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PCRA would also be working with dairy plant in charges and operators in implementing the energy efficiency measures identified in cluster to ensure enhancement of efficiency & technology which will set a new benchmark.

Petroleum Conservation Research Association

Ahmedabad

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1 CHAPTER 1

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

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

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

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

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

- 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 11th Five-Year Plan (2007-2012)-Sub-Group 5. Consequently, the Bureau has initiated the Energy Efficiency Improvement program in 29 SME clusters in India.

1.2 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 CHAPTER 2

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 5th 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^2
Average Annual Rain Fall	800 to 2000 mm
Temperature	27 to 46^o 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.

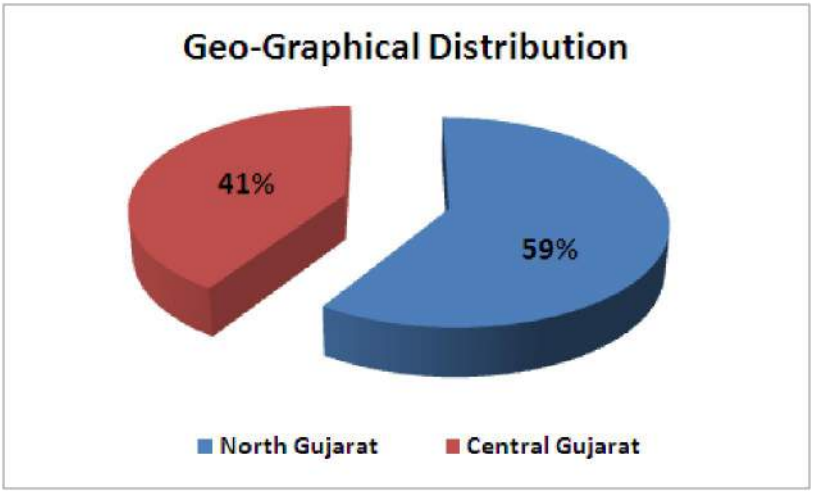


Figure 1: Geographical Distribution of Gujarat (Dairy) Cluster under Study

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

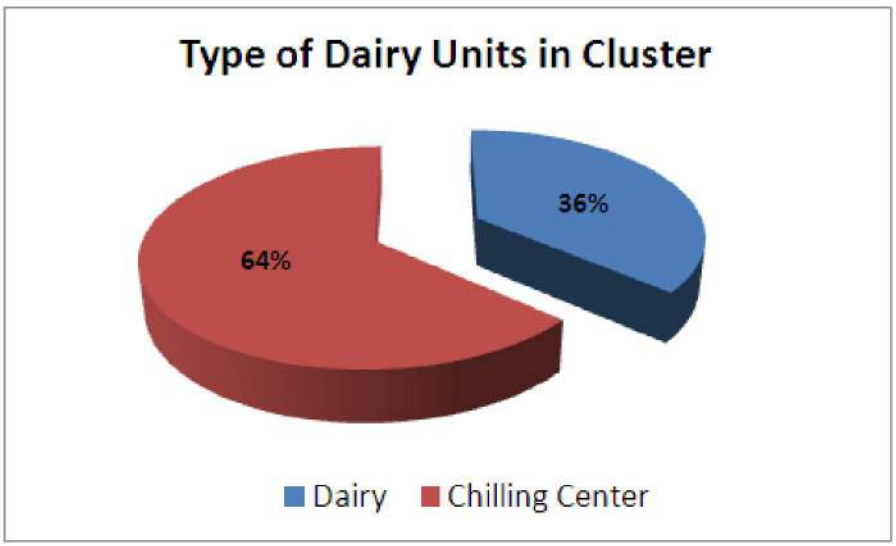


Figure-2: Types of Dairy Units in Gujarat(Diary) SME Cluster

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 ltrs/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 ltrs/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
	Dairies/Chilling Centers Under Detailed Energy Audit							
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	☼	☼					
	Dairies/Chilling Centers Under Detailed Energy Audit							
16)	Unit 16	☼	☼	☼				
17)	Unit 17	☼			☼			
18)	Unit 18	☼	☼	☼				☼ *(Castor DOC)*
19)	Unit 19	☼			☼ *(Saw Mill Dust)*			☼ *(Steam directly from*

								Outside)
20)	Unit 20	☼	☼					
21)	Unit 21	☼	☼					
22)	Unit 22	☼	☼					

For LT type of consumer the rates of electricity are ranging from Rs.5.05/- to Rs. 5.29/- per kWh. For HT type consumer the electricity charges are Rs. 5.65/- to 6.25/- per kWh. The rate of Wood varies from Rs.2\- per kg to 3.25\- per kg depending on location & region of unit. PNG rates are also varying depending on location from Rs. 12\- to Rs.20\- per scm. FO & LDO rates are market dependant and are available in range from Rs.28\- per kg & Rs.32\- per kg respectively.

