units, delta-connection)
6. Transformer Suitable voltage transformation to suit control power (contactors, ventilation,...)



An automatic power factor correction unit is used to improve power factor. A power factor correction unit usually consists of a number of capacitors that are switched by means of contactors. These contactors are controlled by a regulator that measures power factor in an electrical network. To be able to measure power factor, the regulator uses a current transformer to measure the current in one phase. Depending on the load and power factor of the network, the power factor controller will switch the necessary blocks of capacitors in steps to make sure the power factor stays above a selected value

3.4.1.2 Benefits

- Reduction in I2R losses
- Improved voltage regulation
- Decrease in KVA loading
- Reduction in energy kWH consumption
- Rebate on electricity bill
- Avoidance of power factor penalty
- Reduction in Maximum demand
- Longer life of electrical distribution components such as switch gears, transformers, cables etc

3.4.1.3 Life Cycle Analysis

Installation APFC will save the power consumption So cumulatively it saves lot of electrical energy.

Electrical load	45 kW
Existing power factor	0.9
Proposed power factor	0.99
Installation of APFC	15 KVAR

Comparison of energy consumption with APFC

Saving	4% of monthly electricity bill (Load 45 kW)
Running Hours	10 hrs/day 3000 hrs/year
Energy Saving	=0.04 x Electricity bill/month X 12 months/yr

3.4.1.4 Cost of implementing

Cost of APFC varies as per installed capacity of electrical system and size of plant. On an average cost varies from Rs 400 to Rs 600 per kvar. For 15 KVAR, cost would be around Rs. 7500/.

3.4.1.5 Saving

For a load of 50 kW, the yearly savings would be around Rs. 6000/.

3.4.1.6 Simple Payback Period

Simple payback period would be 12 months.

3.4.1.7 Issues / barrier

One of the barriers in implementing this proposal is vendors. Because of remote location very few suppliers of APFC are available.

D) 3.4.1.4 Installation of T5 lamps in place of 40 W Light

Background

During Audit, study of lighting was carried out for energy saving. In plant area there are many lights of 40 W each, with electrical choke which are having losses of 15 watts/ballast. Energy efficient T5, 28 W lamps are designed with special powder coating inside the lamp, hence gives same lumens with reduced power.

Reflector lamps are used when light is only desired to be emitted in a single direction, or when an application requires the maximum amount of light. T5 lamps deliver 2900 Lumens, which is more than 2000 lumens with 40 W tube.

Operating principle of Fluorescent lamps:-

A fluorescent lamp or fluorescent tube is a gas-discharge lamp that uses electricity to excite mercury vapor. The fundamental means for conversion of electrical energy into radiant energy in a fluorescent lamp relies on inelastic scattering of electrons. An incident electron collides with an atom in the gas. If the free electron has enough kinetic energy, it transfers energy to the atom's outer electron, causing that electron to temporarily jump up to a higher energy level. The collision is 'inelastic' because a loss of energy occurs.

This higher energy state is unstable, and the atom will emit an ultraviolet photon as the atom's electron reverts to a lower, more stable, energy level. Most of the photons that are released from the mercury atoms have wavelengths in the ultraviolet (UV) region of the spectrum predominantly at wavelengths of 253.7 nm and 185 nm. These are not visible to the human eye, so they must be converted into visible light. This is done by making use of fluorescence. Ultraviolet photons are absorbed by electrons in the atoms of the lamp's interior fluorescent coating, causing a similar energy jump, then drop, with emission of a further photon. The photon that is emitted from this second interaction has a lower energy than the one that caused it. The chemicals that make up the phosphor are chosen so that these emitted photons are at wavelengths visible to the human eye. The difference in energy between the absorbed ultra-violet photon and the emitted visible light photon goes toward heating up the phosphor coating.

When the light is turned on, the electric power heats up the cathode enough for it to emit electrons. These electrons collide with and ionize noble gas atoms inside the bulb surrounding the filament to form a plasma by a process of impact ionization. As a result of avalanche ionization, the conductivity of the ionized gas rapidly rises, allowing higher currents to flow through the lamp.

The lamp is more costly because it requires a ballast to regulate the current through the lamp.

3.4.1.2 Benefits of Implementing T5 lamps in place of 40 W Light

Advantages:-

- Low mercury content
- High efficacy (Lumens / Watt)
- Environmental friendly (Low Hg content, 3-4 mg)
- Reduces work related headaches
- Reduces sick building syndrome
- Operates at low voltage
- High PF (0.99)
- Instant start up

3.4.1.3 Life Cycle Analysis

Type	**Power Consumption including ballast**
Conventional fluorescent lamp (40 W with electrical choke)	55 W / Tube
Energy efficient T5 lamp (28 W with electronic choke)	28 W / Tube

Comparison of energy consumption between 40 W lamp and T5 lamps

Saving	25 W / lamp
Running Hours	5000 hrs/year
Energy Saving	= 0.025 kW/lamp x 5000 hrs/yr X Rs. 4.8 / kWh = **Rs. 600/ year/lamp**

Typically a fluorescent lamp will last between 10 to 20 times as long as an equivalent incandescent lamp when operated several hours at a time. The higher initial cost of a

fluorescent lamp is usually more than compensated for by lower energy consumption over its life. The longer life may also reduce lamp replacement costs, providing additional saving especially where labour is costly. Replacement of T5 lamps can be done on failure and replacement basis for any lamp.

3.4.1.4 Cost of implementing

Cost of implementing this proposal varies in plant as per capacity and size of plant. Cost of T lamps lies in range of 600-700 each.

3.4.1.5 Simple Payback Period

Installation of T5 lamps in place of 40 W tube has payback of only 12-15 months.

3.4.2 Availability of Technology

As far as technology is concerned it is available in local/ national market. It is well proven technology which is adopted in many of the other similar and dissimilar units.

E) 3.4.1.5 Replacement of 250 W HPSV lamps by (24 x 4) W T5 lamps

Background

During Audit, study of lighting was carried out for energy saving. In plant area there are many lights of 250 W, high pressure mercury vapor lamp. Energy efficient T5, 24 x 4 W lamps are designed with special powder coating inside the lamp, hence gives same lumens with reduced power. HPSV lamps are mainly used for street lighting or in plant. Reflector lamps are used when light is only desired to be emitted in a single direction, or when an application requires the maximum amount of light.

