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CII

Widening the coverage of PAT Scheme

Indian Dairy Industry

December 2013

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3. Dudhmansagar Dairy, Delhi
4. Forbes Marshall, Pune
5. Mahanand Dairy, Mumbai
6. Pennar Enviro, Hyderabad
7. Scoops Ice Cream, Hyderabad
8. Tirumala Dairy, Hyderabad

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List of Abbreviations

BEE – Bureau of energy efficiency
CHP- Combined Heat and Power
CII – Confederation of Indian Industry
COP – Coefficient of Performance
CRA- Central Registration Authorities
ETP – Effluent treatment plant
FO – Furnace Oil
FSSAI – Food Safety and Standards Authority of India
HHP - Hydrostatic Pressure

HSD – High Speed Diesel
IBEF – Indian brand equity federation
IDA - Indian Dairy Association
IDDP -Integrated Dairy Development Project
IFCN - International Farm Comparison Network
LDO – Light Diesel Oil
MMPO-Milk and Milk Products Order
MNRE - Ministry of Renewable Energy
MOFP-Ministry of Food Processing
NABARD – National Bank for Agriculture and Rural Development
NDDB - National Dairy Development Board
NDP-National Dairy Plan
NDRI - National Dairy Research Institute
PAT – Perform Achieve and Trade
PCRA-Petroleum Conservation Research Association
PEF - Pulsed Electric Field
PHE – Plate Heat Exchanger
SEC- Specific energy consumption
SRA – State Registration Authorities
SSEF – Shakti Sustainable Energy Foundation
TMDD-Technology Mission on Dairy Development
UHT – Ultra High Temperature
VAR – Vapour Absorption Refrigeration
VCR – Vapour Compression Refrigeration
VFD – Variable Frequency Drive
WHR – Waste Heat Recovery

List of Measuring Units

kCal – Kilo Calorie
kg - Kilogram
kWh- Kilo Watt Hour
lm – Lumen
LPD- Litres per Day
MT – Metric Tonne
MTOE – Metric Ton of Oil Equivalent
TPD – Ton per Day
TR – Ton of Refrigeration

List of Conversion Factors

1 Gcal = 10^6 kCal
1 kWh = 860 kCal
1 MTOE = 10^7 kCal
1 GJ = 238846 kCal
1 tonne (milk)[1] = 1000 lt
1 tonne (milk) = 1000 kg
1 USD = Rs 55

[1] The average milk density is 1.028 kg/lit but in order to simplify calculation, this conversion has been considered.

1. EXECUTIVE SUMMARY

This report is an attempt of CII to provide an overview of the Indian dairy sector's total energy consumption, Specific Energy Consumption (SEC), its variation and the energy reduction potential. The report also highlights the major energy saving opportunities available in the sector and provides an overview of growth opportunities and technology / policy barriers faced by the sector. A set of recommendations which will assist the sector in improving energy efficiency have also been highlighted in this report. This report has emerged after a wide stakeholder consultation with sector experts, dairy plants, associations, institutes and technology suppliers. This report also examines the energy saving possible if a mandatory energy efficiency scheme like Perform Achieve and Trade (PAT Scheme of Bureau of Energy Efficiency (BEE), Ministry of Power, Government of India) scheme is introduced in this sector. The term 'dairy sector' has been used in this report to refer only to milk and milk product processing units.

World milk production (cow and buffalo milk) for the year 2011 was 708.7 million tonnes[2]. Out of the total milk produced globally, about 62% [3] milk is processed. India has emerged as the largest milk producing country in the world with the present level of annual milk production estimated as 127.9 million tonnes[4]. Despite being the largest milk producer in the world, India has an installed capacity to process only about 35%[5] of the milk produced. The Indian dairy sector has been growing at a rate of 3.6% in the past few years.

The dairy sector consumes a significant amount of energy in its heating, cooling and processing activities. Typical dairy plants derive about 70% of their energy requirements in the form of thermal energy and the remaining 30% is consumed in the form electricity.

