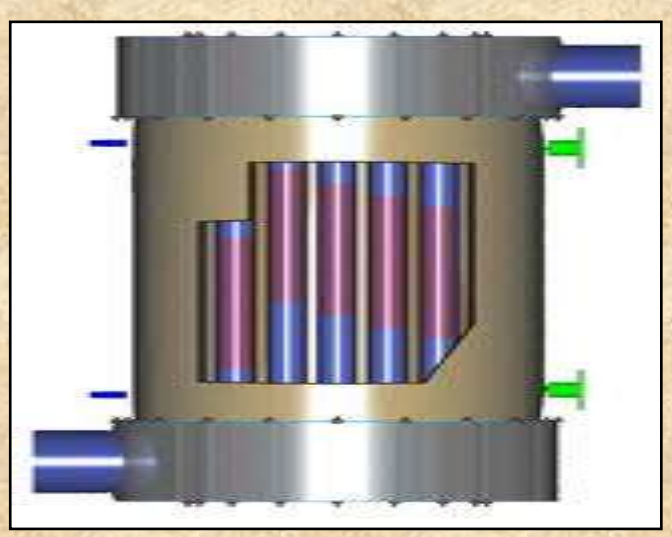
MANUAL ON ENERGY CONSERVATION MEASURES IN CHEMICALS & DYES CLUSTER VAPI



Bureau of Energy Efficiency (BEE)

Ministry of Power, Government of India

Prepared By

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Hyderabad

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ZENITH ENERGY SERVICES PVT LIMITED
HYDERABAD

CHAPTER 1 INTRODUCTION

1.1 About BEE'S SME Program

The Government of India has enacted the Energy Conservation Act – 2001 due to high energy saving potential in industries, agriculture, domestic and transport sectors; to reduce the gap between demand and supply; to reduce environmental emissions through energy saving; and to effectively overcome the barriers. The Act provides the much-needed legal framework and institutional arrangement for embarking on an energy efficiency drive.

The Bureau of Energy Efficiency (BEE), an agency of the Union Ministry of Power, has introduced a programme "BEE SME Program" to help small and medium enterprises (SMEs) to use energy efficiently.

As a part of the implementation of "BEE-SME Programme" about 35 SME clusters were identified. After ground-level situation analysis, 29 of them have been selected for further activities in consultation with the Ministry of Micro, Small and Medium Enterprises (MoMSME).

According to the Indian Institute of Foreign Trade, SMEs contribute about 6% of the country's GDP. Although energy is an important input required for economic and social development, attaining higher energy efficiency is considered an important element in meeting India's future energy challenges and ensuring its energy security.

The SME sector is facing rising energy costs and on the other hand, prices and cost pressures are soaring. The government, from time to time, has offered various fiscal incentives and other interventions to SMEs, as well as help for technology up-gradation and improvements in performance efficiency, but a program for energy saving of this kind is novel and has tremendous potential.

Vapi Chemicals & Dyes Cluster has been identified as one of the clusters to implement the BEE-SME Program. BEE has entrusted M/s Zenith Energy Services (P) Ltd to implement the project.

1.2 Project Objectives

The BEE SME Program is aimed at improving Energy Efficiency of Small and Medium Enterprises by technological interventions in the various clusters of India. The Energy Intensity in SME is intended to be enhanced by helping these industries in the mostly energy intensive cluster units identified 29 SME clusters of India to through improve Energy efficiency and performance through technology interventions and also develop the consistent steps for successful implementation of energy efficiency measures and projects in the cluster units and also financial planning for the SME owners.

The project also aims at creating a platform for dissemination of best practices and best available technologies in the market for energy efficiency and conservation and to create awareness among cluster unit owners and also the demonstration projects may stimulate adoption of successful/available technologies.

The BEE SME program have been designed in such a way that to set up to a deal with specific needs of the industries in the SME sector for energy efficiency and designed to overcome all the common barriers for implementation of Energy Efficient technologies and equipments/processes. The following are proposed to be covered under BEE SME program:

1. **Energy Use and Technology Studies** – The studies are aimed for status of the technologies installed, energy use pattern and its cost, operating practices, identification of the technologies and measures for improving energy efficiency etc
2. **Conduct Dissemination Program –** Disseminate the technologies and measures identified & best practices in the cluster units for reducing energy consumption.
3. **Implementation of EE measures –** Preparation of bankable and replicable detailed project reports for facilitating the cluster unit owners for implementation. The DPR's are to be prepared for a minimum of 5 technologies for various sizes capacities
4. **Identification of the Local Services Providers –** The program also aimed for identification of local service providers and capacity building to facilitate them for implementation of the technologies in the clusters
5. **Facilitation of Innovative Financing Mechanisms –** The program also aims for encouraging the SME owners in implementation of technologies through innovative financing schemes. The project also aims to impart training for the officials of various financial institutions like SIDBI and local lead bankers of the clusters location for evaluating energy efficiency related projects.

The BEE SME program model developed is innovative and designed in such a way that the involvement of various stakeholders like SME owners, consultants, technology providers, Local Service Providers, Financial institutions etc to facilitate :

- To identify the technologies and process up-gradation from various the detailed studies undertaken by the consultants.
- Active involvement of Financial Institutions to overcome financial barriers and development of a financial model for the technologies/equipments identified which is readily available and at best possible interest.

1.3 Expected Project Outcome

The BEE SME program aims at improving energy efficiency in various cluster units of the country. On overall, the program creates opportunities for all the stakeholders in the cluster viz. SME owners, Local Service Providers, Equipment Suppliers and Financial Institutions.

Initially, a situation analysis had been carried out and detailed information pertaining to the technologies employed, energy use pattern and financial strengths of SME's in the cluster were established.

The present BEE SME Program implementation in Vapi Chemicals & Dyes Cluster, the following outcomes are expected

Energy Use and Technology Analysis

The detailed comprehensive energy use and technology studies in various cluster units has explored the information on status of Vapi Chemicals & Dyes Cluster, production capacities, present status of the technologies employed, energy consumption pattern, identified all possible measures for energy efficiency and conservation, techno-economic feasibility of the identified measures, energy saving potential in the units surveyed and in total cluster units, technologies and equipments available locally, technical capabilities of LSP's for implementation, environmental impact due to reduction in energy consumption, etc. The major projects to be implemented which have more impact on energy conservation and common technologies which are more or less applicable for all the cluster units were identified for preparation of bankable detailed project reports and incorporated in the manual

Implementation of EE measures

To facilitate SME owners for implementation of energy efficiency measures by developing the bankable detailed project reports for a minimum of 5 technologies for various capacities as per the suitability of cluster unit sizes. These DPR's can be replicate as per the unit suitability for availing loans from financial institutions. The DPR contains various technical and financial indicators like IRR, NPV, ROI, etc for projecting the project viability. A total of 15 DPR's will be prepared

Capacity Building of LSP's and Bankers

The local service providers and equipments suppliers has already been identified in Vapi Chemicals & Dyes Cluster and the capability building programs planned for various stakeholders like local service providers, bankers and equipments suppliers to facilitate them for implementation of the energy efficiency measures.

A Conclusion dissemination workshop to be conducted to provide the information for all the stakeholders for the status and achievement of the program

1.4 Project Duration

The total duration of the project is 18 months and the details of the duration for each activity are furnished in Figure 1 below:

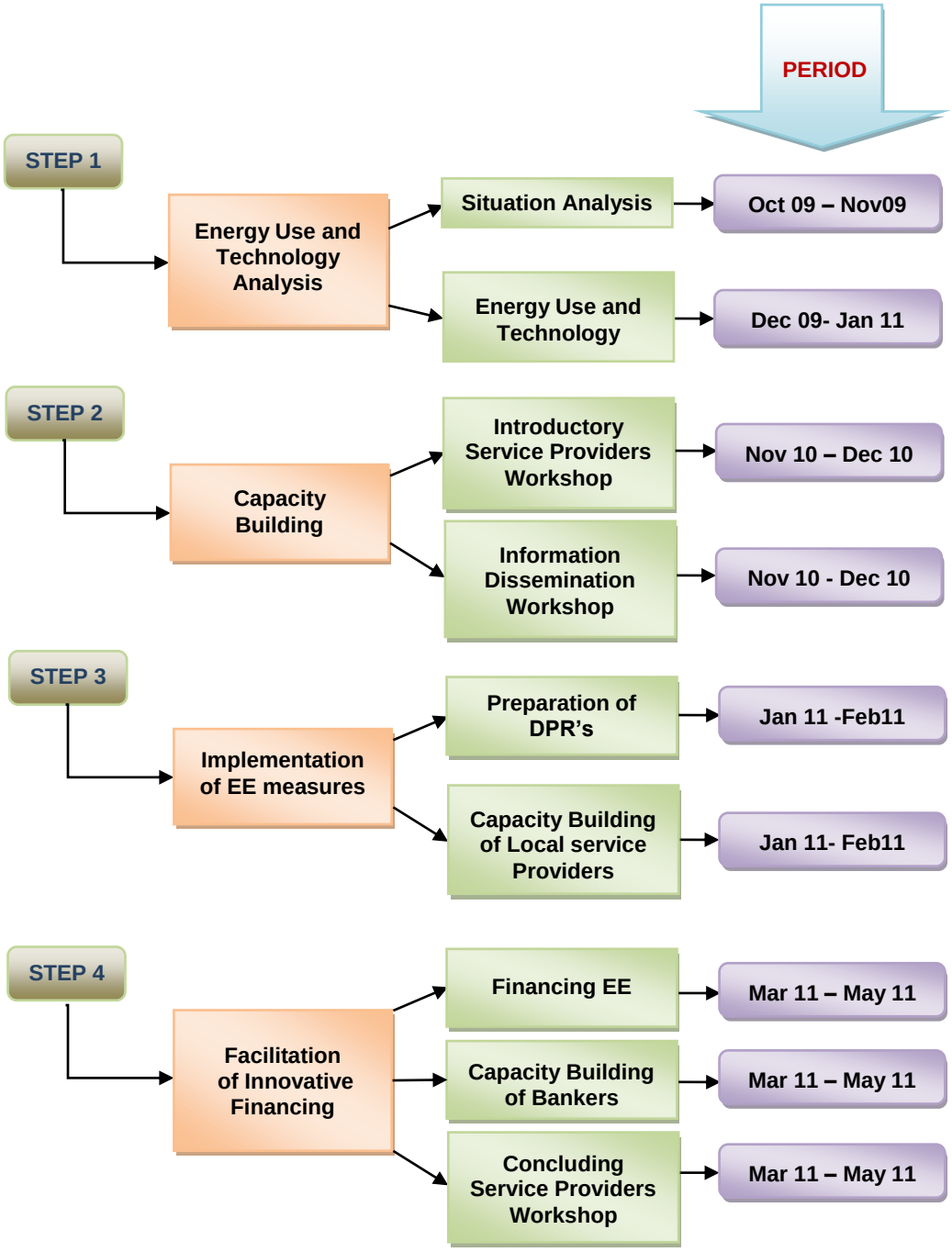


Figure 1: Project Duration

1.5 Identified Clusters under the BEE SME Program

The BEE has identified 29 SME Clusters to implement the BEE SME Program for energy efficiency improvement and the list of chosen clusters are furnished below in Table 1.1:

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

1.6 About the present study

BEE has awarded the Vapi Chemicals & Dyes cluster study to Zenith Energy Services Pvt. Ltd based on the competitive bidding under BEE SME program. Zenith Energy Services Pvt Ltd had taken the task of implementing the program and two full time energy auditors were deployed in the cluster and a project office had been established at Vapi with all facilities like state of art energy audit instruments, Laptops, Printers, and Internet etc. As a part of the program, the details of the studies undertaken in cluster units are furnished in Table 1.2.

Table 1.2: The details of the studies undertaken in cluster units

S. No	Type of audits	No. of units covered
1	Preliminary Energy Audits	30
2	Detailed Energy Audits	22
3	Technology audits	10

The studies were conducted covering all types of industries and capacities in the cluster and the reports were submitted to all individual units for implementation of measures identified. Based on the studies carried out and data analysis, a cluster manual had been prepared for the following:

- Cluster details
- Products manufactured
- Energy forms used, costs, availability and consumption pattern
- Technologies/equipments installed
- Efficiencies levels of the equipments installed
- Measures & technologies/equipments identified for energy conservation and saving, Investment required
- Simple payback period
- Various barriers for implementation
- Local Service Providers details

1.7 Structure of the Report

The present report has been divided into the following Chapters:

Chapter 1: Introduction

Chapter 2: Overview of Vapi Cluster

Chapter 3: Energy Audit and Technology Assessment

Chapter 4 : SGA and TEM activities for energy conservation and efficiency

Chapter 5: Conclusions

Chapter 1: This chapter discusses about BEE SME program, project objectives, project outcomes and about the present study.

Chapter 2: Discusses broadly about the cluster, classification of units, energy situation, energy forms used and their availability, production capacities of the units, products manufactured, manufacturing process, technologies employed, current policies of various state and central government for energy efficiency and energy conservation, various issues and barriers in implementation of EE measures and technology up-gradation etc.

Chapter 3: Highlighted the methodology adopted, observations made on process and technologies, energy consumption profile, efficiencies of the equipments installed, housekeeping practices adopted, availability of data and information, technology gap analysis, energy conservation and measures identified, cost benefit analysis, Local service providers availability, technology providers availability, etc

Chapter 4: Systematic approach for energy conservation by implementation of SGA/TEM activities

Chapter 5 Highlighted the environmental benefits and quantity of GHG emission reduction expected due to implementation of the measures identified for energy saving.

CHAPTER 2
ABOUT VAPI CLUSTER

2.1 Overview of Vapi SME Cluster

2.1.1 Cluster Background

Vapi Industrial Estate was developed by Gujarat Industrial Development Corporation, came into existence four decades ago i.e. in 1967-68. The estate was developed in phases as 1st phase, 2nd phase, 3rd phase, 4th phase etc. As per the local association, there are about 308 Chemicals & Dyes industries in the cluster.

Vapi Chemicals & Dyes cluster like many other clusters, was in dire straits in regard to the energy efficiency and conservation. In almost all units, whether big or small, there had been no conscious effort to take up energy conservation and energy efficiency measures as a part of day to day operations. Some of the bigger units had experimented with few parameters to improve the energy efficiency in the units, but the results and outcome was confined to them only. All the units in cluster had been operating in traditional conditions and most of the equipments in cluster were procured from the local suppliers. They are making the equipments by their traditional expertise, which has remained unchanged over the years.

The Chemicals & Dyes units in the cluster use Wood, Imported Coal, LDO, Furnace Oil, Ground Nut Briquettes & Natural Gas as fuels for boilers, Thermopacs, Tray Dryers & Spray Dryers. Electricity is used to run reactors, motors, pumps, centrifuges, blowers, fans & Air Compressors etc.

2.1.2 Product Manufactured

There are various types of chemical products that are manufactured in Vapi chemicals & dyes cluster, few of them are Organic/Inorganic chemicals, Specialty chemicals, Disperse dyes, Dye Intermediates, Reactive dyes, Acid dyes, Direct dyes etc. In fact majority of the chemical units in the cluster are manufacturing two or three types of products as per the demand for the products in the market.

2.1.3 Classification of units

The **Vapi Chemicals & Dyes** Cluster units can be broadly classified:

2.1.3.1 Classification based on production

In **Vapi Chemicals & Dyes** Cluster, there are about 308 units, the units can be categorized into two types based on production capacity, and they are:

- Less than 50 tonnes / month
- Above 50 tonnes / month

There are about 204 units are having production capacity less than 50 tonnes / month and balance 104 units falls under second category having production capacity more than 50 tonnes / month. The classification based on production capacity is furnished graphically in Figure 2.