2.3.1.2 Energy Consumption in a typical milk chilling center

a) Energy consumption distribution Cost Wise :-

Energy Type		Average Monthly Consumption
Electricity	**=**	403130
FO	**=**	256099
Total In Rs.	**=**	**659229**

b) Energy Consumption on Mcal Basis

Energy Type		Monthly Average Consumption	Unit	Monthly Consumption in Mcal
Electricity	**=**	67413	kWh	57975180
FO	**=**	8831	kgs	92725500
		Total in kCal		**150700680**

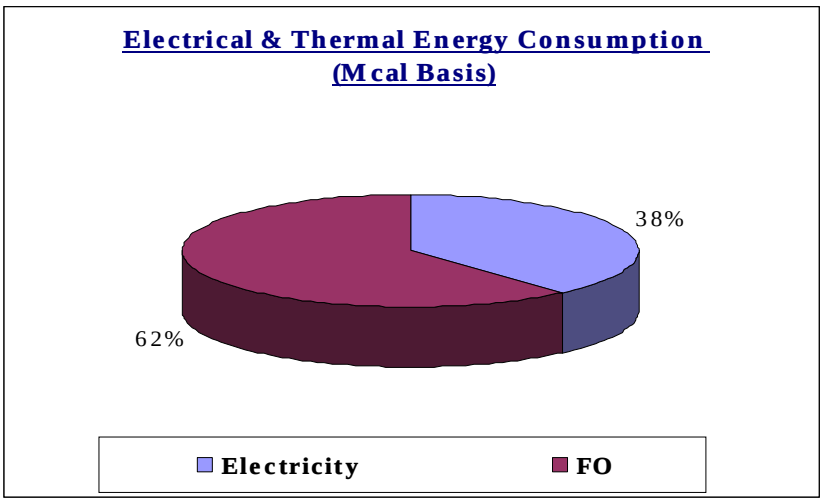


Figure 2 : Energy Consumption Mcal Basis

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
Total In Rs.	=	**2297234**

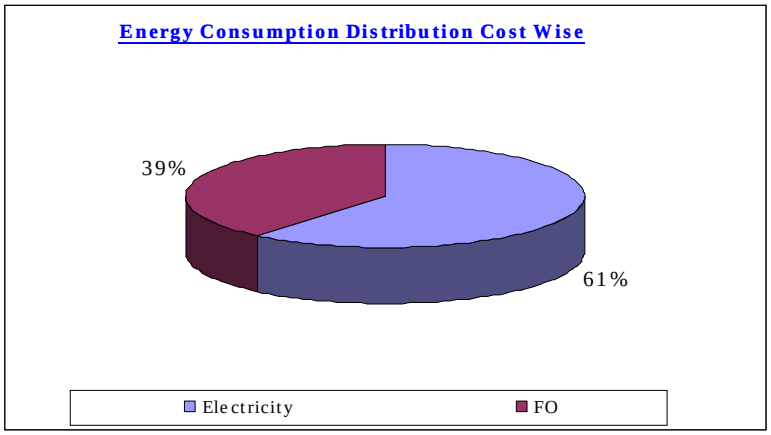


Figure 3 : Energy Consumption Cost Wise

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
		Total in kCal		**905931030**

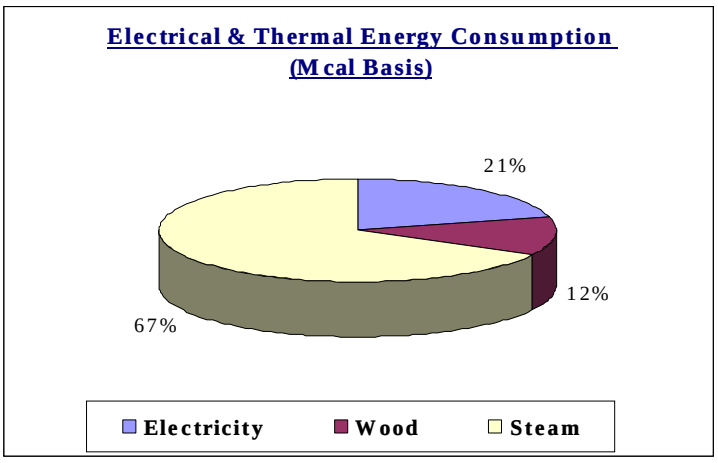


Figure 4 : Energy Consumption on Mcal Basis

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

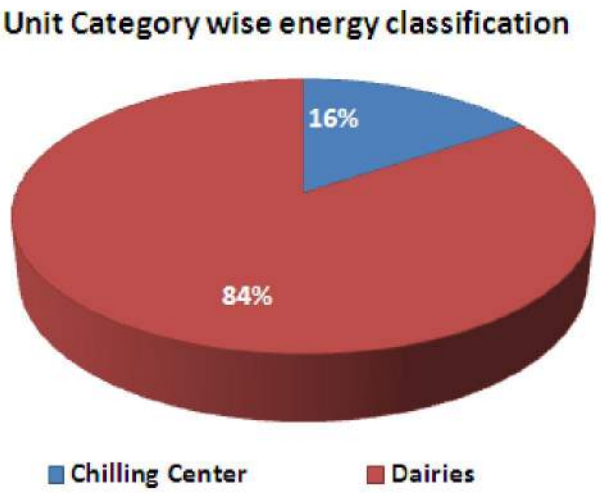


Figure 5 : Share of various types of units in annual energy consumption

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.