This study involved secondary desk research; primary research through visiting plants, interacting with experts, organizations, technology suppliers; and data collection by sending out questionnaires to about 50 plants in India and from annual reports of a few plants. Energy consumption data for 36 plants has been collected from filled-in questionnaires. This data set has been used in the report for the estimations. Views, comments and suggestions from various stakeholders on energy trends, reduction opportunities, technology / policy barriers, etc. were gathered and deliberated upon during a stakeholder consultation workshop organized as part of this study.

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2 International Farm Comparison Network (IFCN) – (http://www.ifcndairy.org/media/bilder/inhalt/News/DR2012/IFCN-Dairy-Report-2012-press-release-corrected.pdf)
3 IFCN dairy report 2012
4National Dairy Development Board (NDDB)
5 Ministry of Food Processing Industries MOFPI(http://mofpi.nic.in/ContentPage.aspx?CategoryId=145)

The energy consumption details collected show a range of specific energy consumption:

- **25 kWh/MT – 60 kWh/ MT** (electrical) and
- **20,000 kCal/MT – 90,000 kCal/ MT** (thermal)

A weighted average approach of the collected data was used to assume average specific energy consumption values of

- **40kWh/MT** (electrical) and
- **60,000kCal/MT** (thermal) for this estimation

Based on the weighted average method, the energy consumption for the Dairy sector in India, with an installed processing capacity of 120,548 TPD [6] and a capacity utilization of 70%[7], has been calculated to be about 0.29 million MTOE.

Energy consumption of different processing plants varies widely, depending on capacity utilization, availability of milk, age and scale of the plant, technology used, level of automation and product mix. Due to lack of existing benchmarks and detailed energy consumption data of all plants, the general consensus among the stakeholders during the course of this project is that it would be very difficult to compare dairies simply on the basis of specific energy consumption. There is a need to set energy benchmarking standards for plants with similar sizes, capacity utilization for each product (or product mix), etc. before a common system for comparison of dairies can be arrived at. Activities of this nature were beyond the scope of this project.

With the growth rate of dairy sector at 3.6%[8], the sector's overall energy consumption is expected to increase to about 0.4million MTOE[9] by 2017.

The major areas with high energy saving potential in dairy plants have been identified to be co-generation, tri-generation, de-super heater technology, evaporative cooling and utilization of renewable energy sources. Other process and utility related energy efficiency measures have also been discussed in the report. The estimated energy saving potential in typical dairy plants is in the range of 15 to 20%.

6 Food Safety and Standards Authority of India, Ministry of Health and Family Welfare (Installed capacity of all registered plants)

7 From the collected data set – refer table 6

8 NDRI vision 2030 (http://www.ndri.res.in/ndri/Design/Vision.pdf)

9 With 3.6% growth rate processing capacity by 2017 calculated to be 143866 TPD (assumed capacity utilization 80%)

- **Energy consumption of dairy sector* = 0.29 million MTOE**
- **Energy saving of overall sector at 5% reduction = 0.0145 million MTOE**
- **Suggested threshold limit for inclusion in PAT scheme, if considered = 3,000 MTOE**
- **Estimated number of plants above suggested threshold (designated consumers) = 50**
- **Contribution of designated consumers to overall sector's energy consumption= 24%**
- **Estimated energy saving from designated consumers if included under PAT with a 5% reduction target = 0.0035 million MTOE.**

Due to the low energy savings potential, it is not recommended as a potential sector for inclusion in cycle 2 of PAT.

* calculated based on India's installed capacity, considering 70% average capacity utilization and SEC that has been calculated by a weighted average approach of collected data.

The challenges faced while estimating the sector's energy consumption are:

1. The sector is dominated by a large number of small players, whose operational capacities are low. Capacities range from 10 to 200 TPD, thus individually contributing less when compared to the sector's overall energy consumption.
2. There is lack of awareness and energy efficiency receives low importance among small players.
3. There is some reluctance to share data. The primary data collected for estimations in the report are either from desk research or plant data gathered through questionnaires (accounting to about 24.79% of total capacity).
4. Lack of policies that encourage energy efficiency measures.
5. Lack of financial support from the Government and other agencies to encourage small players of the sector towards energy efficiency.