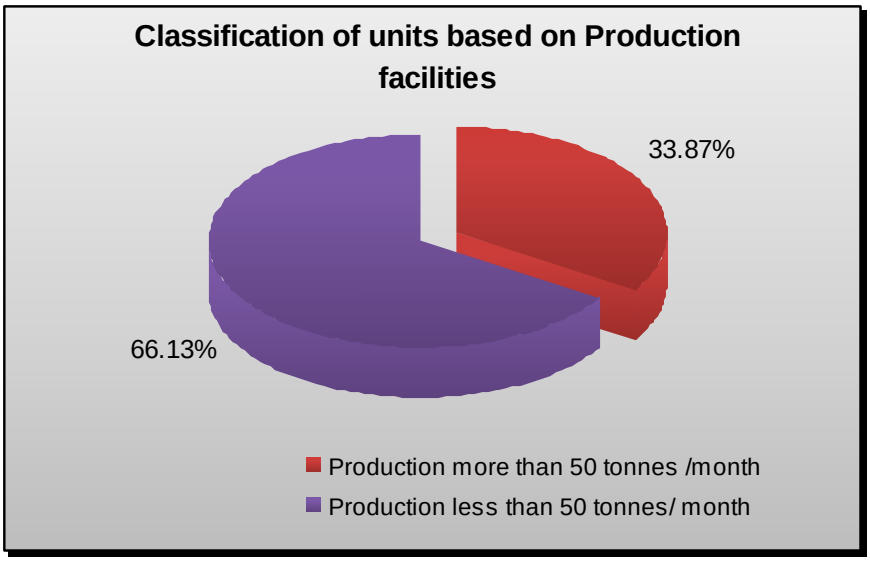


Figure 2: Classification of units based on production facilities

2.1.3.3 Classification based on annual energy bill

Out of 308 units, 116 units have energy bill below ₹.30.00 lakhs per annum, 96 units have energy bill between ₹.30.00 lakhs to ₹. 60.00 lakhs per annum and the balance 96 units have energy bill above ₹.60.00 lakhs. The classification based on annual energy bill is furnished graphically in Figure 3.

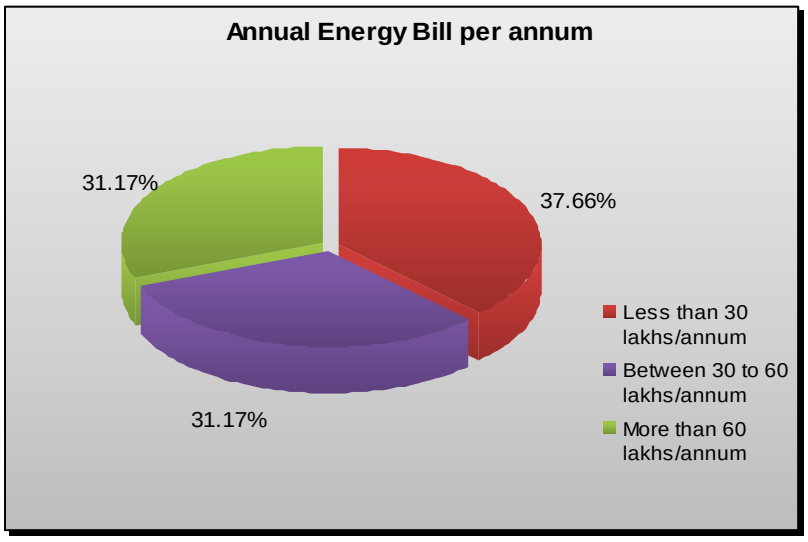


Figure 3: Classification of units based on annual energy bill

2.1.4 Raw materials used

The raw material is different for the industries and depends on the product manufactured in the respective industry.

2.2 Energy Consumption scenario of the Cluster

The main energy forms used in Chemical & Dye units of the cluster are Electricity, Wood, GN briquettes, Imported Coal, Natural Gas, FO and LDO. The fuels are used for the boilers, Thermopacs, dryers, hot air generators etc. Electricity is required for operating the machinery like reactor agitators, refrigeration compressors, blowers, fans, pumps, electrical motors and air compressors.

2.2.1 Fuels used and price

The major fuels used in the cluster units are Wood, GN briquettes, Imported Coal, Natural Gas, FO and LDO. The prevailing prices of fuels and electricity in the cluster are furnished below in Table 2.1.

Table 2.1: Prevailing price range of fuels & electricity in the cluster

S. No	Fuel type	Price range (₹.)
1	Wood	3,500 per ton
2	Imported Coal	4,000 per ton
3	Furnace Oil	30 per kg
4	LDO	38 per Liter
5	Ground Nut Briquettes	4,400 per ton
6	Natural Gas	17 per SCM
7	Electricity	6 per kWh

2.2.2 Energy Consumption

The main energy forms used in a typical unit of the cluster are Electricity, Wood, GN briquettes, Imported Coal, Natural Gas, FO and LDO. The annual energy consumption of the three typical units in the cluster is furnished in Table 2.2 below:

Table 2.2: Annual energy consumption of the three typical units

Details	Value	Unit -1	Unit -2	Unit -3
Wood	tons	360	-	-
Imported Coal	tons	-	-	360
Furnace Oil	tons	-	-	-
LDO	Liters	-	-	-
Ground Nut Briquettes	tons	-	-	-
Natural Gas	scm	74,181	14,33,596	1,86,876
Electricity	kWh	4,09,158	31,81,440	3,61,776

The annual consumption of fuels and electricity of the entire cluster units are furnished table 2.3 below:

Table 2.3: Annual energy consumption of the total cluster units

S. No	Type of energy	Consumption	Tons of oil Equivalent (TOE)
1	Wood	14,967 tons/annum	497.60
2	Imported Coal	49,482 tons/annum	2,878.96
3	Furnace Oil	15,407 tons/annum	1,600.80
4	LDO	433 kL/annum	45.06
5	Ground Nut Briquettes	56,373 tons/annum	2,342.80
6	Natural Gas	30,675,356 scm/annum	1,963.40
7	Electricity	197 GWh	1,768.43
Total			**11097.05**

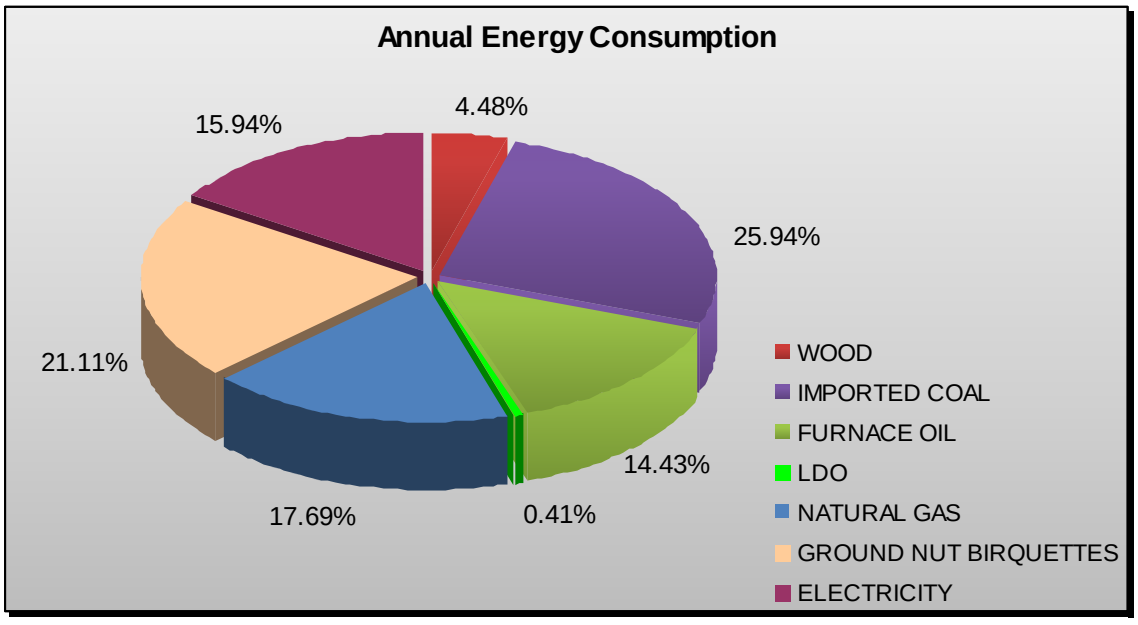


Figure 4: Annual energy consumption of the cluster (TOE)

2.2.3 Specific Energy Consumption

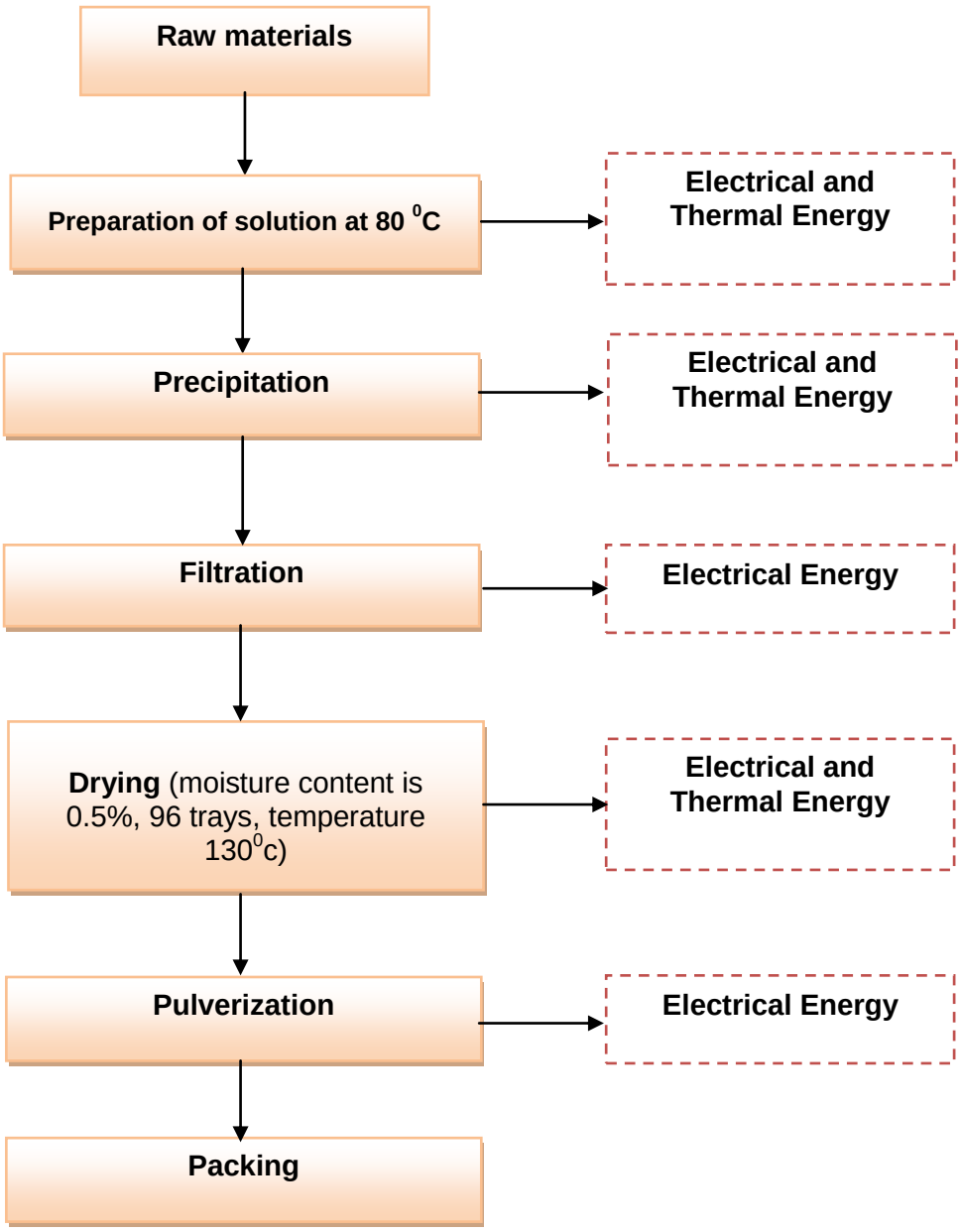
The specific energy consumption for various types of units in the cluster is furnished below in Table 2.4:

Table 2.4: Specific energy consumption

Equipment	Unit 1 (TOE)	Unit 2 (TOE)	Unit 3 (TOE)
Chemicals unit	0.44	0.50	0.68
Dyes unit	0.11	0.41	0.65

2.3 Manufacturing process

The detailed process flow diagram of a typical unit is furnished below.



2.4 Current policies and Initiatives of Local bodies

About GEDA

The Gujarat Energy Development Agency (GEDA), is Nodal Agency established by the Government of Gujarat in June 1979 for prompting use of renewable energy sources and energy conservation in Gujarat. GEDA is also the State Designated Agency for implementing the Energy Conservation Act-2001 enacted by the Govt. of India. Promotion of Energy Efficiency in the industrial and buildings sector form one of the major mandates of the EC Act as it has tremendous potential for improvement.

There is a potential for conserving 30-40% energy in some key industrial clusters. Absence of systematic energy monitoring mechanism is a major factor that is responsible for a large amount of unproductive energy utilization in industries. GEDA's Energy Audit Scheme provides financial assistance as well as technical expertise through trained & experienced energy expert, to industries and building owners for analyzing their energy usage and to increase their profits through achievement of higher energy efficiency. Energy audits of industrial units, commercial complexes, hotels and hospitals are covered under this subsidy scheme.

The subsidy will cover up to 50 % cost of the Energy Audit Study (EAS), upto a maximum of ₹20,000/-. Industries with an electrical CD of less than 200 kVA and commercial complexes with an electrical CD less than 75 kW would only be eligible for subsidy under this Scheme.

Scheme for Mass Scale Walk-through Energy Audit of SMEs in Gujarat Background

The Industrial Sector of Gujarat is a major energy consumer – both thermal and electrical energy. The industrial sector constitutes more than 35% of the energy used in the state. The SMEs form a vital part of the Industrial Sector and represent nearly 40% of the country's GDP. The SMEs account for a large share of energy consumption and energy cost forms a big portion of the total manufacturing cost. Reduction in the energy consumption through efficiency improvement in SMEs could enhance the profitability and cutting edge of the SMEs. At present there are around 3 lakh SME units in Gujarat and their share exceeds 30% of total manufacturing and exports of the State. Some of the important SME clusters in Gujarat include:

1. Readymade Garments, at Ahmedabad
2. Drugs & Pharmaceuticals, at Ahmedabad
3. Dyes & Intermediates, at Ahmedabad
4. Re-rolling Mills at Bhavnagar

5. Plastic Industry at Dhoraji;
6. Brass Parts at Jamnagar;
7. Chemicals at Nandesari, Vapi & Ankleshwar;
8. Ferrous Castings, at Rajkot
9. Wrist Watch & Components at Rajkot;
10. Power looms, Diamonds, Gems & Jewellery, Jari at Surat;
11. Pottery & Ceramics at Surendranagar (Than) & Wankaner;
12. Ceramic Products at Thangadh and
13. Petrochemicals at Vadodara.
14. Diesel Engines, at Rajkot
15. Electric motors, at Rajkot
16. Machine Tools, at Rajkot

Improving Energy Efficiency in Small & Medium Enterprises (SMEs)

With rapid globalization SMEs are facing business risks where cost of manufacturing is going up every day and competition is bringing down the selling price of their products. These demands for an innovative approach to cut down input costs on recurring basis so as to remain competitive. This would require focused approach for improving productivity & efficiency, adoption of newer technology, capacity building of human resources, innovative financing options, and cluster based projects on Research & Development etc.

