

## ACKNOWLEDGEMENT

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**Petroleum Conservation Research Association**

**Ahmedabad**

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## 1.1 ABOUT BEE SME PROGRAM

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

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

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

As a result of increasing awareness towards efficient usage of energy and other resources, there has been a visible reduction in energy intensity in comprehensive Indian industrial sector. However, focusing the observation on the MSME sector reveals that the energy intensity per unit of production is much higher than that of the organized large

scale sector. Since energy cost is significant contributor to the overall production cost of SMEs due to high and rising energy costs in current scenarios, it is required to increase the Energy Efficiency (EE) levels in order to ensure the sustenance of SMEs. One of the ways to reduce the inefficiencies is by replacing the conventional/old/obsolete technology with feasible and adaptable energy efficient technologies. This would not only contribute towards reduction in production cost, but would also improve the quality and productivity of MSME products. However, while knowing the way out, there are still numerous barriers (as listed below) and market failures that have prevented widespread adoption of new energy efficient technologies. .

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

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

Majority of SMEs are typically run by entrepreneurs and are leanly staffed with trained technical and managerial persons to deploy and capture energy efficiency practice to reduce manufacturing cost and increase competitive edge. Therefore, it will be useful to build energy efficiency awareness in the SMEs by funding/subsidizing need based studies in large number units in the SMEs and giving energy conservation recommendations including short term energy conservation opportunities, retrofit/replacement options and technology up-gradation opportunities.

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

## 1.2 PROJECT OBJECTIVES

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

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

The program also aims at creating a platform for dissemination of the best practices and the best available technologies available in the market for energy efficiency and conservation, to create awareness in the clusters, and to demonstration of the new technology interventions/ projects to stimulate adoption of similar technology/projects in the clusters.

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

- Ü Energy use and technology studies
- Ü Capacity building of stake holders in cluster for building EE projects
- Ü Implementation of energy efficiency measures
- Ü Facilitation of Innovative financing mechanisms for implementation of energy efficiency projects

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

### 1.2.1 Energy use and technology studies

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

### 1.2.2 Capacity building of stakeholders

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

### 1.2.3 Implementation of EE measures

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

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

### 1.2.4 Facilitation of innovative financing mechanisms

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

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

## 1.3 EXPECTED PROJECT OUTCOME

Expected project outcome of BEE SME program in clusters are:

### 1.3.1 Energy Use and Technology Analysis

The outcome of the activity will include identification of the EE measures, potential of renewable energy usage, fuel switching, feasibility analysis of various options, and cost benefit analysis of various energy conservation measures including evaluation of financial

returns in form of payback period, IRR and cash flows. The cost liability of each measure, including the capital and operational cost will also be indicated.

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

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

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

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

The specific outcomes of this activity will be as follows:

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

### 1.3.2 Implementation of EE measures

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

The activity will ensure that there is close match between the proposed EE projects and the specific expertise of the Local Service Providers (LSPs). These DPRs will be prepared for EE, renewable energy, fuel switching and other possible proposed measures during course of previous activities. Each DPR will include the technology assessment, financial assessment, economic assessment and sustainability assessment of the EE project for

which it has been developed. The technology assessment will include the details of the design of equipment/ technology along with the calculation of energy savings. The design details of the technology for EE project will include detailed engineering drawing for the most commonly prevalent operational scale, required civil and structural work, system modification and included instrumentation and various line diagrams. The LSPs will be required to report the progress of the implementation of each such project to BEE PMC. Such implementation activities can be undertaken by the LSPs either solely or as a group of several LSPs.

### **1.3.3 Capacity Building of LSP's and Bankers**

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

### **1.3.4 Concluding workshop**

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

## **1.4 PROJECT DURATION**

The mentioned activity of the project was initialized in September 2009 the expected successful completion of the project is March 2011.

## 1.5 IDENTIFIED CLUSTERS UNDER THE PROGRAM & TARGET CLUSTER FOR IMPLEMENTATION

29 most energy intensive MSME clusters across different end use sectors have been identified to implement the BEE SME program for EE improvement. The details of industrial sector and identified cluster are provided in Table 1 below:

**Table 1-List of clusters identified for BEE SME Program**

S. No.	Cluster Name	Location
1.	Oil Milling	Alwar; Rajasthan
2.	Machine Tools	Bangalore; Karnataka
3.	Ice Making	Bhimavaram; Andhra Pradesh
4.	Brass	Bhubaneswar; Orissa
5.	Sea food processing	Kochi, Kerala
6.	Refractories	East & West Godavari Andhra Pradesh
7.	Rice Milling	Ganjam, Orissa
8.	Dairy	Gujarat
9.	Galvanizing	Howrah, West Bengal
10.	Brass & Aluminum	Jagadhari, Haryana
11.	Limestone	Jodhpur, Rajasthan
12.	Tea processing	Jorhat, Assam
13.	Foundry	Batala, Jalandhar & Ludhiana, Punjab
14.	Paper	Muzzafarnagar, Uttar Pradesh
15.	Sponge iron	Orissa
16.	Chemical & Dyes	Vapi, Gujarat
17.	Brick	Varanasi, Uttar Pradesh
18.	Rice Milling	Vellore, Tamil Nadu
19.	Chemical	Ahmedabad, Gujarat
20.	Brass	Jamnagar, Gujarat
21.	Textile	Pali, Rajasthan
22.	Textile	Surat, Gujarat
23.	Ceramics	Morbi, Gujarat
24.	Textile	Solapur, Maharashtra
25.	Rice Milling	Warangal, Andhra Pradesh
26.	Coir	Alleppey, Kerala
27.	Textile	Tirpur, Tamil Nadu
28.	Roof Tiles	Mangalore, Karnataka
29.	Glass	Firozabad, Uttar Pradesh

As a part of BEE SME program, one of cluster identified was the Gujarat (Dairy) Cluster. It was proposed to carry out energy use and technology audit studies in 22 units in the Gujarat (Dairy) SME Cluster covering all types and sizes of the industries to understand/give valuable insight into the process of developing energy efficiency solutions relevant to the SME industries in the Gujarat (Dairy) Cluster



## 2.1 GUJARAT (DAIRY) SME CLUSTER SCENARIO

## 2.2 OVERVIEW OF GUJARAT (DAIRY) SME CLUSTER

The Gujarat (Dairy) SME Cluster is spread over the geographical state of Gujarat at the western coast of Indian Peninsula. It borders Pakistan & Rajasthan in North East, Madhya Pradesh in East, Maharashtra & Union Territories of Diu, Daman, Dadra & Nagar Haveli in South. India has emerged as largest milk producer in the world, having production capacity of 108.5 million tones/annum (Yr.2008-2009). The per capita availability of Milk is 258 gms/day (Yr.2008-2009). Gujarat is 5<sup>th</sup> largest milk producer state in India. This itself explains the importance of dairy cluster in Gujarat State.

**Table 2 : Gujarat at a Glance**

Geographical Location	23:00 N & 72:00 E
Geographical Area	196027 km <sup>2</sup>
Average Annual Rain Fall	800 to 2000 mm
Temperature	27 to 46° C
Population	41310 lakh
Literacy	61.29%

The global objective of the BEE SME programme is to improve the energy intensity of the Indian economy by undertaking actions in the SME sector which directly or indirectly produced 60% of the GDP. The immediate objective of this programme is to create the awareness to accelerate the adoption of EE technologies and practices in 29 chosen clusters in the SME sector through knowledge sharing, capacity building and development of innovative financing mechanisms. To build the energy efficiency awareness by funding/subsidizing need based studies in large number units in the SMEs and giving energy conservation recommendations including technology up-gradation opportunities.



### 2.2.1.1 Cluster Background

Gujarat is the “HUB” for Dairy Industries in India. The dairy industries in Gujarat are flagship for the state of Gujarat & matter of pride for our nation. Apart from these facts, considerable economy of the region particularly farmers depend on these dairies. Most of these dairies are important SMEs. Worldwide the Micro, Small and Medium Enterprises (MSMEs) have been accepted as engines of economic growth to promote and accelerate equitable development. The major advantage of this sector is its enormous employment potential at significantly low capital involvement. This can be established from the simple fact that the MSMEs constitute over 90% of total enterprises in most economies and are credited with generating the highest rates of employment growth and also account for a major share of industrial production and exports. In the Indian context, MSMEs play a pivotal role in the overall industrial economy. In recent years the sector has consistently registered higher growth rate as compared to the overall industrial sector. With its agility and dynamism, the sector has shown admirable innovativeness and adaptability to survive the recent economic downturn and recession.

Majority of the dairy units studied are part of the Gujarat Co-operative Milk Marketing Federation (GCMMF). Few dairies are also owned by private owners.

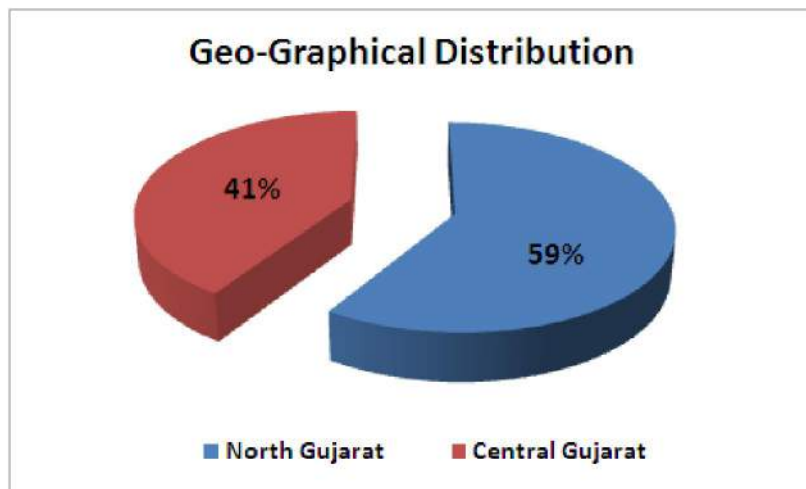


Figure 1: Geographical Distribution of Gujarat (Dairy) Cluster under Study

The GCMMF is providing the members union and in turn various dairy units abreast of the latest development with necessary technical knowhow. Also, they support them in capacity building, training & skill updation. However there is a lot of opportunity for the industry to learn & implement energy efficiency measures.

### 2.2.1.2 Product Manufactured

- 1) Tone Milk
- 2) Tea Milk
- 3) Tetra Pack Milk

- 4) Flavored Milk
- 5) Butter Milk
- 6) Curd
- 7) Milk Cream
- 8) Butter
- 9) Ghee
- 10) Paneer
- 11) Cheese
- 12) Skimmed Milk Powder
- 13) Whole Milk Powder
- 14) Baby Food (Milk Powder Based)
- 15) Ice Cream.
- 16) Indian Sweets.

### **2.2.1.3 Classification of Units**

The units can be classified broadly in two categories: a) Milk Chilling Centers & b) Dairy.

#### **I) Milk Chilling Center (MCC)**

Milk being highly perishable, needs to be stored and preserved at lower temperature processed. The chilling center plays vital role in segregation, quality control & weighing of raw milk. Milk collection process involves Grading, Weighing (Milk is recorded in kgs), Chilling, Dumping, Sampling, Loading in Tanker & dispatch to main processing plant. Most of the chilling centers are located in remote villages to collect the milk from various local 'Mandalis'. Now a day a new trend of providing BMC (Bulk Milk Storage) is emerging. These give added advantages of directly preserving milk even in small space. At few places even BMC are further divided in small numbers & placed in various remote places.

The main plant & machinery in conventional Milk Chilling centers are as follow:

- 1) Ammonia Compressor with electric motor.
- 2) Ammonia Receiver with pipe line.
- 3) Atmospheric condenser or PHE with cooling tower.
- 4) IBT Tank with Agitator.
- 5) Milk Chiller.
- 6) Milk Weighing machine.
- 7) Can unloading arrangement.
- 8) Hot water generator (boiler type) for CIP & can washing hot water requirement.
- 9) Milk Storage Vats.
- 10) Electrical supply system such as Bus bar, Capacitors, Mains, Motor Starters etc
- 11) Milk loading arrangement.

12) Effluent collection & treatment plant.

## II) Dairy

Dairies process the milk received from various milk chilling center. The quality control, storage, processing, storage of finished product etc are vital role of dairies. Various products required various stages of milk processing, quality control & packaging. The dairies are processing milk for various products as mentioned below:

- 1) Butter
- 2) Ghee
- 3) Cheese
- 4) Paneer
- 5) Khoa
- 6) Dahi
- 7) Shrikhand
- 8) Flavored Milk
- 9) Skimmed Milk Powder (S.M.P.)
- 10) Whole Milk Powder (W.M.P.)
- 11) Spray Powder (A.S.P.)
- 12) White Butter
- 13) Tone Milk
- 14) Tea Milk
- 15) Tetra Pack Milks
- 16) Butter Milk
- 17) Ice Cream
- 18) Sweets

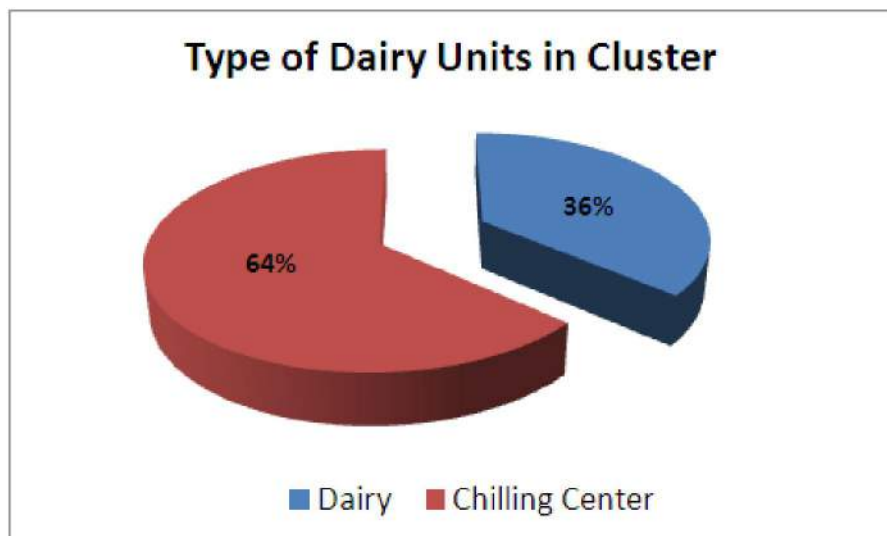


Figure-2: Types of Dairy Units in Gujarat(Diary) SME Cluster

### 2.2.1.4 Installed Production Capacity

Details of units of cluster subjected to Preliminary Energy Audit.

SN	Particulars of SME	Dairy / Chilling Center	Production Capacity in Itrs/day
1)	Unit 1	Dairy	25000
2)	Unit 2	Dairy	14500
3)	Unit 3	Dairy	9000
4)	Unit 4	Chilling Center	30000
5)	Unit 5	Chilling Center	140000
6)	Unit 6	Chilling Center	165000
7)	Unit 7	Chilling Center	160000
8)	Unit 8	Chilling Center	160000
9)	Unit 9	Chilling Center	150000
10)	Unit 10	Chilling Center	140000
11)	Unit 11	Chilling Center	160000
12)	Unit 12	Chilling Center	36000
13)	Unit 13	Chilling Center	20000
14)	Unit 14	Chilling Center	20000
15)	Unit 15	Chilling Center	30000

Details of units of cluster subjected to Preliminary Energy Audit.

SN	Particulars of SME	Dairy / Chilling Center	Production Capacity in Itrs/day
1)	Unit 16	Dairy	160000
2)	Unit 17	Dairy	1280000
3)	Unit 18	Dairy	5000
4)	Unit 19	Dairy	500000
5)	Unit 20	Dairy	400000
6)	Unit 21	Chilling Center	450000
7)	Unit 22	Chilling Center	200000

### 2.2.1.5 Raw material used

The basic raw material required is Milk (Cow & Buffalo Milk). Apart from Milk, which is main raw material, other raw material required for making various related product such as butter milk, flavored milk, ice cream, baby food etc, additional material such as –

- I) Sugar
- II) Culture for Curd & Butter Milk
- III) Flavors (For Ice cream & flavor milks)

- IV) Skimmed milk powder (Some dairy not producing milk powder)
- V) Additional material required for ice cream making
- VI) Proteins for Baby food (Ingredients for baby food) etc

## 2.3 ENERGY SITUATION IN THE CLUSTER

### 2.3.1.1 Energy Type & Prices

Electricity is basic form of energy used in cluster units. Other fuels used in various units in cluster are FO, Wood, LDO, HSD, Natural Gas, Saw Mill Dust (Bio-mass), Castor Oil DOC (De-oiled cake). Depending on accessibility, feasibility, equipment capability selection of fuel is done. Bio mass based fuel is though preferable, consistent availability has been given top priority due to perishable nature of milk. Also due to various milk processes, milk being food item, many fuels capable of producing dust/fine ash like coal are avoided.

Table 3 : Energy consumption pattern of all units

SN	Name of Unit	Electricity	FO	PNG	Wood	HSD	LDO	Other
<b>Dairies/Chilling Centers Under Detailed Energy Audit</b>								
1)	Unit 1							
2)	Unit 2							
3)	Unit 3							
4)	Unit 4							
5)	Unit 5							
6)	Unit 6							
7)	Unit 7							
8)	Unit 8							
9)	Unit 9							
10)	Unit 10							
11)	Unit 11							
12)	Unit 12							
13)	Unit 13							
14)	Unit 14							
15)	Unit 15							
<b>Dairies/Chilling Centers Under Detailed Energy Audit</b>								
16)	Unit 16							
17)	Unit 17							
18)	Unit 18							<i>(Castor DOC)</i>
19)	Unit 19				<i>(Saw Mill Dust)</i>			<i>(Steam directly from)</i>



2.3.1.3 Energy Consumption in a typical Dairy

a) Energy consumption distribution Cost Wise :-

Energy Type		Average Monthly Consumption
Electricity	=	1280984.28
Wood	=	93750
Steam	=	922500
<b>Total In Rs.</b>	<b>=</b>	<b>2297234</b>

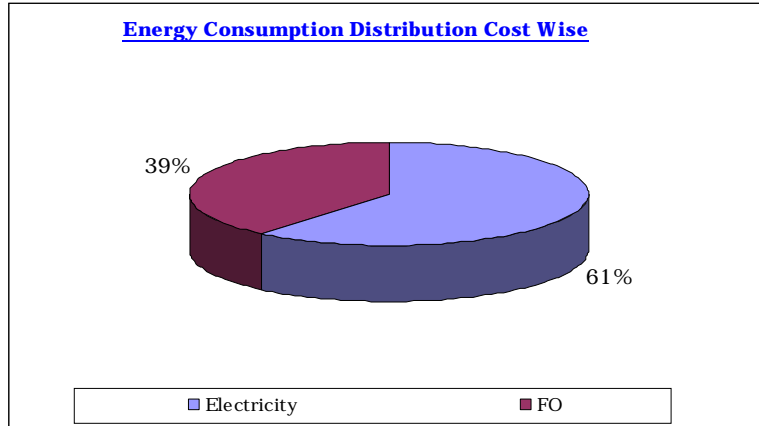


Figure 3 : Energy Consumption Cost Wise

b) Energy Consumption on Mcal Basis :-

Energy Type		Monthly Average Consumption	Unit	Monthly Consumption in Mcal
Electricity	=	218598	kWh	187994280
Wood	=	37.5	Tons	112500000
Steam	=	922.5	Tons	605436750
		<b>Total in kCal</b>		<b>905931030</b>

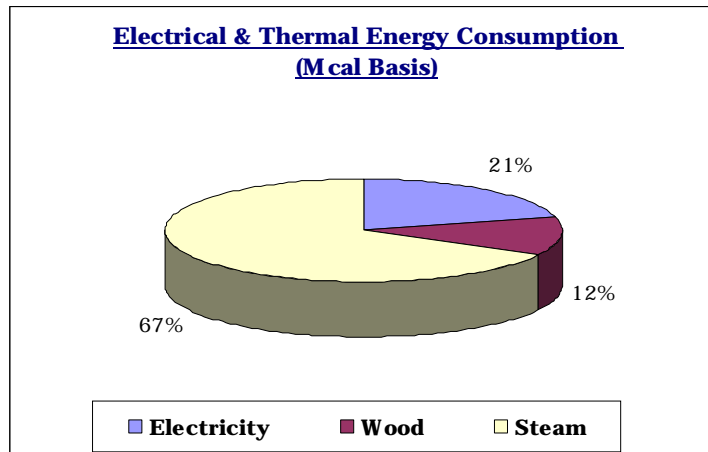


Figure 4 : Energy Consumption on Mcal Basis



Table 4 : Energy Consumption Pattern of Gujarat (Dairy) SME Cluster

Parameter	Unit	Chilling Center	Dairy	Total Cluster
Annual Electricity Consumption	kWh/year	7838891	27607940	35446831
Annual Wood Consumption	GJ/year	6234	6072	12306
Annual FO Consumption	GJ/year	25182	113485	138667
Annual NG Consumption	GJ/year	0	108919	108919
Annual LDO Consumption	GJ/year	344	2325	2669
Annual HSD Consumption	Lt/year	26031	0	26031
Total Energy Consumption	GJ/year	61162	330207	391369
% of Total Energy Consumption	%	15.63	84.37	100

Unit Category wise energy classification

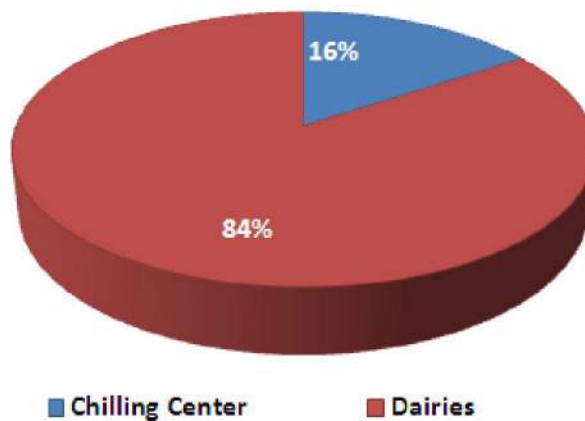


Figure 5 : Share of various types of units in annual energy consumption

#### 2.3.1.4 Specific Energy Consumption in Gujarat (Dairy) SME Cluster

The specific energy consumption depends on the final product being manufactured by the dairy units. The production varies with demand, quantity of incoming milk & other various parameters. The specific power consumption product wise is not maintained in the units of cluster. Thus the specific power consumption cannot be estimated accurately. However a broad picture for specific energy consumption of typical milk chilling center & Dairy is as given below.