The next steps suggested to be carried out in this sector are:

1. Arrive at India specific energy benchmarks
    - To collect data from all plants and formulate plant level, process block level and/or process level assessment methodology.
    - Arrive at energy benchmarks for plants to compare themselves, which will in turn encourage them to reduce their energy consumption.

- Capacity building

  - The sector requires capacity building towards latest energy efficient technology and their benefits. One way of doing this is by organizing missions to best performing dairies and sharing best practices.

  - A platform needs to be created for the technology suppliers and dairies to interact.

2. Favorable policy and financial support

   - Government needs to formulate policies favoring energy efficiency for the dairy sector.

   - Funding is required to encourage dairy plants to adopt energy efficient technology. The Government can consider creating a technology up gradation fund for improvement in energy efficiency in dairies.

   - Award dairies on the basis of performance to encourage movement towards energy efficiency

3. Technology adoption

   - Large efficient plants to demonstrate new technology adopted to encourage small players

   - Industry associations like IDA, CII etc. could help facilitate development of turnkey technology packages for energy efficiency.

2. INTRODUCTION

2.1 Sector importance

India has emerged, over the past few years, to be the largest milk producing nation in the world, with milk production of 127.9 million tonnes[10] during 2012. India's dairy industry is growing at an annual growth rate of 3.6%[11], which is much more than the world average rate of 1.5%. Milk marketed by the cooperatives alone stood at 8.2 million tonnes for the year 2011, which is 4% higher than the previous year.[12]

2.2 International scenario

World milk production (cow and buffalo milk) in 2011 was 708.7 million tonnes[13]. It has been estimated that out of this total production, about 62% is delivered to milk processors; the remaining 38% is consumed on the farms or sold informally.

The world milk production is projected to increase by 153 million tonnes[14] from 2010 levels by the year 2020. A majority of this growth is anticipated to come from developing countries like India and China, with the two together accounting for 38% [15] of global gains. The increasing range and popularity of dairy products are the key drivers of dairy markets worldwide.

2.3 International standing of sector

India is the largest milk producing country, as indicated earlier and contributes to about 18%[16] of the world milk production. The rate of growth in milk production in India in the past few decades, at about 3.6%[17], is more than double the world average growth rate of 1.5 %[18]. Though the recent economic crisis has affected production in many milk producing countries, the Indian dairy production system has been comparatively unaffected by these economic developments.[19]

India lies behind the world average in terms of processing, which is only about 35%[20] of milk produced, indicating a potential for significant growth in processing capacity and processed products.

2.4 Market scenario

Indian dairy sector's production, processing, marketing and consumption of milk have a unique pattern compared to other large milk producing countries.

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10 NDDB
11NDRI vision 2030 (http://www.ndri.res.in/ndri/Design/Vision.pdf)
12 NDDB annual report 2011
13 International Farm Comparison Network
14 Organization for Economic Co-operation and Development (OECD)-Food and Agriculture Organization of United Nations(FAO) AGRICULTURAL OUTLOOK 2011-2020 (IFCN)
15 OECD-FAO AGRICULTURAL OUTLOOK 2011-2020
16 International Farm Comparison Network
17NDRI vision 2030 (http://www.ndri.res.in/ndri/Design/Vision.pdf)
18 NDRI vision 2030
19 NDRI vision 2030
20 IAI vision 2020,NDRI (http://www.iaidairyexpo.co.in/files/2013/05/White-Paper.pdf)

Due to pressures on land and fragmentation of agricultural holdings, there are fewer medium or large privately owned dairy farms compared to other countries. Efforts by some manufacturers of dairy products to set up such farms did not succeed and they depend mainly on milk collected from small producers in the rural areas either by their agents or by the co-operatives.