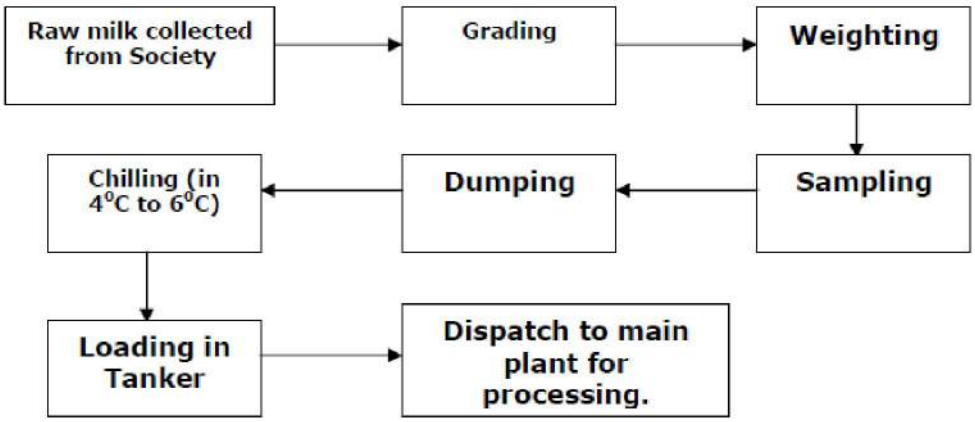
Table 5 : Energy Consumption Pattern of Gujarat (Dairy) SME Cluster