One of the primary input costs for SMEs is Energy; therefore conservation of Energy demands utmost importance to remain competitive on a global scale.

Energy Audit Scheme for SMEs of Gujarat

Gujarat Energy Development Agency (GEDA), with the objective of promoting fast-track Energy Efficiency (EE) Improvement, is introducing a novel Scheme for rendering technical guidance and assistance to the SMEs in the State. GEDA has proposed to help SME sector through an intensified energy auditing program to be executed by force of qualified Energy Auditors (EAs). GEDA approved Energy Auditors would be deployed to carry out Walk-Through Energy Audits (WTEA) of selected SMEs units and submit a Energy Audit Report with recommendations and suggestions for reducing the energy consumption in the SME unit audited.

A Walk-Through energy Audit is a simple visual investigative audit and table-top survey of the Energy Bills of the manufacturing facility. The WEA report would comprise of the submission of the energy Consumption pattern of the work place and suggestions for Energy Conservation.

The WEA would also point out good 'House Keeping' practices relevant to the industry being audited. Depending upon type and size of industry WEA may be carried out in 1 – 3 days.

Scope of the Scheme

It has been proposed to carry out a 5000 walk-through energy audits during the year 2009-10 under the Scheme. GEDA shall depute its approved Energy Auditors to carry out the assignment, the entire cost of which shall be borne by GEDA. Other benefits to the SMEs include:

1. Invaluable energy consultancy & guidance at "no cost".
2. Documented information on options and opportunities for energy saving in the industry. Concise report of WTEA with pinpointed quickly implement able EC measures would be submitted to the industry for further implementation.
3. List of qualified vendors for procuring EE Technologies to help the SMEs in the procurement and EC implementation process.
4. Based on the findings of the WTEA SMEs would be selected for conducting Detailed Energy Audit (DEA) under the GEDA Industrial Energy Audit Subsidy Scheme during the subsequent year.

2.5 Major barriers for implementation of Energy Efficiency

2.5.1 Energy Availability

The main energy forms used in the cluster units are Wood, Imported Coal, LDO, FO, Natural Gas, Ground nut Briquettes and Electricity. Though, the electricity is available, the power cuts are imposed for one day in a week for each phase. Some of the units have installed DG sets for un interrupted power supply to reduce production loss.

2.5.2. Technological Issues

The major technical barriers that prevented the implementation of energy efficiency measures are as below:

- Lack of awareness and information about the technologies available in the market
- No knowledge among the workforce about energy conservation and efficiency
- Dependency on local technology suppliers who do not have sufficient knowledge on efficient equipments

2.5.3 Lack of Technical know-how & Organizational capacity

Majority of the Chemical units entrepreneurs in Vapi Chemicals & Dyes cluster do not have any in depth technical expertise and knowledge on energy efficiency, and are dependent on local technology suppliers or service companies, which normally also rely on established and commonly used technology. The lack of technical know-how has made it difficult for the Chemical unit owners to identify the most effective technical measures.

Majority of Chemical units in Vapi Chemicals & Dyes cluster have been established several years ago when energy efficiency was not an important issue for the operation of a plant. They are operating with outdated and low end technologies.

As a majority of the entrepreneurs in cluster are not aware of the energy losses in the plant, there may be a strong feeling that the energy efficiency initiatives in manufacturing facility can have a cascading or domino effect of failure in critical production areas directly or indirectly connected if the intended performance of the replaced / retrofitted equipment falls below design values.

There is a strong feeling in the chemical unit entrepreneurs that, energy efficiency initiatives are a challenge, and people are not ready to take the risk of business interruption due to production loss against the drive to save energy. However these can be overcome by motivating them to attend the awareness programs on energy efficiency. Further, sourcing of expertise on maintenance service provider or training by the equipment supplier will definitely overcome the above mentioned barriers

.2.5.4 Financial Issues

Significant amount of investment is not commonly seen in most of Vapi Chemicals & Dyes industries. Further, from the business perspective for any industry owner, it is more viable, assured and convenient to invest in project expansion for improving the production capacity, rather than make piecemeal investment in retrofit and replace options for energy savings. Investment returns on large capacity addition or technology adoption shows up prominently in terms of savings and helps in benchmarking operations. Further, there is a strong feeling among the industry owners that, energy conservation- initiatives of replacement and retrofit nature is not a common practice as it involves large capital investment against low returns. In view of this and given the limited financial strength of entrepreneurs from chemical units in Vapi would not have taken up the risks to invest in energy efficiency measures. Lack of interest of investing on the new technologies, as these industries getting profits with the existing technologies

CHAPTER 3 ENERGY AUDIT AND TECHNOLOGY ASSESSMENT STUDY

3.1 Methodology adopted

3.1.1 Energy use and Technical Assessment study

3.1.1.1 Pre-energy audit activities

The pre-energy audit activities comprised collection of preliminary information from cluster units for products manufactured, production capacity, status of technologies / equipments installed, willingness of the unit for the study, and implementation of the measures identified.

3.1.1.2 Preliminary Energy Study

The following methodology has been adopted for preliminary energy audit study:

a) Collection of past energy consumption details and energy bill

b) Establish specific energy consumption, if possible

c) List out major energy consuming areas of the plant

d) Level of technologies adopted (latest or old, crude or efficient, local or reputed company make)

e) Status of instruments installed in the plant and necessary instrumentation required for the detailed study

f) Identify areas for special attention for low cost measures with quick payback period

g) Understanding detailed manufacturing process with energy and material balance

h) Identify areas for detailed study and measurements required

i) Collect bottleneck areas of the plant for detailed study

3.1.1.3 Detailed Energy Study

The following methodology has been adopted for conducting detailed energy study:

- Monitoring of energy related parameters of various equipment / machines using portable instruments of ZESL
- Collection of operating data from various measuring instruments / gauges installed in the plant
- Collection of past operating data / historical data from log books and data registers

- 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 / monitored by ZESL
- Technology status of the equipments installed
- Detailed process flow of the plant
- Identification of energy wastage areas and quantification of energy losses
- Identification of suitable measures for reducing energy wastages
- Identification of areas for reuse and recycle

Table 3.1: The details of the studies undertaken in cluster units

S. No	Type of audits	No. of units covered
1	Preliminary Energy Audits	30
2	Detailed Energy Audits	22
3	Technology audits	10

3.1.1.4 Technology Audit

The methodology adopted for conducting technical audit is as follows:

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

3.2. Observations made

3.2.1 Manufacturing Process and Technology employed

There are about 308[1] chemicals & dyes units in the cluster. The raw material is varied according to the requirement:

The process flow diagram of a typical unit of the cluster is furnished in the Figure 5 below:

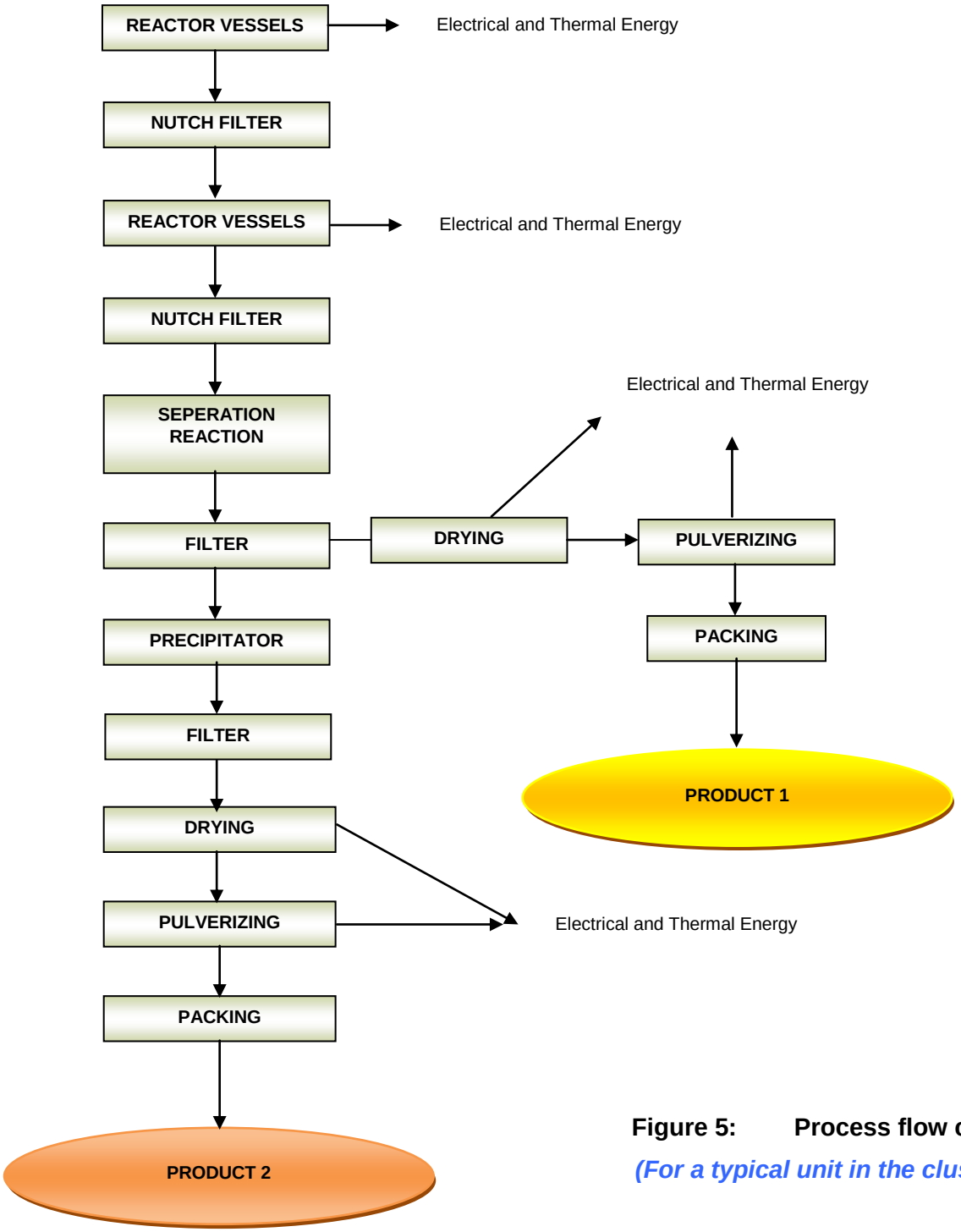


Figure 5: Process flow chart

(For a typical unit in the cluster)

[1] VIA web site

The comprehensive study of the units carried out by ZESL has revealed the following:

i) The status of present technologies installed like boiler, hot air dryers, refrigeration systems and hot air generators are poor as compared to the technologies and practices / equipments available in the market. Various technological gaps have been identified in the cluster units as under and these may be due to lack of awareness on the technologies available and non availability of LSPs or equipment suppliers.

ii) Though, the managements are interested in implementation, the energy loss areas and EE technologies could not be identified by the management/workers or LSPs for implementation due to lack of awareness. Hence, the unit owners are depending entirely on illiterate workers and the local technology suppliers for their low cost and their availability any point of time.

iii) Further, the sector faces deficiencies such as lack of technical manpower, technical knowledge among workforce and unit owners and largely concentrated on the trading related activities by the owners.

3.2.2 Energy Consumption profile

The supply and consumption pattern of energy inputs are analyzed of the cluster and the details are furnished below:

3.2.2.1 Wood, Imported Coal, Furnace Oil, LDO, Natural gas, Ground Nut briquettes and Electricity

The cluster units use Wood, Imported Coal, Furnace Oil, LDO, Natural gas, Ground Nut briquettes and Electricity. The variation of prices of different forms of energy used in the clusters is furnished below table 3.2:

Table 3.2: Variation of different forms of energy price in cluster units

S.No	Fuel type	Price range (₹)
1	Wood	3,500 per ton
2	Imported Coal	4,000 per ton
3	FO	30 per kg8
4	LDO	38 per liter
5	Natural Gas	17 per SCM
6	Ground Nut Briquettes	4,400 per ton
7	Electricity	6.07 (including all service taxes)

3.2.2.2 Electricity

LTP 1 :

(a)	For installation having contracted load upto and including 10 BHP: For entire consumption during the month	370 Paise per Unit
(b)	For installation having contracted load exceeding 10 BHP: For entire consumption during the month	400 Paise per Unit

For installation having contracted load of 50 BHP and above for all reactive units (KVRAH) drawn during the month	10 Paise per KVARH

(a)	When contracted load is upto 75 BHP	Rs.105 per BHP
(b)	When contracted load exceeds 75 BHP	Rs.180 per BHP

LTP 2 :

For all units consumed during the month	410 Paise per Unit

LTP3:

(a)	**For billing demand upto the contract demand**	
	(i) For first 15 to 40 kW of billing demand	Rs.65/- per kW per month
	(ii) Next 20 kW of billing demand	Rs.100/- per kW per month
	(iii) Above 60 kW of billing demand	Rs.165/- per kW per month
(b)	**For billing demand in excess of the contract demand**	Rs.210/- per kW

For the entire consumption during the month	405 Paise per Unit

For all the reactive units (KVARH) drawn during the month	10 Paise per KVARH

HTP1:

(a)	For first 500 kVA of billing demand	Rs.100/- per kVA per month
(b)	For next 500 kVA of billing demand	Rs.140/- per kVA per month
(c)	For next 1500 kVA of billing demand	Rs.210/- per kVA per month
(d)	For billing demand in excess of 2500 kVA	Rs.240/- per kVA per month

For billing demand in excess over the contract demand	Rs.370 per kVA per month

For entire consumption during the month		
(a)	Upto 1000 kVA billing demand	390 Paise per Unit
(b)	For 1001 kVA to 2500 kVA billing demand	410 paise per Unit
(c)	Above 2500 kVA billing demand	420 Paise per Unit

3.2.3 Housekeeping practices

Based on the detailed energy audits carried out in the cluster units, no unit is adopting better operating practices. The instrumentation is also poor in the units. Further, there is no monitoring of fuel consumption, process parameters, instrumentation for various equipments are not practiced and these may be due to lack of awareness.

3.2.4 Availability of data and Information

The data and information pertaining to electricity consumption is available and however, the fuel consumption details are not maintained in the records. The data such as energy consumption and production monitored during the field visits have been used for evaluating specific energy consumption and potential for energy saving.

3.2.5 Any other relevant Aspect

Majority of the machine operators and helpers deployed in the cluster units are non technical and illiterates and their knowledge is based on the past experience. They do not have technical skills and knowledge on energy conservation. This is one of the important factors for inefficiency of the process and energy losses.

3.3 Technology gap analysis

3.3.1 Technology up-gradation

i) The state of art of technology of the units installed is poor as compared to the technologies available in the market. Various technological gaps were identified in the units as under and these may be due to lack of awareness on the technologies available, quantum of energy loss, lack of awareness among the workforce and unit owners, etc.

ii) There is a need for these industries to adopt energy efficient technologies.

iii) The sector also faces deficiencies such as the lack of access to technology and technology sharing and the inadequacies of strong organizational structure, professional attitude etc.

iv) There are many technologies and energy efficient equipments available in the market and local service providers in dealing with these technologies.