Operating principle of Fluorescent lamps:-

A fluorescent lamp or fluorescent tube is a gas-discharge lamp that uses electricity to excite mercury vapor. The fundamental means for conversion of electrical energy into radiant energy in a fluorescent lamp relies on inelastic scattering of electrons. An incident electron collides with an atom in the gas. If the free electron has enough kinetic energy, it transfers energy to the atom's outer electron, causing that electron to temporarily jump up to a higher energy level. The collision is 'inelastic' because a loss of energy occurs. This higher energy state is unstable, and the atom will emit an ultraviolet photon as the atom's electron reverts to a lower, more stable, energy level. Most of the photons that are released from the mercury atoms have wavelengths in the ultraviolet (UV) region of the spectrum predominantly at wavelengths of 253.7 nm and 185 nm. These are not visible to the human eye, so they must be converted into visible light. This is done by making use of fluorescence. Ultraviolet photons are absorbed by electrons in the atoms of the lamp's interior fluorescent coating, causing a similar energy jump, then drop, with emission of a further photon. The photon that is emitted from this second interaction has a lower energy than the one that caused it. The chemicals that make up the phosphor are chosen so that these emitted photons are at wavelengths visible to the human eye. The difference in energy between the absorbed ultra-violet photon and the emitted visible light photon goes toward heating up the phosphor coating.

When the light is turned on, the electric power heats up the cathode enough for it to emit electrons. These electrons collide with and ionize noble gas atoms inside the bulb surrounding the filament to form a plasma by a process of impact ionization. As a result of avalanche ionization, the conductivity of the ionized gas rapidly rises, allowing higher currents to flow through the lamp. The lamp is more costly because it requires a ballast to regulate the current through the lamp.

3.4.1.2 Benefits

Low mercury content
High efficacy (Lumens / Watt)
Environmental friendly (Low Hg content, 3-4 mg)
Operates at low voltage
High PF (0.99)
Instant start up

3.4.1.3 Life Cycle Analysis

Type	**Power Consumption including ballast**
HPSV lamps (250 W)	250 W
Energy efficient T5 lamp (24 x 4 W)	96 W / assembly

Comparison of energy consumption between 40 W lamp and T5 lamps

Saving	150 W / lamp
Running Hours	3000 hrs/year
Energy Saving	=0.150 kW/lamp x 3000 hrs/yr X Rs. 4.8 / kWh = **Rs. 2160/ year/lamp**

The higher initial cost of a fluorescent lamp is usually more than compensated for by lower energy consumption over its life. The longer life may also reduce lamp replacement costs, providing additional saving especially where labour is costly. Replacement of HPSV lamps by 24 x 4 W can be done on failure and replacement basis for any lamp.

3.4.1.4 Cost of implementing

Cost of 24 x 4 W lamps lies in range of 3500-4500 each.

3.4.1.5 Saving

Around Rs. 2000/yr/lamp can be saved.

3.4.1.6 Simple Payback Period

Installation of 24 x 4 W lamps in place of 250 W HPSV lamps has payback of 18 – 24 months.

3.4.2 Availability of Technology

As far as technology is concerned it is available in local/ national market. It is well proven technology which is adopted in many of the other similar and dissimilar units. In-fact some of the units in Jodhpur have already installed this lamps, and getting energy saving.

F) 3.4.1.6 Replacement of 150 W HPSV lamps by (14 x 4) W T5 lamps

Background

During Audit, study of lighting was carried out for energy saving. In plant area there are many lights of 150 W, high pressure mercury vapor lamp. Energy efficient T5, 14 x 4 W lamps are designed with special powder coating inside the lamp, hence gives same lumens with reduced power. HPSV lamps are mainly used for street lighting or in plant.

Reflector lamps are used when light is only desired to be emitted in a single direction, or when an application requires the maximum amount of light.

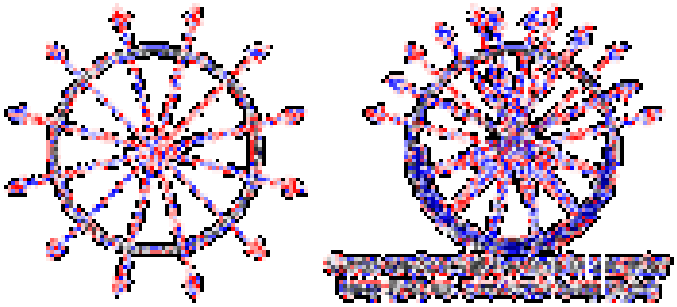
Operating principle of Fluorescent lamps:-

A fluorescent lamp or fluorescent tube is a gas-discharge lamp that uses electricity to excite mercury vapor. The fundamental means for conversion of electrical energy into radiant energy in a fluorescent lamp relies on inelastic scattering of electrons. An incident electron collides with an atom in the gas. If the free electron has enough kinetic energy, it transfers energy to the atom's outer electron, causing that electron to temporarily jump up to a higher energy level. The collision is 'inelastic' because a loss of energy occurs.

This higher energy state is unstable, and the atom will emit an ultraviolet photon as the atom's electron reverts to a lower, more stable, energy level. Most of the photons that are released from the mercury atoms have wavelengths in the ultraviolet (UV) region of the spectrum predominantly at wavelengths of 253.7 nm and 185 nm. These are not visible to the human eye, so they must be converted into visible light. This is done by making use of fluorescence. Ultraviolet photons are absorbed by electrons in the atoms of the lamp's interior fluorescent coating, causing a similar energy jump, then drop, with emission of a further photon. The photon that is emitted from this second interaction has a lower energy than the one that caused it. The chemicals that make up the phosphor are chosen so that these emitted photons are at wavelengths visible to the human eye. The difference in energy between the absorbed ultra-violet photon and the emitted visible light photon goes toward heating up the phosphor coating.

When the light is turned on, the electric power heats up the cathode enough for it to emit electrons. These electrons collide with and ionize noble gas atoms inside the bulb surrounding the filament to form a plasma by a process of impact ionization. As a result of avalanche ionization, the conductivity of the ionized gas rapidly rises, allowing higher currents to flow through the lamp.

The lamp is more costly because it requires a ballast to regulate the current through the lamp.



3.4.1.2 Benefits of Implementing

Low mercury content
High efficacy (Lumens / Watt)
Environmental friendly (Low Hg content, 3-4 mg)
Operates at low voltage
High PF (0.99)
Instant start up

3.4.1.3 Life Cycle Analysis

Installing (14 x 4) lamps in place of 150 W HPSV lamps saves power consumption for lighting since it saves running power of light. In some units HPSV lamps are used for street lighting purpose. All street lighting can be replaced by 14 x 4 lamps whose power consumption is much lower than HPSV lamps.

Type	Power Consumption including ballast
HPSV lamps (150 W)	150 W

Energy efficient T5 lamp (14 x 4 W)	56 W / assembly

Comparison of energy consumption between 40 W lamp and T5 lamps

Saving	94 W / lamp
Running Hours	3000 hrs/year
Energy Saving	=0.094 kW/lamp x 3000 hrs/yr X Rs. 4.8 / kWh = **Rs. 1350/ year/lamp**

The higher initial cost of a fluorescent lamp is usually more than compensated for by lower energy consumption over its life. The longer life may also reduce lamp replacement costs, providing additional saving especially where labor is costly.

3.4.1.4 Cost of implementing

Cost of 14 x 4 W lamps lies in range of 3500-4500 each.

3.4.1.5 Saving

Around Rs. 1300/lamp/yr can be saved.