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-

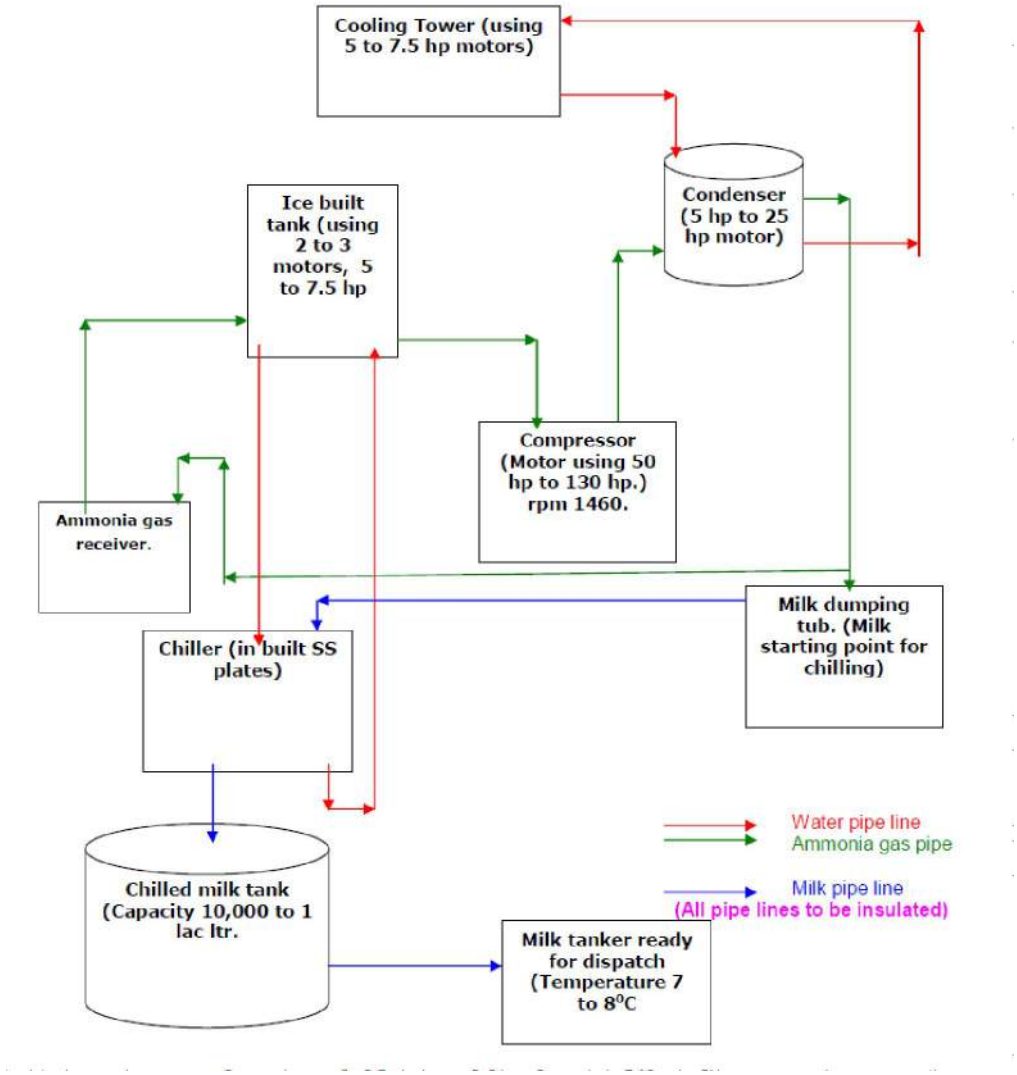


Milk collection process involves Grading, Weighing (Milk is recorded in kgs), Chilling, Dumping, Sampling, Loading in Tanker & dispatch to main processing plant. Most of the chilling centers are located in remote villages to collect the milk from various local 'Mandalis'. Now a day a new trend of providing 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.

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.

The schematic diagram of typical plant is as given below-



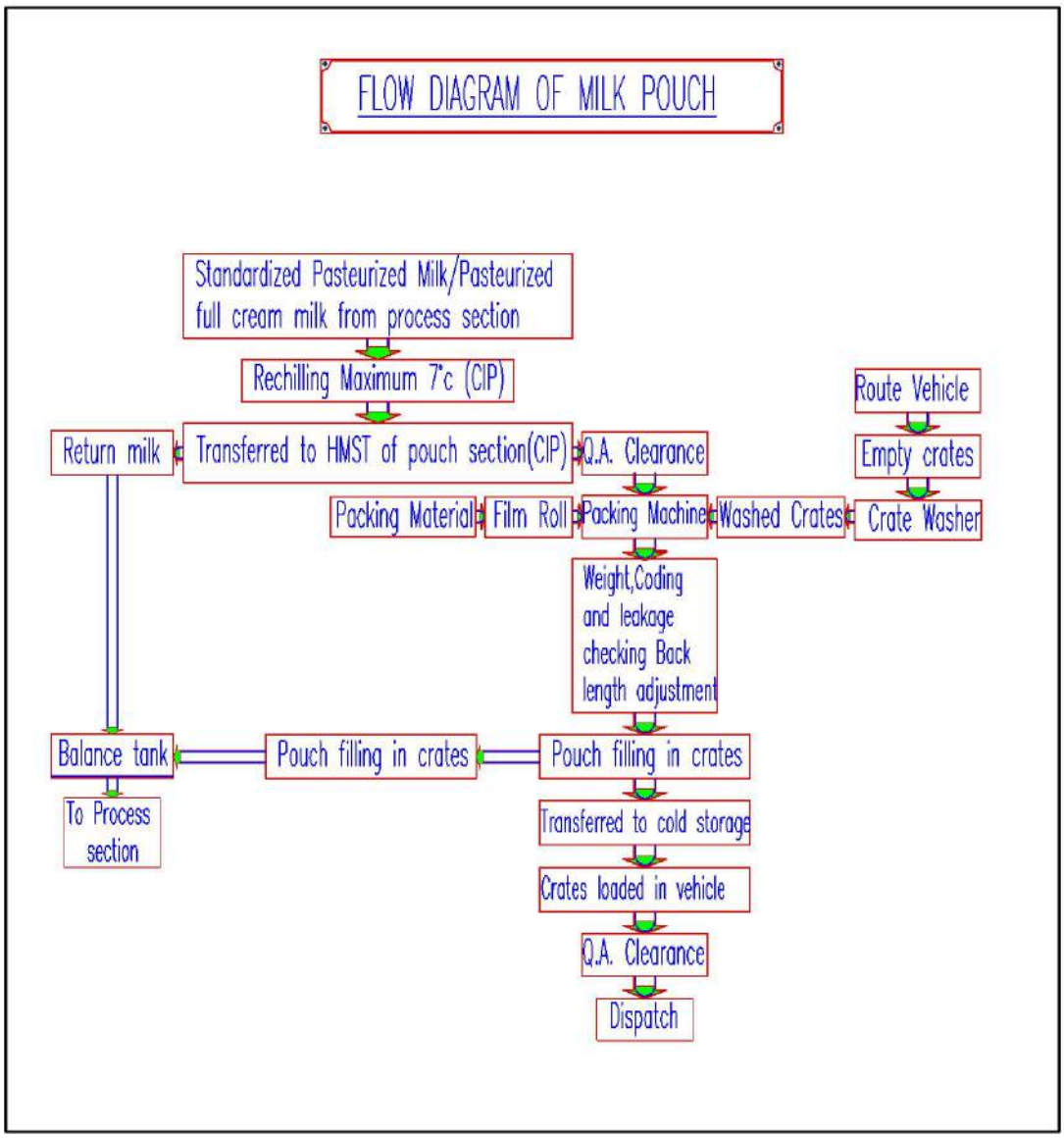
2.4.1.2 Process Technology & Overview in Typical Dairy.