3.3.2 Process upgradation

Though, there is potential for process upgradation in the cluster units for improving the quality and enhancing production, many industry owners are not willing for process upgradation due to high investment and low returns. Further, majority of the unit owners are marketing their products through agents and does not have knowledge on the market demand, trend, and

requirement. The details of equipment-wise technology gaps identified and technology interventions required are furnished below:-

Table 3.4: Technology gaps identified and technology interventions

S.No	Equipments	Technology Gaps Identified	Technology Interventions
1	**Boilers**	• Energy Cost is more by Single flue gas path system • Poor heat transfer efficiency • No Waste Heat Recovery and high flue gas losses • Low loading of the boiler • The basic instrumentation like pressure gauges were also not installed • No proper monitoring of fuel feeding to the boiler • Overall inferior design of the boiler	• New Improved Design high efficiency boiler.
2	**Hot Air Generators**	• More Energy Cost • In efficient Hot air generator • High radiation losses • Manual fuel feeding and no control over it • Overall inferior design of the system	• New Improved Design high efficiency hot air generator
3	**Waste Heat Recovery System (WHR)**	• High flue gas temperature • No waste heat recovery	• Install waste heat recovery to boiler and thermopac
4	**Energy Efficient Pumps**	• Local make pumps with poor impeller design • Old pumps • Low efficiency • More electricity consumption	• New efficient pumps to reduce electricity consumption
5	**Variable Frequency Drives (VFD)**	• The flow is controlled by mechanical dampers and hence more power consumption	• Install variable frequency drives
6	**Wood gasifier for Boiler and thermopac**	• Energy Cost is more by using LDO and furnace oil	• Install Wood Gasifier for oil fired boilers and thermopacs
7	**Vertical agitator system**	• Horizontal agitator system	• Vertical agitator system
8	**Screw compressors**	• Presently old reciprocating refrigeration compressors are used	• Install screw refrigeration compressors

3.4 Energy Conservation measures identified

3.4.1 Description of proposals including technology/product specifications

The various proposals have been identified for implementation in the cluster units for reducing energy consumption consisting of high, medium and no/ low cost measures

3.4.1.1 Boilers

Background

The boilers are installed in the cluster units for steam generation. Steam is used for various process equipments. Based on detailed studies carried out in cluster units, some of the boilers installed in the various industries of the cluster were found to be inefficient due to inferior design like single pass system, high flue gas losses, heat losses through grate and high radiation losses with efficiencies around 40%. The low efficiency can also be attributed to sub-optimal loading of boiler, inferior boiler design, old/obsolete and local boilers, and absence of waste heat recovery.

Boilers

Recommendation

It is recommended to install new boilers having efficiency over 70% by replacing the present boilers.

The cost benefit analysis of replacing the boiler is furnished below:

Present efficiency of the boiler	: 44%
Rated Efficiency of the new boiler	: 70%
Efficiency at normal operating conditions	: 65%
Present fuel consumption	: 200 tons
Wood savings	: 30% = 60 tons
Monetary savings per annum	: ₹.1,80,000
Investment required for new boiler	: ₹.3,50,000.
Payback period	: 2 years

The features of high efficiency boilers are furnished as under:

- The boiler is of three-pass construction consisting of furnace section as first pass and two convective tubular pass.
- The boiler is fully wet back construction, which is located in the rear of the furnace effectively, quenches streaks of flame entering it ensures complete turnaround mixing of the gases prior to entering the second pass.
- The front smoke box also ensures complete turnaround and the mixing of the gases prior to entering the third and final pass of the smoke tubes.
- The bigger diameter smoke tube ensure smooth passage of flue gases and prevent choking, clinkering at the tube ends. Further it makes cleaning easy.
- Fuel firing system consists of fixed grate made of heat resistance, cast iron, complete with furnace refractory for reducing radiation losses
- Adequate heating surface ensures guaranteed performance.
- Adequate grate area and furnace volume to ensure safe grate loading and furnace heat loading
- Optimum gas velocities are maintained to ensure minimum pressure drop on gas side and most effective heat transfer
- The staggered tube arrangement in convective zone ensures effective water circulation and hence heat transfer
- MS hinged door, completed insulated with heat resistance refractory provided for easy access to the smoke side of the boiler
- Compact, quick steaming, sturdy and dependable, this units are simple to install.

***Benefits*:**

- Reduces fuel consumption and faster generation of steam
- Reduces GHG emissions
- Improves working environment for workers due to reduction in radiation losses and flue gas temperatures

Hot Air Generators

Background

Some of the cluster units have installed hot air generators. The hot air is required for tray dryers. The hot air generators are of local make, single pass system and wood fired. A detailed study had been carried out for assessing the efficiency of the hot air generator. The

efficiencies are found to be low i.e., in the range of 20 -30 % only. The low efficiency of the hot air generators is due to the following reasons:

- **Uncontrolled combustion and manual feeding of wood**
- **Poor heat transfer efficiency**: The hot air generator is of single pass system and heat transfer between the flue gas and air is low. Due to poor heat transfer area and short time contact time between flue gas and hot air leads to high flue gas losses and hence leads to inefficiency of the hot air generator system.
- **Heat loss from charging door**: The charging door is always kept open due to various reasons; those are human error and non compatibility of wood lags in combustion chamber. Grate/combustion chamber is not sufficient for burning bigger size logs.
- **There is no control on fuel firing**: In Conventional/existing hot air generator there is no control system of fuel firing in combustion chamber
- **Poor insulation on hot air generator**
- **No waste heat recovery and flue gases are vented out without any waste heat recovery**

Based on above, it is recommended to replace the present conventional hot air generator with new hot air generator. The new hot air generator will have efficiency of 70%.

Proposed energy efficient wood fired hot air generator operates on force draft system and controlled fuel combustion system. Improved grate area, this will reduce the resistance to the draft system and reduction of radiation loses from combustion chamber. This system has three pass design compared single path design in conventional hot air generator system which will improves the heat transfer area and time, this automatically lead to improved heat transfer efficiency between flue gas and air. Due to all above mentioned things will lead to improved drying air temperature; this automatically reduces drying time.

Technical, economic, environmental and safety aspects of conventional hot air generator and energy efficient hot air generator are compared over life cycle of equipment, same is presented in table below:

Table 3.5: Comparison of conventional hot air generator with energy efficient hot air generator

Details	Conventional hot air generator	Energy efficient hot air generator
		
Wood consumption	High	Low
Environment pollution	High (*partial combustion & more fuel consumption*)	Low (*Complete combustion & less fuel consumption*)
Safety of workers	Poor	Good
Maintenance	High	Low
Operational cost	High	Low
Availability of local service providers	Yes	Yes
Technical comparison between convention & energy efficient hot air generators		
Draught system	Induced	Forced/induced
Fuel combustion	Partial	Complete
Control of fuel combustion	No	Yes
Temperature monitoring & control	No	Yes
Radiation losses	More	Less
Heat transfer between hot gasses and cold air	Less (Single path flue gas); Heat transfer efficiency is less	More (Three path flue gas); heat transfer efficiency is more
Radiation heat in combustion chamber	Not utilized	Utilized in the transfer of heat

From the above table it is clear that energy efficient hot air generator has significant advantages in energy, environmental, economic & safety aspects over conventional hot air generator. It is justifiable to install energy efficient hot air generator in place of conventional hot air generator.

Technical specification

Design specifications of proposed energy efficient hot air generator are presented in table below:

Table 3.6: Technical specifications of AHA-300-C"energy efficient hot air generator"

Details	Units	Value
Name of equipment	NA	Energy efficient wood fired hot air generator
Model	NA	AHA-300-C
Capacity	kCal/hr	30,000
Blower model	NA	25-200
Blower capacity	hp	2
Fuel used	NA	Wood
Fuel consumption	Kg/hr	20
ID Fan model	NA	28-160
ID Fan motor	hp	½
ID Fan control	NA	ON-OFF
Total connected electrical load	hp	2.5
Electric supply	NA	AC 3 phase, 415V, 50 Hz
Hot air pipe outlet dimensions	in*in	9*9
Diameter of flue gas outlet	in	8
Air temperature of outlet	deg C	150 (Max)

Benefits of proposals

Major advantages of the replacement of conventional hot air generator with energy efficient hot air generator are presented below:

- Improved productivity
- Quality improvements
- Reduction of manufacturing cost
- Improved working environment
- Reduction of deforestation
- Resultant GHG reduction
- Improved life of hot air generator system
- Easy operation& maintenance
- Cost benefit analysis

Energy & monetary savings after implementation of energy efficient hot air generator in place of conventional hot air generator in typical chemical manufacturing unit are presented below.

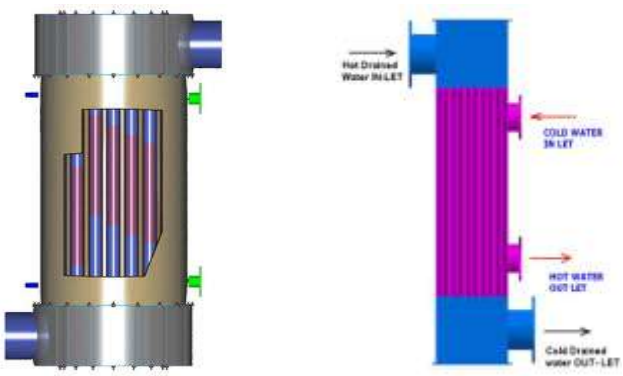
Details	Units	Value
Present efficiency of the hot air generator	%	26.5
Efficiency of proposed new efficient hot air generator	%	60
Increase in efficiency	%	33.5
Percentage reduction in fuel consumption	%	50
Present fuel consumption	tons	350
Fuel savings	tons	175
Monetary savings per annum	lakhs	`.5.25
Investment required	lakhs	`.5.00
Payback period	months	12

From the above table it is clear that it clear that replacement of conventional hot air generator with energy efficient hot air generator project seems more viable in terms of energy and economical point of view.

Waste Heat Recovery System (WHR)

Background

In Vapi dyes & chemical industries, boilers are used for steam generation required for process equipments such as i.e., reactor vessels & dryers etc. there is no waste heat recovery system for the boilers and flue gases are vented to the atmosphere without any recovery of heat. The heat in flue gases can be recovered and can be used for pre-heating combustion air or feed boiler water temperature and improves the efficiency of the boiler and leads to reduction in fuel consumption.



Waste heat recovery system

Recommendation

It is recommended to install WHR system for preheating combustion air or boiler feed water. The present flue gases temperature is around 250 ^{o}C and is vented to the atmosphere without any heat recovery. By doing so, about 5% to 10% of total LDO or FO or Wood consumption can be reduced. The cost benefit analysis of installing waste heat recovery system (economizer) for a typical unit is furnished below:

S.NO	PARAMETER	VALUE	UNIT
1	Proposed saving of LDO on installing Economizer	10	%
2	Present LDO consumption	22,140	kgs/annum
3	Present Efficiency of the Boiler	62.2	%
4	Increased Efficiency	69	%
5	LDO savings per annum	2,214	kgs/annum
6	Monetary savings per annum	61,992	₹
7	Investment	50,000	₹
8	Pay back period	0.8	years

Benefits:

- Reduces production cost
- Improves working environment
- Reduces GHG emissions
- Lesser pay-back period
- Utilizes heat available in waste flue gases and hence no fuel is required
- Increases production for the same period
- Improves working environment due to reduction in temperature of flue gases
- Low investment and high returns
- No operation and maintenance costs

Energy Efficient Pumps

Background

The pumps are one of the major energy consuming equipments in dyes and chemical industries and the pumps are installed for boiler feed water pumps, refrigeration plant water circulation pumps, process circulation pumps and plant water supply

pumps. Majority of the pumps installed are of local make or old and pumps are found to be highly inefficient.

Recommendation

It is recommended to install KSB, CRI, and Grundfos pumps have higher efficiency than the local pumps due to improved design of impellers, diffusers, and shaft and these pumps are made up of AISI stainless steel and designed to deliver best possible hydraulic efficiency. The impellers and diffusers are of best efficiency and extended life. The pumps are powered by a totally enclosed fan cooled, A.C induction motor, suitable for continuous duty. Motor stator is made of low watt loss steel laminations assembled under pressure and rigidly locked in the frame. Dynamically balanced rotor ensures vibration and noise free operations.

The cost benefit analysis of installing new energy efficient pumps for a typical unit is furnished below:

S.NO	PARAMETER	VALUE	UNIT
1	Present efficiency of the pumps	43	%
2	Efficiency of new KSB pump of 15 cum/hr and 25 mH	70	%
3	Power consumption of the present pump (5 HP)	2.56	kW
4	Power consumption of the new pump	1.6	kW
5	Power savings	1.0	kW
6	Annual power savings	8,176	kWh/annum
7	Monetary savings	0.45	₹.in Lakhs/annum
8	Investment	0.30	₹. in Lakhs
9	Pay back period	0.7	years

Benefits:

- Reduces power consumption and hence effects the production cost
- Low investment and high returns, the payback period is 6-9 months
- Reduces GHG emissions due to reduction in electricity consumption
- More discharge for the same power consumption and hence reduces processing time
- Reduces maintenance costs due to improved quality of pump parts
- Reduces production down time

Variable Frequency Drives (VFD)

Background

Normally, more than 50% of 3 phase-AC induction motors are fitted to fans or pumps. The flow from most of the fans and pumps are controlled by restricting the flow by mechanical dampers is used on fans, and valves are used on pumps. This mechanical constriction will control the flow and may reduce the load on the fan or pump motor, but the constriction itself adds an energy loss, which is obviously inefficient.

The typical applications where energy savings can be confidently expected in Vapi Dyes and chemical Units, by using VFD, include:

- Induced draft fans and forced draft fans of boilers/thermopacks
- Water circulation pumps
- Centrifuges
- Process pumps

Recommendation

It is recommended to install VFD's for above mentioned equipments and the flow can be controlled by reducing the speed of the fan or pump motor this would offer a more efficient means of achieving flow control. In fact the saving is greater than that might initially be expected. As the speed of the fan or pump is reduced, the flow will reduce partially, while the power required by the fan or pump reduce with the cube of the speed.

The flow can be reduced by 20%; the corresponding speed reduction will be 80% of the normal speed; this will reduce the power consumption to 0.8^3 = 51.2%.

The cost benefit analysis of installing variable frequency drives for a typical unit is furnished below:

S. No.	Parameter	Value	Unit
1.	Rated capacity of centrifuges, primary and secondary pumps	41.2	kW
2.	Actual power consumption of 3 motors	22.3	kW
3.	Avg. running hours	20	Hrs

4.	Avg. operating days/yr	330	Days
5.	Expected Savings	20	%
		4.45	kW
6.	Annual power Savings	29,422	kWh
7	Annual monetary savings (₹ 6.07/kWh)	1.78	₹ in lakhs
8.	Investment	2.65	₹ in lakhs
9.	Simple Payback Period	18	Months

Benefits

- Reduction in breakdowns and smooth start
- Unity power factor
- Reduction in breakage and motor burnt
- Improved life of the motor and increased production
- Reduction in production cost and maintenance cost due to frequent failures of belts, bearings, yarn breakages
- Improved power factor (0.98 across speed range)
- Maximize power distribution system
- Reduced Inrush Currents
- Minimize Peak Demand Charges
- Soft Start/Soft Stop
- Eliminates Mechanical Shock and Stress on Power Train (couplings, belts, drive shafts, gear boxes, etc.)
- Reduce Utility (Operating) Costs
- Reduced Energy Consumption, Process Operates at Most Efficient Point
- Allows Load Shedding
- May Qualify for Utility Rebates
- Controlled Acceleration and Deceleration

Wood gasifier for Boiler and thermopacs

Background

Based on the detailed energy audits conducted in various units of the cluster, the operating thermal efficiency levels of the present oil fired boilers and thermopacs are in the range of 50% to 62%. Further, the steam generation and oil heating with LDO and furnace oil is costly and cost of these fuels is ever increasing in future due to more demand for the fossil fuels.