3.4.1.6 Simple Payback Period

Installation of 14 x 4 W lamps in place of 150 W HPSV lamps has payback of around 30 months.

G) 3.4.1.7 Improve handling/storage of Pet Coke

Background

Uncertainty in the availability and transportation of fuel necessitates storage and subsequent handling. Stocking of pet coke has its own disadvantages like build-up of inventory, space constraints, deterioration in quality and potential fire hazards. Other minor losses associated with the storage of pet coke include oxidation, wind and carpet loss. A 1% oxidation of coal has the same effect as 1% ash in coal, wind losses may account for nearly 0.5 – 1.0% of the total loss. The main goal of good coal storage is to minimise carpet loss and the loss due to spontaneous combustion. Formation of a soft carpet, comprising of coal dust and soil causes carpet loss. On the other hand, gradual temperature builds up in a coal heap, on account of oxidation may lead to spontaneous combustion of coal in storage.

Present System

At present industry keeps its fuel in open space and at ground as such, taking less care for quality of coal.

Proposed System

With considering above theory action need to be taken for maintaining quality of fuel. The measures that would help in reducing the carpet loses are as follows:

1. Preparing a hard ground for petcoke to be stacked upon.
2. Preparing standard storage bays out of concrete and brick. In process Industry, modes of petcoke handling range from manual to conveyor systems. It would be advisable to minimise the handling of coal so that further generation of fines and segregation effects are reduced.

Preparation of Pet coke

Preparation of petcoke prior to feeding into the kiln is an important step for achieving good combustion. Poor feeding of pet coke and lime stone may cause the following problems:

Poor combustion conditions
and inadequate Kiln temperature

3.4.1.2 Benefits

Carpet loss can be avoided. Spontaneous combustion of pet coke in the storage yard can also be avoided.

3.4.1.3 Cost of implementing

Cost of implementing this proposal varies in plant as per capacity and size of plant. Approximately Rs. 1.0 Lakhs would be required for flooring & pet coke yard.

3.4.1.5 Saving

Around 2 – 3% losses of fuel can be avoided. Around Rs. 1.0 Lakhs/unit/yr can be saved.

3.4.1.6 Simple Payback Period

Improved handling of petcoke has lucrative payback of only 6 months.

3.4.1.7 Issues / barrier

(a) Lack of awareness: This is the major reason behind the Carpet losses. By very small investment in flouring of Pet coke handling area these losses can be reduced. The flouring of the Pet coke handling area can be provided easily which doesn't need any specific suppliers or manufacturers of technology.

3.5 IDENTIFICATION OF TECHNOLOGIES / EQUIPMENT FOR DPR PREPARATION

From energy use and technology audit studies carried out in Jodhpur Lime Stone Cluster, it became apparent that the equipments/utilities installed are inefficient, inferior quality and consuming more energy. There is considerable potential in Lime Stone cluster units for energy conservation by replacing the old/obsolete technology/equipments with energy efficient technologies/equipments.

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

- Installation of energy efficient Kiln
- Providing insulation in existing Kiln to reduce radiation losses
- Installation of energy efficient motors in place of old/re-winded motors
- Provide APFC to maintain unity power factor
- Providing concrete floor & roof to avoid fuel losses
- Replacement of Conventional Incandescent Lamps by CFL´s
- Replacement of 40 W Tube Light by 28 W Energy Efficient Tube Light

Environmental Benefits

As Lime Stone Units are not producing any pollutants, it is not having direct relation to benefits to environment. Although improvement in energy efficiency will give lot of indirect benefits to environment, as reduction in fuel & electricity consumption will lead to saving of environment.

4.1 Reduction in waste generation

In Lime Stone units, there is only ash form Kiln, which is sold to the nearby Cement plants & Brick manufactures. Improving energy efficiency will not only saves the energy but also help in having higher production of lime as well as reduces waste.

4.2 Reduction in GHG emission such as CO2, NOx

As implementation of above proposal will give reduction in fuel/electrical energy consumption, it will directly lead to reduce formation of Green house gases.

4.3 Reduction in emission such as SOx

As implantation of above proposal will give reduction in fuel/electrical energy consumption, it will directly lead to reduce formation of SOx gases.

CHAPTER 5

SMALL GROUP ACTIVITIES/TOTAL ENERGY MANAGEMENT

1. Introduction

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

In this situation Energy Conservation (EC) is the critical needs in any countries in the world.

Of special importance of Energy Conservation are the following two aspects:

(1) Economic factors

(2) Environmental impacts

1.1 Economic factors of Energy Conservation

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

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

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

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

- Some line Ministries and organizations like BICP, BIS, NPC, PCRA, REC, Ministry of Agriculture, TERI, IGIDR, CSIR, PETS (NPTI)
- State energy development agencies
- Industry associations
- All India financial institutions

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

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

1.2 Environmental impacts of Energy Conservation

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

2 Small Group Activities (SGA)

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

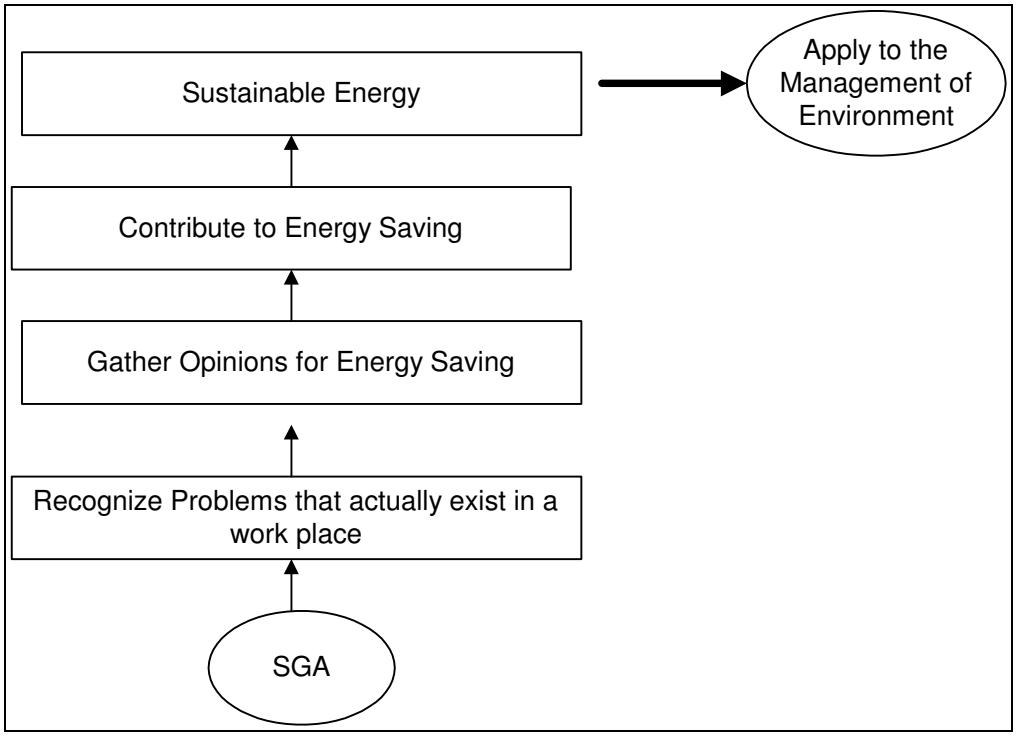
2.1 Importance of SGA

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.