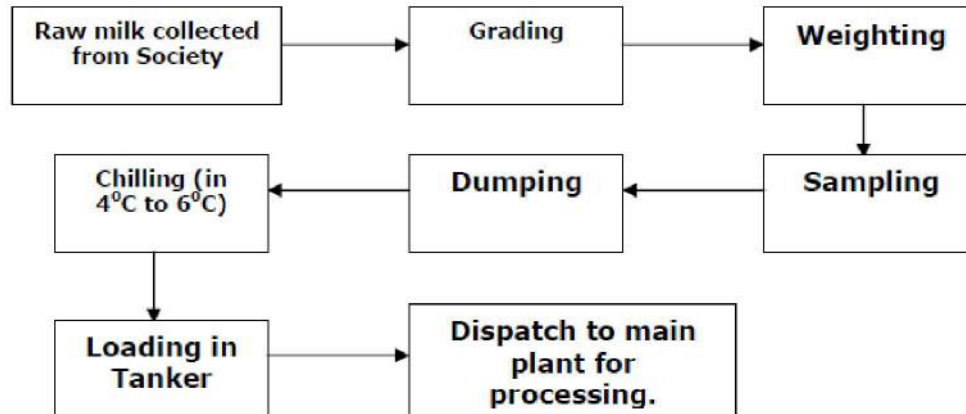
Table 5 : Energy Consumption Pattern of Gujarat (Dairy) SME Cluster

Type of Unit	Specific Energy Consumption, GJ/Ton	Specific Energy Consumption, kWh/Ton
Milk Chilling Center	0.11	14.5
Dairies	0.13	16.9
Average	0.12	15.7

## 2.4 MANUFACTURING PROCESS/TECHNOLOGY OVERVIEW

### 2.4.1.1 Process Flow Diagram in Typical Milk Chilling Center.

The typical Milk chilling center process is as given below-

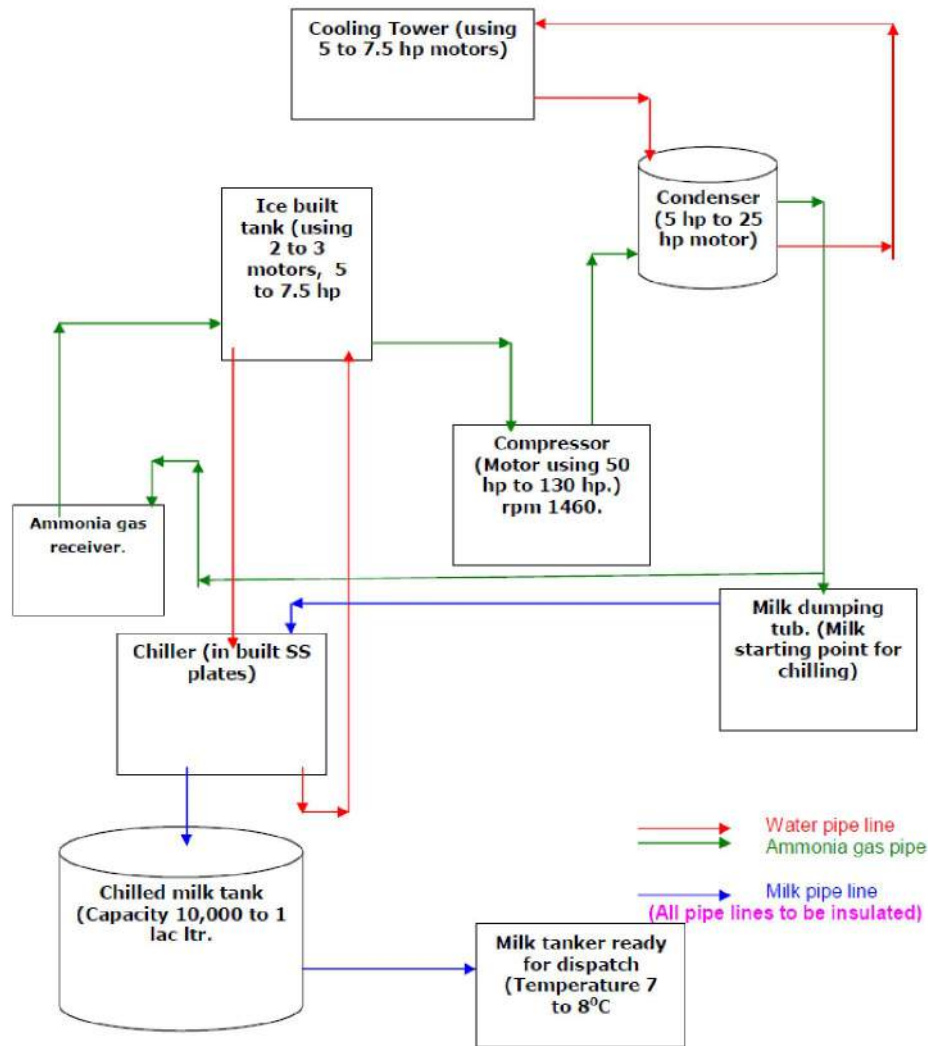


Milk collection process involves Grading, Weighing (Milk is recorded in kgs), Chilling, Dumping, Sampling, Loading in Tanker & dispatch to main processing plant. Most of the chilling centers are located in remote villages to collect the milk from various local 'Mandalis'. Now a day a new trend of providing BMC (Bulk Milk Storage) is emerging. These give added advantages of directly preserving milk even in small space. At few places even BMC are further divided in small numbers & placed in various remote places.

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- 5) Milk Chiller.
- 6) Milk Weighing machine.
- 7) Can unloading arrangement.
- 8) Hot water generator (boiler type) for CIP & can washing hot water requirement.
- 9) Milk Storage Vats.
- 10) Electrical supply system such as Bus bar, Capacitors, Mains, Motor Starters etc
- 11) Milk loading arrangement.
- 12) Effluent collection & treatment plant.

The schematic diagram of typical plant is as given below-



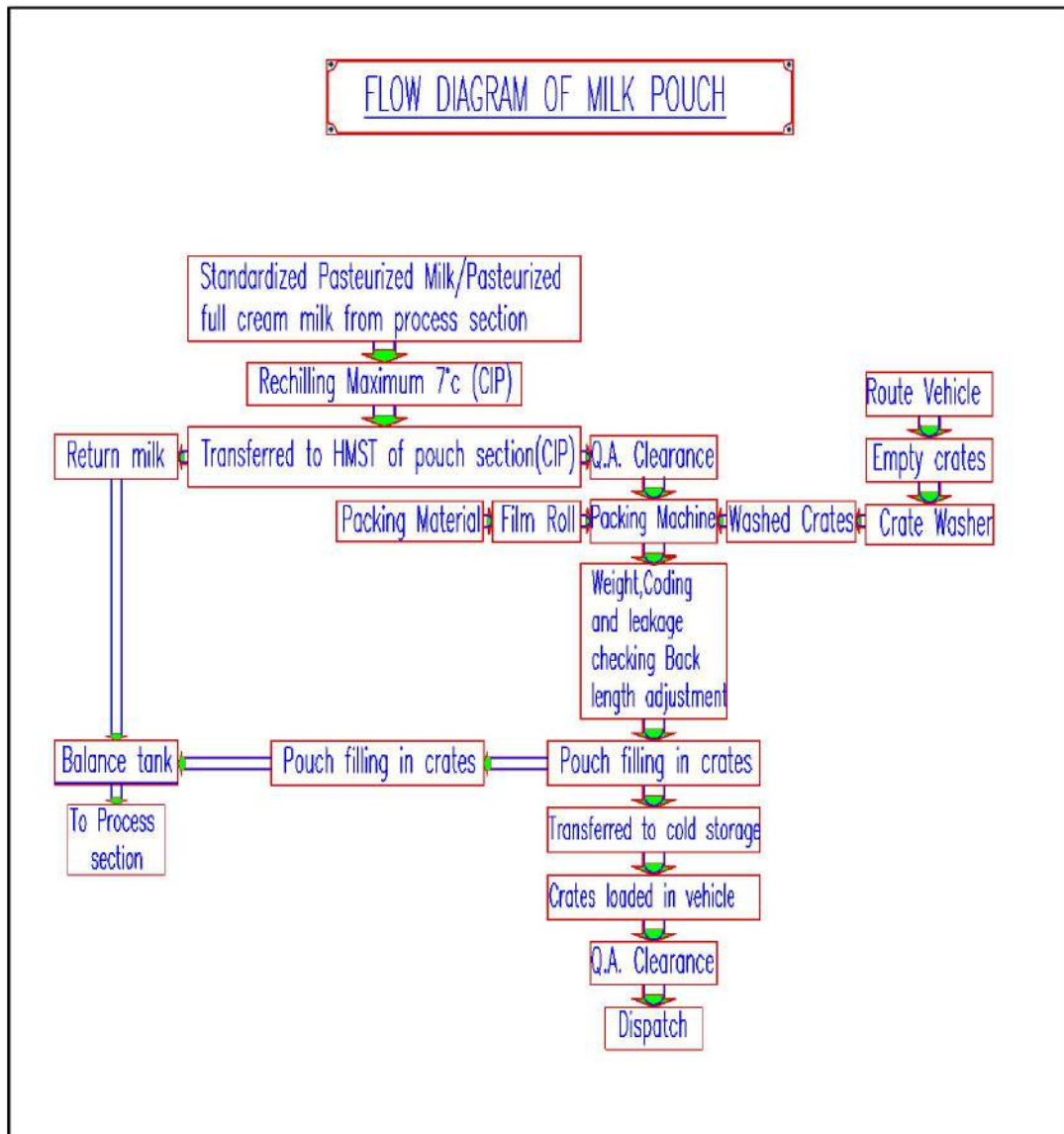
#### 2.4.1.2 Process Technology & Overview in Typical Dairy.

The dairies are processing milk for various products as mentioned below –

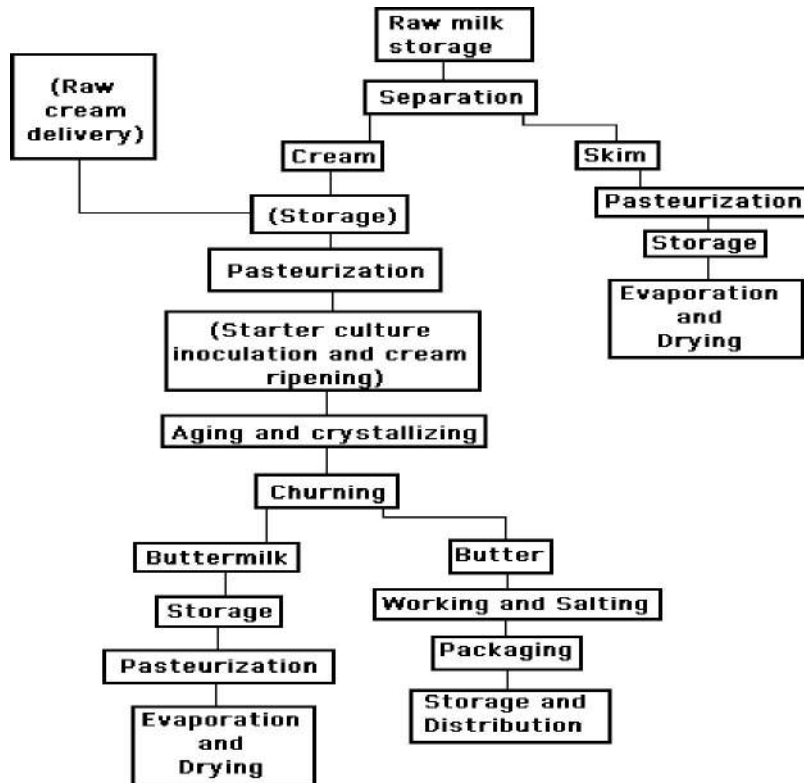
- 1) Butter
- 2) Ghee
- 3) Cheese
- 4) Paneer
- 5) Khoa
- 6) Dahi
- 7) Shrikhand
- 8) Flavored Milk
- 9) Skimmed Milk Powder (S.M.P.)
- 10) Whole Milk Powder (W.M.P.)

- 11) Various forms of milk powder.
- 12) Spray Powder (A.S.P.)
- 13) White Butter
- 14) Tone Milk
- 15) Tea Milk
- 16) Tetra Pack Milks
- 17) Butter Milk
- 18) Ice Cream
- 19) Sweets