Recommendation

The steam generation and thermic oil heating by wood gasifier is economical and efficient. Further, the wood is available in plenty in the area. It is recommended to install wood gasifier. The cost benefit analysis of wood gasifier for a typical unit is furnished below:

Present System:

S.NO	PARAMETER	VALUE	UNIT
1.	Capacity of the Boiler & Thermopac	300 + 6 lac kcal	kg
2.	Total Furnace oil consumption per batch	41	kg/hr
3.	Cost of furnace oil	28	₹
4.	Fuel cost per batch	1148	₹/hr

Gasifier System to replace LDO

S.NO	PARAMETER	VALUE	UNIT
1	Capacity of the Boiler & Thermopac	300 + 6 lac kcal	kg
2	Wood consumption in gasifier	140	kg/hr
3	Cost of wood	3	₹
4	Wood cost per batch	420	₹/hr
5	Electricity cost	41	₹/hr
6	Total energy cost per batch	461	₹/hr

Cost Benefit analysis

S.NO	PARAMETER	VALUE	UNIT
1	Monetary savings due to wood gasifier system per hr	687.0	₹ /hr
2	No. of hours per day	3.0	hrs/day
3	No. of days of operation per annum	250	days/annum
4	Monetary savings per annum	5.2	₹ in lakhs
5	Investment required	15.0	₹ in lakhs
6	Payback period	2.9	years

Gasifier Specification

S.No	Parameter	Details
1	Model	GT-700
2	Mode	Burning Application
3	Rated output	200 KW (Can replace up to 50 L/Hr of FO)
4	Design	Down Draft with Throat
5	Fuel	Wood Chips
6	Feed size	2" - 3" (any dimensions)
7	Fuel Consumption	175 Kg/Hour (Corresponds to Max.rated output)
8	Moisture content of fuel	15%
9	Fuel Feeding Cycle	Hourly once
10	Fuel charging	Manually
11	Hopper Holding Capacity	800 Kg (Approx.)
12	Auxiliary Power	6 HP

Benefits:

- Low cost of energy cost
- Low operating costs
- Reduces GHG emissions
- Improved combustion
- The fuel feeding can be critically controlled
- Reliable, continuous delivery of cost effective energy and reduces dependence on fossil fuels

Vertical agitator system

Background

Existing agitator system installed in the reactors are of very primitive design, it is recommended to replace the conventional agitator system with scientifically designed agitator system by considering the viscosity, specific gravity of material etc. By considering these parameters for the design of agitator system will improve the heat and mass transfer in process and hence reduces heating and cooling loads and also improves the quality of the final product.

Recommendations

The cost benefit analysis of agitators for a typical unit is furnished below:

S. No.	Parameter	Value	Unit
1.	Capacity of the motor	5	hp
2.	Average input power consumption	2.6	kW
3.	% of loading of motor	69.33	%
4.	% of power saving after replacing agitators	30	%
5.	Amount of power saving by using vertical agitators	0.78	kW
6.	No of working hours per annum	4800	hrs
7.	No of units saving per annum	3744	kWh
8.	Monitor saving per annum for 4Nos	0.91	₹ in lakhs
9.	Investment required for vertical agitator 4 Nos	4.4	₹ in lakhs
10.	Pay Back period	4.84	years

Benefits:

- Improved product quality
- Saving in stirring time, it automatically leads to energy savings
- Improved drive transmission efficiency (Directly connected instead of belt drive)
- Saves energy in replacing the conventional truck gear system with energy efficient planetary gear system
- Vertical mounted motors in place of conventional horizontal motors, this saves the energy

Screw Compressors for Refrigeration Systems

Background

The refrigeration compressors are installed in the cluster units for chilled water and brine requirement for the reactors. The compressors installed are of reciprocating type and are old. Based on the detailed energy use and technology audits carried out in various cluster units, the performance of the refrigeration systems are found to be low.

Recommendation

It is recommended to replace the reciprocating and old refrigeration systems with new screw refrigeration systems for reducing power consumption and improving the system performance.

Benefits

- Reliable and highly energy-efficient scroll compressors
- Intelligent microprocessor control with digital setting of temperature levels for optimal cooling and power saving
- Auto-distribution of load for efficient running of the chiller
- Capacity modulation ensures that only required number of compressors operate to handle the load, thus saving power
- Lower electrical infrastructure costs
- In-built anti-freeze protection ensures cut-off before freezing point for reduced breakdowns
- User-friendly remote control operation for convenience, and remote emergency control in case of fault

Technical Specifications

DESCRIPTION		UNITS	MODELS				
			XWC2S-011	XWC2S-026	XWC3S-039	XWC4S-052	XWC4S-085
Nominal Cooling Capacity		kW (TR)	38.67 (11)	91.42 (26)	137.12 (39)	182.84 (52)	298.81 (85)
Capacity Control		%	100,50	100,50	100,66,33	100,75,50,25	100,75,50,25
Nominal Dimensions	Length	mm	1700	2300	2300	2700	2700
	Width	mm	550	950	950	1550	1550
	Height	mm	1415	1490	1490	1812	1812
Net Weight / Unit (Approx.)		Kg	650	1175	1600	2500	2900
No. of Compressors		No.	2	2	3	4	4
Power Supply		V/PH/Hz	380 - 420V, 3PH, 50Hz				
Total Power Consumption		kW	9	22	33	44	70.5
Condenser (Shell & Tube Type)	Qty	No.	1(2 in 1)	2	3	4	4
Water Flow Rate	Min	USGPM	27.5	65	97.5	130	212
	Max	USGPM	38.5	91	136.5	182	298
Water Connections / condenser	In & Out	No.	1	1	1	1	1
	Size		1 ¼" BSP	1 ¼" BSP	1 ¼" BSP	1 ¼" BSP	1 ¼" BSP
Cooler (Shell & Tube Type)	Qty	No.	1 (2 in 1)	1 (2 in 1)	1 (3 in 1)	2 (2 in 1)	2 (2 in 1)
Water Flow Rate	Min	USGPM	20	48	72	96	160
	Max	USGPM	28	67	101	134	225
Water Connections / cooler	In & Out	No.	1	1	1	1	1
	Size		1 ½" NB	3" NB	3" NB	3" NB	4" NB

Source: Blue star

De-super-heater for hot water generation

Adiabatic compression in ammonia and Freon refrigeration systems results in high discharge gas temperature at compressor outlet at 120 ^{0}C and above. Normally, this gas is cooled and condensed in water cooled or air cooled condensers and consists of cooling towers and pumps.

Gas heat removed in de super heater heats circulating water up to 55 to 77 ^{0}C depending on the load and this hot water can be used as boiler feed water and hot water requirement either in process, which reduces the coal consumption in the boiler. Apart from the hot water generation, this system also improves the performance of the refrigeration system leading to reduction in power consumption of the compressor and also reduced maintenance of the condenser and compressor. This also enhances the life of the compressor. Further the load on

the cooling towers considerably reduces leading to reduced power consumption of condenser water pumps

Recommendation

As a long term option and to avoid regular maintenance for clean and effective heat transfer, it is recommended to install de super heater in the circuit between compressor discharge and condenser, removes high temperature gas heat and passes entire gas to condenser to condense similar to normal refrigeration cycle.

Cost benefit analysis

The cost benefit analysis of installing de-super heater is detailed below for a typical industry having refrigeration system of 50 TR:

Operating load	: 50 TR
Quantity of hot water generation can achieve	: 9 KL per day (@70 ^{0}C)
Equivalent coal savings	: 60 tonnes/ year
Monetary savings per annum (@Rs.3300/- per tonne)	: Rs.2.00 lakhs
Investment required for de-super heater	: Rs.4.50 lakhs
Simple Payback period	: 24 months

3.4.2 Life cycle analysis for the suggested Energy saving proposals

The life cycle analysis for each of the suggested energy saving proposal has been prepared as per the Indian industry norms, government policies, and as per the guarantee provided by the equipment/technology suppliers and presented below.

Table 3.11: Life cycle analysis for energy saving proposals suggested

S. No	Energy Saving Proposal	Life cycle analysis
1	**Boilers**	The life of the boiler is considered at 15 years and the initial rated efficiency is 70% and the efficiency de-rates by 2% for each year of operation. The depreciation is considered at 5.28% by straight line method
2	**Hot Air Generators**	The life of the hot air generators is considered at 20 years. The depreciation is considered at 5.28% by straight line method.
3	**Waste Heat Recovery System (WHR)**	The life of the Waste heat recovery system is considered at 20 years. The depreciation is considered at 80% by straight line method.
4	**Energy Efficient Pumps**	The life of the pumps is considered at 15 years. The depreciation is considered at 5.28% by straight line method

5	**Variable Frequency Drives (VFD)**	The life of the variable frequency drives is considered at 20 years. The depreciation is considered at 80% by straight line method.
6	**Wood gasifier for boiler and thermopac.**	The life of the Wood Gasifier is considered at 20 years. The depreciation is considered at 80% by straight line method.
7	**Vertical agitator system**	The life of the Vertical agitator system is considered at 20 years. The depreciation is considered at 5.28% by straight line method.
8	**Screw compressors for refrigeration plant**	The life of the screw compressors for refrigeration system is considered at 20 years. The depreciation is considered at 5.28% by straight line method
9	**De-superheater for hot water generation**	The life of the de-super heater is considered at 20 years. The depreciation is considered at 80% by straight line method

3.4.3 Cost of Implementation

The investment required for various proposals identified for different capacities for **Vapi Chemicals & Dyes** Cluster is furnished below.

Table 3.12: Details of cost of implementation for the entire cluster

S. No	Equipment Details	Capacity	Investment (₹ In Lakhs)
1	**Boilers**	600 kg	385
2	**Hot Air Generators**	400 kg	50
3	**Waste Heat Recovery System (WHR)**		17.5
4	**Energy Efficient Pumps**	5 hp	162
5	**Variable Frequency Drives (VFD)**	7.5 hp	1457.5
6	**Wood gasifier for Boiler and thermopac.**	50 lts/hr	75
7	**Vertical agitator system**	7.5 hp	440
8	**Screw compressors**	50 TR	250
9	**De-superheater**	--	135

3.4.4 Monetary savings

As per the detailed audits carried out on various equipments of **Vapi Chemicals & Dyes Cluster** units, the monetary savings, investment required and payback period have been estimated for each proposal and the details are furnished below:

Table 3.13: Energy saving details for the suggested energy saving proposals

S. No	Equipment Details	Investment (₹ in Lakhs)	Monetary savings (₹ in lakhs)	Payback period (years)
1	**Boilers**	385	198	1.9
2	**Hot Air Generators**	50	52.5	1.0
3	**Waste Heat Recovery System (WHR)**	17.5	21.35	0.8
4	**Energy Efficient Pumps**	162	243	0.7
5	**Variable Frequency Drives (VFD)**	1457.5	979	1.5
6	**Wood gasifier for Boiler and thermopac.**	75	26	2.9
7	**Vertical agitator system**	440	91	4.8
8	**Screw compressors**	250	80	3.1
9	**De-superheater**	135	60	2.3

3.4.6 Issues/barriers in implementation of EE proposals

The major barriers identified for implementation of the proposals in the cluster units are described below:

- One of the major barriers is the lack of awareness and information among the cluster owners on energy / monetary losses, EE technologies, and energy efficiency. A few demonstration projects may motivate them to take up the projects.
- About 80% of the cluster unit owners doesn't have financial strength for implementation of high cost technologies.
- Though, LSPs are available in the cluster, they don't have technical strengths for supply of efficient equipments.
- Production loss during implementation of the energy saving proposals

3.4.7 Availability of Technologies in Local / National

For majority of the technologies and proposals identified, the equipments suppliers/ dealers / branch offices are available in Mumbai, Ahmedabad &Vapi. Among the technologies /

equipments identified for implementation for Vapi Chemicals & Dyes cluster units, some of the measures can be implemented by the local service providers and the balance equipments can be procured at nearest city i.e., Mumbai. The detail of equipment which can be implemented by LSPs and those needs to be procured from other cities is furnished below:

Table 3.14: Details of technologies available for the suggested proposals

S. No	Equipment details	LSPs (Mumbai, Vapi)	India
1	**Boilers**	√	
2	**Hot Air Generators**	√	√
3	**Waste Heat Recovery System (WHR)**	√	
4	**Energy Efficient Pumps**	√	
5	**Variable Frequency Drives (VFD)**	√	
6	**Wood gasifier for Boiler and thermopac.**	√	
7	**Vertical agitator system**	√	
8	**Screw compressors**	√	
9	**De-superheater**	√	

Note: √ Available

3.5 Identification of Technologies/Equipments for DPR preparation

Based on the detailed studies carried out, there is considerable potential in all cluster units for energy conservation and efficiency. As the process and equipments are more or less similar in all cluster units, all the technologies / equipments identified can be replicated as per the requirement and detailed project reports for the specific technologies prepared also can be replicated for different units as per the capacity requirement.

The technologies/equipments considered for preparation of detailed project report are furnished in Table 3.15:

Table 3.15: The list of technologies for DPR preparation

S.No	Technology/equipment	No. of DPR's	Capacities
1	**Boilers**	3 no	600 kg, 1000 kg and 2000 kg
2	**Hot Air Generators**	2 no	400 kg and 800 kg
3	**Waste Heat Recovery System (WHR)**	2 no	---
4	**Energy Efficient Pumps**	3 no	5 HP, 7.5HP and 10 HP
5	**Variable Frequency Drives (VFD)**	1 no	7.5 HP
6	**Wood gasifier for boiler and thermopac**	2 no	30 and 50 lts/hr
7	**Vertical agitator system**	1 no	7.5 hp
8	**Screw compressors**	1 no	50 TR/25TR
9	**De-superheater**	--	--

3.6 Environmental benefits

3.6.1 Reduction in GHG emissions

The major GHG emission reduction source is CO_2 due to implementation of the technologies identified, as the technologies will reduce fossil fuels like coke and furnace oil consumption.

3.6.2 Reduction in other emissions

The technologies identified upon implementation for the Vapi Chemicals & Dyes Cluster units will reduce wood, furnace oil, coal and electricity consumption and hence SOx emissions may reduce at power generating stations and at units using furnace oil.

Table 3.16: Estimated annual fuel/electricity savings in the cluster

S. No	Energy conservation measure	Annual Energy/Fuel saving Per Annum	Annual Monetary saving (₹ lakhs)	Implementation cost (₹ Lakhs)	Simple payback period (Years)	Short listed for DPR preparation (Yes/No)	No of units this can be implemented
1	**Boilers**	6600 tons	198	385	1.9	Yes	110
2	**Hot Air Generators**	1750 tons	52.5	50	1.0	Yes	10
3	**Waste Heat Recovery System (WHR)**	70 kilo liters	21.35	17.5	0.8	Yes	35
4	**Energy Efficient Pumps**	44,15,040 kWh	243	162	0.7	Yes	540
5	**Variable Frequency Drives (VFD)**	161,82,100 kWh	979	1457.5	1.5	Yes	550
6	**Wood gasifier for Boiler and thermopac.**	90 kilo liters	26	75	2.9	Yes	5
7	**Vertical agitator system**	3,74,400 kWh	91	440	4.8	Yes	100
8	**Screw compressors**	14,54,545 kWh	80	250	3.1	Yes	50
9	**Desuperheater**	2000 tons of wood	60	135	2.3	Yes	30

Table 3.17: Estimated annual fuel/electricity savings in the cluster

S. No	Fuel	Total fuel savings/annum in the cluster
1	Wood	8,350 tonnes
2	FO	160 kilo liters
3	Electricity	20.97 GWh

CHAPTER 4

SYSTEMATIC APPROACH FOR ENERGY CONSERVATION BY TEM/SGA

4.1 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

4.2 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.