The organized section of this sector, consisting of large, medium and small scale dairy plants, processed about 13 million tonnes[21] annually; while the unorganized section of the sector processed about 22 million tonnes per annum[22] in 2009 (milk production in 2009 was 112 million MT). The market size of processed products in the organized and unorganized sector (at 2003-04 prices) was estimated to be USD 4.6 billion[23] and USD 16.5 billion[24], respectively, for the year 2011. Ethnic products like Milk cake, Chenna, Rasmalai, Peda, Kheer, Khoa and other traditional sweets, which are largely sold in unbranded form in Indian markets, have a great potential for growth in terms of value addition and processing.[25] Divergences in consumption of various dairy products exist due to various factors like region, cultural factors, disposable incomes, heritage and culture; local climate; government intervention; advertising; and evolving diets, tastes and preferences.

2.5 Growth in past and future prospects

Milk production grew from 21 million tonnes in 1970 to nearly 69 million tonnes in 1996 - more than threefold, at a compounded annual growth rate of 4.5%. This growth rate of 3.6%[26] has continued to prevail in the dairy sector during the past few years, as seen in the figure below.[27]

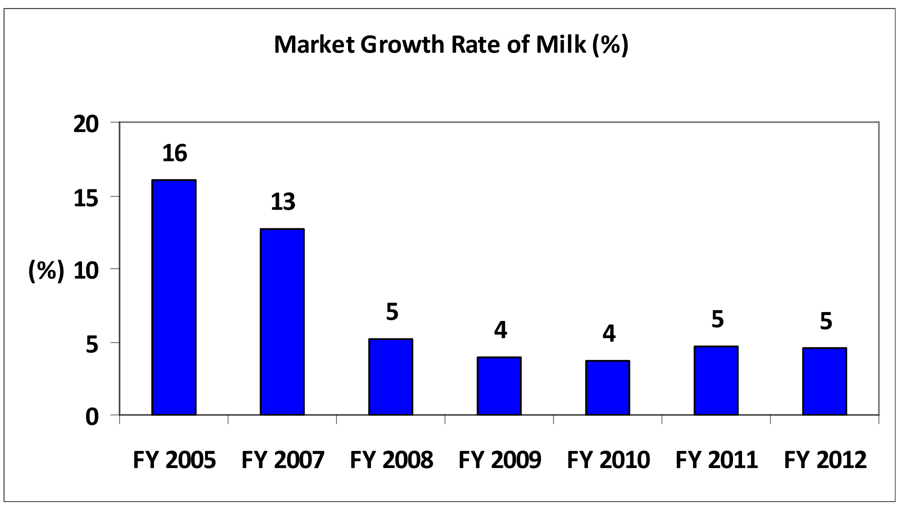


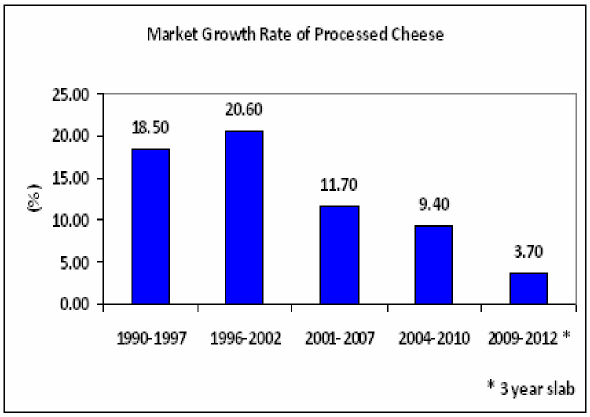
Figure 1 - Market growth rate of milk (%) [28]

21 NDRI vision 2030
22 NDRI vision 2030
23 NDRI vision 2030
24 NDRI vision 2030
25 NDRI vision 2030
26NDRI vision 2030 (http://www.ndri.res.in/ndri/Design/Vision.pdf)
27 NABARD(technical digest issue 9)
28 MOFPI(http://mofpi.nic.in/ContentPage.aspx?CategoryId=145)

The major factors driving growth in milk consumption are increased demand due to population growth, growing household incomes and increased demand for value-added milk products.[29]

The current per capita consumption of milk of 291 gm/day[30], which is low compared to the world average of 590 gm/day[31], points to the fact that the domestic dairy sector has a huge potential for growth.