2.2 How SGA leads to Energy Conservation?

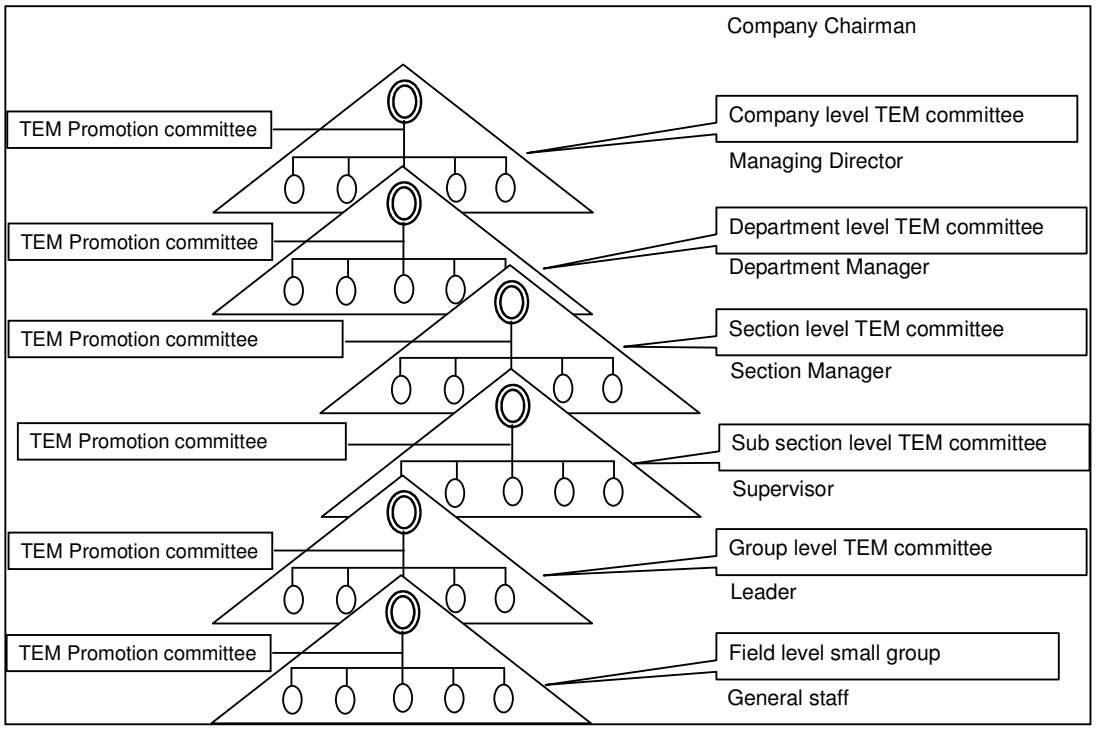
An excellent example of organizational structure that promotes energy management emphasizing participation is that they form overlapping small groups as in figure 14. The feature of this structure is that a small group for energy management is distributed to various sections as in figure 15, which is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



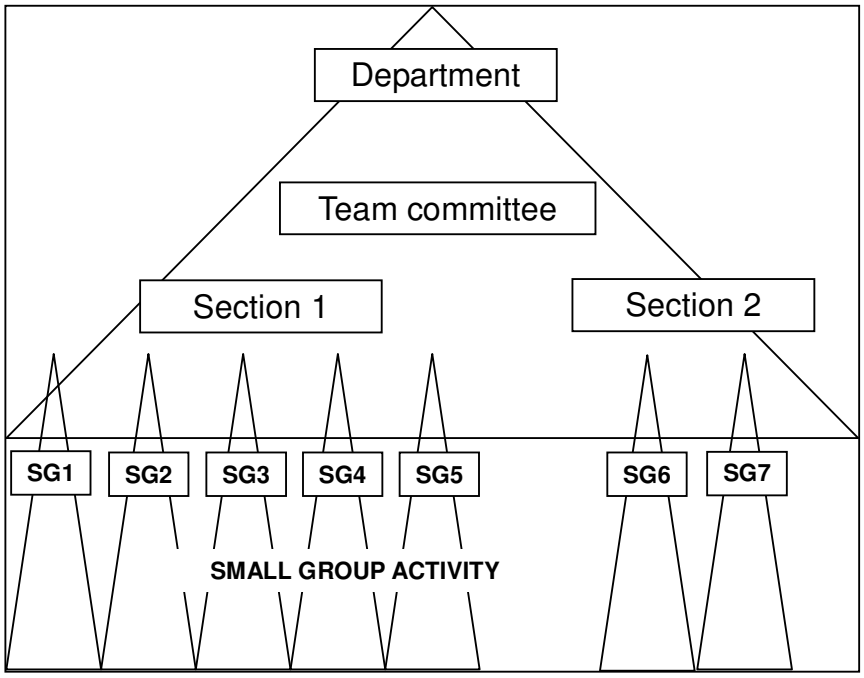
Relationship of SGA and energy saving

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, as already mentioned in Part 2, 2."Strategy for Improving the Efficiency of Energy Usage further", Step 2 Proper EC Organization including Assignment of Energy Manager (page 12).