4.3 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.

4.4 Total Energy Management (TEM)

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

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

- Identify management strength and weakness
- Analyze stakeholders' needs
- Anticipate barriers to implement
- Estimate the future trend

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

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

Steps of the Key Step Approach.

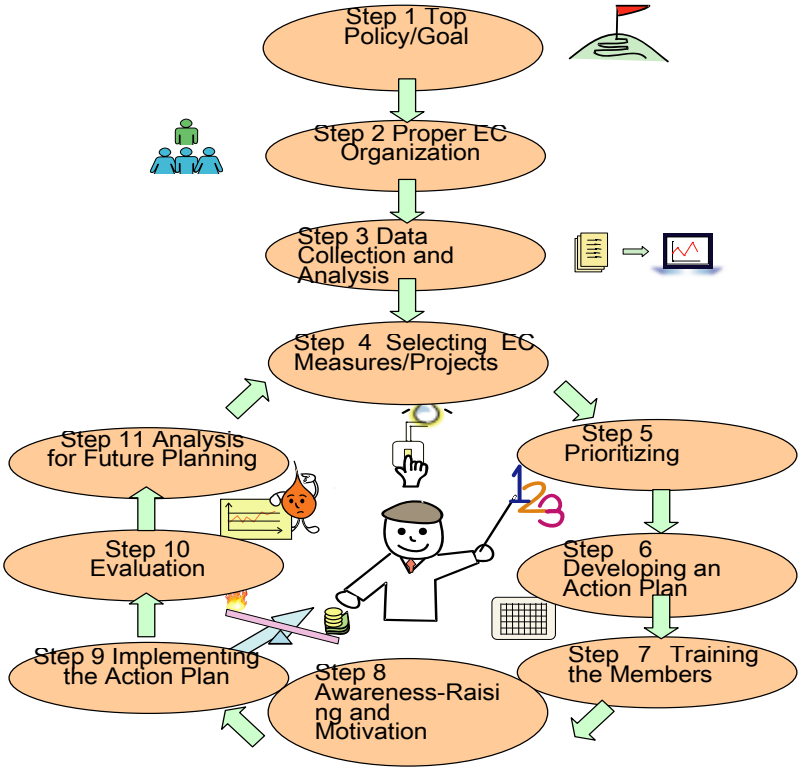


Figure 6: Key Step Approach

Each step is explained in this order as below:

Step 1: Top Management policy/Goal

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

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

(1) Develop a policy statement

It is desired that the top (senior) management announces the "Energy Policy Statement". This is very effective to let people inside and outside the company clearly knows the management's commitment to Energy Management (or Energy

Conservation). The format of the energy policy statement is various, but it usually includes the goal or objective of the company and the more concrete targets in the field of Energy Management (or Energy Conservation). It often shows the major measures and timetables. The statement shall match the company's mission statement or overall management strategy plan.

(2) Set targets

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

Step 2: Proper EC Organization including Assignment of Energy Manager

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

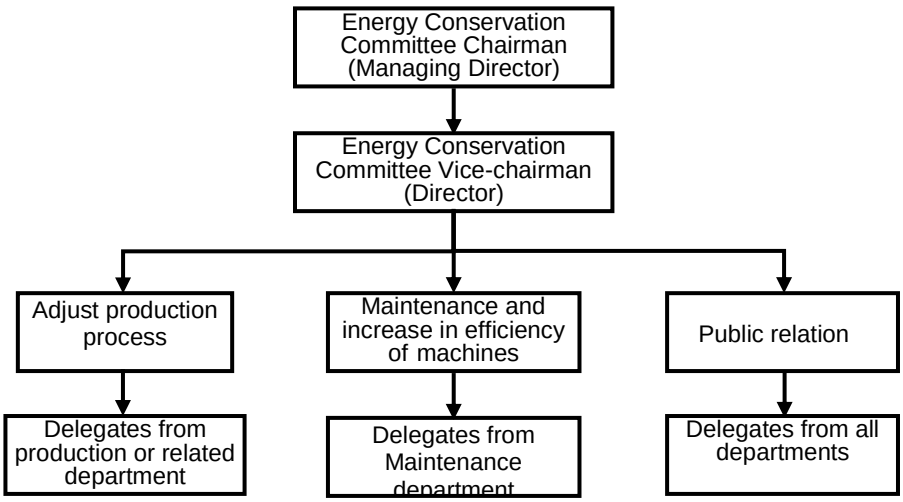


Figure 7: Example of energy conservation committee's organization

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

(1) Utilize Line (Formal) Job-related Organization for TEM purpose

(2) Use TPM Organization for TEM purpose

(3) Use TQM Organization for TEM purpose

(4) Add Employee Suggestion System to Energy Conservation Organization for TEM purpose

(5) Utilize another organization for TEM purpose

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

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

Step 3: Data collection and Analysis

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

The key steps for this purpose are shown below:

(1) Collect data on current energy use and analyze them

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

(2) Identify Management Strength and Weakness

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

(3) Analyze stakeholders' needs

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

(4) Anticipate barriers to implement

Making out a realistic and practical program also needs consideration of anticipated barriers for the implementation of Energy Management program or action plan.

Some possible examples of such barriers are:

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

(5) Estimate the future trend

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

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

Suppress: Using during the time in which it is not necessary to use. Examples include using electricity before or after working hours or when there is no one working.

Stop: Using equipment when it is not necessary. Examples include using all lightings during break time.

Reduce: Amount, pressure, temperature, speed, or brightness, or quality that exceed requirement. Examples include reducing intensity of lighting if not necessary.

Prevent: Prevent leakage or loss of energy. Examples include reducing space that leads to outside in order to prevent the leakage of heat into air.

Improve: Improve or repair machines to increase efficiency or modify manufacturing process to the one which enables us to conserve energy more. Examples include changing transparent sheet over the roof.

Store: Re-use the discarded energy. Examples include re-using heat from exhaust fume in order to reduce use of electric heater to warm heavy oil.

Change: Change how to use, type of energy, or energy sources to a suitable one from technical or economic point of view. Examples include changing the grade of heavy oil to an appropriate one or changing furnace systems or welding machines to the ones that use gas.

Increase Production

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

Step 4: Selecting EC Measures/Projects

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

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

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

1. Effects of energy conservation: Activities that can conserve energy more than others are more promising.
2. Investment amount: Activities that require less investment are more promising.
3. Pay-back period: Activities with short pay-back period for investment amount in equipment are more promising because all energy conservation will be profits after pay-back period.
4. Length of implementation: Activities that can be performed in a short period are more promising because they do not influence production process of the factory.

5. Number of personnel required: Activities that require a large number of personnel tend to be burdensome.
6. Importance to executives and reputation of the company: Some activities provide little financial benefit but cause good image or reputation.
7. Risk of the project: Some activities bring about big financial benefits but involve high risk from various factors. In this case projects have less importance.

Step 5: Prioritizing

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

Step 6: Developing an Action Plan

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

Shown below is an example of such a plan.

Table 4.1: Example of energy saving plan

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

Step 7: Training the related members

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

Step 8: **Awareness-raising and Motivation**

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

Shown below is an example of awareness raising plan.

Table 4.2: Example of awareness raising campaign

Detail of the plan	Length (Months)						Person in charge	Budget	Inspected by
	1	2	3	4	5	6			
1. Display the results of energy conservation every month	*	*	*	*	*	*	Mr.Prayat	-	Mr. Laaied
2. Evaluate every month	*	*	*	*	*		Miss Aom	-	Mr. Laaied
3. Perform energy conservation activity every 6 months	*					*	Mr. Matthayas	-	Mr. Laaied
4. Perform "Finding measures" activity in order to make energy conservation plan	*					*	Miss Thanom	-	Mr. Laaied
5. Provide rewards to sections that have achieved high efficiency						*		-	

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

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

The actual records of implementation shall be closely watched and monitored. If some problems arise, or some variance between the planned figures and the actual record is observed, then necessary actions shall be taken immediately.

Step 10: Evaluation (Management Review)

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

Thus the activities are repeated to form a cyclic movement.

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

- Short-term evaluation for the follow-up of the performance
- Long-term evaluation for the evaluation of the whole project that will be used for the future planning

Evaluation can be made in the following 3 levels.

1. **Self Audit:** Self evaluation that is made in a small group or a department based on the predefined form. (Inspection may be made every month).

2. Upper **Manager Audit:** Evaluation that is made by the section/department manager intended to raise performance of the activity. (Inspection may be made every 3 month).
3. **Top Management Audit:** Evaluation made by the executives of the organization that will be used for the evaluation of annual bonus. (Inspection may be made every 6 month).

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

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

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

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

4.4 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, be it in "man, material, method, or machine," and develop cost-effective and practical methods for solving the problem.

4.5 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 28.

4.6 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.

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

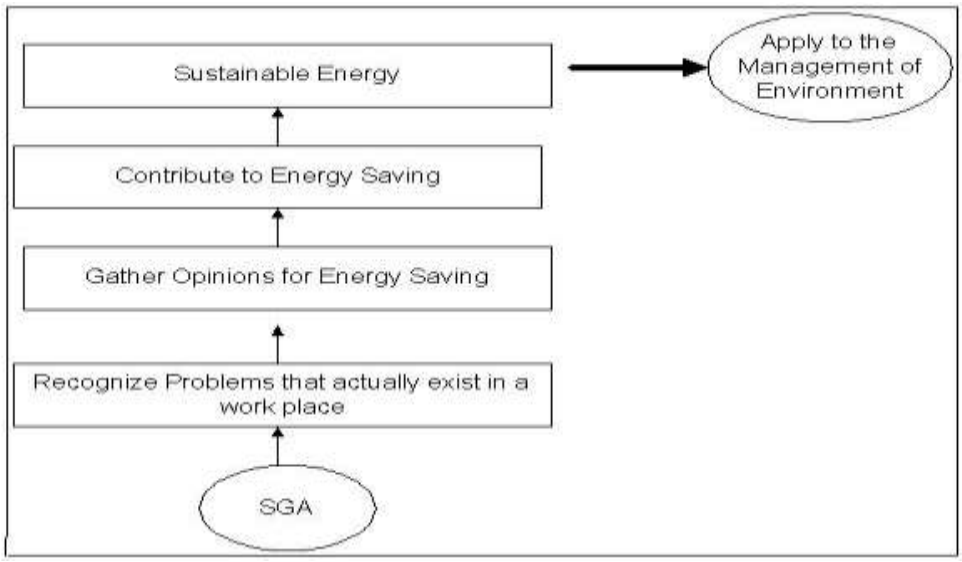


Figure 8: Relationship of SGA and energy saving

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.

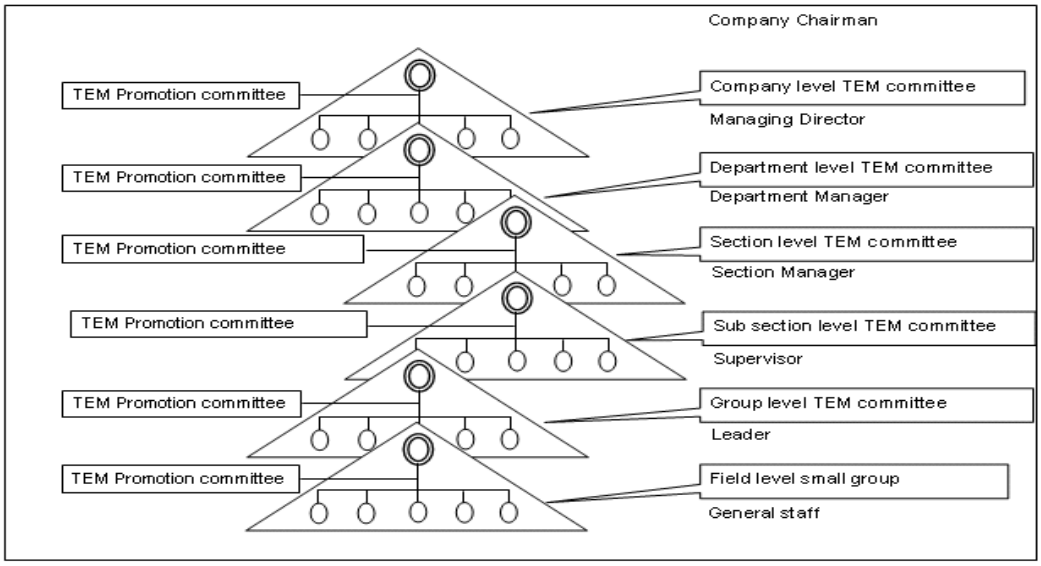


Figure 9: Positioning of SGA in Main Job Structure

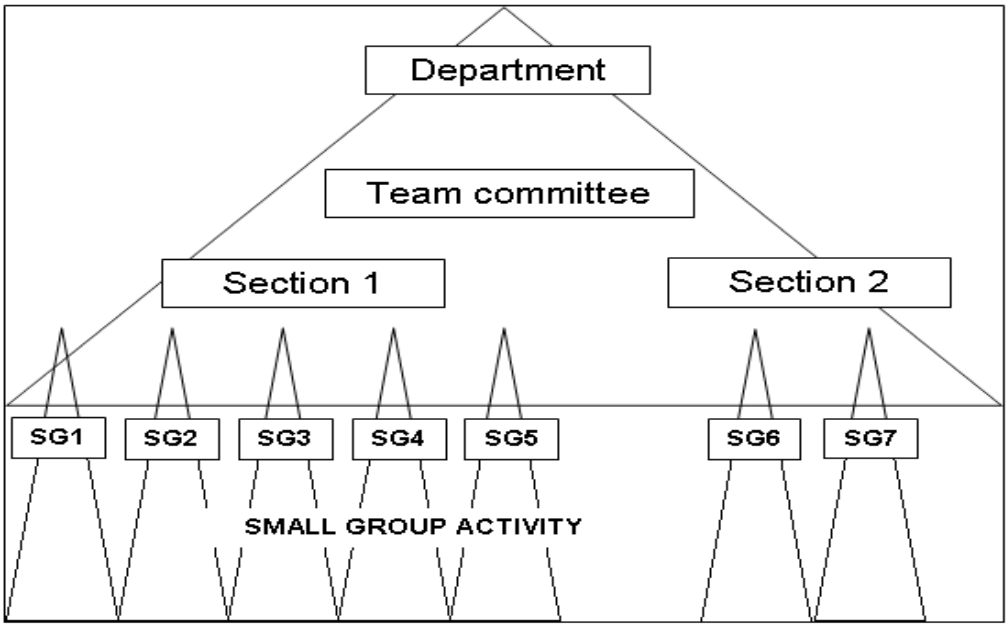


Figure 10: Positioning of SGA in Main Job Structure

4.7 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

4.8 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

4.9 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

4.10 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

4.11 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

4.12 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

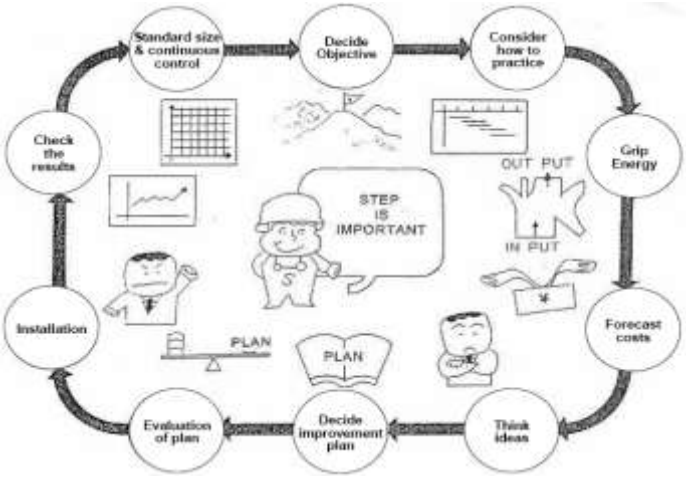


Figure 11: Steps of Small Group Activities

- 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.