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

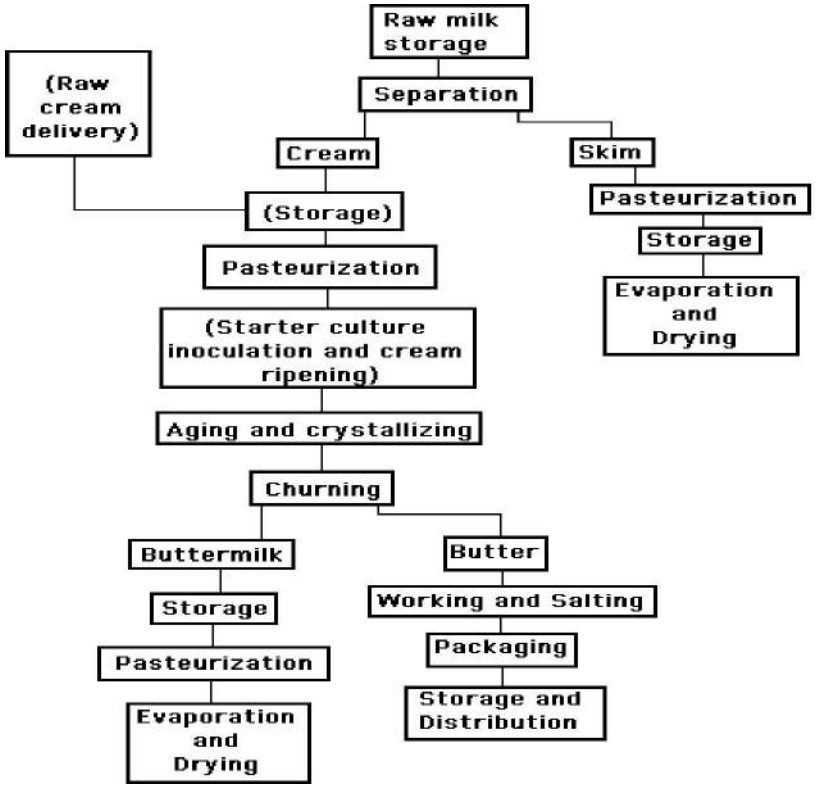
1) Butter
2) Ghee
3) Cheese
4) Paneer
5) Khoa
6) Dahi
7) Shrikhand
8) Flavored Milk
9) Skimmed Milk Powder (S.M.P.)
10) Whole Milk Powder (W.M.P.)