Market growth rates and future projections of a few dairy products are as shown below:



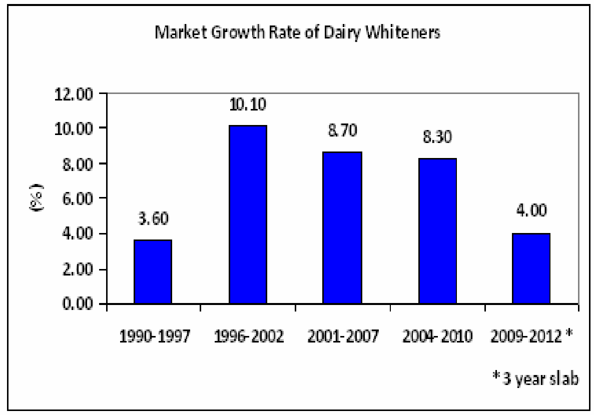


Figure 2 - % growth rate of processed cheese[32] & dairy whitener[33] production

With the Indian Government removing restrictions on foreign players in consumer products in 2001, international companies have entered the Indian cheese market. The decrease in the growth rates of processed cheese is due to imports from these international players. Few of the international brands include Boursin, Kraft, Bel Fromageries, Woerle, Probolene, Colby etc.

The rate of growth in production of dairy whiteners has also seen a slight reduction over the past few years due to increase in imports from international players. However this increase in imports is comparatively smaller than cheese imports.

29 USDA-GAIN report no. IN2132
30 NDDB
31 International dairy federation bulletin 2009
32 MOFPI - assumed constant growth rate of 7.4% between 2009 to 2012 from forecasted figure up to 2015
33 MOFP - assumed constant growth rate of 8 % between 2009 to 2012 from forecasted figure up to 2015

2.6 Production data

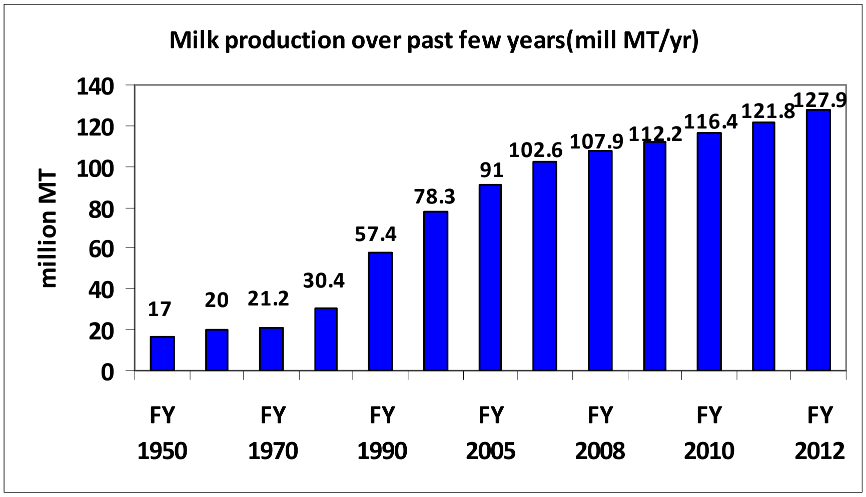


Figure 3 - Milk production over past few years [34]

The production of milk in India has been rising over the past few years. When compared to the growth in world milk production, India with 3.6% has been growing at more than double the rate.