Figure 12: SGA CIRCLE

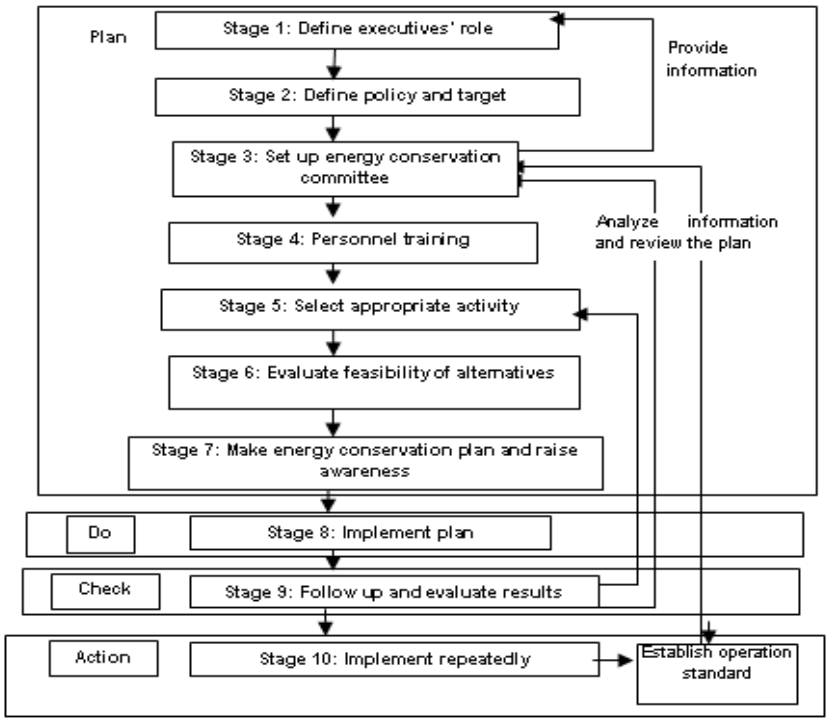


Figure 13: 10 STAGES

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

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.

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.

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.

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.

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

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.

Stage 8: Implement Plan

Implement according to the plan of each group.

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.

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.

4.13 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.

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

4.14.1 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

Figure 14: Five steps

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.

4.15 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 5
CONCLUSIONS

5.1 Summary of Energy saving measures identified for the Cluster

The summary of the energy saving proposals identified for Vapi Chemicals & Dyes Cluster units is furnished below in Table:

Table 5.1: Summary of energy saving proposals identified for Vapi Chemicals & Dyes Cluster

S. No	Energy Saving Proposals
1	Energy efficient boilers
2	Energy efficient pumps
3	Energy efficient hot air generators
4	Vertical Agitators
5	Wood Gasifier
6	Waste Heat Recovery Systems
7	Variable frequency drives
8	Screw compressors for refrigeration system
9	De superheater for hot water generation

5.2 Technology gap assessment for Energy saving proposals Identified for the Cluster

The technology gap assessment had been carried for each of the energy saving proposal recommended and is furnished below.

Table 5.2: Technology gap assessment for the suggested energy saving proposals

S. No	Technology Identified	Gap Assessment
1	**Energy efficient boiler.**	• The boilers are of Single pass flue gas path system leading to low heat transfer and high flue gas losses • Low loading of the boilers less than 40% • No waste heat recovery leading to reduction in efficiency of the system • High Heat losses from the grate and surface due to damaged insulation and opening of the charging doors • No control on fuel firing • No monitoring of air supply • Partial combustion leading to un-burnt

		carbon
2	**Energy Efficient Pumps**	Majority of the industries in the cluster installed local make pumps and some are old pumps. The following technology gaps were identified for low efficiency: • Pump impellers are of inferior design and local make • Pumps were installed on HP basis and not on head and flow • The pumps installed are of high head than required • No preliminary assessment of pressure and flow required • Poor water distribution design • Low suction head for the pumps installed
3	**Energy Efficient Hot Air Generator**	• In the industries Hot air generators are installed which are of local make and inferior design. • More radiation losses • No insulation • No control on fuel firing • No monitoring of supply air • Low efficiency
4	**Vertical Agitator**	• In many of the industries horizontal agitators are installed. • More electricity consumption • Old systems
5	**Wood Gasifier**	• In some industries LDO and FO are used as fuel in the boiler and thermopac. • The fuel cost is more as compared with wood
6	**Waste Heat Recovery Systems**	• The boiler and thermic fluid heaters installed doesn't have waste heat recovery system. • High flue gas temperature
7	**Variable frequency drives**	• The flow can be controlled by throttling of valves and speed controlled by mechanical dampers. • More losses by using mechanical dampers
8	**Screw compressors for refrigeration system**	• Reciprocating type and old refrigeration compressors • Low performance of the refrigeration compressors due to wear and tear • High power consumption
9	**De-superheater**	• The refrigerant is cooled in water cooled condensers and hence condenser performance • The heat available in the refrigerant is rejected in the cooling tower water

5.3 Techno–Economic analysis for suggested Energy saving proposals

The details of techno economic analysis of various energy saving proposals identified for **Vapi Chemicals & Dyes Cluster units** is furnished below

Table 5.3: Techno – Economic analysis for various energy saving proposals suggested

S.No	Energy saving proposal	Techno economic analysis	Remarks
1.	**Energy efficient boiler.**	• The technology will replace inefficient boilers and reduces production cost due less fuel consumption • High investment and lower payback period	Technically and financially viable
2	**Energy Efficient Pumps**	• Reduces Electricity consumption • The technology will replace in efficient pumps with new efficient pumps	Technically and financially viable
3	**Energy Efficient Hot Air Generator**	• The technology will replace the old hot air generator with new efficient generator • Reduces fuel consumption • Environmental friendly	Technically and financially viable
4	**Vertical Agitator**	• The technology replaces present agitators with new vertical agitator systems. • reduce electrical consumption	Technically and financially viable
5	**Wood Gasifier**	• Fuel shifting from LDO to wood • Reduces the energy cost	Technically and financially viable
6	**Waste Heat Recovery Systems**	• Will increase the efficiency of the boiler by recovering the heat from flue gases. • Reduces fuel consumption	Technically and financially viable
7	**Variable frequency drives**	• The speed can be controlled critically • Reduces electricity consumption	Technically and financially viable
8	**Screw compressors for refrigeration system**	• High performance • Less power consumption per ton of refrigeration	Technically and financially viable
9	**De-super heater for hot water generation**	• Reduces fuel consumption in the boiler • Reduces load on the cooling tower • Reduces power consumption of pumps and fans	Technically and financially viable

5.4 Barriers in Implementation of identified Energy saving proposals

Table 5.4: Barriers in implementation for various energy saving proposals suggested

S. No	Energy saving proposal	Barriers identified	Steps to overcome barriers
1	**Energy efficient boiler.**	• High initial investment • Lack of awareness on the losses and benefits • Lack of Skilled manpower • Lack of interest to invest high investment	• Providing soft loans may motivate the unit owners for implementation • Training programs, Demonstration and motivation
2	**Energy Efficient Pumps**	• Lack of awareness on the losses and benefits • High initial investment	• Providing soft loans may motivate the unit owners for implementation
3	**Energy Efficient Hot Air Generator**	• Dependence on local suppliers • Lack of knowledge on the benefits and economics • High initial investment	• Providing soft loans may motivate the unit owners for implementation
4	**Vertical Agitator**	• Lack of knowledge on the benefits and economics • Lack of awareness	• Training programs, Demonstration and motivation
5	**Wood Gasifier**	• Lack of knowledge on the benefits and economics • Lack of awareness • High initial investment	• Providing soft loans may motivate the unit owners for implementation
6	**Waste Heat Recovery Systems**	• Lack of knowledge on the benefits and economics	• Providing soft loans may motivate the unit owners for implementation
7	**Variable frequency drives**	• Lack of awareness of the drives • Lack of knowledge on the benefits and economics	• Training programs, Demonstration and motivation
8	**Screw compressors for refrigeration system**	• Lack of awareness • High initial investment • longer payback period	• Training programs, Demonstration and motivation • Providing soft loans may motivate the unit owners for implementation
9	**De-super heater for hot water generation**	• Lack of awareness • High initial investment • longer payback period	• Training programs, Demonstration and motivation • Providing soft loans may motivate the unit owners for implementation

5.5 Short listed Technology/Products for DPRs

The following technologies were identified for preparation of detailed project reports for **Vapi Chemicals & Dyes** Cluster:

- Energy Efficient Boilers
- Hot Air Generators
- Efficient Pumps
- VFD's
- Wood Gasifier
- Waste Heat Recovery
- Vertical Agitator
- Screw compressors
- De-super heater

5.6 Summary of level of awareness on Energy savings and Energy saving Technologies in Vapi Chemicals & Dyes Cluster

The level of awareness on energy saving among the SME owners in the cluster is poor. About 10% of the unit owners have good conscious on energy saving technologies and is limited. The energy saving technologies are implemented based on success stories in the cluster units and practical demonstration of the energy saving technologies in the units. Though the clusters units are in operation since last 4 decades, the achievement on energy efficiency in the cluster units is poor and same old technologies are continued.

Some of the demonstration projects in the cluster may motivate the SME owners in implementation of the energy saving technologies.

LIST OF ANNEXURE

ANNEXURE – 1

Technical calculations of typical unit in the cluster

a) Efficiency Evaluation for Boiler

S.No	PARAMETER	DETAILS	UNITS
1	Fuel used	Wood	
2	Wood	300	Kg
4	Calorific value of wood	3200	kcal/kg
6	Total Heat input	9,60,000	Kcal
7	Steam generation	675	Kg
8	Steam pressure	6	Kg/cm^2
9	Enthalpy of steam at 85 PSI	660	kcal/kg
10	feed water Temperature (Enthalpy)	30	kcal/kg
11	Heat output per kg of steam	630	kcal/kg
12	Heat Output	425250	Kcal
13	Efficiency	44	%
Flue gas Analysis			
14	Flue gas Temperature	286	^0C
15	CO_2	4.19	%
16	O_2	13.2	%
17	Combustion Efficiency	72.9	%
18	Excess Air	171.4	%

b) Efficiency Evaluation for Hot Air Generator

S.No	PARAMETER	DETAILS	UNITS
1	Fuel used	Wood	
2	Wood consumption for 8 hours	600	kg
4	Calorific value of wood	3200	kcal/kg
6	Total Heat input	19,20,000	kcal
7	Hot air generated	13875	kg
8	Rise in temperature of hot air	140	^0C
9	Specific heat	0.26	kcal/kg ^0C
10	Heat output	508935	kcal/kg
11	Efficiency	26.5	%
Flue gas Analysis			
14	Flue gas Temperature	296	^0C
15	CO_2	4.73	%
16	O_2	13.9	%
17	Combustion Efficiency	69.8	%
18	Excess Air	198.6	%

c) Efficiency Evaluation for Thermopac

	PARAMETER	DETAILS	UNIT
1	Fuel used	Imported coal	
2	Imported coal Consumption	450	kg
3	Calorific value of imported coal	5,600	kcal/kg
4	Total Heat input	25,20,000	kcal
5	Thermic fluid oil inlet temperature	183	^{0}C
6	Thermic fluid oil outlet temperature	201.6	^{0}C
7	Oil temperature difference	18.6	^{0}C
8	Thermic fluid oil flow	45,000	lit/hr
9	Specific heat of oil	0.62	kcal/kg ^{0}C
10	Density of oil	0.8	kg/lit
11	Net heat output	4,15,100	kcal
12	Efficiency of the Thermopac	49	%
13	Flue gas Temperature	230	0C
14	CO2	6.03	%
15	O2	11.4	%
16	Combustion Efficiency	82.8	%
17	Excess Air	120.0	%

d) Efficiency Evaluation for Refrigeration Plant

S NO	PARAMETER	DETAILS	UNIT
1	Chilled water flow	25,000	Liters/hr
2	Chilled water inlet temperature	-0.4	^{0}C
3	Chilled water outlet temperature	-1.18	^{0}C
4	Temperature difference	-1.14	^{0}C
5	Refrigeration effect	9.4	TR
Power Consumption Details			
6	Compressor	34.2	kW
7	Primary pump	4.30	kW
8	Cooling tower pump	5.5 (50%)	kW
9	Cooling tower fan	1.3 (50%)	kW
10	Total power consumption	45.3	kW
11	kW per TR	4.80	kW/TR

e) Efficiency Evaluation for Pumps

Power consumption of the pump	: 4.13 kW
Rated flow of the pump	: 15 cum per hour
Head required	: 15 meters
Efficiency of the pump	: 16%

ANNEXURE – 2

Details of technologies/services providers for the cluster

a) Boiler

Veesons Energy Systems Pvt. Ltd
Hemant Gupta
7, ground floor, Millennium plaza
Mumbai -
Cell : 9321652406
Email ID: veesonsbombay@gmail.com

b) Forbes Marshall

Satyen Mehta

Nava Chaitan Society, Ring Road,

Surat - 395003

Cell: 9879487770

c) Step Electricals

Mahesh Bhatt
GIDC, Vapi, Gujarat
Cell:
Email:

d) Subodhan Capacitors

Mr. Subramanya Kumar
Charasta, GIDC, Vapi
Cell: 9228117798
Email: sbrmn.kumar@gmail.com

e) Variable Frequency Drives

Tangent technologies
Anurag Gupta
Vadadora

f) Thermax Ltd

Prasanna A. Hiwase
Chinchwad, MIDC
Pune, Maharashtra
Cell: 9960478685
Email ID: phiwase@thermaxindia.com

g) Jay pumps Ltd (Grundfos)

Shailesh.Kachhadiya
Vishwa karma Archade, Ring Road, Surat
Cell: 99879898205
Email ID: shailesh@jaypumps.com

h) Pipe In Cage (PIC)

Raju Tammakuwala
Atop Nagar Society ,Surat
Cell: 9427646357
Email.: rajutamakuwala@yahoo.co.in

ANNEXURE – 3

Financial schemes (if any) available with local banks for improving energy efficiency in the cluster

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 ₹ 15 lakh or 15% of investment in eligible machinery/Plant equipments whichever is lower. For more details of the scheme visit: www.laghu-udyog.com/scheme/sccredit.htm

2. SIDBI Financing Scheme for Energy Saving Projects in MSME sector under JICA Line of Credit

The Japan International Corporation Agency (JICA) has extended a line of credit to SIDBI for financing Energy Saving projects in Micro, Small and Medium Enterprises (MSMEs). This project is expected to encourage MSME units to undertake energy saving investment in plant and machinery to reduce energy consumption, enhance energy efficiency, reduce CO_2 emissions, and improve the profitability of units in the long run.