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

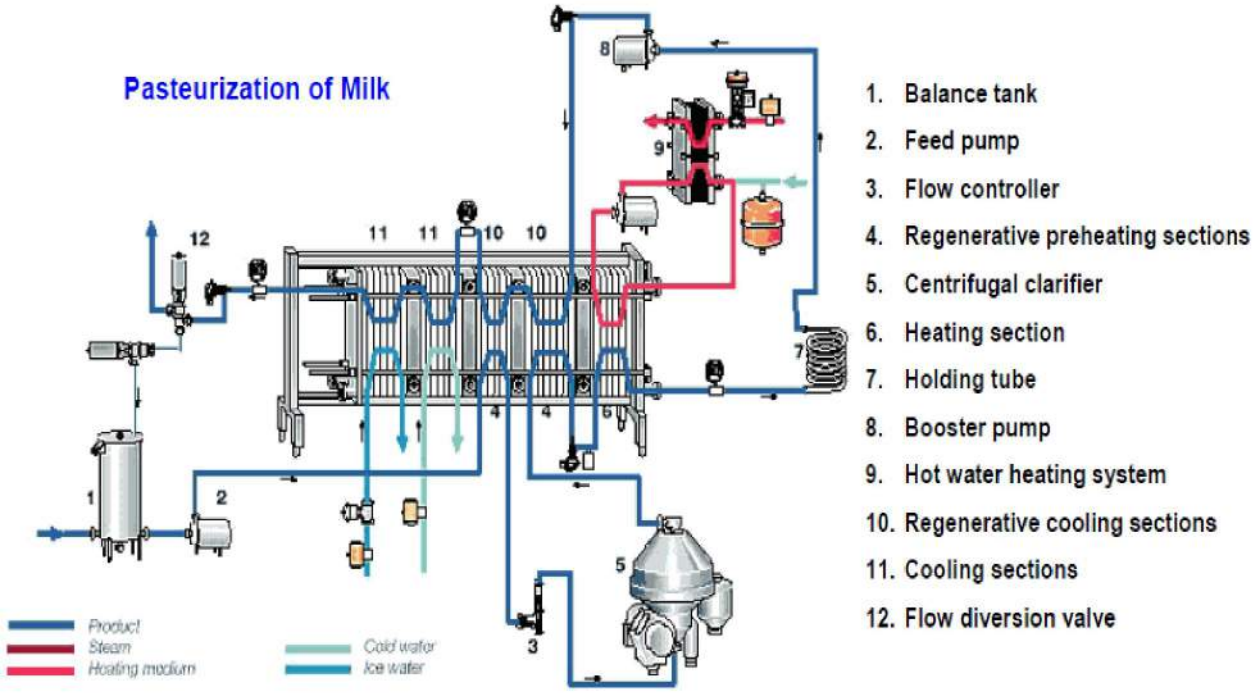
2.4.2 Milk Pouch Flow Diagram



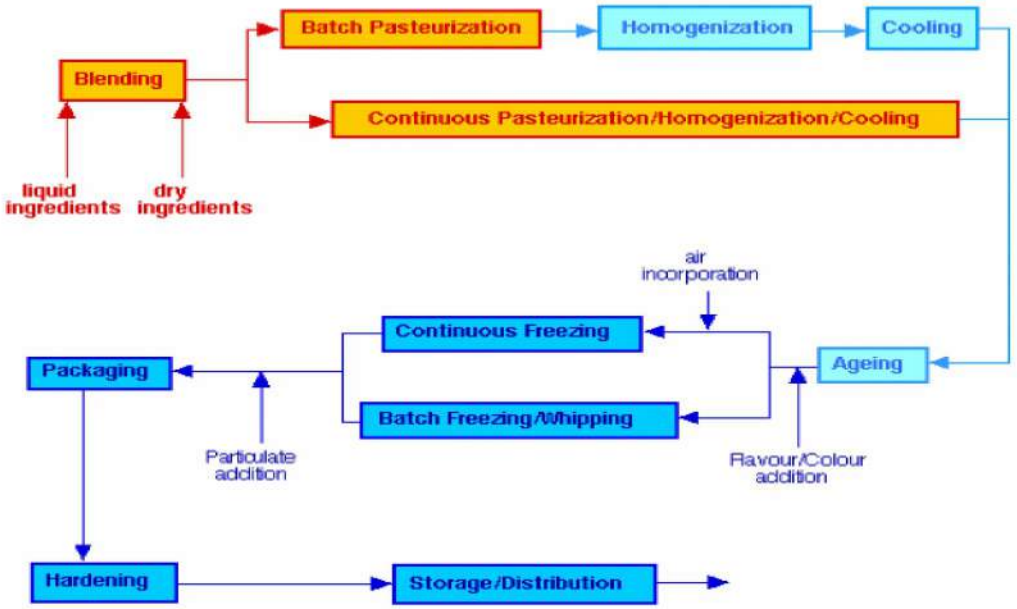
2.4.3 Butter & Butter Milk Process



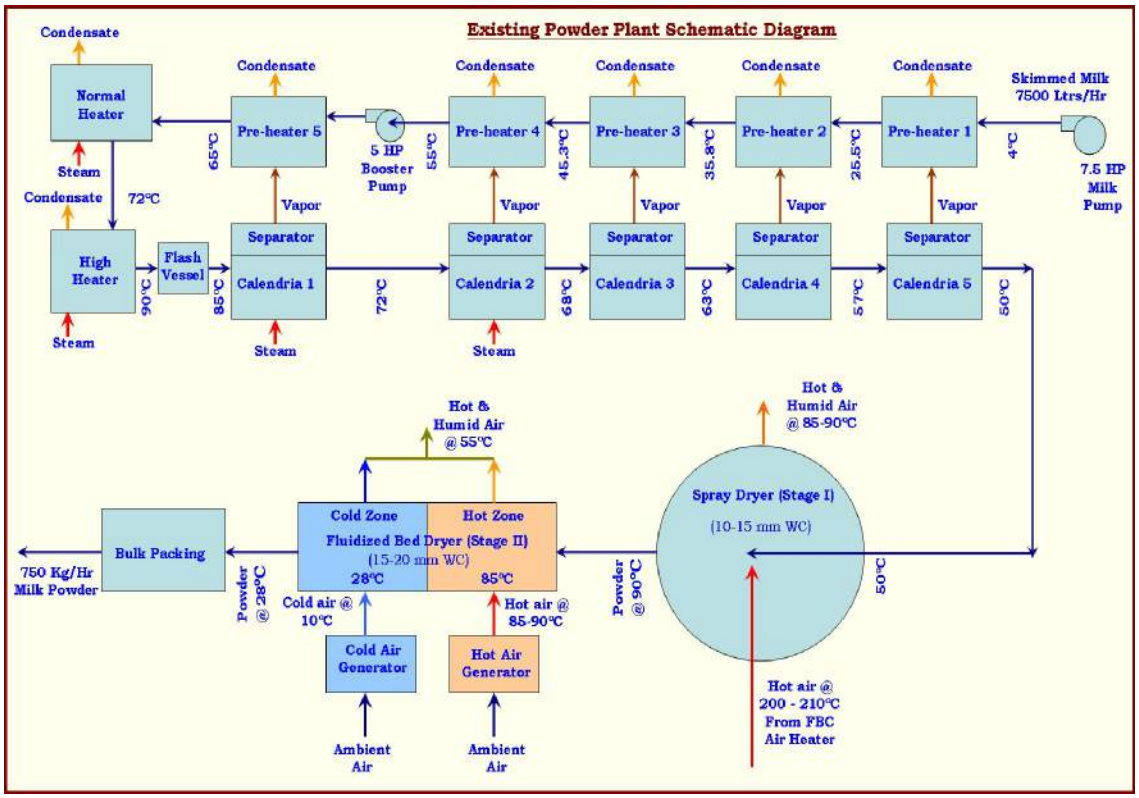
2.4.4 Milk Pasteurization



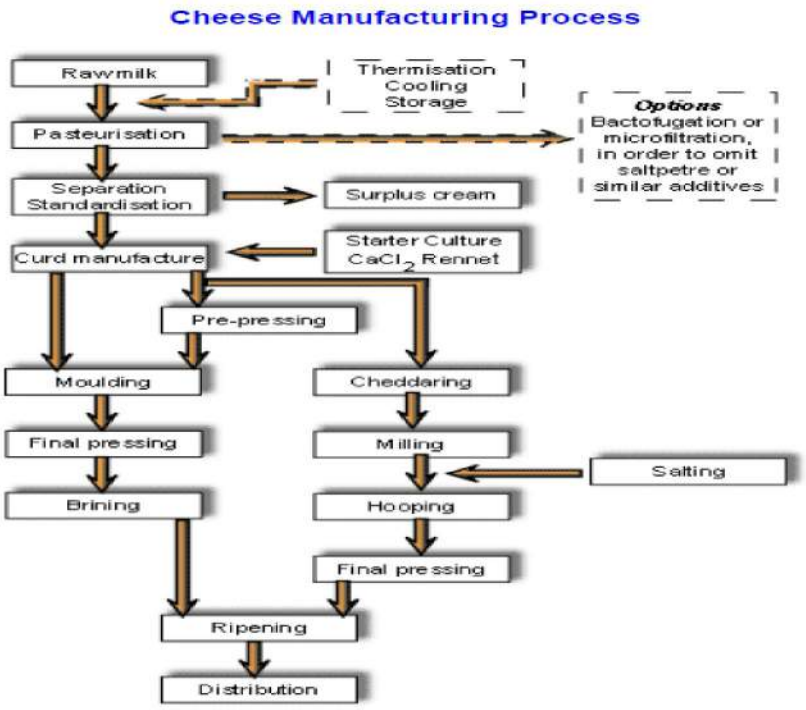
2.4.5 Ice Cream General Process