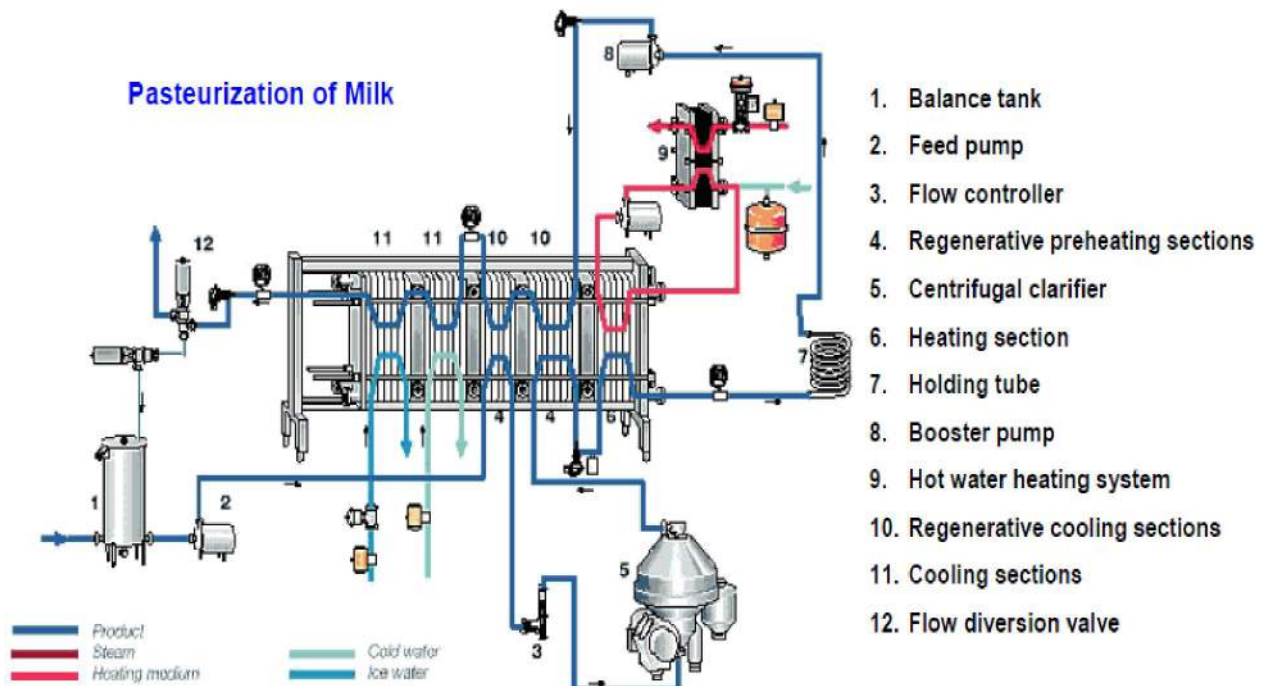
## 2.4.2 Milk Pouch Flow Diagram



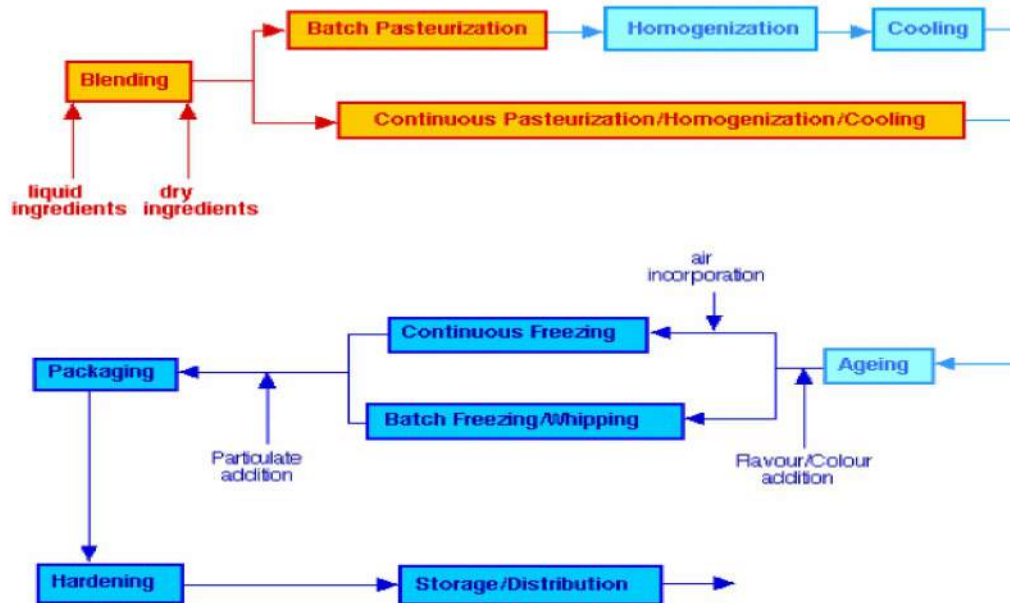
### 2.4.3 Butter & Butter Milk Process



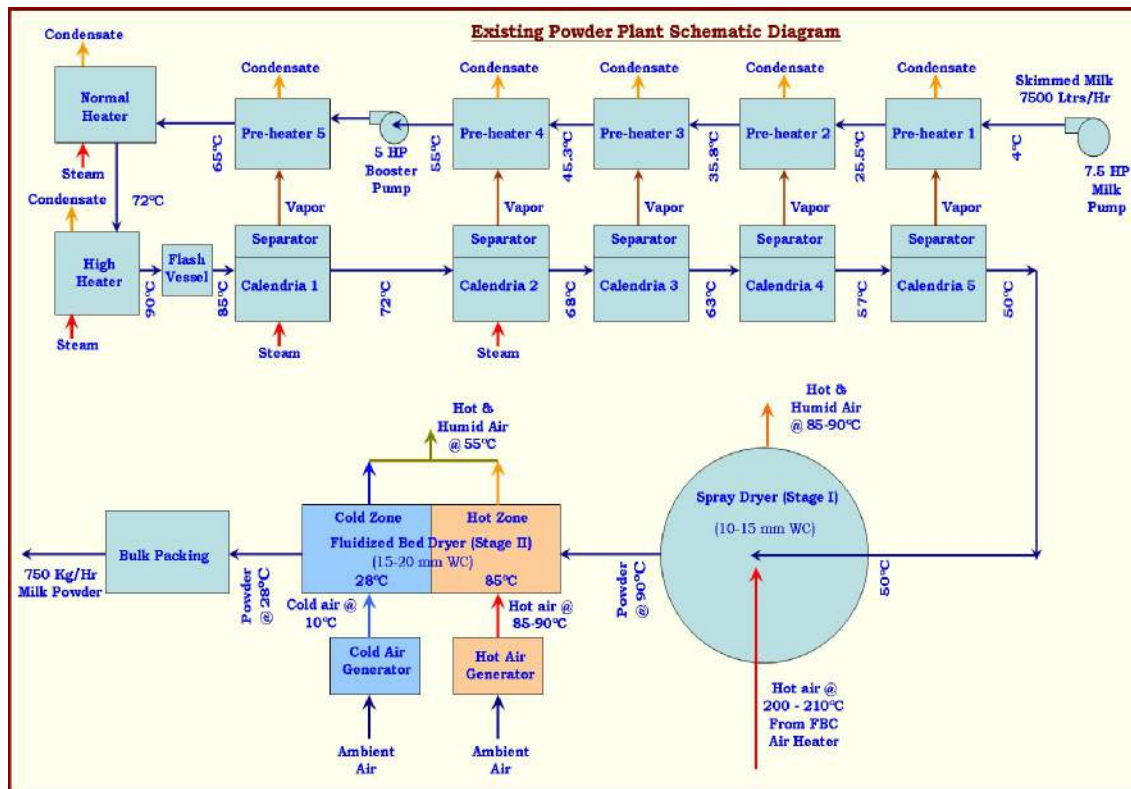
### 2.4.4 Milk Pasteurization



### 2.4.5 Ice Cream General Process

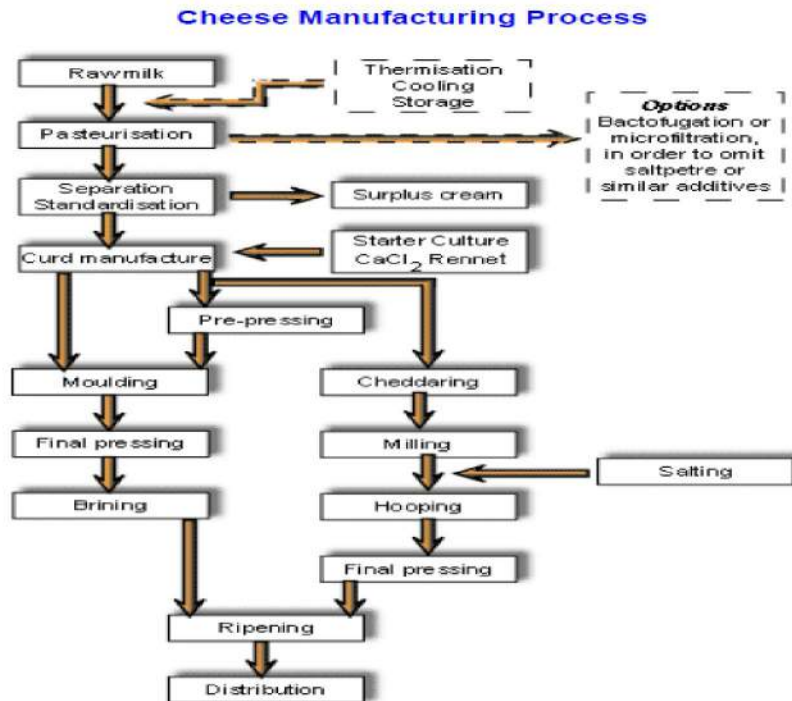


### 2.4.6 Conventional Milk Powder Process





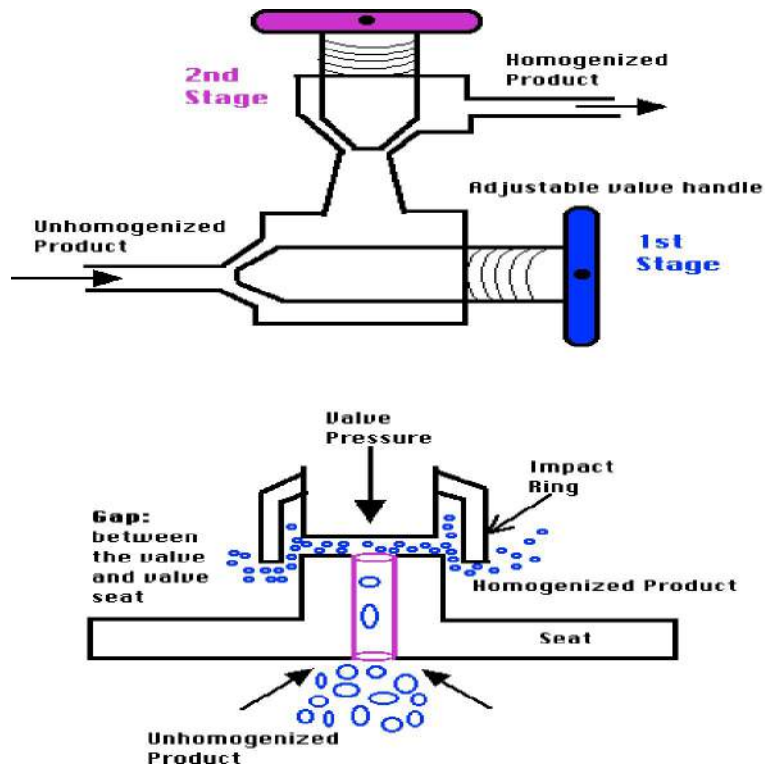
### 2.4.7 Cheese Manufacturing Process



These are few processes. Most of the other milk processes are standard & Conventional one. Details of manufacturing process of individual dairy are already in detailed energy audit report of individual dairy.

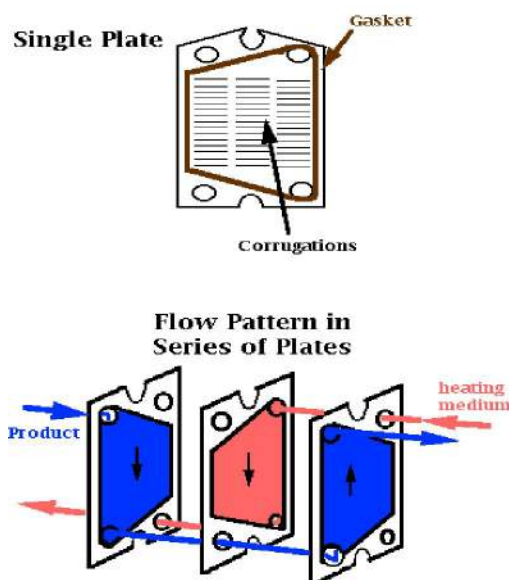
### 2.4.8 Homogenization Mechanism

To understand the mechanism, consider a conventional homogenizing valve processing an emulsion such as milk at a flow rate of 20,000 l/hr. at 14 MPa (2100 psig). As it first enters the valve, liquid velocity is about 4 to 6 m/s. It then moves into the gap between the valve and the valve seat and its velocity is increased to 120 meter/sec in about 0.2 millisecond. The liquid then moves across the face of the valve seat (the land) and exits in about 50 micro second. The homogenization phenomena is completed before the fluid leaves the area between the valve and the seat, and therefore emulsification is initiated and completed in less than 50 micro second. The whole process occurs between 2 pieces of steel in a steel valve assembly. The product may then pass through a second stage valve similar to the first stage. While most of the fat globule reduction takes place in the first stage, there is a tendency for clumping or clustering of the reduced fat globules. The second stage valve permits the separation of those clusters into individual fat globules.



### 2.4.9 Pasteurization

The process of pasteurization was named after Louis Pasteur who discovered that spoilage organisms could be inactivated in wine by applying heat at temperatures below its boiling point. The process was later applied to milk and remains the most important operation in the processing of milk.





## 2.5 CURRENT POLICIES AND INITIATIVES OF LOCAL BODIES

Both central & state governments are promoting the dairy industry. The dairy industry has very special place in day to day life of common man. The income from milk is very important for farmers along with rural economy. Through dairy industry lot of direct & indirect employment is generated which is vital for the economy of country and state. Both central & state provides various incentives, financial assistance, technical assistance, marketing assistance etc for promotion of dairy industry. The ongoing 'Gujarat Dairy Cluster' is excellent example of government assistance to dairy industry. The local bodies like Gram panchayat, Tahsil bodies, district bodies & state bodies provide various assistance to dairy industry & all stake holders associated with dairy industry.

Various schemes for SMEs are already available through District Industries Council (DIC), various financial schemes are also available for SMEs from Nationalized banks, co-operative banks etc. Overall scenario of current policies and initiative of local bodies are very much favorable to the SMEs covered under cluster.

Energy audit subsidy scheme is also provided by Gujarat Energy Development Agency (GEDA). Financial institution like SIDBI offer credit at concessional rate for energy efficiency project, under the scheme of KFW line of credit & AFD line of credit.

**The detailed schemes for energy efficiency are given in annexure-1 & 2.**

## 2.6 ISSUES RELATED TO ENERGY USAGE AND CONSERVATION AND BARRIER IN TECHNOLOGY UP GRADATION.

### 2.6.1.1 Energy availability

The Electricity availability situation in Gujarat state is good. Currently no planned load shedding is imposed on industries. Electricity availability is almost 24X7X365. The quality of power is fairly good. Except general voltage fluctuation no major problem in power quality observed during field study. Comparing the existing electricity availability scenario of entire country, the electricity availability in Gujarat state is far better. The rates are at par with current pricing trend in India.

Other type of energy used in various units in cluster are FO, Wood, LDO, HSD, Natural Gas, Saw Mill Dust (Bio-mass), Castor Oil DOC (De-oiled cake). Depending on accessibility, feasibility, equipment capability selection of fuel is done. Bio mass based fuel is though preferable, consistent availability has been given top priority due to perishable nature of milk.

Also due to various milk process, milk being food item, many fuels capable of producing dust/fine ash like coal are avoided. Natural gas is one of the most preferred fuel in cluster due to existing economical price, cleaner fuel being most suited for dairy industry, ease of operation etc. Coal produces fine fly ash & also coal handling plant often results in

formation of coal dust which can affect the quality of milk products, dairies are avoiding the use of coal for their fuel requirements. Not single dairy or chilling centers under the cluster are utilizing coal. From the study of a typical dairy which consumes both Bio-mass & PNG, it is clear that those industries which have access to PNG, tends to utilize the bio-mass though the supply consistency of bio-mass is not guaranteed, because any short fall in supply of bio-mass can be meet with PNG. It can be concluded that for cluster it if PNG supply is available as main fuel, bio-mass can be effectively utilized.

### **2.6.1.2 Technological Issues**

The existing available technology in Gujarat Dairy Cluster is under constant review by dairy management. Gujarat being one of the front runner state for milk production & processing, special attention is paid for constant technological up gradation.

Many technological up gradation measures already taken by various dairies. The important measures already taken are –

- a) Utilization of solar thermal energy for preheating boiler water in few Milk chilling centers.
- b) Upgrading conventional pneumatic pouch filling machine to automatic PLC based pouch packing machine which consumes less power.
- c) Fuel switching from conventional FO, LDO to either bio-mass or natural gas is in progress.
- d) Regenerative (high efficient i.e. up to 95%) pasteurizers for milk, butter milk have already been introduced.
- e) Few dairies have started replacing conventional EFF2 or lower level of motor to EFF1 or higher efficiency levels.

Thus in nutshell the technological up gradation of entire process along with plant & machinery is constantly under review by the management of dairy along with state & central government bodies.

### **2.6.1.3 Financial Issues**

Most of the units studied under the cluster are SME's but located in milk rich-cash rich belt of Gujarat. Many of these units are under expansion to increase their production to higher level of capacity. Presence of strong co-operative & Support from local bankers facilitates the financing aspects. However, The Financial mechanism proposed under SME Cluster development program will go a long way to help & strengthen the dairy industry in cluster.

### 3 CHAPTER 3

#### 3.1 ENERGY AUDIT & TECHNOLOGY ASSESSMENT

#### 3.2 ENERGY AUDIT & TECHNOLOGY ASSESSMENT IN CLUSTER

PCRA have considerable experience in the field of energy audit of Dairy sector. Before commencement of cluster, energy audit team was engaged in pre energy audit preparation such as going through the earlier carried energy audits, studying latest trends in dairy sector across the world, technological scenario across countries, latest technology available etc.

Historical data such as changes occurred in dairy sector, particularly across 'Gujarat Dairy Cluster' was studied. Situation analysis available with PCRA for relevant dairies studied. Various plant & machinery utilized in dairy sector such as refrigeration system, milk processing machines etc were studied from information available from various sources.

Pre audit discussions among team members were carried. Proper exposure to technicians, engineers & energy auditor associated with cluster program provided.

##### 3.2.1.1 Pre Energy Audit activities

Owner of dairy units and officials of Gujarat Co-operative Milk Marketing Federation (GCMMF) were contacted and informed about the BEE SME cluster program. Information decimation workshop was held for the dairy units studied in cluster and for all the stake holders like LSPs, Equipment suppliers, consultants, local Bankers etc to appraise them about the project of development of Gujarat (Dairy) SME Cluster under BEE SME program. Situational analysis reports made available by BEE to PCRA was shared with all and support from participating members was sought.

##### 3.2.2 Gujarat Co-operative Milk Marketing Federation (GCMMF)

The GCMMF is conglomeration of various (13) Districts Milk Cooperative Producers union. It looks after the Marketing aspects of all the milk process in members unions.

It also provides technological knowhow & support to the member unions.

**Table 6 : The details of GCMMF**

Particulars	Information
Chairman	Mr. Parthi Bhatol
Contact Person	Mr. P.K. Sarkar, OSD
Contact Details	Address: Amul Dairy Road, PB No.10, Anand-388001 Ph:02692-258506, Fax:02692-240208,

### 3.2.2.1 Preliminary Energy study

15 Nos preliminary energy audit studies were conducted in Gujarat (Dairy) SME Cluster.

The methodology followed in Preliminary energy audit is as given below –

- Ü Collection of past energy consumption details
- Ü Establishment energy consumption in the units.
- Ü List of Major energy consuming area of unit.
- Ü Identification of the most likely (and the easiest areas for attention)
- Ü Identification of areas for more detailed study/measurement
- Ü Study of Existing technology of various process & utilities.
- Ü Setting a 'reference point'
- Ü Estimation of the scope for saving.
- Ü Identification of immediate (especially no-/low-cost) improvements/ savings

### 3.2.2.2 Detailed energy study

A comprehensive detailed energy audit studies were conducted in 7 Nos of units under Gujarat Dairy (SME) cluster.

The methodology followed in detailed energy audit is as given below –

- Ü Collection of past energy consumption details & energy bills.
- Ü Establishment energy consumption in the units.
- Ü List of Major energy consuming area of unit.
- Ü Existing technology of various processes & utilities.
- Ü Status of Instruments installed in the plant and necessary instrumentation required for the detailed study
- Ü Identification of the areas for special attention for low cost measures with quick pay back periods
- Ü Understanding the detailed process with energy & material balance.
- Ü Monitoring & measuring of different parameters of various equipments/machines to evaluate performance.
- Ü Collection of operational data from various measuring instruments/gauges installed in the plant.
- Ü Compilation of design data/ name plate, details of various equipments from design manual & brochures
- Ü Discussion with concerned plant personnel to take note of operating practices and shop floor practices being followed in the plant and to identify the specific problem areas and bottlenecks if any with respect to energy consumption.
- Ü Critical analysis of data collected and parameters monitored.
- Ü Identification of the Energy Wastage areas and quantification of energy losses.

- Ü Identification of suitable energy conservation measures for reducing energy consumption.

### **3.3 OBSERVATIONS MADE DURING ENERGY USE & TECHNOLOGY AUDIT**

#### **3.3.1.1 Manufacturing process and technology/equipment employed**

The Milk process has following unit operations that consume electrical energy:

- Ü Milk chilling
- Ü Pasteurization
- Ü Cold storages
- Ü Butter and butter milk
- Ü Ghee
- Ü Flavored milk
- Ü Cheese
- Ü Paneer
- Ü Khoa
- Ü Dahi
- Ü Shrikhand
- Ü Flavored Milk
- Ü Skimmed Milk Powder (S.M.P.)
- Ü Whole Milk Powder (W.M.P.)
- Ü Spray Powder (S.P.)
- Ü White Butter
- Ü Tone Milk
- Ü Tea Milk
- Ü Tetra Pack Milks
- Ü Butter Milk
- Ü Ice Cream
- Ü Sweets

#### **3.3.2 Milk and cream section:**

The milk and cream pasteurization section has following equipment:

- Ü Milk Pasteurize
- Ü Cream Pasteurizer
- Ü Cream separators

Liquid milk after pasteurization is packed in pouches for local market supply. It is required to clean the pasteurization machines after various operations by using chemicals and hot water. There is a CIP section in various plants which is a major consumer of steam.

#### **3.3.3 Butter milk and butter section:**

The unit manufactures butter in a continuous butter manufacturing plant where cream, after pasteurization, is used for butter milk and butter manufacturing. The section uses following unit operations:

**Homogenizers:** Electrical energy is used for agitator motor

**Separators:** Electrical energy is used for centrifugal separation of cream and buttermilk

**Pasteurizers for butter milk and cream:** Electrical energy in the form of chilled water is used for cooling the milk.

### 3.3.4 Ghee section:

The unit produces ghee by further processing butter. The butter is first melted and then filtered to separate ghee which is then stored in tanks which have external cooling arrangement to cool ghee from 950C to 400C. After cooling, ghee is packed and a culture is added to make uniform granules of ghee.

### 3.3.5 Flavored milk section:

The unit produces flavored milk in the plant where little energy is required as the operations involve only addition of flavor to the pasteurized milk.

### 3.3.6 Milk Powder Section:

The milk is first concentrated in multiple effect evaporator (condensing unit) and then is dried by spraying in tower to manufacture milk powder and then packed in pouches as per requirement. The unit operations involved are:

**Evaporation:** The milk is concentrated in multiple effect evaporators from 13% solids to 50% solids. For this, steam and cooling water is used.

**Drying:** To manufacture milk powder, the concentrated milk from condensing unit is sprayed in spray dryer. Thermal energy in the form of Hot air and electrical energy in the form of chilled water and to operate various motors is used.

### 3.3.7 Sweetened Condensed Milk section:

The milk after pasteurization is sent to SCM section. Here, sugar syrup is prepared by mixing sugar with water and heated up to 900C. After filtration the solution is mixed with Standardized pasteurized milk from process section and preheated in series of pre-heaters and lastly in high heater. The mixer is then sent to condensing unit where under vacuum; the mixer is concentrated and cooled. Then the product is sent to storage tank and packed.

### 3.3.8 Cleaning in Place Technology (CIP)

The cleaning requirements are best met with Cleaning-in-Place (CIP) systems. CIP systems offer fast, efficient and reliable cleaning of all types of process plant. It's a method which cleans complete items of plant equipment or pipelines circuits without dismantling the

equipment. Plants must meet high hygienic standards to avoid product's degradation and contamination during operation, and plant cleaning must be carried out quickly and thoroughly.

### 3.3.9 Khoa & Sweet Making

Khoa is made from Milk by condensing milk by evaporation process. After Khoa making, sweets, various dry fruits & additives are mixed to make desired sweet.

### 3.3.10 Major Energy Consuming Equipments installed in Gujarat (Dairy) SME Cluster

- Ü Vapor compression Ammonia System.
- Ü Boilers
- Ü Electric Motors
- Ü Pumps
- Ü Hot Air Generators

#### 3.3.10.1 Energy Consumption Profile & availability

The Electricity availability from grid in Gujarat state is good. Currently no planned load shedding is imposed on industries. The quality of power is fairly good. Except general voltage fluctuation no major problem in power quality observed during field study. The average electricity cost ranges from Rs.5.05/- to 6.65/- per kWh. Both LT (433v) & HT (11kv, 33kv etc) supply are available hurdle free.

Other type of energy used in various units in cluster are FO, Wood, LDO, HSD, Natural Gas, Saw Mill Dust (Bio-mass), Castor Oil DOC (De-oiled cake). Depending on accessibility, feasibility, equipment capability selection of fuel is done. Bio mass based fuel is though preferable, consistent availability has been given top priority due to perishable nature of milk.

Table 7 : Energy Consumption Profile

Parameter	Unit	Energy Consumption Profile
Annual Electricity Consumption	kWh/year	35446831
Annual Wood Consumption	GJ/year	12306
Annual FO Consumption	GJ/year	138667
Annual NG Consumption	GJ/year	108919
Annual LDO Consumption	GJ/year	2669
Annual HSD Consumption	Lt/year	26031
Total Energy Consumption	GJ/year	391369

The consumption pattern obeys general similar pattern across the cluster. No deviation from unit to unit observed. The major energy consumption of dairy unit is in production area. Whereas general facility consumes the little fraction of total consumption.