Example of Organizational Structure with Overlapping



Positioning of SGA in Main Job Structure

2.2.1 Executives level

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

2.2.2 Level of Total Energy Management promotion office

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

2.2.3 Medium level

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

2.2.4 Workers/Operators level

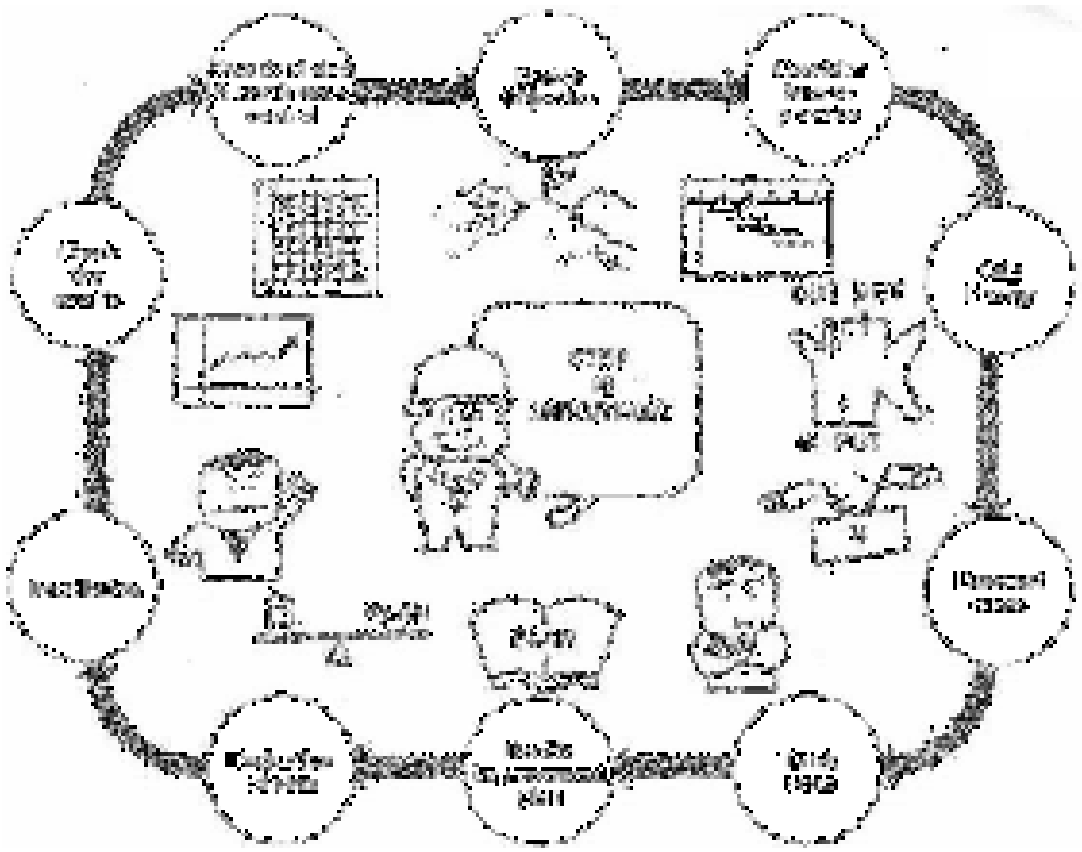
- Implement small group activities with various themes and achieve target
- Report progress and problems encountered during implementation to upper level committee periodically
- Ask for support, suggestions, and opinions from upper level committee

2.2.5 Responsibility of Energy Conservation committee

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

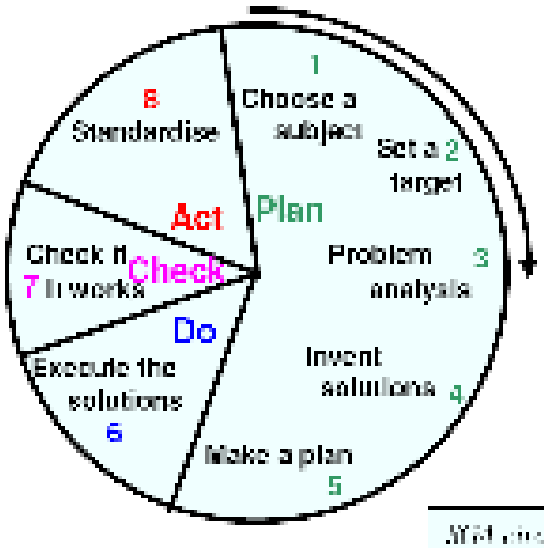
2.3 Steps of Small Group Activities for Energy Conservation

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

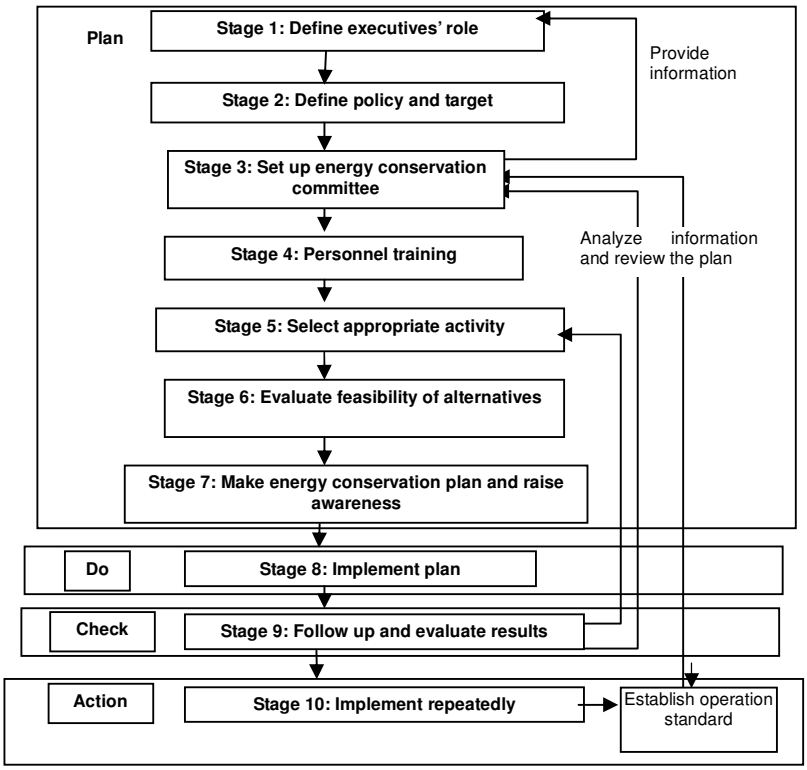


forms

- 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



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.



10 Stages for Success

2.3.1 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

2.3.2 Stage 2: Define Policy and Target

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

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

2.3.3 Stage 3: Set up Energy Conservation Committee

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

2.3.4 Stage 4: Personnel Training

This stage will help employees to have more knowledge and understanding, have new ideas, and have more belief in their own responsibility.

2.3.5 Stage 5: Select Appropriate Activity

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

2.3.6 Stage 6: Evaluate feasibility of alternatives (Analyze problems and decide on the measures and activities in each point)

Each group will gather ideas on the reasons for the problems, obstacles, and how to solve problems in order to decide on the problems, measures, and importance of activities and thus evaluate on the feasibility of activities to do based on advice from department manager. Basically, the following activities are not suitable for small group activities.

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

We have identified the following problems through small group activities.

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

2.3.7 Stage 7: Make Energy Conservation Plan and Raise Awareness

Each group must prepare its activity plan. Generally, implementation for small group activities takes 6 months to 1 year. Activities to be implemented should correspond to the objectives of each group. Besides, it might help to listen to opinions of all organizations in order to receive support from all other organizations.

2.3.8 Stage 8: Implement Plan

Implement according to the plan of each group.

2.3.9 Stage 9: Follow Up and Evaluate Results

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

2.3.10 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.

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

2.4.1 5S

5S is a contraction derived from the Japanese words **Seiri, Seito, Seiso, Seiketsu,** and **Shitsuke**. It is simple methodology that is also extremely useful in practical and realistic life. 5S is a set of actions to be followed through every day activities to advance the operational surroundings and circumstances. 5S is made in order to provide fortification to every personage in diverse profitable and industrialized fields. 5S is an extremely practical contrivance and skill set for anyone who wants to generate a more prolific environment within the workplace or who wants to make it their profession to make other people's businesses more proficient and productive. 5S occupy a list of products including eyewear, ear protectors and safety gears. Look into these different products that make up the significance of an industrialized security supply.