2.4.6 Conventional Milk Powder Process



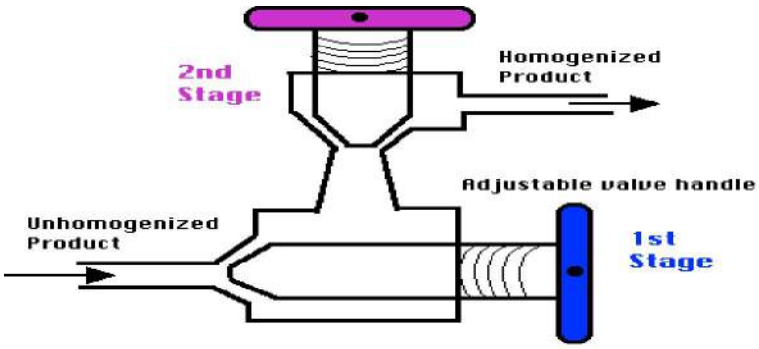
2.4.7 Cheese Manufacturing Process

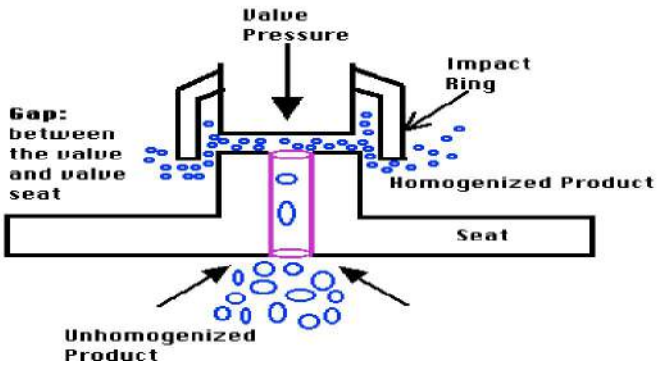


These are few processes. Most of the other milk processes are standard & Conventional one. Details of manufacturing process of individual dairy are already in detailed energy audit report of individual dairy.