Percentage energy consumption of typical dairy industry is furnished as below-

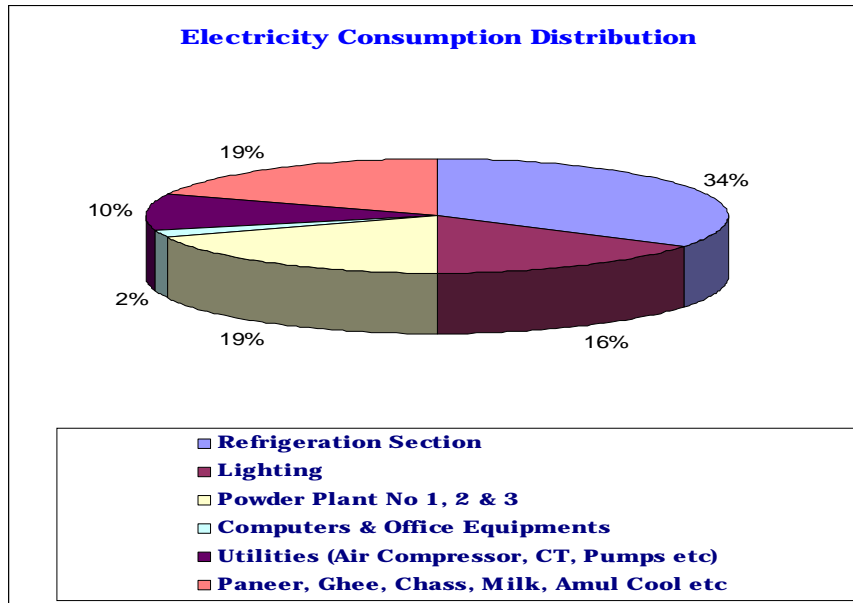


Figure 6 : Energy Consumption Distribution

### 3.3.10.2 Capacity Utilization factor & Plant Load Factor

The capacity utilization in dairy industry depends of availability of milk. The milk availability varies with season. During winter months the milk availability is on higher side while the milk availability in summer is on lower side. The capacity utilization varies with the variation of milk receipts. Also the demand of milk & milk products varies with market considerations & conditions. Therefore it is not possible to estimate the capacity utilization factor for this type of units in the cluster. However the plant operation or plant load factor is about some 80%.

### 3.3.10.3 Housekeeping practices

Majority of the Gujarat (Dairy) SME Cluster maintain very poor operational practices in different utilities. There are no specific procedures to be followed in any of the units for the operation of the various equipments.

Good housekeeping is the best method of controlling the risks of injury and fire within a facility. Operating experience clearly indicates a significant increase in mishaps related directly to poor housekeeping practices. To be an effective risk management tool, housekeeping must include the following considerations:

- Ü Storage space must be physically adequate for the volume of materials being stored. If it is inadequate, and adequate space cannot be obtained, dispose of the material.





- Ü Stored materials must be in a stable configuration in order to permit safe access, avoid clutter, and minimize the hazard of falling materials.
- Ü Materials stored together must be compatible. Materials must not contribute to, or cause ignition of, other materials, nor enhance their rate of combustion once ignited.
- Ü The fuel load (amount of combustible material) within a storage area must be consistent with the fire detection system and the risk management criteria for the area and the building. Questions can be referred to the Ames Fire Marshal or the Safety Division.



- Ü Working and walking surfaces should be dry, smooth, and free of general clutter and provide good traction for walking.
- Ü Equipment and tools, especially those with sharp surfaces, must be kept in their designated storage location when not being used.

- Ü It is well established that the quality and quantity of work are significantly enhanced by good housekeeping and adversely affected by poor housekeeping. Supervisors must expend the necessary effort to achieve and maintain a neat and orderly work environment.



Good housekeeping involves every phase of industrial operations and should apply throughout the entire premises, indoors and out. It is more than mere cleanliness. It requires orderly conditions, the avoidance of congestion, and attention to such details as an orderly layout of the whole workplace, the marking of aisles, adequate storage arrangements, and suitable provision for cleaning and maintenance.

A good housekeeping programme can start only when management accepts responsibility for it. Management must plan it in the first place and then make sure it consistently enforces the measures decided upon. The adoption of such a system will assist in promoting an effective housekeeping campaign.

Good housekeeping helps to create:

- Ü Better working conditions
- Ü Safer workplaces
- Ü Greater efficiency.

It is not an unprofitable sideline. It is part of a good business.

#### 3.3.10.4 Availability of data & Information

A majority of the units in particular milk chilling centres; small dairies do not have any precision instrumentation/data monitoring systems to monitor the various operational parameters. Some of the units have installed some instruments for monitoring of various operational parameters in their units. Calibration of these instruments not frequently done. Fine detail data such electricity consumption of individual section is not being maintained. Specific power consumption in all of the units not maintained product wise but on the basis of milk receipt.

Data of raw material i.e. milk is being regularly maintained by the units. Energy consumption particularly on monthly basis is being regularly monitored. Finished products like butter, butter milk, ghee etc being regularly monitored.

### 3.4 TECHNOLOGICAL GAP ANALYSIS IN DAIRY INDUSTRIES

#### 3.4.1.1 Technological Up-gradation

Apart from energy saving, other main focus area was technological GAP assessment. Technological GAP assessment is very important tool to assess the existing technology adopted by the units of cluster, comparing this existing technology with better to best technology available. Study of existing technology, co-relating the difference with latest available technology & forecasting future expected technology resulted in technological up gradation sequence.

During preliminary energy audit & subsequent detailed energy audit, existing available technology with the units under cluster were studied in detail. Various equipments which consume substantial energy found to be technological obsolete. At the core of technological study was to give a new energy efficient direction for technology used. Various measures recommended in cluster development program are essentially technological up gradation along with energy efficiency enhancement. The thrust are of technological enhancement is major consuming equipments & Systems.

These technological up gradation measures recommended in cluster development program comprises of both Electrical & Thermal measures.

- Ü Energy saving in Ammonia compressor motor by providing soft starter with energy saver at part loads (During modulation at lower loads due to firing of one or two cylinders only)
- Ü Energy saving by improving efficiency of condenser water circulation pumps by providing the glass flake coating to pump impellers and to pump casing.
- Ü Upgrading conventional pneumatic pouch filling machine by PLC based mechanical pouch filling machine which saves energy.
- Ü Energy saving in refrigeration system by providing Thermal energy storage system in place of conventional IBT (Ice Bank Tank) system.

- Ü Energy Saving by replacing existing heavier metallic cooling tower blade with lighter FRP blades.
- Ü Methane Capture from Effluent & Utilization as fuel for boiler / Hot air generator.
- Ü Energy saving by replacing older lower efficiency electric motor with energy efficient motor of at least EFF1 level.

#### **3.4.1.2 Process Up gradation**

Various R&D institution related to dairy are engaged in process up gradation of dairy industries. Dairy industries in Gujarat are on front runner in constant process up gradation. During field study many of the measures found to be taken which indicates that the process is being constantly monitored & subjected to up gradation. Regenerative high efficiency pasteurizers, replacement of pneumatic pouch filling machine with mechanical type pouch filling machine, improved process for paneer, improved process for Ghee etc are many examples of process improvement carried.

### 3.5 MAIN ENERGY CONSERVATION MEASURES IDENTIFIED

#### 3.5.1.1 Waste heat recovery by providing De-super heater in ammonia vapor compression based refrigeration system.

##### 3.5.1.1.1 Background

During vapor compression of ammonia, the ammonia hot gas at out let of ammonia compressor is substantially hot (about 102°C). The heat drawn from IBT and work done by compressor is thrown to condenser. If De-super heater is provided for harnessing the waste heat from this hot ammonia gas, hot water up to 70 to 75°C can be harnessed. This hot water can be used for CIP needs or for other hot water requirements such as preheating of boiler makeup water.

##### 3.5.1.1.2 Benefit of Proposal

De-super heater to be provided on Reciprocating Chiller system to harness waste heat of NH<sub>3</sub> gas. De-super heater is installed on discharge side of NH<sub>3</sub> compressor. The temperature of NH<sub>3</sub> gas observed to be 92 to 95°C. It is standard practice to harness 12 to 15% of Waste heat rejected in condenser by providing De-super heater. The arrangement of de-super heater can be by providing PHE or in case of small reciprocating NH<sub>3</sub> compressor by providing shell and tube type heat exchanger. The hot water temperature can be maintained up to 70°C by proper design of de-super heater along with maintaining flow rate. Apart from the direct energy saving after getting hot water, the heat load on condensing coil or cooling system will be reduced which will further open possibilities of downgrading the cooling water pumps.

The energy saving considered for implementation of De-super heater measure is 12% (Only direct saving is considered. Though when de-super heater is provided, down grading of condenser pump can be done or overall performance of condenser will enhance resulting in increased in COP of refrigeration system.)

##### 3.5.1.1.3 Cost Benefit Analysis :

1)	Capacity of Existing VC Cycle Compressor (Working or on-load. But Actual average load may be lower due to load modulation)	=	28.7	TR
2)	Working Hours for Compressor/day	=	20	hrs/day
3)	Ambient Water Temperature	=	30	°C
4)	Temperature of Hot NH <sub>3</sub> Gas available for WHR from Desuperheater	=	91	°C
5)	Waste Heat Available from Desuper Heater (Considering 12% WHR possible in De-super heater i.e. 12% of total kWh consumed can be recovered)	=	2239	kCal/hr
6)	Expected Temperature of Hot water from De-super heater (Considering Flow Rate and Design of De-super heater to get 65°C hot water for winter conditions)	=	65	°C
7)	Quantity of Hot Water Available	=	64	ltrs/hr

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6)	Expected Temperature of Hot water from De-super heater (Considering Flow Rate and Design of De-super heater to get 65°C hot water for winter conditions)	=	65	°C
7)	Quantity of Hot Water Available	=	64	ltrs/hr

8)	Total Quantity of Hot water that can be generated from De-super heater	=	1280	ltrs/day
	<i>Thus Total Hot water at 65 °C can be generated</i>	=	1.28	kill/day
9]	Cost of Electricity	=	5.5	Rs./kWh
10]	Expected Saving per Day (kWh energy for Compressor recovered, considering above Working Hours)	=	2.6	kWh/hr
11]	Expected Saving Per Annum in kWh	=	18720	kWh/annum
12]	Expected Saving per Annum (Considering 360 Working Days)	=	102960	Rs./annum
13]	Expected Investment Needed	=	143500	Rs.
14)	Simple Payback	=	1.39	Year
			17	Months

#### 3.5.1.1.4 Issue in Implementation

- Ü Lack of awareness on proposed energy conservation measure
- Ü High Initial Cost.

### 3.5.1.2 Improvement in steam & Hot water pipe line insulation to prevent thermal energy loss.

#### 3.5.1.2.1 Background

During energy audit it was observed that the insulation for steam & hot water pipe line are not scientifically (with economical insulation thickness) done across entire stretched of pipe line carrying steam and hot water. The thermal insulation was found to be damaged at many locations. The pipe fittings, flanges & other mountings are not thermally insulated. Hot water pump casing and associated mountings are not thermally insulated.

#### 3.5.1.2.2 Benefit of Proposal

Detailed inspection of entire pipe line for thermal insulation carried which suggest energy saving opportunity exist if thermal insulation is provided for entire pipe line, along with pipe fittings, mountings, accessories. Also scientific preventive maintenance of thermal insulation will also result in energy savings. The estimated loss due to thermal insulation varies from unit to unit depending on actual condition of thermal insulation. The general observation for saving indicates saving from 7 to 12% by providing proper thermal insulation for steam & hot water pipe line.

#### 3.5.1.2.3 Cost Benefit Analysis

1)	Fuel Used	=	Wood	
2)	Average Quantity of fuel Consumed Per Month	=	6000	kgs
3)	Cost of Per Ltrs of fuel	=	2.5	Rs./kg

	Estimated area of existing thermal insulation including pipe line, pipe fittings, mountings and allied accessories.	=	35	m <sup>2</sup>
4)	Estimated area of thermal insulation that can be additional provided, along with repair and reconditioning of existing thermal insulation.	=	3.5	m <sup>2</sup>
5)	Estimated % Loss due to improper insulation and exposed area	=	10	%
6)	Expected Saving by Improving Thermal insulation for Hot water pipe line by considering improper insulation and exposed area.	=	600	kgs/Month
7)	Expected Saving per Annum	=	18000	Rs./annum
8)	Investment Needed for providing additional insulation and improving thermal insulation for hot water pipe line	=	28000	Rs.
9)	Simple Payback	=	1.56	Yrs
		=	19	Months

#### 3.5.1.2.4 Issue in Implementation

Ü Lack of awareness on proposed energy conservation measure

#### 3.5.1.3 Improvement in chilled water pipe line insulation to prevent the heat ingress and thus energy loss.

##### 3.5.1.3.1 Background

During energy audit it was observed that the insulation for chilled water pipe line is not scientifically (with economical insulation thickness) done across entire stretched of pipe line carrying chilled water. The thermal insulation was found to be damaged at many locations. The pipe fittings, flanges & other mountings are not thermally insulated. Chilled water pump casing and associated mountings are not thermally insulated.

##### 3.5.1.3.2 Benefit of Proposal

Insulation of chilled water pipe line found to be not scientifically done at few places. The existing insulation provided is same as that of provided for hot water pipe line. It is recommended to provide the proper insulation suitable for chilled water. Proper layers as required for chilled water to be provided. Insulation to be provided to casing of pump, all the pipe fittings, flanges and other mountings. Detailed inspections of chilled water pipe line insulation suggest energy saving opportunities.

##### 3.5.1.3.3 Cost Benefit Analysis

1)	Capacity of Existing VC Cycle Compressor (Working or on-load)	=	28.7	TR
2)	Working Hours for Compressors/day	=	20	hrs/day
3)	Actual kWh Consumption of Compressor	=	21.7	kWh/hr



4)	Estimated area of existing insulation for chilled water including pipe line, pipe fittings, mountings and allied accessories.	=	40	m <sup>2</sup>
5)	Estimated area of chilled water insulation that can be additionally provided along with repairs and reconditioning of existing insulation.	=	3.6	m <sup>2</sup>
6)	Estimated % Loss due to improper insulation and exposed area	=	9	%
7)	Expected Saving by Improving Thermal insulation for Chilled water pipe line by considering improper insulation and exposed area.	=	2	kWh/hr
8)	Cost of Electricity	=	5.5	Rs./kWh
9)	Expected Saving Per Annum in kWh	=	14400	kWh/annum
10)	Expected Saving per Annum (Considering 360 Working Days)	=	79200	Rs./annum
11)	Expected Investment Needed for Improving Thermal Insulation for Chilled Water Pipe Line	=	28000	Rs.
12)	Simple Payback	=	0.35	Yrs
		=	5	Months

#### 3.5.1.3.4 Issue in Implementation

Ü Lack of awareness on proposed energy conservation measure

#### 3.5.1.4 Energy Saving by Replacing Conventional V-belt with cogged belt.

##### 3.5.1.4.1 Background

V-belts use a trapezoidal cross section to create a wedging action on the pulleys to increase friction and the belt's power transfer capability. Joined or multiple belts are specified for heavy loads. V-belt drives can have a peak efficiency of 95% to 98% at the time of installation. Efficiency is also dependent on pulley size, driven torque, under or over-belting, and V-belt design and construction. Efficiency deteriorates by as much as 5% (to a nominal efficiency of 93%) over time if slippage occurs because the belt is not periodically re-tensioned.

##### 3.5.1.4.2 Benefit of Proposal

Cogged belts have slots that run perpendicular to the belt's length. The slots reduce the belt's bending resistance. Cogged belts can be used with the same pulleys as equivalently rated Vbelts.

They run cooler, last longer, and have an efficiency that is about 2% higher than that of standard V-belts. All the chiller compressors are provided with conventional V-belt drives. It is recommended to replace these conventional V-belts with cogged belt to improve transmission efficiency by 2%.



### 3.5.1.4.3 Cost Benefit Analysis

1)	Capacity of Existing VC Cycle Compressor (Working or on-load)	=	28.7	TR
2)	Working Hours for Compressors/day	=	20	hrs/day
3)	Actual kWh Consumption of Compressor	=	21.7	kWh/hr
4)	Expected Saving by Providing Cogged belt in Place of Conventional V-Belt (About 2%)	=	0.4	kWh/hr
5)	Cost of Electricity	=	5.5	Rs./kWh
6)	Expected Saving Per Annum in kWh	=	2880	kWh/annum
7)	Expected Saving per Annum (Considering 360 Working Days)	=	15840	Rs./annum
8)	Expected Investment Needed for Replacing Conventional V-belt with Cogged V-belt.	=	8610	Rs.
9)	Simple Payback	=	0.54	Yrs
		=	7	Months

### 3.5.1.4.4 Issue in Implementation

- Ü Lack of awareness on proposed energy conservation measure

### 3.5.1.5 Energy Saving by Replacing Reciprocating Air Compressor with Screw Compressor with VFD.

#### 3.5.1.5.1 Background

Reciprocating air compressor for higher capacities (about more than 85 cfm demand) are generally less energy efficient than that of Screw compressor. Also reciprocating air compressor needs higher maintenances cost as compare to screw compressor.

#### 3.5.1.5.2 Benefit of Proposal

The specific power consumption of existing reciprocating compressor found to be higher. Replacing these compressor with screw compressor with VFD which has considerable lower specific power consumption, will result in energy saving. The reciprocating compressors are prone to lower volumetric efficiency. Also the maintenance cost of screw compressor is lower as compared to reciprocating compressor.

#### 3.5.1.5.3 Cost Benefit Analysis

1)	Actual air FAD required	=	68.5	cfm
2)	Existing Specific Power Consumption	=	0.26	kW/cfm
3)	Average working hours per day	=	20	hrs/day
4)	Average existing consumption per hour	=	17.8	kw/hr
5)	Existing consumption per day for air compressor	=	356	kWh/day
6)	Cost of Electricity	=	5.86	Rs./kWh
7)	Specific Power Consumption of analogs screw	=	0.18	kW/

	compressor (100 cfm capacity with VFD)			
8)	Average Saving for same consumption by screw compressor (with VFD)	=	246.6	kWh/day
9)	Expected saving in kWh per day	=	109.4	kWh/day
10)	Expected saving in kWh per annum	=	39384	kWh/annum
11)	Expected saving in Rs. Per Annum	=	230790	Rs./annum
12)	Investment needed for screw compressor with VFD	=	800000	Rs.
13)	Simple payback period	=	3.47	Yrs.
		=	42	Months

#### 3.5.1.5.4 Issue in Implementation

- Ü Lack of awareness on proposed energy conservation measure
- Ü High initial cost.

#### 3.5.1.6 Energy saving by providing condensate recovery system for Boiler.

##### 3.5.1.6.1 Background

Currently in many units the condensate recovery is not done or not as per required standard they also returned condensate temperature is 50°C, which is lower than higher achievable temperature of about 60 to 65°C by providing proper insulation for condensate recovery pipe line along with condensate recovery tank in power section (Combined condensate tank for powder section).

##### 3.5.1.6.2 Benefit of Proposal

Currently no condensate is recovered from the process. It is recommended to recover maximum possible condensate as it will save considerable energy directly, auxiliary energy consumption such as energy consumption for water softener; makeup water pump etc will be saved. Energy audit team is of the opinion that at least 50% condensate can be recovered from various processing section as mentioned above. Though in few sections such as crate washer where open steam is used, condensate recovery is not possible.

##### 3.5.1.6.3 Cost Benefit Analysis

1)	Fuel Used	=	FO	
2)	Calorific Value of FO	=	10500	kCal./ltr
3)	Cost of Per Ltrs of fuel	=	29	Rs./
4)	Daily Steam Generation	=	14	Tons/day
5)	Condensate amount that can be recovered (40% condensate recovery at 70°C.)	=	7	Tons/day
6)	Make up water temperature	=	30	°C
7)	Total kCal that can be saved per Day	=	280000	kCal/day

8)	Boiler Efficiency	=	83	%
9)	Expected FO Saving per day	=	32.13	ltrs/day
10)	Expected FO Saving per Annum	=	11566.8	ltrs/annum
11)	Expected Saving in Rs. Annum	=	335437	Rs./annum
12)	Investment needed for Condensate Recovery	=	425000	Rs.
10)	Simple Payback	=	1.27	Yrs
		=	16	Months

#### 3.5.1.6.4 Issue in Implementation

- Ü Lack of awareness on proposed energy conservation measure
- Ü High initial cost.

#### 3.5.1.7 Energy Saving by Reducing Operating Pressure of Compressed Air by providing Ring Mains & properly sized Compressed

##### 3.5.1.7.1 Background

As operating pressure of compressor increases, specific power consumption increases. It is observed that due to improper compressed air pipe line size, fittings & lack of ring mains lead to higher pressure drop in compressed air system which results in higher operating pressure.

##### 3.5.1.7.2 Benefit of Proposal

The existing operating pressure range of compressor is higher resulting in higher specific power consumption for the air compressors. By reducing operating pressure by 1 kg/cm<sup>2</sup>, 6% energy can be saved. Provision of ring mains and allied mountings such as moisture traps etc will enable to reduce the operating pressure.