Lean Six Sigma experts promise or guarantee for the efficiency of 5S as an enlightening enhancement to better working surroundings in an association. If you dig up Six Sigma guidance that is paid for by your company, you will be in a position to work for your company and make things better for you as well as for everyone. 5S is very useful in lots of industries and job markets, but can often fail simply because of the lack of recognition concerning changes in the office.

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.

2.4.2 QCC (Quality control circle)

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

CHAPTER 6

CONCLUSION

5.1.1 SUMMARY OF ALL ENERGY SAVING PROPOSALS/MEASURES IDENTIFIED FOR THE CLUSTER

S.No	Energy Saving Proposal
1	Installation of Energy Efficient Kiln
2	Providing Insulation to avoid heat loss in existing Kiln
3	Replacement of Re-winded Motors by Energy Efficient Motors
4	Installation of APFC (Automatic Power Factor Controller) for Plant Power Factor Improvement Installation of T5 lamps in place of 40 W Light
5	Improve handling of Pet coke
6	Replacement of 150 W HPSV lamps by (14 x 4) W T5 lamps
7	Replacement of 250 W HPSV lamps by (24 x 4) W T5 lamps
8	Replacement of 100 W Incandescent lamps by 11 W CFL
9	Replacement of 500 W Halogen light by 85 W CFL

5.1.2 SUMMARY OF ALL TECHNOLOGY GAP ASSESMENT FOR ALL ENERGY SAVING PROPOSALS / MEASURES IDENTIFIED FOR THE CLUSTER

S. No.	Present System	Proposed System
1	Kiln with poor Insulation	Installation of Energy Efficient Kiln with good Insulation
2	Poor Insulation on Kiln	Providing Insulation in existing Kiln
	Re-winded Motors for Hammer Mill, Pulverisor, Classifier, Hydrator Motors	Energy Efficeient Motor for Hammer Mill, Pulverisor, Classifier,Hydrator Motors
3	Individual Capacitors on Hammer Mill, Pulverisor, Classifier, Hydrator Motors	Installation of Automatic Power Factor Controller on main Panel
4	Pet Coke storage directly on open ground	Provide Flouring for pet coke handling.
5	250 W HPSV lamps	Replacement by energy efficient Lamps
6	40 W tube light	T5 lamps
7	250 W HPSV lamps	T 24 X 4 W
8	150 W HPSV lamps	T 14 x 4 W
9	500 W halogen	85 CFL

5.1.3 SUMMARY OF TECHNO ECONOMICS (COST SAVING AND SIMPLE PAYBACK PERIOD) FOR ALL ENERGY SAVING PROPOSALS/MEASURES IDENTIFIED FOR THE CLUSTER

S.No	Proposal Identified	Investment Rs (Lakhs)	Saving Per Annum Rs (Lakhs)	Payback Period (Month)
1.	Installation of Energy Efficient Kiln with good Insulation	560 (for 75 Kilns) (Rs. 7.5/Kiln)	970 (for 75 Kilns) (Fuel Cost Rs 7200/T)	8
2.	Providing Insulation in existing Kiln	225 (for 75 Kilns) (Rs. 3.0/Kiln)	485 (for 75 Kilns) (Fuel Cost Rs 7200/T)	6
3.	Energy Efficeient Motor for Hammer Mill, Pulverisor, Classifier,Hydrator Motors	60 (for 75 motors, each of 20 kW)	33.75	22
4.	Installation of Automatic Power Factor Controller on main Panel	6.0 (for 75 units, each of 15 kVAR bank)	6.0	12
5.	Provide Flouring/Shade for pet coke handling.	75.0 (for 75 units)	200	5
6.	T5 lamps	2.0 (for 75 units, 5 T5 in each) unit)	1.5	18
7.	T 24 X 4 W	3.75 (for 75 units, 1 T24 x 4 W in each)	3.0	18
8.	T 14 x 4 W	3.75 (for 75 units, 1 T24 x 4 W in each)	3.0	
	Total	**935.5**	**732.25**	**16**

5.1.4 SUMMARY OF BARRIERS IN IMPLEMENTATION OF IDENTIFIED ENERGY SAVING PROPOSAL

S. No	Barriers
1	Availability of vendors
2	Remote location
3	Financial issues
4	Labor dependency
5	Technology awareness

5.1.5 SUMMARY OF SHORTLISTED TECHNOLOGY PRODUCTS FOR DPR

S. No	Proposal Identified
1.	Installation of Energy Efficient Kiln with good Insulation
2.	Providing Insulation in existing Kiln
3.	Energy Efficeient Motor for Hammer Mill, Pulverisor, Classifier,Hydrator Motors
4.	Installation of Automatic Power Factor Controller on main Panel
5.	Provide Flouring for pet coke handling.
6.	Replacement by energy efficient Lamps
7.	T5 lamps
8.	T 24 X 4 W
9.	T 14 x 4 W

5.2 SUMMARY OF LEVEL OF AWARENESS ON ENERGY EFFICIENCY AND ENERGY EFFICIENT PRODUCTS IN CLUSTER

S.No	Existing good practices
1	Appropriate Power Factor
2	Plant Operation according to the load Management
3	Star delta starter
4	Maximum use of Day lighting
5	Appropriate Capacity Motors
6	Appropriate Capacity Transformers

Annexure 1

Detailed Technology Assessment Report

A) 3.4.1.1 Install Energy Efficient Kiln/Improve Insulation

Cost of New Energy Efficient Kiln/Insulating Existing Kiln

The Cost of a new Kiln with high insulation would be around Rs. 7.5 Lakhs. And the cost of insulating existing Kiln would be around Rs. 3.0 Lakhs.

Saving

Around 4% savings in fuel consumption can be achieved by installing new energy efficient Kiln. Saving would be around Rs. 12.0 Lakhs/annum/Kiln, considering fuel cost Rs. 7200/T & annual consumption 15 T/day.

Simlarly, around 2% savings in fuel consumption can be achieved by providing insulation to existing Kiln. Saving would be around Rs. 6.0 Lakhs/annum/Kiln, considering fuel cost Rs. 7200/T & annual consumption 15 T/day.

Simple Payback Period

Simple payback period would be around 6 - 12 months.

B) 3.4.1.2 Replacement of Re-winded/Old Motors by Energy Efficient Motors

Lifecycle Analysis

Installation of Energy efficient motors in place of re-winded motors will save the power, as Energy efficient motors (EEF1) have 4-5 % efficiency higher than standard motor.