2.7 Important stakeholders

The major stakeholders of the Indian dairy sector include:

- Ministry of Food Processing: Under the department of animal husbandry and fisheries, the ministry is the main agency for promoting growth and development of dairy sector in India. (www.mofpi.nic.in)

- NDDB: The National Dairy Development Board assists dairy cooperatives to strengthen their business and provide better services to their members. (www.nddb.org)

- NDRI: National Dairy Research Institute is India's premier institute for dairy research. (www.ndri.res.in)

- IDA: Indian Dairy Association is the apex body of the dairy industry in India. The members are from cooperatives, MNCs, corporate bodies, private institutions, educational institutions, government and public sector units. IDA functions very closely with dairy producers, professionals and planners, scientists and educationists, institutions and organizations associated with the development of dairying in India. (www.ida.org.in)

- The cooperative, private and other players of dairy industry also play a major role in the present level of technological development and market scenario.

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34 Department of Animal Husbandry ,Dairying and fishery (DAHDF) NDDB – production number for 2012 is 127.9 million tonnes

- A major portion of the Indian dairy sector consists of the unorganized sector, thus the small scale producers of ethnic products belonging which are not registered are also important stakeholder of this sector who may contribute towards energy efficiency.

- Equipment manufacturers and manufacturers of chemicals/instruments/packaging material etc.

2.8 Product categorization

The term 'dairy sector' has been used in this report to refer only to the milk and milk product processing units. There are many dairy products produced in India. The typical products processed in India and their shares are:

Table 1- Indian Dairy Sector's Product Mix (by production)[35]

Products	Percentage share
Fluid milk	46.0
Ghee	27.5
Butter	6.5
Curd/Yogurt	7.0
Khoa (Partially Dehydrated Condensed Milk)	6.5
Milk powder and Dairy whiteners	3.5
Paneer and Chenna (Cottage Cheese)	2.0
Others, including Cream, Ice Cream	1.0

Dairies, however, cannot be classified based on products, since a key feature of this sector is that each plant has a diversified product mix which is different from another.

2.9 Different Players

For purposes of this report, dairies have been classified, by size, as follows:

Table 2 – Size range of dairy plants

Size of dairy plant	Milk handling capacity
Small	< 100 TPD milk handling capacity
Medium	100TPD to 200 TPD milk handling capacity
Large	> 200 TPD milk handling capacity

The major players in the organized Indian dairy sector can be classified into:

- Cooperatives
- Private and
- Others, including public sector or Government controlled

35MNRE - Global Agricultural Information Network-Report

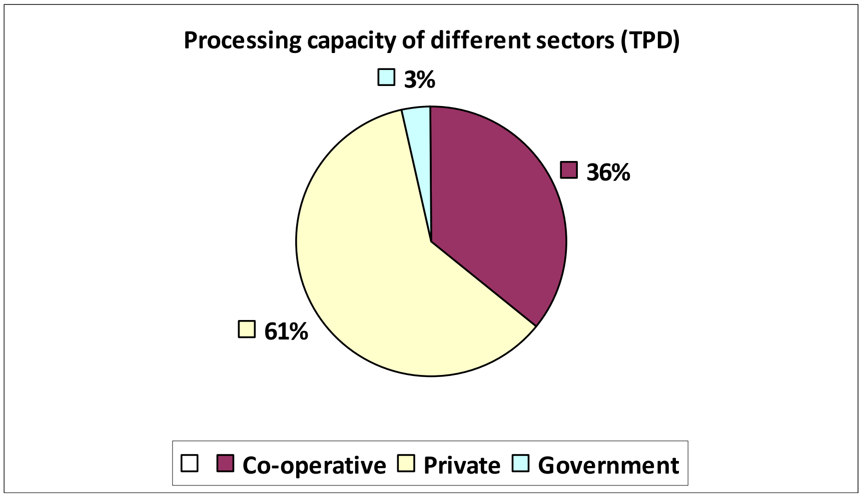

Figure 4- Processing capacities of different sectors

The sector has a vast spread, with 1,065[36] dairies registered[37] up to March 2011. 248[38] dairy plants, with a combined capacity of about 84,242.5 TPD[39], were registered under the Central Registration Authority (CRA) up to 2011 and 817[40] dairy plants with a combined capacity of 36,305.5 TPD[41] were registered under State Registration Authority (SRA). This indicates that there are a large number of small and medium players in the milk processing space, with milk handling capacities below 200 TPD.