##### 3.5.1.7.3 Cost Benefit Analysis

1)	Existing Operating Compressed Air Pressure	=	8	kg/cm <sup>2</sup>
2)	Proposed Operating air pressure	=	5	kg/cm <sup>2</sup>
3)	Average working hours per day for compressor	=	20	hrs/day
4)	Average existing consumption per hour for air compressor	=	17.8	kw/hr
5)	Existing consumption per day for air compressor	=	356	kWh/day
6)	Cost of Electricity	=	5.86	Rs./kWh
7)	Expected saving by reduction in operating pressure (6% energy saving for reduction in operating pressure by 1 kg/cm <sup>2</sup> )	=	0.53	kw/hr
8)	Expected saving in kWh per day	=	10.6	kWh/day
9)	Expected saving in kWh per annum	=	3816	kWh/annum
10)	Expected saving in Rs. Per Annum	=	22361.8	Rs./annum

11)	Investment needed for providing ring main with proper size of compressed air pipe	=	89000	Rs.
12)	Simple payback period	=	3.98	Yrs.
		=	48	Months

#### 3.5.1.7.4 Issue in Implementation

Ü Lack of awareness on proposed energy conservation measure

#### 3.5.1.8 Energy saving by interlocking agitator of Milk Cylo working with level of milk inside cylo.

##### 3.5.1.8.1 Background

Various milk cylos are provided for storing in process milk. It was observed that even if the cylos are empty, the agitator found to be working. This results in energy loss.

##### 3.5.1.8.2 Benefit of Proposal

The agitator for milk cylo is provided with motor along with reduction gear box. During field study idle working of cylo agitator observed. By interlocking the working of agitator with level of milk inside the cylo will avoided idle working of the agitator for average 5 hours per day resulting in energy saving.

##### 3.5.1.8.3 Cost Benefit Analysis

1]	Expected Saving per day	=	58.5	kWh
2]	No of Days working per annum	=	360	Days
3)	Expected kWh Saving per Annum	=	21060	kWh/annum
4)	Cost of Electricity	=	5.22	Rs./kWh
5)	Expected Saving Per Annum	=	109933	Rs./annum
6)	Total Number of Agitators	=	18	Nos.
7)	Expected Investment for One agitator for interlocking	=	20000	Rs./Machine
8)	Total Expected investment	=	360000	Rs.
9)	Simple Payback Period	=	3.27	Yrs
		=	39	Months

#### 3.5.1.8.4 Issue in Implementation

Ü Lack of awareness on proposed energy conservation measure

## 3.6 MAIN ENERGY CONSERVATION & TECHNOLOGY UPGRADATION PROPOSALS

### 3.6.1.1 Provision of Soft Starter with Energy Saver for Ammonia Compressor.

#### 3.6.1.1.1 Background

Ammonia compressor motors are subjected to frequent part load operation due to variation of load. Energy saving in Ammonia compressor motor can be done by providing soft starter with energy saver.

#### 3.6.1.1.2 Benefit of Proposal

The ammonia compressors are subjected to load-unload due to change in no of cylinders loaded. At part loads only one / two /three cylinders are working. The percentage loading on motor may be lower up to 25% at times. At part loads, soft starter with energy saver, by changing firing angle of thyristor, reduces the voltage till the current is not increased. The saving up to 3% of consumption of compressor motor, which is primary energy consumer in chilling center can be achieved. Along with energy saving, MD of the chilling center can be controlled & overall life of components of compressor can be enhanced due to soft starter feature.

#### 3.6.1.1.3 Cost Benefit Analysis

1)	Rated capacity of existing VC Cycle refrigeration system (Working on load)	=	735	TR
2)	Actual TR generated by existing VC Cycle Compressor (Working or on-load)	=	472.5	TR
2)	Working Hours for Compressor/day	=	20	hrs/day
3)	Actual kWh Consumption of Compressor	=	611.5	kWh/hr
4)	Expected Saving by Providing Soft starter with energy saver for VC Compressor Motor working on variable load. (Expected Saving of 3%)	=	18.35	kWh/hr
5)	Cost of Electricity	=	6.49	Rs./kWh
6)	Expected Savings per Annum in kWh	=	132120	kWh/annum
7)	Expected Saving per Annum (Considering 360 Working Days)	=	857459	Rs./annum
8)	No of Motors for Compressor on load	=	9	Nos.
9)	Expected Investment Needed for providing soft starter with energy saver.	=	288000	Rs.
10)	Simple Payback	=	0.34	Yrs
		=	5	Months

#### 3.6.1.1.4 Issue in Implementation

Ü Lack of awareness on proposed energy conservation measure

### 3.6.1.2 Energy saving by improving efficiency of pumps by providing the glass flake coating.

#### 3.6.1.2.1 Background

Due to friction in impeller & casing substantial energy of pump is reduced. By providing glass flake coating to impeller & casing this friction can be reduced resulting in higher efficiency of pump. During glass flake coating the impeller is also dynamically balanced which further improves performance of pump.

#### 3.6.1.2.2 Benefit of Proposal

Improving efficiency of pumps by providing the glass flake coating with proper mixing of different resins to provide smooth coating on impeller and casing along with dynamic balancing of impeller. Due to coating friction loss of fluid and impeller, casing reduces resulting in lower power consumption. Glass Flake coatings have proven to be very effective in extending the life of pumps and other components of system and improving efficiency of pumping operation. The efficiency of pump can be improved by 6 to 12% depending on actual pump condition. For saving calculation purpose we can consider overall saving up to 4% of pump energy consumption.

#### 3.6.1.2.3 Cost Benefit Analysis

1]	No. of pumps considered suitable for glass flake coating.	=	6	Nos.
2]	Combined consumption (at 70% average motor loading)	=	111.9	Kw
3)	No. of normal hours of operation per day	=	20	hrs/day
4)	Expected Saving by providing Glass Fake Coating to pump impeller & to pump casing.	=	6.71	kW/hr.
5)	Cost of Electricity	=	6.49	Rs./kWh
6)	Expected kWh Saving Per Day	=	134.2	kWh/day
7)	Expected Saving in kWh/annum	=	48312	kWh/annum
8)	Expected Saving in Rs. Per Annum	=	313545	Rs./annum
9)	Expected Investment needed for all pumps	=	270000	Rs./Machine
10]	Simple Payback Period	=	0.86	Yrs
		=	10	Months

#### 3.6.1.2.4 Issue in Implementation

- Ü Lack of awareness on proposed energy conservation measure
- Ü High initial cost of implementation.

### 3.6.1.3 Energy saving by replacing conventional pneumatic pouch filling machine with PLC based mechanical type pouch filling machine.

#### 3.6.1.3.1 Background

Conventional pneumatic type pouch filling machine requires compressed air for its operation, which consumes extra energy. The latest PLC based mechanical pouch filling machines are more energy efficiency as compared to conventional milk pouch filling machine.

### 3.6.1.3.2 Benefit of Proposal

Pneumatic pouch filling machine to be replaced by more energy efficient PLC based mechanical pouch filling machines. The pneumatic operated pouch filling machine itself consumes 2.5 HP along with 10 HP air compressors, working with pressure modulation as long as the pouch filling machine works. The average consumption of pneumatic pouch filling machine is 8 Kw. The PLC based mechanical pouch filling machine does not need compressed air and its own consumption is 4.5 HP. The average consumption of PLC based mechanical pouch filling machine is 2.5 Kw. Thus the expected saving is 5.5 kW/Hour.

### 3.6.1.3.3 Cost Benefit Analysis

1]	No. of Existing Conventional Pneumatic Pouch Filling Machine	=	2	Nos.
2]	No. of Hours of operation per day	=	8	hrs/day
3)	Expected Saving per Machine	=	5.5	kW/hr.
4)	Cost of Electricity	=	5.5	Rs./kWh
5)	Expected kWh Saving Per Day	=	88	kWh/day
6)	Expected Saving in kWh/annum	=	31680	kWh/annum
7)	Expected Saving in Rs. Per Annum	=	174240	Rs./annum
8)	Expected Investment for total machines	=	1400000	Rs./Machine
9)	Simple Payback Period	=	8.03	Yrs
		=	96	Months

### 3.6.1.3.4 Issue in Implementation

- Ü Lack of awareness on proposed energy conservation measure
- Ü High initial cost of implementation.

### 3.6.1.4 Energy saving by providing thermal storage system in place of conventional IBT tank for energy saving & availing TOD benefits.

#### 3.6.1.4.1 Background

The conventional IBT (Ice Bank Tank) System is provided in all the milk chilling center and dairies. The conventional IBT Tank is civil constructed tank provided with all civil constructed wall (except bottom side) thermally insulation. While top face of tank is open and covered by wooden planks supported on MS angle fabricated support structure. The IBT tank is not air tight and top portion of tank covered with wooden planks have many gaps and thin spaces where outside atmospheric air comes directly in the contact of chilled water inside the IBT Tank. These leakages are one of the major components of loss of IBT tank. Individual standing on top of IBT tank feels the air conditioning effect in



surrounding. Mechanical stirrers (agitator) are provided (one in each section of IBT tank) for creating forced circulation inside IBT tank for uniform cooling of water inside IBT Tank. These stirrers also induce heat inside the IBT tank proportional to BHP of shaft of stirrer at motor end. As the IBT tank is used in refrigeration system for making ice during off peak hours and using this thermal stored energy during peak hours. The charging of the IBT tank is done almost 20 hrs to 24 hrs per day depending on milk quantity received and ambient conditions.

#### 3.6.1.4.2 Benefit of Proposal

##### Advantages of Thermal Storage System

- 1) Lower losses result in considerable energy.
- 2) TOD benefits or advantages provided by electricity company can be availed.
- 3) Compact and consumes very small space.
- 4) The compressor can be avoided to work on part load resulting in higher specific power consumption.
- 5) Agitator (Stirrer) which consumes additional energy and induces heat by way of churning is avoided.
- 6) Performance of refrigeration system can be improved by charging in night conditions which results in lower specific power consumption.
- 7) Reliable and negligible maintenance.
- 8) Provision of latest thermal storage system will result in better housekeeping and safer working condition.
- 9) Increased thermal storage capacity for 4 hours, will result in time space for preventive maintenance of refrigeration system resulting in better consistent performance of the entire system.
- 10) Through liquid overfeed system by operating at higher suction pressure, with screw compressor with economizer and rust free water quality. Savings are about 15% to 20% (Source of information IDMC)

#### 3.6.1.4.3 Cost Benefit Analysis

1)	Total rated capacity of refrigeration system per hour (Excluding Stand by)	=	35	TR
2)	Normal working hours of refrigeration system per day	=	20	Hours
3)	Actual refrigeration TR generated	=	28.7	TR
4)	Actual electricity consumption	=	21.7	Kw
5)	Specific Power Consumption based on actual performance and actual consumption	=	0.76	kW/TR
6)	Expected Capacity in Hours for Thermal Storage System (Considering Working hours in peak milk received load and Peak TOD tariff)	=	4	hrs/day
7)	Thermal loss through conventional concrete constructed IBT tank with wooden plank cover and due to agitator provided for water churning (Actual study carried at	=	8	%



	dairies)			
8)	Expected losses in proposed thermal storage system	=	1.5	%
9)	Expected net saving in thermal losses by replacing conventional IBT tank with latest thermal storage system.	=	6.5	%
10)	Expected saving in kWh by replacing conventional IBT tank system with latest thermal storage system (Without considering saving in power of agitators)	=	1.41	kWh/Hour
11)	Expected saving in kWh per Day	=	28	kWh/day
12)	Cost of electricity	=	5.5	Rs./kWh.
13)	Expected saving in kWh per annum	=	10080	kWh/annum
14)	Expected saving per day	=	154	Rs./day
15)	Expected saving per annum (Without considering TOD benefits)	=	55440	Rs./annum
16)	Expected saving per annum from TOD benefits of Rs.0.75/kWh for morning and evening peak hours.	=	46872	Rs./annum
17)	Total expected saving considering TOD benefits	=	102312	Rs./annum
18)	Expected Investment needed for proposed thermal storage system (Rated demand for peak hours without additional charging system)	=	630000	Rs.
19)	Simple Payback period (Without TOD benefits)	=	11.36	Yrs
		=	137	Months
20)	Simple Payback period (With TOD benefits)	=	6.16	Yrs
		=	74	Months

#### 3.6.1.4.4 Issue in Implementation

- Ü Lack of awareness on proposed energy conservation measure
- Ü High initial cost of implementation.

#### 3.6.1.5 Replacing metallic blades for cooling tower with FRP blade to save energy.

##### 3.6.1.5.1 Background

Metallic blades for cooling tower are heavier. This results in more energy consumption of fan motor. If the blades are retrofitted with lighter FRP Blades, lower energy will be consumed.

##### 3.6.1.5.2 Benefit of Proposal

The existing aluminum Blades are heavier than the latest available FRP blades. Lighter FRP blades will consume lesser energy for CT Fan motor. The saving of almost 15% can be achieved by replacing CT Fan blade and subsequently down grading CT Fan motor.

### 3.6.1.5.3 Cost Benefit Analysis

1]	Expected Saving per day	=	27	kWh
2]	No of Days working per annum	=	360	Days
3)	Expected kWh Saving per Annum	=	9720	kWh/annum
4)	Cost of Electricity	=	5.33	Rs./kWh
5)	Expected Saving Per Annum	=	51807.6	Rs./annum
6)	Total Number of CT Fans	=	2	Nos.
7)	Expected Investment for two FRP Fans as specified above.	=	65000	Rs.
8)	Total Expected investment including installation & erection	=	70000	Rs.
9)	Simple Payback Period	=	1.35	Yrs
		=	16	Months

### 3.6.1.5.4 Issue in Implementation

- Ü Lack of awareness on proposed energy conservation measure.

### 3.6.1.6 Methane Capture from Effluent & Utilization as fuel for boiler / Hot air generator to save energy.

#### 3.6.1.6.1 Background

Effluents of typical dairy contain high COD & BOD contain. This results in suitable case for anaerobic methane capture. Currently aerobic ETP treatment is carried using various mechanical equipments which consume energy. Capture of methane results in energy saving & benefit to environment.

#### 3.6.1.6.2 Benefit of Proposal

The bio-degradable effluent have high COD which results in liberation of methane gas in to atmosphere which is not desirable. Conventional ETP method both consumes high energy along with liberation of methane in the atmosphere. By various latest techniques such as anaerobic digestion and various other processes, this methane can be captured as fuel to be utilized either in boiler or hot air generator. Along with saving environment, considerable energy can also be saved.

Untreated Effluent Data for Typical Dairy				
1)	BOD	=	2500	mg/
2)	COD	=	5000	mg/
3)	Effluent Quantity	=	41666	ltrs/hr
<i>(1kg=1000000 mg &amp; Considering for ETP, 1kg=1Ltr)</i>				

### 3.6.1.6.3 Cost Benefit Analysis

Calculations for Bio-gas Generation			
1)	COD Load per Day	=	5000 kg/day
2)	COD Reduction Percentage Considered	=	80 %
3)	Actual Reduced COD Load	=	4000 kg/day
4)	Bio-gas Generated	=	0.5 m <sup>3</sup> /kg of Reduced COD Load
5)	Thus Actual Bio-Gas Generated	=	2000 m <sup>3</sup> /day
6)	Calorific Value of Bio-Gas	=	4900 kCal/m <sup>3</sup>
7)	Total heat that can be generated from Bio-gas	=	9800000 kCal/day
8)	Calorific Value of FO	=	10000 kCal/
9)	FO Equivalent of Bio-gas Generated	=	980 kg/day
10)	Cost of FO	=	29 Rs./
11)	Saving from Bio-gas Generation	=	28420 Rs./day
12)	No. of Working Days/annum	=	360 Days
13)	Total Expected Saving per Annum	=	10231200 Rs./annum
14)	Expected KLOE Saving Per Annum	=	353 kloes/annum
15)	Expected Investment for Civil Work, Mechanical Works, electrical works etc	=	22500000 Rs.
16)	Simple Payback Period	=	2.2 Yrs
		=	26 Months
17)	Expected FO Equivalent Saved per Annum	=	352800 KL/annum

#### 3.6.1.6.4 Issue in Implementation

- Ü Lack of awareness on proposed energy conservation measure.
- Ü Higher Initial Cost.
- Ü High awareness requirement.

#### 3.6.1.7 Replacing existing lower efficiency electric motor, with EFF1 or higher level efficiency of motor.

##### 3.6.1.7.1 Background

Existing motors in many industries under cluster are lower efficiency type (EFF3) type & many motors are old many time re-winded electric motor. These motors can be replaced by technological superior EFF1 or higher level of electric motors.

##### 3.6.1.7.2 Benefit of Proposal

Electric motor having efficiency less than EFF1 level of efficiency, old many time rewind electric motors to be replaced by electric motors of at least EFF1 or higher level of efficiency. The reciprocating chiller compressor motors, condenser water pump motors,

chiller pump motors, motors for can washing machine etc with efficiency less than EFF1 level can be replaced by EFF1 or higher level of electric motors. It is strongly recommended to adopt standard rewinding practices along with standard rewinding material to maintain the efficiency level of electric motors. The existing older motors are of efficiency level of EFF2 or lower efficiency. Thus by replacing these motors with energy efficient motors of EFF1 or higher level can result in energy saving up to 5% of electricity consumption by major Non EFF1 electric motors.

### 3.6.1.7.3 Cost Benefit Analysis

1)	Capacity of Existing VC Cycle Compressor (Working or on-load)	=	585	Kw
2)	Working Hours for Compressor/day	=	20	hrs/day
3)	Actual kWh Consumption of Compressor	=	611.5	kWh/hr
4)	Expected Saving by replacing electric motors having efficiency less than that of EFF1 level with EE motor having Efficiency level of at least EFF1 or higher level (5% Expected)	=	30.58	kWh/hr
5)	Cost of Electricity	=	6.49	Rs./kWh
6)	Expected Saving in kWh/annum	=	220176	kWh/annum
7)	Expected Saving per Annum (Considering 360 Working Days)	=	1428942	Rs./annum
8)	Expected Investment Needed for replacing existing motor with EE motor.	=	2459000	Rs.
9]	Simple Payback	=	1.72	Yrs
		=	21	Months

### 3.6.1.7.4 Issue in Implementation

- Ü Lack of awareness on proposed energy conservation measure.
- Ü High Initial Cost.

### 3.6.1.8 Energy saving by replacing conventional motor & gear box based drive for CT Fan by permanent magnet motor & Drive.

#### 3.6.1.8.1 Background

Cooling towers are subjected to mainly chillers system load. The nature of load is fluctuating & continuously varying. There are lot of variables such as variation of chilled water requirement load, seasonal variation, day & night condition variation etc. But currently the cooling tower fan is continuously working at same rating. By providing the permanent magnet motor with drive will make the cooling tower load responsive.

#### 3.6.1.8.2 Benefit of Proposal

Cooling tower fan currently works at same rating across year & also subjected to transmission efficiency loss for reduction gear box (about 8%). Replacing these with

permanent magnet motor (which is much higher efficient than conventional motor) along with drive arrangement will result in energy saving for CT fan. The expected energy saving is about 15% (8% transmission efficiency + 2% motor efficiency + 5% due to variation in load using drive)

### 3.6.1.8.3 Cost Benefit Analysis

1]	Expected Saving per day	=	17.55	kWh
2]	No of Days working per annum	=	360	Days
3)	Expected kWh Saving per Annum	=	6318	kWh/annum
4)	Cost of Electricity	=	5.33	Rs./kWh
5)	Expected Saving Per Annum	=	33675	Rs./annum
6)	Total Number of CT Fans	=	1	Nos.
7)	Expected Investment for two FRP Fans as specified above.	=	100000	Rs.
8)	Total Expected investment including installation & erection	=	105000	Rs.
9)	Simple Payback Period	=	3.12	Yrs
		=	37	Months

### 3.6.1.8.4 Issue in Implementation

- Ü Lack of awareness on proposed energy conservation measure

## 3.7 OTHER ENERGY RECOMMENDATIONS

### ECM-1 Power Factor Improvement & Installation of APFC Panel

During the energy audit study of power sources, the power parameters of electricity supply company for Gujarat were also studied and analysed to identify the deviation from the rated and operational pattern as per installed equipments and machinery in the plant and the applied tariff for power supply. In this context, the power factor was also studied at main incomer feeder of the unit. It has been observed that the power factor at main comer is on lower side. The units are not able to achieve full PF incentives given by electricity supply company. It is recommended to improve the power factor to unity at main incomer level by applying the fixed capacitor banks or automatic power factor controller. The electricity supply company offers incentive of 0.5% for every percentage point improvement from 0.95 PF to Unity. Apart from incentive in electricity bill, improved PF reduces line losses and improves voltage at load terminals. Maintaining unity PF is beneficial in all respects. It is recommended to provide additional capacitors or Provision of APFC panel of proper rating and setting will ensure Unity PF.