Equipment	Power consumption
Standard / Rewinded motor	32 kW
Energy efficient motor	30 kW
Saving potential	2 kW

Comparison of energy consumption between Standard and energy efficient motor

Saving	2 kW
Running Hours	10 hrs/day 7000 hrs/year
Energy	= 2 kW/Motor x 7000 hrs/yr x Rs. 4.8 / kWh

Saving	= **Rs. 0.67 Lakh/ year/motor**

Cost of Implementing

Cost of implementing this proposal varies in plant as per capacity and size of plant. For a motor size of 30 kW, investment would be **Rs. 1.2 Lakhs**.

Saving

Savings would be around Rs. 0.67 Lakh/motor.

Simple Payback Period

Installation of energy efficient motors in place of standard motors has payback of only 29 Months

C) 3.4.1.3 Installation of Automatic Power Factor Controller to maintain unity power factor

Life Cycle Analysis

Installation APFC will save the power consumption So cumulatively it saves lot of electrical energy.

Electrical load	45 kW
Existing power factor	0.9
Proposed power factor	0.99
Installation of APFC	15 KVAR

Comparison of energy consumption with APFC

Saving	4% of monthly electricity bill (Load 45 kW)
Running Hours	10 hrs/day 3000 hrs/year
Energy Saving	=0.04 x Electricity bill/month X 12 months/yr

Cost of implementing

Cost of APFC varies as per installed capacity of electrical system and size of plant. On an average cost varies from Rs 400 to Rs 600 per kvar. For 15 KVAR, cost would be around Rs. 7500/.

Saving

For a load of 50 kW, the yearly savings would be around Rs. 6000/.

Simple Payback Period

Simple payback period would be 12 months.

D) 3.4.1.4 Installation of T5 lamps in place of 40 W Light

Life Cycle Analysis

Type	**Power Consumption including ballast**
Conventional fluorescent lamp (40 W with electrical choke)	55 W / Tube
Energy efficient T5 lamp (28 W with electronic choke)	28 W / Tube

Comparison of energy consumption between 40 W lamp and T5 lamps

Saving	25 W / lamp
Running Hours	5000 hrs/year
Energy Saving	= 0.025 kW/lamp x 5000 hrs/yr X Rs. 4.8 / kWh = **Rs. 600/ year/lamp**

Cost of implementing

Cost of implementing this proposal varies in plant as per capacity and size of plant. Cost of T lamps lies in range of 600-700 each.

Simple Payback Period

Installation of T5 lamps in place of 40 W tube has payback of only 12-15 months.

Availability of Technology

As far as technology is concerned it is available in local/ national market. It is well proven technology which is adopted in many of the other similar and dissimilar units.

E) 3.4.1.5 Replacement of 250 W HPSV lamps by (24 x 4) W T5 lamps

3.4.1.3 Life Cycle Analysis

Type	**Power Consumption including ballast**
HPSV lamps (250 W)	250 W
Energy efficient T5 lamp (24 x 4 W)	96 W / assembly

Comparison of energy consumption between 40 W lamp and T5 lamps

Saving	150 W / lamp
Running Hours	3000 hrs/year
Energy Saving	=0.150 kW/lamp x 3000 hrs/yr X Rs. 4.8 / kWh = **Rs. 2160/ year/lamp**

3.4.1.4 Cost of implementing

Cost of 24 x 4 W lamps lies in range of 3500-4500 each.

3.4.1.5 Saving

Around Rs. 2000/yr/lamp can be saved.

3.4.1.6 Simple Payback Period

Installation of 24 x 4 W lamps in place of 250 W HPSV lamps has payback of 18 – 24 months.

F) 3.4.1.6 Replacement of 150 W HPSV lamps by (14 x 4) W T5 lamps

Life Cycle Analysis

Type	**Power Consumption including ballast**
HPSV lamps (150 W)	150 W
Energy efficient T5 lamp (14 x 4 W)	56 W / assembly

Comparison of energy consumption between 40 W lamp and T5 lamps

Saving	94 W / lamp

Running Hours	3000 hrs/year
Energy Saving	=0.094 kW/lamp x 3000 hrs/yr X Rs. 4.8 / kWh = **Rs. 1350/ year/lamp**

3.4.1.4 Cost of implementing

Cost of 14 x 4 W lamps lies in range of 3500-4500 each.

3.4.1.5 Saving

Around Rs. 1300/lamp/yr can be saved.

3.4.1.6 Simple Payback Period

Installation of 14 x 4 W lamps in place of 150 W HPSV lamps has payback of around 30 months.

G) 3.4.1.7 Improve handling/storage of Pet Coke

Cost of implementing

Cost of implementing this proposal varies in plant as per capacity and size of plant. Approximately Rs. 1.0 Lakhs would be required for flooring & pet coke yard.

Saving

Around 2 – 3% losses of fuel can be avoided. Around Rs. 1.0 Lakhs/unit/yr can be saved.

Simple Payback Period

Improved handling of petcoke has lucrative payback of only 6 months.

Annexure 2

Details of Technology / Service Providers in Jodhpur Lime Stone Cluster

Energy Conservation Measure	**Source of Product**	**Details of Local Vendor / Service Provider**
Energy Efficient Motors	Kirloskar Brothers Ltd	Everest Traders & Engineers Private Limited,(Supplier of Energy Efficient motors) Bhandari Buildings, First A Road Sardarpura Jodhpur Rajasthan - 342003 Tel: +91 291 2434410, 2614461 Fax: +91 291 2438610
Energy Efficient Motors, Automatic Power Factor Controllers, energy efficient lightings	Havells	Mr. Sunil Kumar
Energy Efficient Motors	Vijay Agencies	Mr. Jagdish Agarwal Opp Shiv Mandir Jodhpur Tel 07462-220678 (O) 222577 (R)
Translucent Sheet	B.S. Fibres	Mr. Mahesh Khandelwal Plot No.G-890, Badharna Road No.14 VKI Area Jaipur 09413837371
Improve plant power factor through APFC pannel	ABB	Mr. Neeraj Verma Power Product SCO-13-14-15 Sector-34A Chandigarh Phone: 0172-4321845 Telefax: 0172-2601618 Mobile: 09878613484 email: neeraj.verma@in.abb.com
Energy Efficient Motors	Bharat Bijlee Ltd	Mr. Rakesh Verma Sr. Manager – Marketing rakesh.verma@bharatbijlee.com 09871861872
APFC	Neptune	Mr. Manoj 09351328666

APFC	Epcos	Mr. Jayant Cont. No. 09829065472
Energy Efficient Kiln/Kiln Insulation	Arihant Refractories & Minerals	New Power House Road, Industrial Area, Jodhpur - 342003 Tel: +91 291 2649281,2654580 Fax: +91 291 2649281 Contact Person: Mr. V S Porwal
Supplier of Energy Management, Energy conservation, Industrial Process Control Automation	Madhav Enterprises	Q-5, Near Than Chand Mehta Building, Gole Building Road, Jalori Gate Jodhpur Rajasthan -342001 Contact Person: Mr. Hari Singh Bhandari
Supplier of Energy Efficient motors	Everest Traders & Engineers	Bhandari Buildings, First A Road Sardarpura Jodhpur Rajasthan - 342003 Tel: +91 291 2434410, 2614461 Fax: +91 291 2438610

Annexure 3

Financial Schemes Available with Local Banks for Improving Energy Efficiency in the Cluster

Most of the Nationalized & Private Sector Bans are located in Jodhpur Regions providing loans to the required Lime units. SIDBI offices are also located in Jodhpur & Jaipur regions.