3. Eligible Sub Projects/ Energy Saving Equipment List under JICA line of Credit:

- Acquisition (including lease and rental) of energy saving equipments, including newly installing, remodeling and upgrading of those existing
- Replacement of obsolete equipments and/or introduction of additional equipment which would improve performance
- Equipments/ Machinery that meets 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 involves change in process and technologies as a whole, duly supported by technical consultancy will be eligible for coverage.

Financial parameters:

The financial parameters for appraising the project are:

Parameter	Norms
Minimum Assistance	₹ 10 lakh
Minimum promoters contribution	25% for existing units; 33% for new units
Interest rate	The project expenditure eligible for coverage under the line will carry a rate of interest rate of 9.5-10% p.a
Upfront fee	Nonrefundable upfront fee of 1% of sanctioned loan plus applicable service tax
Repayment period	Need based. Normally the repayment period does not extend beyond 7 years. However, a longer repayment period of more than 7 years can be considered under the line if necessary

Eligibility criteria for units (Direct assistance):

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

For further details eligible energy saving equipments/machinery, projects can be financed under this scheme and details of scheme, please contact the nearest SIDBI branch office or refer to SIDBI website (**www.sidbi.in**)

TECHNOLOGY UPGRADATION FUND SCHEME (TUFS)

A scheme devised by Govt. of India, Ministry of Power, to enable SSI units (Chemicals & Dyes unit) to induct State-of-the-art technology in which technology levels are bench marked in terms of specified machinery for each sector of **Chemicals & Dyes** industry. Machinery with technology levels lower than that specified will not be permitted for funding under the TUF scheme.

Eligible Borrowers Sole Proprietorships, Partnerships, Co-operative Societies, private / public limited companies.

- Existing units with or without expansion and new units
- Existing units proposing to modernize and/or expansion with state-of-the-art-technology
- New units which are being set up with appropriate technology

Quantum Of Loan & Mode Of Assistance Assistance shall be need based and NO CEILING on project cost/amount of loan. Assistance shall be by way of Term Loan.

Margin 15 to 25% of the project cost

Security 1st charge on fixed assets financed under the scheme Additional security such as personal guarantees, pledge of promoters share holdings as determined by Bank on merits of the case

Incentive Available Under The Scheme

Interest Reimbursement at the rate of 5% of the interest payment made by the unit to Bank on the loan outstanding. No Interest Reimbursement will be available for the extended period of loan or during the NPA status of the loan.

Repayment Within 7 years including moratorium up to 1 year

ANNEXURE – 4

Name and address of units in the cluster

S.No.	Name of the Industry	Address
1	Dungra Chemicals Pvt Ltd	36, Phase 1, GIDC VAPI
2	Nandosal Chem Industries Pvt Ltd	Plot No-49, Phase 1, GIDC VAPI
3	Eagle Chemical Works	Plot No-29-A, Phase 1, GIDC VAPI
4	Kamala Intermediates	Plot No C1B/52 & 53, LIC Sector
5	Hema DyeChem Pvt Ltd	Plot No C1B/50, LIC Sector
6	Jaysons Chemicals Industries	Plot No: 317/7, 40 Shed Area
7	Yash Dyes and Intermidiates	Plot No 797, Near VOXCO
8	NetMatrix	C-1/77-524, 78/525, 100 ShedArea
9	Vapi Oxide Colours Pvt Ltd	Plot No: 794, 794/1/A & 794/1/B
10	Varsha Chemicals	Plot No: 70/33 & 70/34 J Type Area
11	Chemodist Industries	Plot No: 808/B-2,3rd Phase, GIDC
12	Nitin Dye chem Pvt Ltd	195, GIDC , Vapi
13	Techno color Corporation	C1 B-35, Phase 1, GIDC
14	Yasho Industries Pvt Ltd	Plot No:2514, Phase 4, GIDC
15	Pharma Chem Industries (Gujarat) Pvt Ltd	Plot No:303/8-G, Phase 2, GIDC
16	S.M.Chemicals	Plot No: 313/1, 2nd Phase GIDC, Vapi
17	Siddhi Silcal Dyes Pvt Ltd	A-1/2203, 3rd Phase
18	Avik Pharmaceutical Ltd	A-1/7, 1st Phase, GIDC
19	Vapi Organic Chemicals Pvt Ltd	Plot No 20 A, 1st Phase, GIDC, Vapi
20	Chemiesynth (Vapi) Ltd	Plot No:27,1st Phase, GIDC
21	CS Speciality Chemicals P Ltd	Plot No 6101/11,IV Phase,GIDC Vapi
22	Anjaria Envirotech P Ltd	Plot No 2920 New J-Type area,I Phase
23	Herculas Pigments P Ltd	316/B II Phase GIDC Vapi
24	Shiv sakti Industries	Plot No 924 IV Phase Near Fine Chemicals GIDC Vapi
25	Ratnakar Chemicals	C-1/2312. 3rd Phase, GIDC Vapi
26	Anupam Colours Private Limited	1704A, 3rd Phase, GIDC Vapi
27	Anupam Colours & Chemicals Industries	A-2, 2324, 3rd Phase, GIDC, Vapi
28	Anupam Colour Pvt Ltd	3Phase , GIDC, Vapi
29	Suryakiran Chemicals	1503/2, 3rd Phase, GIDC
30	TinyChem Specalities Pvt Ltd	J/2315, 3rd Phase, GIDC
31	KK Poonja & sons	1422, 3rd Phase, GIDC
32	Sona interchem Pvt Ltd	1703/B, 3rd Phase, GIDC
33	Vapi Products inustries pvt ltd	287/1&2A, Phase 2, GIDC
34	J J Corporation	193/3, 2nd Phase, GIDC
35	Mangalam Drugs & Organics Ltd II	1203, 3rd Phase, GIDC
36	L S Chemicals & Pharmaceticals	798/2, 2nd Phase, GIDC Vapi
37	Vapi Spectro chem P Ltd	1st Phase, GIDC
38	Prashant Dye Chem Industries	plot no.303/8/c, 2nd phase, GIDC, Vapi
39	Asian DyeChem Industries	shed no:A-2/9/ phase-I, behind UPL, GIDC, Vapi
40	Chemsons Industrial Corporation	plot no.2901-2902, phase-1, Near telephone exchange
41	S R Chemical Industries	Plot No 1001/2, Phase 4, GIDC, Vapi
42	Arochem Industries	Plot No: 154, Phase 2, GIDC , Vapi
43	Super Sulphates	Plot no.702/9, 40 Shed area, GIDC, Vapi
44	Bhageria Dyechem	Plot No. 6310, 4th Phase, GIDC, Vapi
45	Swapnil	Plot No. 6306, 4th Phase, GIDC, Vapi
46	Colour india	Plot No. 2606/1, Phase 3, GIDC, Vapi
47	Kunder chemicals pvt ltd	2 Phase,GIDC, VAPI
48	Hardik Dye chem.ind	C-1/53, 100 shed area, Selvas road

49	Dilip Chemicals	C 1B-43,Nr.GIDC, VAPI
50	Chempha industries	C- 1-2122/2, 3 rd Phase,GIDC, VAPI
51	Sterling Pigments & Chemicals	791/3/A, 40 shed area,GIDC, VAPI
52	Shree satya dye chem	C- 1B,722, 40 shed area,GIDC, VAPI
53	Spectra Satya Dye chem	C- 1B,722, 40 shed area,GIDC, VAPI
54	Avs chemical	Plot No. c-1/64, 100 shed area, GIDC, Vapi
55	Arthi industry ltd	Plot No. 610, 100 shed area, GIDC, Vapi
56	Durga dye chem	Plot No. 637, 100 shed area, GIDC, Vapi
57	Padmavathi boramities	Plot No. c-1B/72, 100 shed area, GIDC, Vapi
58	Daya sar industries	100 shed area, GIDC, Vapi
59	polyols & polymers	Plot No. c-1/58-59, 100 shed area, GIDC, Vapi
60	Asv industries	Plot No. C1/56, 100 shed area, GIDC, Vapi
61	Sudish chemicals pvt ltd	Plot No. C1/71, 100 shed area, GIDC, Vapi
62	haatkesh chem& engg industry	Plot No. C1/85, 100 shed area, GIDC, Vapi

ANNEXURE – 5

Quotations

VEESONS
ENERGY SYSTEMS PVT. LTD.

ANNEXURE – 1

MAIN SPECIFICATIONS

1.0.	TYPE OF BOILER	: HORIZONTAL MULTI TUBULAR DRY BACK TWO PASS SMOKE TUBE BOILER.
2.0.	DESIGN, FABRICATION, INSPECTION & TESTING CODE	: IBR 1950 WITH LATEST AMENDMENTS.
3.0.	MODEL	: DB-04-N & DB-05-N
4.0.	EVAPORATION CAPACITY (F & A 100°C)	: 500 KG/HR & 750 KG/HR
5.0.	MAX. WORKING PRESSURE (SAFETY VALVE SET OFF)	: 150 PSI(G) / 10.54 KG/CM^2(G)
6.0.	FUEL	: SOLID AGROWASTE
7.0.	GROSS CALORIFIC VALUE	: 4000 KCAL/KG
8.0.	MODE OF COMBUSTION	: NATURAL DRAUGHT
9.0.	TYPE OF FEEDING	: MANUALLY THROUGH FIRE DOOR

VEESONS ENERGY SYSTEMS PVT. LTD.

ANNEXURE – 2

PRICE SCHEDULE AND COMMERCIAL TERMS

1.0. PRICE SCHEDULE :

1.1. STANDARD SUPPLY

1.1.1. SUPPLY OF 'VEESONS' HORIZONTAL MULTITUBULAR DRY BACK 2 PASS SMOKE TUBE STEAM BOILER OF MODEL DB-N AS DETAILED SCOPE OF SUPPLY IN ANNEXURE – 3.	) RS.7,00,000/-) (FOR 500 KG/HR)) RS.7,82,000/-) (FOR 750 KG/HR)

2.0 COMMERCIAL TERMS :

2.1.	BASIS OF PRICE	: EX-WORKS, TRICHY.
2.2.	TAXES AND DUTIES	: EXTRA AS APPLICABLE AT THE TIME OF DESPATCH / INVOICING. AT PRESENT RATES APPLICABLE ARE,
	A) CENTRAL EXCISE DUTY(CED)	: 10%) AT PRESENT EXEMPTED
	B) EDUCATIONAL CESS	: 2 % ON ED) SINCE AGROWASTE IS
	C) SECONDARY & HIGHER EDUCATIONAL CESS	: 1 % ON ED) USED AS FUEL.
	D) VAT	: 4 %
2.3.	PACKING & FORWARDING	: 2 % ON BASIC PRICE
2.4.	GUIDANCE OF ERECTION AND COMMISSIONING	: 2 % ON BASIC PRICE
2.5.	TRANSPORTATION & TRANSIT INSURANCE	: BUYER'S SCOPE.
2.6.	TERMS OF PAYMENT	: 75 % ADVANCE ALONGWITH ORDER. BALANCE PAYMENT PLUS TAXES AND DUTIES 7 DAYS BEFORE READINESS OF BOILER AGAINST PROFORMA INVOICE.
2.7.	DELIVERY PERIOD	: WITHIN 45-60 DAYS FROM THE DATE OF RECEIPT OF YOUR TECHNICALLY & COMMERCIALLY CLEAR PURCHASE ORDER ALONG WITH FULL ADVANCE.
2.8.	VALIDITY	: OUR OFFER IS VALID FOR 15 DAYS FROM THE DATE OFFERED, AFTERWARDS SUBJECTED TO MARKET FLUCTUATIONS.

VEESONS ENERGY SYSTEMS PVT. LTD.

ANNEXURE – I

TECHNO COMMERCIAL OFFER

I. MAIN SPECIFICATION

1.0.	Type of Boiler	: Horizontal Multitubular 3 pass - wet back Fluidised front feed Smoke tube Package Boiler.
2.0.	Design, Fabrication, Inspection & Testing Code	: IBR 1950 with latest Amendments.
3.0.	Model	: FFF
4.0.	Evaporation Capacity	: 1000 Kg/hr (F&A 100°C)
5.0.	Max Working Pressure (Safety valve set off)	: 10.54 Kg/cm^2(g) / 150 PSI (g)
6.0.	Fuel	: Paddy husk
7.0.	Gross Calorific Value (GCV)	: 3275 K.cal/Kg
8.0.	Type of feeding	: Fluidised Front Feeding
9.0.	Mode of combustion	: Forced draught

ANNEXURE – 2

VEESONS ENERGY SYSTEMS PVT. LTD.

PRICE SCHEDULE AND COMMERCIAL TERMS

1.0 PRICE SCHEDULE :

1.1 STANDARD SUPPLY

1.1.1 Supply of 'VEESONS' Horizontal Multitubular fluidised front feed smoke tube steam Boiler of Model FFF as detailed STANDARD SCOPE OF SUPPLY in Sl.No.III. } Rs.9,96,000/-

2.0 COMMERCIAL TERMS :

2.1.	Basis of Price	: Ex-Works, Trichy.
2.2.	Taxes and duties	: Extra as applicable at the time of despatch / invoicing. At present rates applicable are,
	a) Central excise duty(CED)	: 10.30 % (At present exempted if agrowaste is used as fuel)
	b) Sales Tax (VAT)	: 4 %
2.3.	Packing & Forwarding	: 2% on basic Price.
2.4.	Guidance of Erection and Commissioning	: 2% on basic price.
2.5.	Transportation & Transit Insurance	: Buyer's Scope.
2.6.	Terms of payment	: 50 % advance alongwith order. Balance payment plus taxes and Duties 7days before readiness of boiler against proforma invoice.
2.7.	Delivery period	: Within 45-60 Days from the date of receipt of your technically & commercially clear Purchase order along with full advance.
2.8.	Validity	: Our offer is valid for 30 days from the date offered, afterwards subjected to market fluctuations.

Control
ENGINEERING
COMPANY

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E-mail : cecohyd@cecoelectronics.in

With reference to the above we thank you very much for your interest on our LSIS KOREA (FORMERLY KNOWN AS LGIS) make AC Variable Frequency Drives. In continuation to the above we are here with submitting our most competitive offer for the above cited requirement for your kind consideration and perusal.

Following is the quotation for the same.

Sl.No	Description	Qty.	Unit Price
	LSIS Korea make (FORMERLY KNOWN AS LGIS KOREA make) AC Variable Frequency Drive suitable for 3-phas 440V input and 3Ph 440V output squirrel cage induction motor with output Frequency up to 400Hz.		
1.1	SV040iG5A-4 rated at 4 KW / HP	1No.	19,800.00
1.2	SV055iG5A-4 rated at 5.5 KW / 7.5HP	1No.	28,200.00
1.3	SV075iG5A-4 rated at 7.5 KW / 10HP	1No.	31,500.00

TERMS & CONDITIONS:

Price	:	Net & Ex-works Kolkata.
Excise Duty	:	10.30% extra as applicable at the time of dispatch.
CST	:	Extra @ 2%, against declaration form C
Delivery	:	With in one week from the date of issue of P.O.
Payment	:	30% advance and balance against delivery
Warranty	:	12 months from the date of installation or 15 months from the date of dispatch which ever is earlier.

Hope you will find the above in order and place your valued order on us at an early date. However if you require any further clarification/confirmation in this regard you may please feel free to contact us.

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