1)	Average Monthly Consumption	=	24138	kWh/Month
2)	Maintained PF as per last bill	=	0.818	
3)	Expected Additional PF incentive by maintaining Unity PF (For Demand and Electricity charges only).	=	9	%
4)	Cost of Electricity in Rs./kWh	=	5.5	Rs./kWh
5)	Estimated cost of Electricity for Demand & Electricity Charges (Excluding variable and fixed monthly Duty, taxes, Meter charges, FAC etc)	=	4.68	Rs./kWh
6)	Total Expected PF incentive per Month	=	10166.9	Rs./Month
7)	Total Expected Saving Per Annum	=	122003	Rs./annum
8)	Expected Investment Needed for maintaining Unity PF (Additional Capacitor / APFC)	=	175000	Rs.
9)	Simple Payback	=	1.43	Yrs
		=	17	Months

### ECM-2 Energy saving by providing Solar Water heater for boiler water pre-heating & hot water requirements

Solar water heating system to be provided for hot water requirements. Hot water is required for both process & for cleaning purpose. The properly maintained solar system of 5000 ltrs/day capacity will result in hot water at 70°C. Solar hot water system, do not have any costly maintenance along with literally lowest operation cost.

The solar system can be effectively utilized for post heating hot water (65 °C) obtained from de-super heater to heat the water up to 85 °C so that most of the fuel requirement for boiler can be saved.



1]	Heat energy saved by providing solar water heater (5000 ltrs/day capacity providing hot water at 70°C from ambient water temperature from 27°C)	=	215000	kCal/day
2]	Fuel used currently for hot water generator	=	Wood	
3)	Calorific Value of currently used fuel	=	3000	kCal/kg



4)	Specific Gravity Considered for Fuel	=	1	
5)	Expected Saving of Currently used fuel considering hot water generator eff. Of 65%	=	110.26	kg/day
6)	Cost of Fuel on day of computation	=	2.5	Rs./kg
7)	Expected Saving of Fuel per Annum (Considering effective full working day for solar system to be 300 days only)	=	33078	kg/annum
8)	Expected Saving of Fuel per Annum (Considering effective full working day for solar system to be 300 days only)	=	33078	ltrs/annum
9]	Expected Saving in Rs/annum	=	82695	Rs./annum
10]	Expected Investment for Solar Heating System with Insulated Storage Tank, Pipe lines and associated insulation	=	750000	Rs./Machine
11)	Simple Payback Period	=	9.07	Yrs
		=	109	Months

### ECM-3 Replacement of conventional tube lights with energy efficient ones

In maintenance & facility areas about 78 numbers Fluorescent TL with 40W and 36 W with conventional ballast is provided. The conventional ballast consumes about 12 W, which is nearly 33% of lamp wattage. The electronic ballast consumes only 2W and has additional advantage of wide voltage variation, enhances life of the Fluorescent tube. Further the T5 lamp with electronic ballast would consume about 30 W as against 52 W by fitting with normal ballast, without compromise in the lux level.



1)	Total Number of FTL with Conventional Magnetic Ballast	=	21	Nos.
2)	Working Hours for these FTL/day	=	12	hrs/day
3)	Existing Consumption by these FTL	=	13.1	kWh/day
4)	Expected Saving by Providing Electronic Ballast / T5 FTL / CFL (Expected saving of 25%)	=	3.28	kWh/day
5)	Expected Savings in kWh/annum	=	1181	kWh/annum
6)	Cost of Electricity	=	5.5	Rs./kWh
7)	Expected Saving per Annum (Considering 360 Working Days)	=	6494	Rs./annum
8)	Expected Investment Needed for Retrofit	=	17850	Rs.
9)	Simple Payback	=	2.75	Yrs
		=	33	Months

### 3.8 AVAILABILITY OF TECHNOLOGY SUPPLIERS/LOCAL SERVICE PROVIDERS FOR IDENTIFIED ENERGY CONSERVATION PROPOSALS

The technology recommended in the detailed energy audit is easily available. Various manufacturers of the energy efficiency improvement products, systems have already been contacted & discussion held with them regarding the applicability, feasibility & expected lines of implementation. The PCRA team does not foresee any problem in availing the recommended technology within nation market itself. India is one of the major dairy product producers in the world having good infrastructure for dairy development & dairy technology. Batteries of manufacturers are available for implementation of energy conservation as well as technological up gradation measures.

**Details of the identified technology supplier/local service providers in Gujarat (Dairy) SME Cluster are furnished as per Annexure 2**

### 3.9 IDENTIFIED TECHNOLOGIES FOR DPR PREPARATION

For selecting the technologies & products for DPRs, energy efficiency & technological up gradation was prime criteria. Some measures are resulting in better saving of and some measures on long term will induce a better technology in the units of cluster. During field study and during discussion the feedback received from various unit managements was also at the core of the selection of DPR. Various other factors such as cost of implementation, possibility of capacity building of LSP etc was also considered while selecting the technologies for DPR.

Item/Description	Potential for Replication in No. of Units
Energy saving in Ammonia compressor motor by providing soft starter with energy saver at part loads (During modulation at lower loads due to firing of one or two cylinders only)	21
Energy saving by improving efficiency of condenser water circulation pumps by providing the glass flake coating to pump impellers and to pump casing.	12
Upgrading conventional pneumatic pouch filling machine by PLC based mechanical pouch filling machine which saves energy.	6
Energy saving in refrigeration system by providing Thermal energy storage system in place of conventional IBT (Ice Bank Tank) system.	22
Energy Saving by replacing existing heavier metallic cooling tower blade with lighter FRP blades.	7
Methane Capture from Effluent & Utilization as fuel for boiler /	3



Hot air generator.	
Energy saving by replacing older lower efficiency electric motor with energy efficient motor of at least EFF1 level.	15
Waste heat recovery by providing De-super heater in ammonia vapor compression based refrigeration system.	14
Improvement in steam & Hot water pipe line insulation to prevent thermal energy loss.	22
Improvement in chilled water pipe line insulation to prevent the heat ingress and thus energy loss.	22
Energy saving by improving transmission efficiency in chiller compressor and other machines by providing cogged belt in place of conventional V-belt (For Reciprocating Chiller Compressors).(deletion)	21
Replacing reciprocating compressor (with higher specific power consumption) by screw compressor with VFD to save energy.	5
Maintaining unity PF to get maximum PF incentive along with reducing line losses and improve terminal voltage.	15
Energy Saving by utilization of renewable solar energy for hot water generation.(2)	12
Energy saving in lighting system by providing T5 type FTL and or CFL in place of conventional FTL with magnetic ballast. Also providing luminaries for improvement in lighting system performance. Also Replacing Mercury Vapor Lamps with Metal Halide Lamps.(deletion)	22

## 4.1 SYSTEMATIC APPROACH FOR ENERGY CONSERVATION BY TEM/SGA

### 4.2 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.

Special importances of Energy Conservation are the following two aspects:

- (1) Economic factors
- (2) Environmental impacts

#### 4.2.1.1 Economic factors of Energy Conservation

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

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

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

- Ü 1974: setting up of fuel efficiency team by IOC, NPC and DGTD (focus still on industry)
- Ü 1975: setting up of PCAG (NPC main support provider) : focus expanded to include agriculture, domestic and transport
- Ü 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
- Ü 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)

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

#### **4.2.1.2 Environmental impacts of Energy Conservation**

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

### **4.3 TOTAL ENERGY MANAGEMENT (TEM)**

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

(1) Top management policy/Goal

- Ü Develop a policy statement
- Ü Set targets

(2) Proper EC Organization including Assignment of Energy Manager

- Ü Establish proper EC organization (utilizing SGA)
- Ü Assignment of Energy Manager

(3) Data collection and Analysis

- Ü Collect data on current energy use
- Ü Analyze the collected data

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

(4) Selecting EC Measures/Projects

- Ü Selecting EC Measures
- Ü Selecting EC Projects
- Ü 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.

Each step is explained in this order as below:

#### **4.3.1 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 companies clearly know 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.

**4.3.2 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.

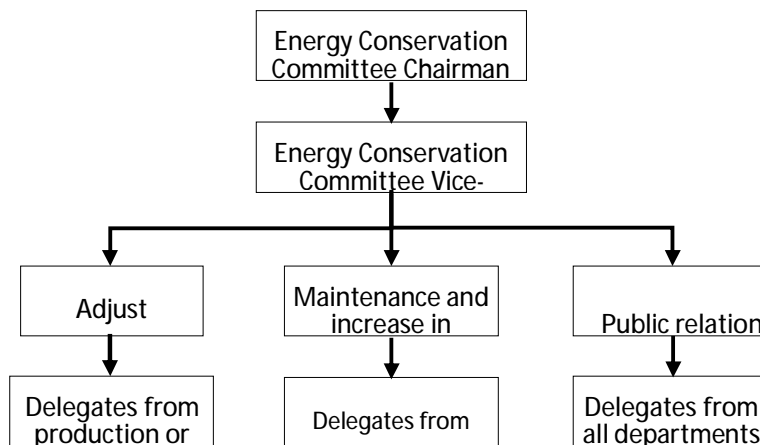


Figure 3 Example of Energy conservation committee

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?")

### 4.3.3 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:

- Ü Insufficient understanding and support by top management
- Ü Insufficient understanding and cooperation of managers within factories
- Ü Insufficient awareness of people to get successful results
- Ü Insufficient capability of people due to lack of training
- Ü Insufficient available technology due to lack of information
- Ü Insufficient availability of manpower for EC activities within factories
- Ü 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.

#### **4.3.4 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.

#### **4.3.5 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.

#### **4.3.6 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 8 : 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. Prayant		
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		

**4.3.7 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.

**4.3.8 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 9 : 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						*		-	

#### 4.3.9 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.

#### 4.3.10 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.

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

- Ü 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.

**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.)

**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.)

**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.

#### **4.3.11 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, are it in "man, material, method, or machine," and develop cost-effective and practical methods for solving the problem.

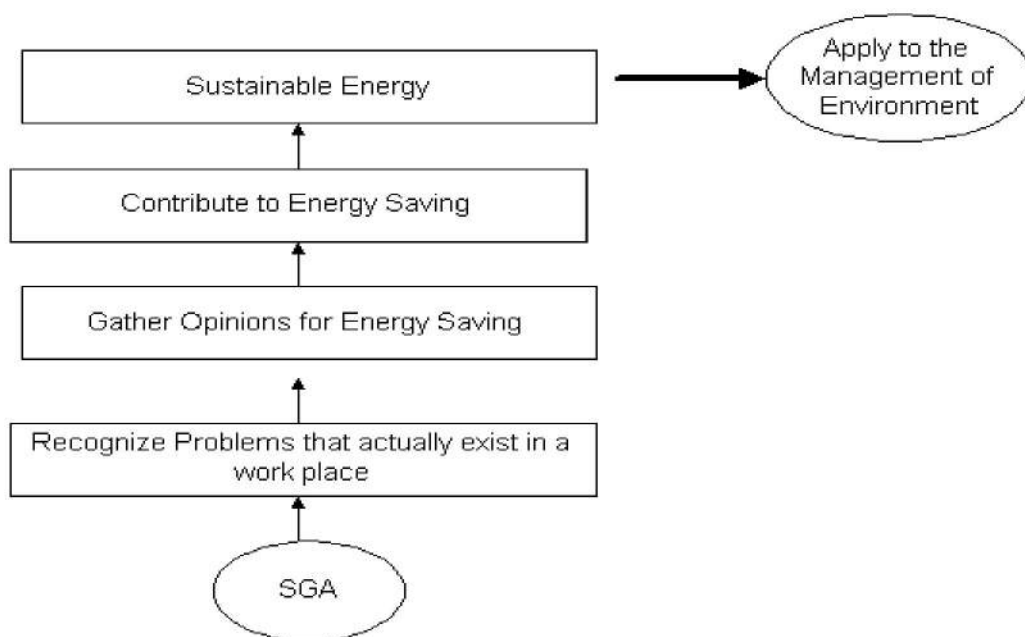
#### **4.4.1.1 Importance of SGA**

SGA are activities by group of employees at operator (working Group) level. They aim to solve problems that occur at the place taken care of by each employee and put emphasis on participation and team work. Factories can apply small group activities to many kinds of work along with normal work or other measures that are already underway. The burden on employees will not increase because of small group activities. They are not only bringing benefits to factories but also boosting the knowledge and ability in

performing jobs of employees, improving communication among employees, increasing creativity, and make it possible to express their own proposal with less hesitation to management. As a result, employees will start to think “This is our problem.” This SGA can be applied to Energy Conservation, too, with successful results, as shown in Figure 13.

#### 4.4.1.2 How SGA leads to Energy Conservation?

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

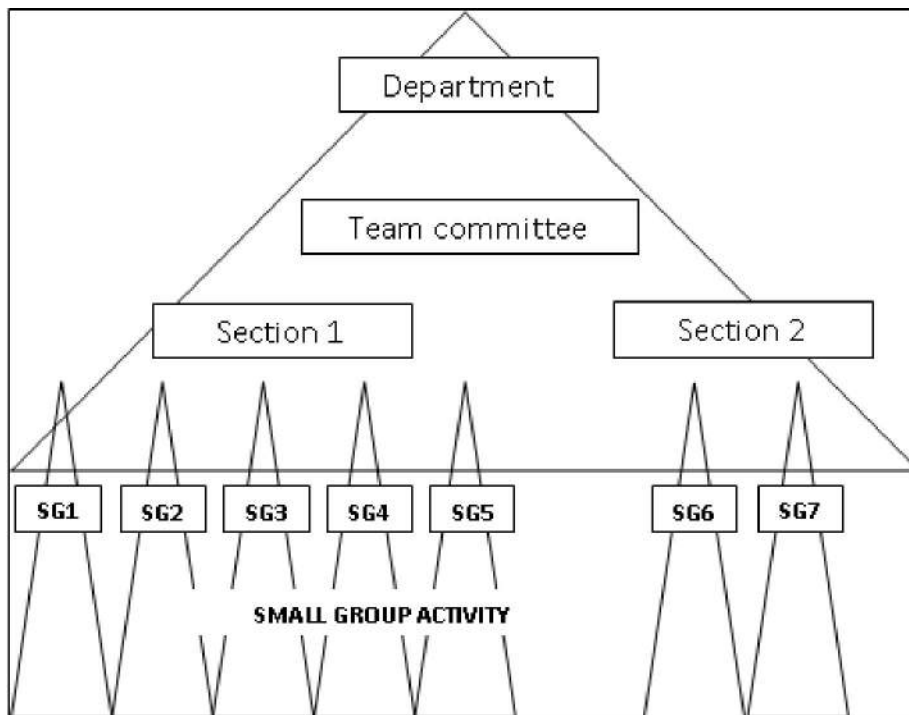


**Figure 7 : Relationship of SGA and energy saving**

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

Small group activities for TEM can be divided into 4 or 5 levels depending on the scale of the organization. This division is in order to emphasize the fact that everyone must improve in their job under the responsibility to each other. It also enables us to make improvement without overlapping. The following example shows utilizing the existing job-related organization as much as possible, as already mentioned in Part 2, 2.”Strategy

for Improving the Efficiency of Energy Usage further”, Step 2 Proper EC Organization including Assignment of Energy Manager (page 12).



**Positioning of SGA in Main Job Structure**

#### 4.4.13 Executives level

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

#### 4.4.14 Level of Total Energy Management promotion office

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

#### 4.4.15 Medium level

- Ü Define the policies of each department that are consistent with the policy of the Total Energy Management and the target of the company

- Ü Define numerical targets to sub-groups apart from the target of the company as a whole
- Ü Follow-up the progress in order to provide to sub-groups
- Ü Report the progress along with suggestions and opinions to upper level committee periodically

#### 4.4.1.6 Workers/Operators level

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

#### 4.4.1.7 Responsibility of Energy Conservation committee

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

### 4.5 STEPS OF SMALL GROUP ACTIVITIES FOR ENERGY CONSERVATION

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

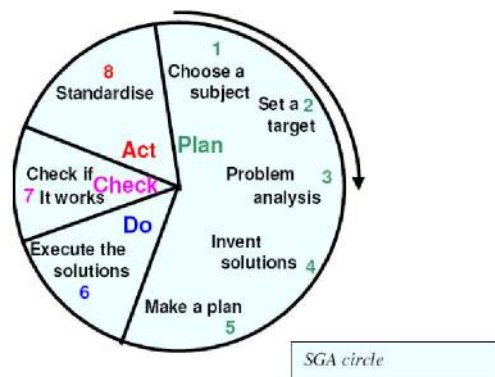
Plan: Make an efficient plan in order to improve operation

Do: Implement according to the plan

Check: Check if implementation was according to the plan

Act: Judge what to improve, what to learn and what to do from what we have checked

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



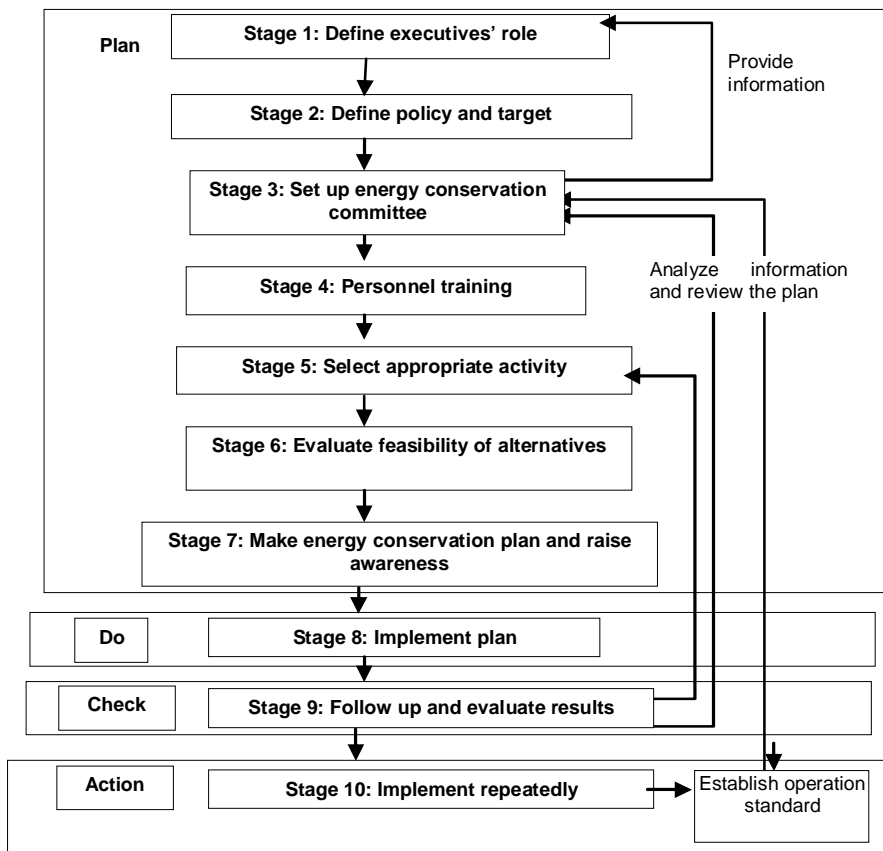
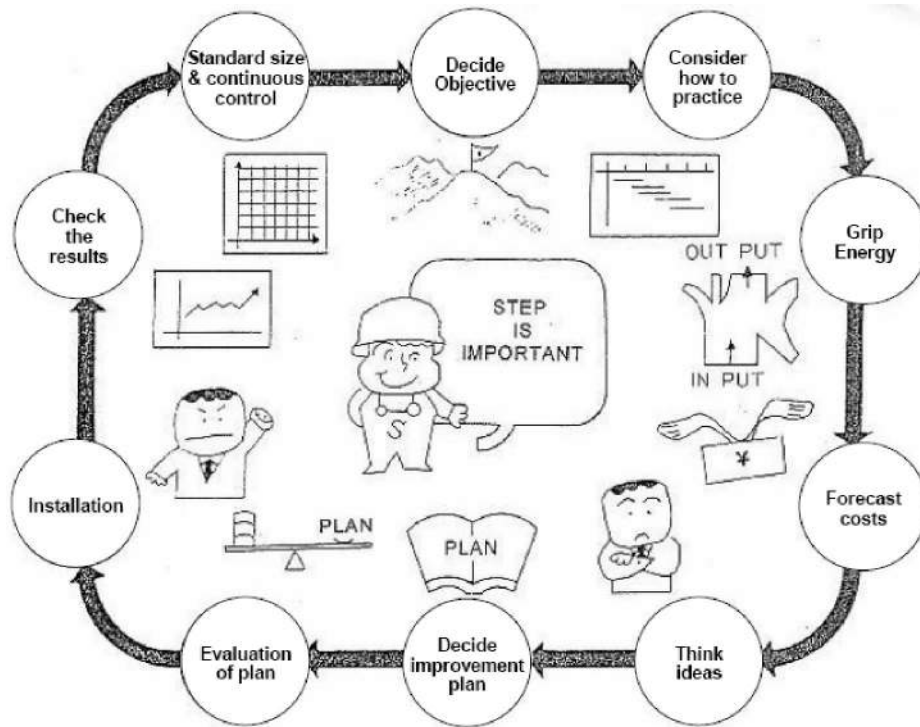


Figure 8 : 10 Stages for Success



#### 4.5.1.1 Stage 1: Define Executive's Role

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

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

#### 4.5.1.2 Stage 2: Define Policy and Target

- Ü Executives must announce a policy of supporting small group activities.
- Ü 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.