Government Fiscal Incentives for MSME Sectors

The Ministry of micro, Small and Medium Enterprises (MoMSME) provides support to activities in MSME units. The schemes that are eligible for the lime industry are given below.

1. Credit Linked Capital Subsidy Scheme (CLCSS)

Under this scheme, the Ministry of MSME is providing subsidy to upgrade technology (Machinery/Plant equipments). Subsidy limit per unit is Rs. 15 lacs or 15% of investment in eligible Machinery/ Plant equipments whichever is lower. For more details of the scheme visit www.laghu-udyog.com/schemes/sccredit.htm

2. Credit Guarantee Fund Trust for MSE

This scheme will cover both term loan and working capital facility upto Rs.100 lacs. Under this scheme, loan will be sanctioned without any collateral security or third party guarantee. For more details of the scheme visit www.cgtmse.in

3. Market Development Assistance Scheme

To encourage MEME entrepreneurs to tap overseas market potential and represent India in the overseas market, Government of India is reimbursing 75% of air fare by economy class and 50% space rental charges of stalls for exhibition of their products in the overseas trade fairs/ exhibitions. For more details of the scheme visit www.fisme.org.in/MDA%20Faq.doc

4. Quality Up-Gradation/Environment Management Scheme

Under this scheme charges would be reimbursed for acquiring ISO - 9000/ISO - 14001/HACCP certifications to the extent of 75% of the expenditure (maximum to Rs. 75,000/- in each case). For more details of the various schemes visit http://msme.gov.in/

5. SIDBI Financing Scheme for Energy saving project in MSME Sector

To improve the energy efficiency levels in various MSME sectors, SIDBI is providing loans to eligible projects under JICA line of credit at a nominal rate of interest of 9.5 - 10% p.a. For more details of the list of eligible projects under this line of credit visit: www.sidbi.in

SIDBI Financing Scheme for Energy Saving Projects in MSME Sector under JICA
Line of Credit

The Japan International Cooperation Agency (JICA) has extended a line of credit to SIDBI for financing Energy Saving projects in Micro, Small and Medium Enterprises (MEMEs). This project is expected to encourage MSME units to undertake energy saving investments in plant and machinery to reduce energy consumption, enhance energy efficiency, reduce CO2 emissions, and improve the profitability of units in the long run.

Eligible Sub Projects/ Energy Saving Equipment List under JICA Line of Credit

- ✓ Acquisition (including lease and rental) of energy saving equipments, including installing, remodeling and upgrading of those existing
- ✓ Replacement of obsolete equipments and/or introduction of additional equipments which would improve performance.
- ✓ Equipments/Machinery that meet energy performance standards/ Acts
- ✓ Introduction of equipments that utilize alternative energy sources such as natural gas, renewable energy etc., instead of fossil fuels such as oil and coal etc.
- ✓ Clean Development Mechanism (CDM) projects at cluster level that involve change in process and technologies as a whole, duly supported by technical consultancy, will be eligible for coverage.

Eligible Criteria for Units (Direct Assistance)

- ✓ Existing units should have satisfactory track record of past performance and sound financial record
- ✓ Projects will be screened as per Energy Saving list, which is available on the SIDBI website
- ✓ Units should have minimum investment grade rating of SIDBI
- ✓ Projects which may result in negative environmental and social impacts are also not eligible under this scheme

The Confederation of Indian Industry (CII) works to create and sustain an environment conducive to the growth of industry in India, partnering industry and government alike through advisory and consultative processes.

CII is a non-government, not-for-profit, industry led and industry managed organisation, playing a proactive role in India's development process. Founded over 115 years ago, it is India's premier business association, with a direct membership of over 8100 organisations from the private as well as public sectors, including SMEs and MNCs, and an indirect membership of over 90,000 companies from around 400 national and regional sectoral associations.

CII catalyses change by working closely with government on policy issues, enhancing efficiency, competitiveness and expanding business opportunities for industry through a range of specialised services and global linkages. It also provides a platform for sectoral consensus building and networking. Major emphasis is laid on projecting a positive image of business, assisting industry to identify and execute corporate citizenship programmes. Partnerships with over 120 NGOs across the country carry forward our initiatives in integrated and inclusive development, which include health, education, livelihood, diversity management, skill development and environment, to name a few.

CII has taken up the agenda of “Business for Livelihood” for the year 2010-11. Businesses are part of civil society and creating livelihoods is the best act of corporate social responsibility. Looking ahead, the focus for 2010-11 would be on the four key Enablers for Sustainable Enterprises: Education, Employability, Innovation and Entrepreneurship. While Education and Employability help create a qualified and skilled workforce, Innovation and Entrepreneurship would drive growth and employment generation.

With 64 offices and 7 Centres of Excellence in India, and 7 overseas in Australia, China, France, Singapore, South Africa, UK, and USA, and institutional partnerships with 223 counterpart organisations in 90 countries, CII serves as a reference point for Indian industry and the international business community.

Business enterprises worldwide are increasingly focusing on enhancing production and improving quality, while reducing costs. In such a scenario, it is important for small and medium enterprises (SMEs) to remain competitive.

The CII - AVANTHA Centre for Competitiveness for SMEs was established in 2004, with a view to providing SMEs in India with a one-stop consultancy service. There are more than 11.86 million SMEs in India, which contribute nearly 40 per cent of the country's total industrial output. If the country's economy is to be strengthened, it is imperative that these SMEs receive tactical support to remain competitive.

The Chandigarh-based CII - AVANTHA Centre for Competitiveness for SMEs aims to build competitive and visionary SMEs. The Centre offers consultancy services on a wide range of critical issues such as manufacturing excellence, energy management, cost management, human resource development, etc. Although the Centre does provide services to individual companies, it encourages the formation of groups or clusters of SMEs. A number of companies, which share the same location, sector or even OEM vendor, are allocated to these clusters. This approach encourages SMEs to form, share and draw from a common knowledge pool.

The CII - AVANTHA Centre for Competitiveness for SMEs has successfully established such clusters at Mohali, Gurgaon and Jalandhar and is running parallel clusters across the country at Jaipur, Faridabad, Lucknow, Pune, Kolkata, Chennai and various other locations. Apart from offering consultancy services, the Centre is also committed to helping SMEs remain abreast of contemporary issues through seminars, conferences and training programmes.

The Centre offers the following services

- Clusters for Competitiveness
- Energy Audit and Management
- Manufacturing Excellence
- Total Cost Management
- Human Resource Management
- Corrosion Management
- New Product Development