2.4.8 Homogenization Mechanism

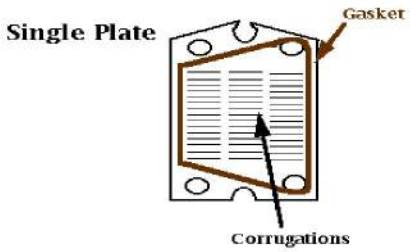
To understand the mechanism, consider a conventional homogenizing valve processing an emulsion such as milk at a flow rate of 20,000 l/hr. at 14 MPa (2100 psig). As it first enters the valve, liquid velocity is about 4 to 6 m/s. It then moves into the gap between the valve and the valve seat and its 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.

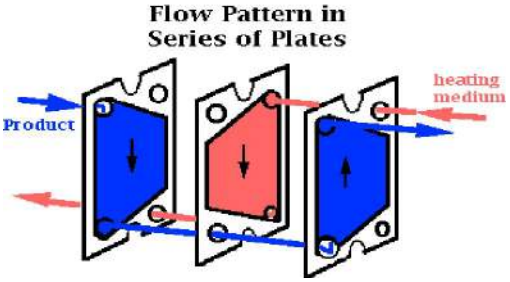




2.4.9 Pasteurization

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 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,

	email:gcmmf@amul.com

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.

- 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:

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

3.3.2 Milk and cream section:

The milk and cream pasteurization section has following equipment:

- Milk Pasteurize
- Cream Pasteurizer
- 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-

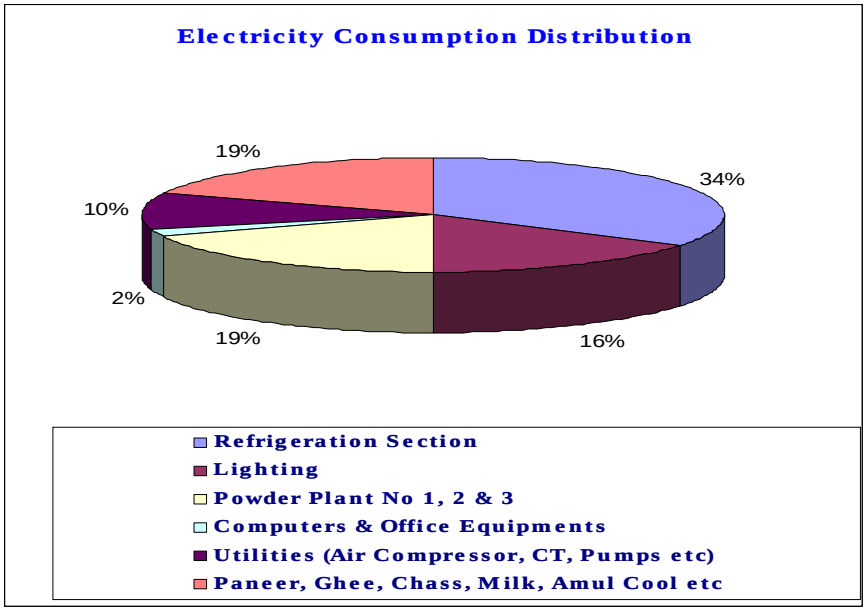


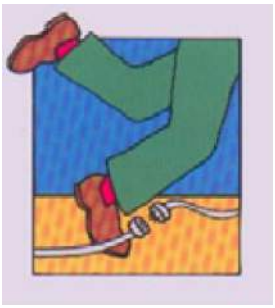
Figure 6 : Energy Consumption Distribution

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.

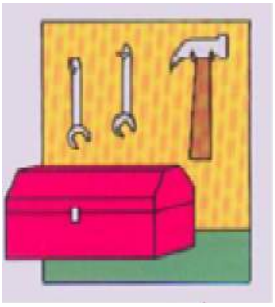


Good housekeeping is the best method of controlling the risks of injury and fire within a facility. Operating experience clearly indicates a significant increase in mishaps related directly to poor housekeeping practices. To be an effective risk management tool, housekeeping must include the following 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 NH3 gas. De-super heater is installed on discharge side of NH3 compressor. The temperature of NH3 gas observed to be 92 to 95ºC. 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 NH3 compressor by providing shell and tube type heat exchanger. The hot water temperature can be maintained up to 70ºC 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	ºC
4)	Temperature of Hot NH3 Gas available for WHR from Desuperheater	=	91	ºC
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 65ºC hot water for winter conditions)	=	65	ºC
7)	Quantity of Hot Water Available	=	64	ltrs/hr