#### 4.5.1.3 Stage 3: Set up Energy Conservation Committee

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

#### 4.5.1.4 Stage 4: Personnel Training

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

#### 4.5.1.5 Stage 5: Select Appropriate Activity

In doing small group activities, each member must be able to think, express their own ideas, and make decisions based on reality and by investigating electrical equipment, machines, and office equipment that exist in the area of their responsibility. Items to consider include size, number, where to use, situation of usage, current situation, and the number of hour's 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.



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

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

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

We have identified the following problems through small group activities.

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

#### **4.5.1.7 Stage 7: Make Energy Conservation Plan and Raise Awareness**

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

#### **4.5.1.8 Stage 8: Implement Plan**

Implement according to the plan of each group.

#### **4.5.1.9 Stage 9: Follow Up and Evaluate Results**

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

#### **4.5.1.10 Stage 10: Implement Repeatedly**

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

#### **Dos and Don'ts in Energy Conservation**

- Ü Don't emphasize the mistakes in the past. It is better to talk about the present.
- Ü Don't be worried about the theory or principles. Don't spend too much time in discussion or analysis of problems in meeting rooms.

- Ü 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.
- Ü Do start with an activity that requires small amount of investment.
- Ü Do Raise awareness so that all employees understand the necessity and importance of energy conservation and participate in it.
- Ü Do start the activity now without postponing to tomorrow.

#### 4.5.1.11 Tools that are Used Often for Small Group Activities for Energy Conservation

#### 4.5.1.12 5S

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

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

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

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

**3. Seiso / Brush away/ Sweep-**  
Examine all 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.

**4.5.1.13 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.



## 5.1 ENVIRONMENTAL BENEFITS

One of the measure for capture of methane from effluent & its productive use as fuel, recommended in the cluster development has CDM potential. The methane capture from Effluent by anaerobic digestion results in methane generation which is used as fuel for boiler. Methane is one of the undesirable gases from effluent. Along with direct hazard to human health, methane is potent green house gas. While the contribution from dairy effluent ponds is relatively small, increasing concern about climate change means that reducing emissions of greenhouse gas is a priority wherever feasible. The opportunity to capture methane and recover energy is becoming increasingly attractive. Every cubic meter of methane captured and burnt reduces its global warming potential and yields approximately 36 MJ or 10 kWh of energy. Around one-third of the typical dairy's energy consumption results from producing hot water. Biogas fired boilers are commercially available and can convert 80 to 90% of the energy in the methane into thermal energy. Natural gas boilers may be modified to run on biogas. As per recent data published by International Institute for Energy Conservation, the opportunity of methane capture & its productive use potentials are good.

***CH<sub>4</sub> emission mitigation in organized sector alone is very high***

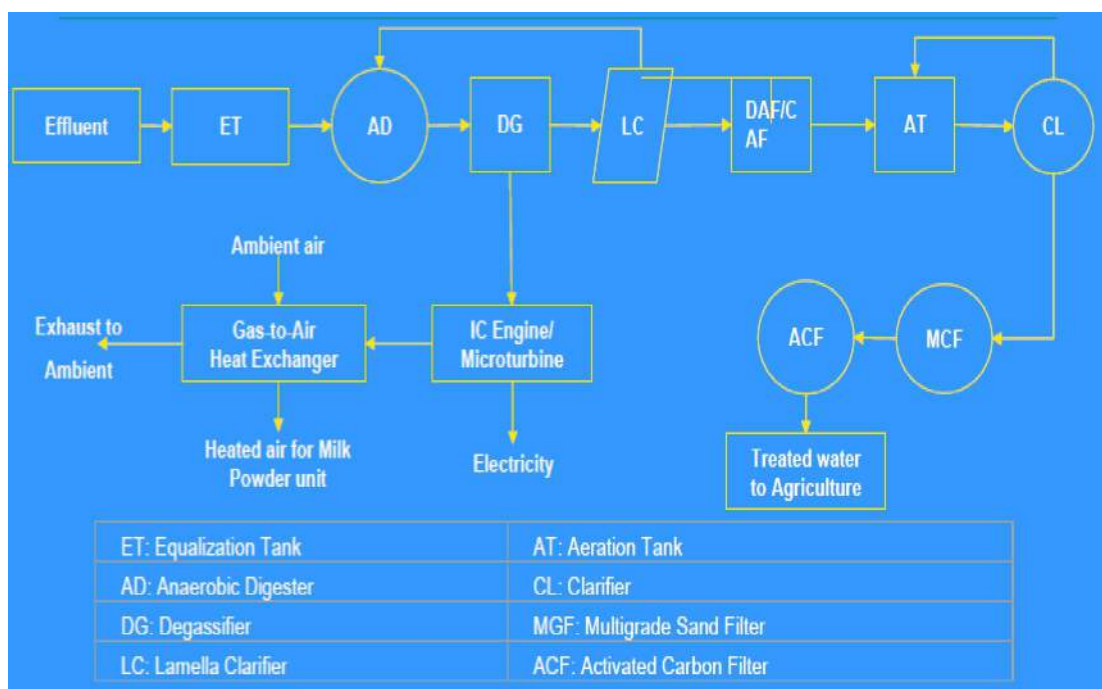
<b>Organized sector milk production</b>	<b>12.3 × 10<sup>6</sup> tons/year</b>
<b>Biogas generation potential</b>	<b>50 × 10<sup>6</sup> m<sup>3</sup>/year</b>
<b>Electricity generation potential</b>	<b>80 MUs/year</b>
<b>Oil equivalent</b>	<b>28,800 tonnes</b>
<b>Methane emission reduction</b>	<b>23,075 tonnes</b>

*Electricity generation potential = 80 MUs  
CH<sub>4</sub> mitigation = 23,000 tonnes*

The above figures are self explanatory regarding the potential of methane capture & its productive use in dairy industry in India. Considerable amount of energy can be recovered from methane & above all the hazardous methane emission can be reduced. The existing aerobic type effluent treatment consumes electricity which is also saved in anaerobic methane capture method. Recent data published by International Institute for Energy Conservation suggest few following facts.

- **Potential assessment for a typical dairy in Maharashtra**
  - **Waste water generation** 1000 m<sup>3</sup>/day
  - **COD** 2000-3000 mg/lit
  - **Biogas generation potential** 823 m<sup>3</sup>/day
  - **Electricity generation** 1317 units/day
- **Initial investment (considering ETP exists)** Rs. 5 Mio (approx.) (\$ 125,000)
- **Net saving potential** up to Rs. 16.5 lacs/yr (\$ 41,250)
- **Simple payback (with waste heat capture)** 3.03 years

Though the methane captured can be utilized directly for boilers with some modifications, other option such as electricity generation cannot be ruled out. For a typical methane capture scheme, offering combination of electricity & process heat option for a typical dairy can be explained by a schematic diagram given below-



India being largest producer of milk in the world with annual milk production of approximately 98.3 million tons (Yr.2006), with annual growth rate of 4% has tremendous potential in methane capture for productive use. The methane capture & productive use have positive impact on environment & have currently CDM potential.



## 5.2 GHG REDUCTION

The result of the cluster development is saving of 1176 per annum. The figure itself indicates the effect of this on GHG emission, environmental impact and thus reduction in pollution related issue. Various measures directly & many time indirectly results in reduction GHG gases. All proposed energy conservation measures will have less energy consumption or fuel consumption compared to conventional/existing technology/equipment consumption, these automatically leads to reduction of GHGs emissions. Reduction of GHGs emissions leads to improved environment and better compliance with environmental regulations

After implementation of proposed energy conservation measures will reduce the grid electricity consumption, natural gas and non renewable wood. Major GHGs emission reduction due to saving of grid electricity and fuels is CO<sub>2</sub>, reduction of other GHGs are negligible.

## 5.3 IMPROVED WORKING ENVIRONMENT

Due to energy saving, utilization of renewable sources of energy, methane capture, use of energy efficient products will have very good & positive impact on environment. Indirectly it reduces Burdon on environment & helps in reducing Green House effect & thus global warming. Before the Industrial Revolution, human activities released very few gases into the atmosphere and all climate changes happened naturally. After the Industrial Revolution, through fossil fuel combustion, changing agricultural practices and deforestation, the natural composition of gases in the atmosphere is getting affected and climate and environment began to alter significantly. By reducing energy consumption we can reduce the effect of global warming.

## 6.1 CONCLUSION

## 6.2 SUMMARY

In this section summary of energy use and technology studies conducted in Gujarat (Dairy) SME Cluster is discussed, which include identified energy conservation measures, its energy & monetary benefits, payback period, issues in implementation are discussed. Details of the same are furnished in table below:

**Table 10 : Summary of Maintenance/General House keeping proposals in Gujarat (Dairy) SME Cluster**

S. No	Housekeeping practices/No cost energy conservation measures	Issues in implementation
1	Proper tightening/tensioning of belts in various drives	Ü Lack of awareness EC measure
2	lubrications of gear systems	Ü Lack of awareness EC measure
3	Cleaning of compressor filters regularly	Ü Lack of awareness EC measure
4	Switch off the lights after completion of work	Ü Lack of awareness EC measure
5.	Continuous monitoring of Compressed air leakage	Ü Lack of awareness EC measure

Table 11 : Summary of energy saving proposals in Gujarat (Dairy) SME Cluster

SN	Name of Measure	Annual Energy Saving in kwh/annum	Annual Fuel Saving in kgs/annum	Annual Monetary saving (Rs. lakh)	Implementation Cost (Rs. lakh)	Simple payback period (years)	Applicable to number of units in cluster (Nos.)	Annual Cluster Saving Potential of particular EC Measure (Rs. lakh)
1)	Waste heat recovery by providing De-super heater in ammonia vapor compression based refrigeration system.	1050782.4	--	64.41	55	0.85	14	128.82
2)	Improvement in steam & Hot water pipe line insulation to prevent thermal energy loss.	--	186764.22	25.64	5	0.2	22	80.58
3)	Improvement in chilled water pipe line insulation to prevent the heat ingress and thus energy loss.	263376	--	16.13	8	0.5	22	50.69



4)	Energy saving by improving transmission efficiency in chiller compressor and other machines by providing cogged belt in place of conventional V-belt (For Reciprocating Chiller Compressors).	154512	--	9.62	3	0.31	21	33.67
5)	Replacing reciprocating compressor (with higher specific power consumption) by screw compressor with VFD to save energy.	91332	--	5.42	25	4.61	5	9.03
6)	Reducing operating pressure of compressed air system by providing properly size compressed air pipe line along with ring mains, primary and secondary vessels.	17510.4	--	1.06	4	3.77	5	1.77
7)	Energy saving by condensate recovery for boiler.	--	25444.8	7.37	9	1.22	4	14.74

8)	Energy Saving by avoiding Idle running of agitator of Milk Cylo by interlocking working of agitator with level of milk inside cylo.	21060	--	1.1	4	3.64	1	1.1
<b>Total Energy/Cost reduction possibility using proposed recommendations in the Gujarat (Dairy) SME Cluster</b>								<b>320.4</b>

Table 12 : Summary of EC & Technological Up-gradation proposals in Gujarat (Dairy) SME Cluster

SN	Name of Measure	Annual Energy Saving in kwh/annum	Annual Fuel Saving in kgs/annum	Annual Monetary saving (Rs. lakh)	Implementation Cost (Rs. lakh)	Simple payback period (years)	Applicable to number of units in cluster (Nos.)	Annual Cluster Saving Potential of particular EC Measure (Rs. lakh)
1)	Energy saving in Ammonia compressor motor by providing soft starter with energy saver at part loads (During modulation at lower loads due to firing of one or two cylinders only)	232344	--	14.5	6	0.41	21	50.75
2)	Energy saving by improving efficiency of condenser water circulation pumps by providing the glass flake coating to pump impellers	90460.8	--	5.44	9	1.65	12	16.32

	and to pump casing.							
3)	Upgrading conventional pneumatic pouch filling machine by PLC based mechanical pouch filling machine which saves energy.	63360	--	3.6	28	7.78	6	10.8
4)	Energy saving in refrigeration system by providing Thermal energy storage system in place of conventional IBT (Ice Bank Tank) system.	569160	--	34.88	283	8.11	22	109.62
5)	Energy Saving by replacing existing heavier metallic cooling tower blade with lighter FRP blades.	16200	--	1.04	1	0.96	7	3.64
6)	Methane Capture from Effluent & Utilization as fuel for boiler / Hot air generator.	--	352870	122	325	2.66	3	183
7)	Energy saving by replacing older lower efficiency electric motor with energy efficient motor of at least	332899.2	--	20.63	38	1.84	15	61.89

	EFF1 level.							
8)	Energy Saving by replacing existing conventional gear box based drive arrangement along with squirrel cage motor for CT Fan by permanent magnet motor & Drive.	6318	--	0.34	1	2.94	3	1.02
<b>Total Energy/Cost reduction possibility using proposed recommendations in the Gujarat (Dairy) SME Cluster</b>								<b>437.04</b>

Table 13 : Summary of Other energy conservation proposals in Gujarat (Dairy) SME Cluster

SN	Name of Measure	Annual Energy Saving in kwh/annum	Annual Fuel Saving in kgs/annum	Annual Monetary saving (Rs. lakh)	Implementation Cost (Rs. lakh)	Simple payback period (years)	Applicable to number of units in cluster (Nos.)	Annual Cluster Saving Potential of particular EC Measure (Rs. lakh)
1)	Maintaining unity PF to get maximum PF incentive along with reducing line losses and improve terminal voltage.	--	--	8.85	10	1.13	15	22.13
2)	Energy Saving by utilization of renewable solar energy for hot water generation.	--	94896	8.95	38	4.25	12	21.48

<p>3) Energy saving in lighting system by providing T5 type FTL and or CFL in place of conventional FTL with magnetic ballast. Also providing luminaries for improvement in lighting system performance. Also Replacing Mercury Vapor Lamps with Metal Halide Lamps.</p>	<p>62287</p>	<p>--</p>	<p>3.74</p>	<p>9</p>	<p>2.41</p>	<p>22</p>	<p>11.75</p>
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### 6.2.1 Summary of Level of Awareness on Energy Efficiency & Energy Conservation Products in the Cluster

The overall energy efficiency awareness among various units under cluster is improving continuously. As energy audits are mandatory and its implementation to certain extent is also regularly previewed by Gujarat Government, the overall awareness regarding energy saving is improving. Also various agencies like PCRA which are dedicated for energy conservation are regularly spreading the awareness through their various programs.

Still many more efforts can be done at various levels to achieve awareness of higher level. The increased population of engineers in dairy sector will definitely help this cause. Workshops, seminars for higher management, middle level management, engineers, technicians & workers will further improve awareness among the sector. Level of awareness on energy efficiency and energy conservation products in the units of cluster may be lower in few cases (smaller dairies), due to below mention reasons.

- Ü Lack of awareness on the Energy efficiency
- Ü Lack of organizational commitment
- Ü Narrow focus on Energy
- Ü Not clear about their existing level of operations and efficiency, due to lack of instrumentation & non availability of Energy consumption data
- Ü Limited manpower
- Ü Lack of trained manpower
- Ü Limited information on new technologies
- Ü Cost of Energy conservation options

Major energy sources being used in cluster are the Electrical energy and Diesel. Annual electrical energy consumption and Diesel Consumption in Bangalore cluster is around **2,26,79,100 kWh** and **99,376 litres** respectively. Total energy consumption in the Bangalore Machine Tool cluster is around **85,196 GJ**. After implementation of proposed energy conservation measures, the possibilities of reduction in energy consumption is to the tune of **36,55,563kWh**, and reduction in cost of the cluster is estimated to be about Rs. 2664 per annum. However this implementation will require the investment of Rs. 11376 initially. The payback period estimated for these proposals is about 4.2 years, which is very acceptable to the cluster

## List of Annexure

### ANNEXURE – 1: DETAILED TECHNOLOGY ASSESSMENT REPORT

Most of the units in Gujarat (Dairy) Cluster are of co-operative based units with few privately owned units. The units can be classified as milk chilling centers & Dairies. This 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. Comprehensive Study conducted at various Gujarat (Dairy) cluster to assess the technology gap in different processes and utilities. The various factors, which influence the management towards implementation energy efficiency and energy conservation projects in Gujarat (Dairy) cluster, are:

- Ü Energy efficiency and energy conservation is low cost investment option which reduces energy consumption
- Ü The energy efficiency improvement will enhance the plant management to be competitive in local and global markets by reducing production cost
- Ü The energy efficiency and conservation measures reduces GHG emissions because of low carbon dioxide and particulate emissions
- Ü Energy efficiency and conservation is a viable strategy to meet future energy needs of the expanding plans in the industry
- Ü The energy efficiency and conservation places no financial and administrative burden as no separate manpower is required and only training of operation and maintenance of the technologies adopted is envisaged.
- Ü The return on investment is attractive with lower pay back periods.

Technical gap analyses in below mentioned areas are identified and details are presented below sections:

Equipments/Systems	Areas/Operation
Ice Built Tank	Refrigeration System
De-super Heater (Waste Heat Recovery)	Refrigeration System
Methane Capture Anaerobic Digester	ETP & Process
Soft Starter with Energy Saver for Ammonia Compressor	Refrigeration System



**Ice Built Tanks:-**

The thermal losses & operational losses of conventional ice built tank, which acts as thermal storage system for milk chilling centers & dairies, found to be on higher side. Detailed study of the existing IBT tank losses for various locations at various ambient conditions carried. The conventional IBT (Ice Bank Tank) system is provided in all the milk chilling center and dairies for thermal storage purpose. IBT tank acts as buffer for thermal energy & as ice bank.

The main losses in the IBT tank are

- Ü Higher thermal losses as the existing IBT tank is not air tight arrangement.
- Ü Higher energy consumption as agitator (Stirrer) which consumes additional energy and induces heat by way of churning.
- Ü Bulky Size due to which overall constructed area needed in higher.
- Ü Low thermal storage capacity.
- Ü TOD Benefits cannot be availed.

Based on the data measured/collected from the plant during energy audit, the calculation details of loss for typical unit, carried in winter season are as given below –

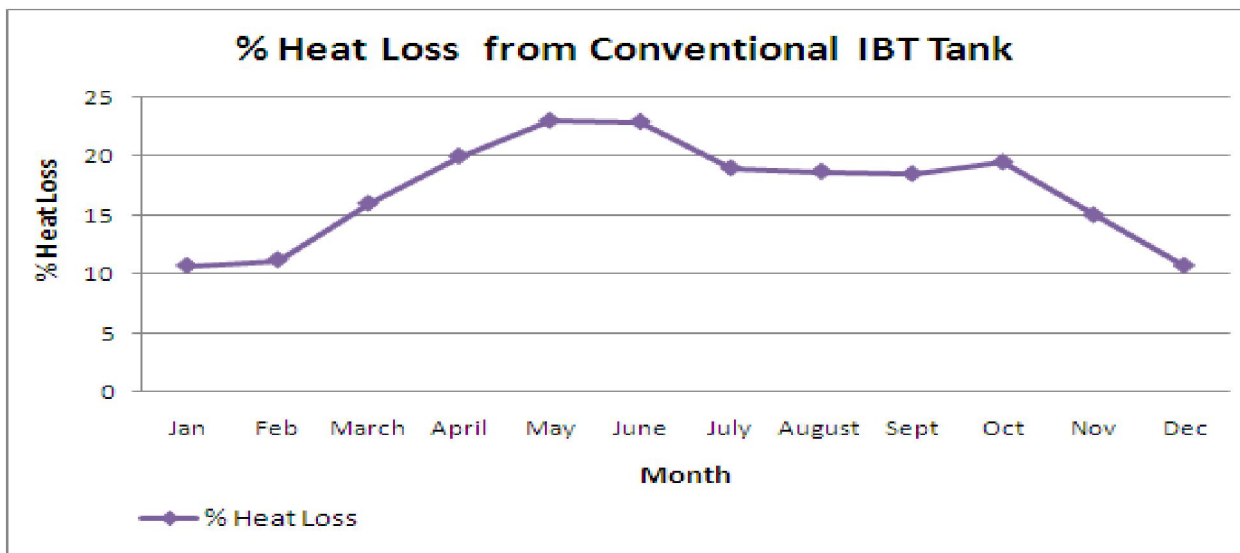
IBT Tank Particulars	L mtrs	W mtrs	H mtrs	Volume m <sup>3</sup>	Initial Time	Initial Temp in °C	Final Time	Final Temp in °C	Total Heat in kCal	Heat Loss in kCal	Time in hrs	% Loss
IBT Tank No.1	7.2	2.8	2.8	56.45	2.30 pm	1.6	4:00 PM	1.8	90320	11290	1.5	8.33
IBT Tank No.2	7.2	2.8	2.8	56.45	2.30 pm	1.5	4:00 PM	1.7	84675	11290	1.5	8.89
IBT Tank No.3	7.2	2.8	2.8	56.45	2.30 pm	1.5	4:00 PM	1.7	84675	11290	1.5	8.89
			<b>Total</b>	<b>169.35</b>					<b>259670</b>	<b>33870</b>	<b>Av.</b>	<b>8.7</b>

The above calculated losses are calculated in Jan-2010 i.e. winter season. The losses in summer will be on higher side. Please refer losses calculated in summer i.e. June-2010 are as given below-

IBT Tank Particulars	L mtrs	W mtrs	H mtrs	Volume m <sup>3</sup>	Initial Time	Initial Temp in °C	Final Time	Final Temp in °C	Total Heat in kCal	Heat Loss in kCal	Time in hrs	% Loss
IBT	4.42	4.05	1.768	31.7	3.30	0.9	6.00	1.3	28530	12680	2.5	17.8

Tank No.1					pm		pm					
IBT Tank No.2	5.09	5.06	1.89	48.71	3.30 pm	1	6.00 pm	1.7	48710	34097	2.5	28
IBT Tank No.3	Under Repair & Maintenance											
			<b>Total</b>	80.41					77240	46777	<b>Av.</b>	<b>22.9</b>

Thus it is clear that, the losses vary with season. Please refer following chart for assessing yearly pattern of loss.



It can be seen from above data that the direct average thermal losses are 8.7%. Apart from direct thermal losses other losses are stirrer losses due to agitator provided, losses in electrical energy of ammonia compressor as subjected to part load operation many times due to lower capacity of existing thermal storage system. Also for HT consumers, electricity Supply Company provides TOD benefits. These benefits cannot be availed by the industry employing IBT tanks.

**De-super Heater (Waste Heat Recovery)**

The refrigeration system is basically a heat pump, which pumps heat from lower temperature to higher temperature. As lower temperature is required for refrigeration needs, the waste heat pumped out can be used for to save energy by using De-super heater.

The study carried during preliminary & detailed energy audit field study focused on amount of waste heat available from vapor compression ammonia system. For calculating the details, temperature of ammonia gas post compression monitored, amount of actual TR generated by the vapor compression ammonia system studied.

Capacity of Existing VC Cycle Compressor (Working or on-load. But Actual average load may be lower due to load modulation)	=	472.5	TR
Working Hours for Compressor/day	=	20	hrs/day
Ambient Water Temperature	=	30	°C
Temperature of Hot NH3 Gas available for WHR from Desuperheater	=	94	°C
Waste Heat Available from Desuper Heater (Considering 12% WHR possible in De-super heater i.e. 12% of total kWh consumed can be recovered)	=	63107	kCal/hr
Expected Temperature of Hot water from De-super heater (Considering Flow Rate and Design of De-super heater to get 65°C hot water for winter conditions)	=	65	°C
Quantity of Hot Water Available	=	1803	ltrs/hr
Total Quantity of Hot water that can be generated from De-super heater	=	36060	ltrs/day
<i>Thus Total Hot water at 65 °C can be generated</i>	=	36.06	kill/day

### Methane Capture Anaerobic Digester

Apart from energy saving, these measures have very positive impact on environment. The bio-degradable effluent have high COD which results in liberation of methane gas in to atmosphere which is not desirable. Conventional ETP method both consumes high energy along with liberation of methane in the atmosphere.

By various latest techniques such as anaerobic digestion and various other processes, this methane can be captured as fuel to be utilized either in boiler or hot air generator. Along with saving environment, considerable energy can also be saved.

The field study carried primarily focused on following aspects of existing untreated effluent –

- Ü Quantity of Untreated Effluent Available
- Ü Various parameters of untreated effluent like BOD, COD etc.

Untreated Effluent Data			
BOD	=	2500	mg/
COD	=	5000	mg/
Effluent Quantity	=	41666	ltrs/hr
<i>(1 kg=1000000 mg &amp; Considering for ETP, 1kg=1L tr)</i>			

Based on the above data, COD load per day is calculated. COD reduction considered is 80% based on which actual COD load and amount of methane capture per day is calculated. One of the measure for capture of methane from effluent & its productive use as fuel, recommended in the cluster development has CDM potential. The methane capture from Effluent by anaerobic digestion results in methane generation which is used as fuel for boiler. Methane is one of the undesirable gases from effluent. Along with direct hazard to human health, methane is potent green house gas.

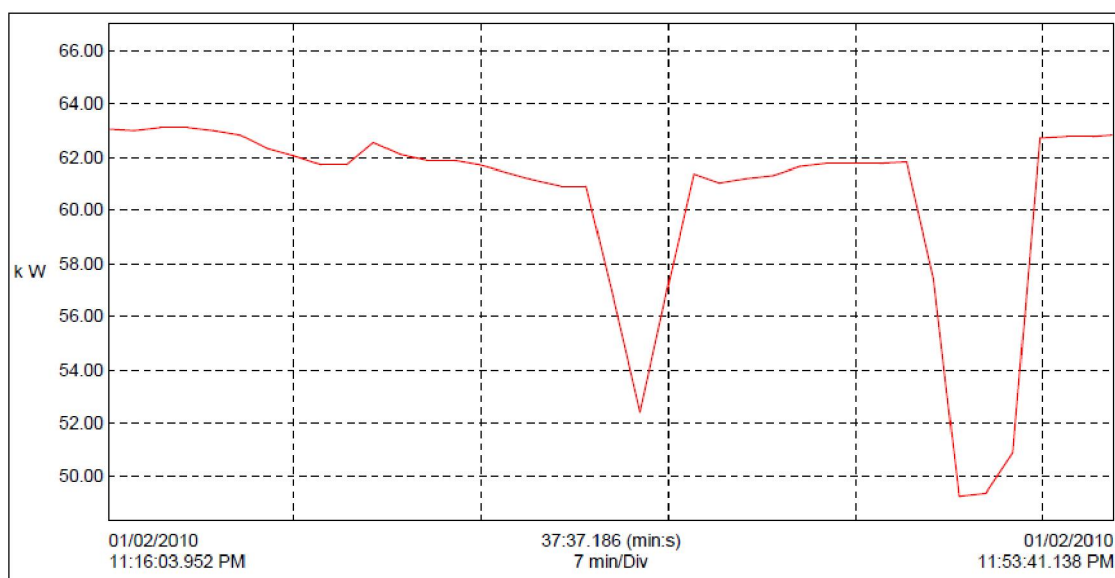
**The further details are already discussed in the chapter for environment in this manual.**

### Soft Starter with Energy Saver for Ammonia Compressor

The energy audit of ammonia compressor was carried. Various parameters such as actual kwh consumed by compressor motor, suction pressure, discharge pressure, suction temperature, discharge temperature, RPM of compressor etc measured. Also one of the important aspect of the compressor i.e. part load operations also studied.

For energy saving in ammonia compressor, apart from other aspects part load operations of the ammonia compressor also studied. The ammonia compressors are subjected to part loads during entire course of operation due to various reasons such as fluctuating demand, variation in ambient condition due to day, night, seasonal variation etc. The other important aspect is during peak time (milk receipt) time, the demand of chilled water is highest but at other time demand is low. All these factors contribute to part load operation of ammonia compressors at many times during entire day cycle.

Detailed data logged for compressor motor for a dairy and load profile is generated as given below –



**Figure 9 : Load Profile of Compressor**

The part load operation by bye-passing of number of cylinders of compressor is reflected in terms of drop in kWh consumption. The field study

SN	Ammonia Compressor Particulars		Model	Motor Rated Kw	Measured Kw	Rated TR	Actual TR
1)	Comp. No.1	=	KC-4	75	53.5	60	40.8
2]	Comp. No.2	=	Sabroe (Equi. Of KC4)	75	57.9	60	44.4
3)	Comp No. 3	=	KC-4	75	56.8	60	40.8
4)	Comp No. 4	=	KC-3	45	44	45	29.7
			Total	270	212.2	225	155.7
	<b>Total Actual on Load</b>			120	97.5	105	70.5
	<b>Specific Power Consumption in kw/Tr</b>						1.38
	<b>For Milk Chilling Only</b>				53.5	60	40.8

The above data clearly indicate the consumption by ammonia compressor of refrigeration section. By providing soft starter with energy saver, energy at partly loaded motor of ammonia compressor can be saved. The energy saved by soft starter with energy saver due to –

- U Reduction in motor supply voltage at part loads.
- U Improved power factor.
- U Improved efficiency of motor at part loads.

## Annexure -2 : Details of Technology/Service Providers.

### Screw Type Air Compressors

- a) Atlas Copco  
401, Atma House, Opposite Reserve Bank  
Ashram Road, Ahmedabad, Gujarat  
380009  
079 30009693
- b) Ingersoll Rand (India) Ltd  
21-30, Gidc Estate, Naroda,  
Ahmedabad - 079 22820123
- c) Kaeser Compressors India Pvt Ltd  
21-30, Gidc Estate, Naroda,  
Ahmedabad - 079 22820123

### Solar Hot Water System Manufacturer

- a) Ankur Scientific Technologies Private Ltd.  
Ankur, Near Old Sama Jakat Naka,  
Sama Road, BARODA - 390 008,  
INDIA
- b) Urmi Solar System Limited  
Plot No. 2113, Phase - III, GIDC,  
Vatva, AHMEDABAD - 382 445,  
INDIA
- c) Tata BP Solar India Limited  
205, Abhishree, Opp. Iskon Mall,  
Satellite Road,  
Ahmedabad - 380 015

### Methane Capture

- Sun Enviro Technologies Pvt. Ltd.,  
178, Chhatrapati Nagar,  
Wardha Road, Nagpur - 440 015  
Maharashtra, India
- a) ENERGY OPTIONS INCORPORATION  
216, Krishna Con-Arch 2,

### Refrigeration related technology & Services including Thermal Storage System

- a) Refrecon Magic Systems Private Limited  
2<sup>nd</sup> floor, Airotek House, S. No. 37/3,  
Vadgaon Khurd, Sinhgad Road,  
Pune, Maharashtra - 411 041 (India)
- b) Cristopia Energy Systems  
303, Kothari Manor, 10 Diamond Colony,  
New Palasia, Indore,  
Madhya Pradesh - 452001 (India)
- c) Kehems Consultants Private Limited  
B-23, Monica Building, J. P. Road,  
Andheri West, Mumbai - 400 058,  
India
- d) IDMC Limited  
Plot No. 124-128, GIDC Estate,  
Vithal Udyognagar 388 121,  
Gujarat, India
- e) MODERN REFRIGERATION  
70, Anand Vyapari Sankool, Road  
No.33,  
Near E.S.I.S Hospital, Wagle  
Industrial Estate,  
Thane ( West), - 400 604, Maharashtra, India.

### Energy Efficient Electric Motors, VFD, Soft Starter with Energy Saver, PM motor drive for Cooling Tower

- a) Simens Ltd  
Shanti Chamber, Terapanth Marg,  
Income Tax Cross Road,  
Ahmedabad - 079 27546172
- b) Baldor Electric India Pvt Ltd

- Tagore Road, Godown Road Corner,  
Rajkot – 360002, Gujarat
- b) BIO ENERGY ENGINEERING  
MLS Business Centre, Panchasheel  
Tech Park, Hinjewadi, Pune – 57  
Maharashtra
- c) INDWA TECHNOLOGIES PVT. LTD.  
501, Topaz Building, Punjagutta,  
Hyderabad. (A.P.) – 500 082. INDIA.
- 19, Commerce Avenue,  
Mahaganesh Colony, Paud Road  
Pune – 411038
- c) Bharat Bijlee Ltd  
202 8/A, Arth Building, Rashmi  
Society, Mithakali 6 Road, Bh A K  
Patel House, Navrangpura,  
Ahmedabad - 079 25506846
- d) Kirloskar Brothers Ltd  
Opp. Railway Station,  
Dewas (MP) 455001

#### Pump Glass Resin Coating

- a) Kirloskar Corrocoat Private Ltd  
Sahakar Nagar, Pune 411009
- e) URJA TECHNIQUES (INDIA) PVT.  
LTD.

#### Boiler, Steam System & WHRS

- a) Thermax Ltd  
D-13, MIDC Industrial Area,  
R.D. Agra Road, Chnchwad  
Pune-411019
- b) Forbes Marshall  
4, Shetoor Bungalows, Opposite Drive  
In Petrol Pump  
Bodakdev, Ahmedabad, Gujarat  
380054
- B-17, SHRIRAM INDUSTRIAL ESTATE, G.  
D.AMBEDKAR ROAD, WADALA,  
Mumbai-400031, Phone:91-22-  
24160606/24150505

#### Thermal Insulation

- a) Lloyd Insulations  
386, Veer Savarkar Marg, Mumbai – 400025
- b) Se Woon T&S Co., Ltd; Dynaweld Engineering Company Private Limited 72/427, Vijaynagar,  
Naranpura, Ahmedabad – 380013
- c) NOVOTA INDUSTRIES  
2nd Floor, Sharada Sadan, S.G.Marg, Opp.Pritam Hotel, Dadar(East), Mumbai 400014.

**Note :-** Apart from above mentioned manufactures & Service providers, Other manufactures & service providers are also welcome to participate in the cluster development project. Till implementation additional LSP are expected.



## Annexure – 3 : Quotations for Techno-commercial Bids from service/technology providers

Date: 29.11.2010

Ref: SFIS/HQ/

To,

Kind Attn.:

Dear Sir,

### Sub: Proposal Thermal Energy System

We are pleased to submit hereunder our offer for Thermal Energy Storage System for Milk Chilling Unit at Kheralu.

#### 1.0 SCOPE OF SUPPLY & PRICE

Thermal Energy Storage System of 960 TR-HR capacity complete with M.S. Tank, Tank Insulation & Thermal Storage Nodules.

Interconnecting piping, valves and mechanical seal pumps

Price : Rs. 49,50,000/-

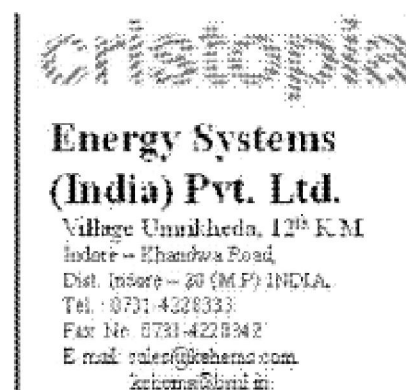
( Rupees Forty Nine Lacs Fifty Thousand Only )

#### 2.0 PRICE BASIS

Prices quoted are all inclusive at site basis.

#### 3.0 TAXES & DUTIES

Prices are Inclusive of Excise duty, VAT or CST against for C, Octroi / Entry Tax (if applicable), Transportation and handling charges



**CORRESPONDENCE ADDRESS:** 303, Kothari Mansar, 10, Diamond Colony, New Palasia, Indore -451 001 M.P., Ph. 2536624

**Mumbai:** B-25, Marine, 2<sup>nd</sup> floor, J.P. Road, Andheri (W) Mumbai -55 Ph. 26256856, Fax. 26241642, E-mail: mumbai@reheema.com

**Bangalore:** House No. 3462 1<sup>st</sup> 'A' Main, EAL II Stage, Indira Nagar, Bangalore -08 Ph. 25203185 Fax. 25203186, E-mail: bangalore@reheema.com

**Pune:** Flat No. 16-17, Ground Floor, Building 'F' Hari Parv Residency, Grina Bagh, Solapur Road/Pune-13, Ph. 6400797, E-mail: pune@reheema.com

**Noida:** C-191, Sector-10, Noida-201 304 Tel: 0120-4258731 / 3 Telefax : 0120-4258731 E-mail : rehemadelhi@gmail.com



*Shandilya Energy Systems Pvt. Ltd.*



Regd. Off. : B4/5, Utkarsh Nagar, Hadapsar, Pune - 411 028, India Telefax : 91-20-26991782  
E-mail : shandilyaenergy@rediffmail.com

Works : Gat No. 176, Dhamalwadi, Bhekral Nagar, Fursungi, Pune - 412 308. Ph. : 91-20-65783335

To, 04/12/10  
**M/s Petroleum Conservation & Research Association,**  
**Ahmedabad**

Kind Attn: Mr. Shashibhushan Subhash Agarwal

Sub: Quotation for EnergySaver

Dear Sir,

We are pleased to submit you our quotation for reciprocating compressor for your perusal

SR NO.	MODEL OF ENERGEEESAVER	PRICE IN RUPEES each
1	SES 45 FC (FOR 55KW MOTOR	Rs. 48000/- including vat
		Total for 6 no. Rs.2,88,000/-

Note: The saving is possible in this case only 3%.

**TERMS AND CONDITION**

1. PRICE FOR: PUNE
2. DELIVERY: 6 WEEKS
3. TRANSPORTATION: AT ACTUAL
4. INSURANCE: DONE BY PARTY
5. P&F: 2%
6. Warranty: 2years

Pankaj Pundey  
Director

TECHNICAL SPECIFICATION S.W.H.S. COMPONENTS

## 1. ISI- SOLAR FLAT PLATE COLLECTOR

<b>'ISI' - "Solchrome-" Collector</b>		
1.	Type of Collector	Flat Plate Collector
2.	Collector dimensions	Length: 2040mm $\pm$ 10mm Width: 1040mm $\pm$ 10mm Thickness: 100mm $\pm$ 10mm
4.	<b>Absorber Area</b>	<b>2 Sq. Mtr.</b>
5.	Absorber Coating	Copper Solchrome Selective coated " <b>Fin &amp; Tubes</b> "
	Absorptivity	93% $\pm$ 2%
	Emissivity	12% $\pm$ 2%
	Absorber thickness	0.12mm
6.	Collector Box Material	Powder Coated Extruded Aluminum,
	Size	100mm x 25mm x 25mm/25mm x 25mm
	Thickness	1.6mm /1.2mm
7.	Collector Back	0.46 Aluminum Sheet As per BIS.
	Copper Risers	<b>9 Nos.</b>
	Riser Thickness / O.D.	0.56mm / O.D:12.7mm
8.	Copper Header	02 Nos.
	Header Thickness / OD.	0.7mm / 25.4mm
9.	Method of bonding to absorber	100 % Continues <b>Ultrasonic</b> welding
10.	Insulation Material:	
	Material	<b>Rock wool</b>
	Thick. Of Bottom Insulation	50mm 25mm
	Thick. Of Side Insulation	48Kg./M3
	Density	0.33W/MK.
	Thermal conductivity	
11.	Insulation Cover	Aluminium foil
12.	Details of Glazing	
	Material	Toughened Glass
	Thickness	4mm
	Transmitivity	85%
	Sealing	U-Type EPDM Rubber, Silicone sealing
13.	Header Inlet/Outlet	Brass flanges
14.	Test Pressure	6Kg./Sq.Cms.
15.	Collector Weight	<b>42 Kgs.</b>
16.	Supporting Structure	M.S structure of 30 X 30 X 3 mm angle dully Epoxy painted
17.	Flange gasket	CHAMPION/KLINGER "CAF"
18.	Flange Bolts & Nut	SS 304
19.	Connection	<b>Brass</b>

URMI/UCHCHL/10-11/260

11-Oct-10

URMI /UCHCHL/10-11/260

11-Oct-10

2. Hot Water Storage Tank & Insulation:

Material for Tank & Insulation:	<b>2000</b>
Material	<b>M.S. Tank: 4 mm thk &amp; Descend 5mm thk</b>
Coating	Inside & Outside Epoxy Painted.
Inlet & Out let	1½" BSP Coupling
Insulation	100 mm thick. 50kg/Cu.mtr. Fiber glass wool
Cladding	Aluminum sheet 24 SWG
Working. Pressure	Hydraulically <b>5 kg/cm<sup>2</sup></b>

**TERMS & CONDITIONS:**

PRICE	FOR your site 1 <sup>st</sup> floor of the building at Uchchal, Nr. Tapi.
TAX	5 % VAT, Transportation, lifting & installation charges are included. If any other charges applicable at the time of delivery will be charged extra.
PAYMENT	50 % advance with order.
	40 % before material dispatched.
	10 % after installation but within 10 days after delivery.
	<b>State Bank of India, Vatva Industrial Estate Branch, GIDC, Vatva, Ahmedabad-382445, Gujarat, India. A/C. No. : 10278778933,(IFS Code: SBIN0001754)</b> <b>Pan No. AAACU1488P, GST: 24075700657</b>
DELIVERY	Within 20 days after receiving your confirm order & advance.
GUARANTEE	ONE year against manufacturing defect. We do not guarantee system damage due to nature cause, Glass breakage & Scale formation in the system.