The number of registered plants and installed capacity of the above groups are given below:

36 Food Safety and Standards Authority of India, Ministry of Health and Family Welfare; (http://www.efreshindia.com/efresh/dairyfarming/pdf/Number%20of%20Dairy%20Plants%20in%20India-Dairy%20Statistics.pdf)

37 Unit handling more than 10 TPD is registered by the registering authority appointed by the Central Government. As per Milk and Milk Product Order (MMPO)-92 regulations dairy units handling below 200 TPD of milk are to be registered by State/Union Territory Registration Authority (SRA), while those handling above 200 TPD of milk are to be registered by the Central Registering Authority (CRA). SRA is the registration authority appointed by the sate Government while CRA is the registration authority appointed by the central Government.

38 Food Safety and Standards Authority of India, Ministry of Health and Family Welfare

39FSSAI(http://www.fssai.gov.in/Regulations/MilkandMilkProductRegulationsMMPR2009.aspx)

40 Food Safety and Standards Authority of India, Ministry of Health and Family Welfare

41 Food Safety and Standards Authority of India, Ministry of Health and Family Welfare

Table 3- Installed processing capacity of major players [42]

Sector	Registered under CRA		Registered Under SRA		Total Capacity (TPD)
	Number	Capacity (TPD)	Number	Capacity (TPD)	
Co-operative	125	37,109	138	6,142	43,251
Private	107	43,914	658	29,337.5	73,252
Government	16	3,220	21	826	4,046
Total	**248**	**84,242.5**	**817**	**36,305.5**	**1,20,548**

2.9.1 Cooperatives

With 15 State Federations, 177 District Unions and 1, 44,246 Village Cooperative Societies[43], Dairy Cooperatives account for a large share of processed liquid milk marketed in India and has witnessed a gradual growth.

The list of state cooperatives with their corresponding processing capacity and market share is shown in the table below:

Table 4 – Capacity and market share of state co-operatives [44]

Sr.No.	State Cooperatives (^Federal Dairy Cooperatives of State)	Number of plants	Capacity (TPD)	Market share (%)
1	Andhra Pradesh ^	9	2,150	1.8
2	Bihar ^	10	700	0.6
3	Chhattisgarh	1	100	0.1
4	Goa	1	30	0.02
5	Gujarat ^	16	13,160	10.9
6	Haryana ^	5	470	0.4
7	Himachal Pradesh ^	3	60	0.05
8	Karnataka ^	16	4,323	3.6
9	Kerala ^	15	1,222.5	1.0
10	Madhya Pradesh ^	5	1,000	0.8
11	Maharashtra ^	86	7,865	6.5
12	Orissa ^	13	523	0.4
13	Puducherry	1	50	0.04
14	Punjab ^	13	1,820	1.5
15	Rajasthan ^	18	2,420	2.0
16	Sikkim	1	25	0.02
17	Tamil Nadu ^	11	4,030	3.3
18	Tripura	1	10	0.01

42 Food Safety and Standards Authority of India, Ministry of Health and Family Welfare

43 IDA

44 The Food Safety and Standards Authority of India, Ministry of Health and Family Welfare

19	Uttar Pradesh ^	35	2476	2.1
20	West Bengal ^	3	816	0.7
Total		**263**	**43,250.5**	**36**

The major state co-operatives contributing almost 31% of India's milk processing market share are Gujarat, Maharashtra, Karnataka, Tamil Nadu, Rajasthan, Uttar Pradesh and Punjab.

2.9.2 Private dairies

The major presence of private players is seen in Uttar Pradesh, Maharashtra, Delhi, Madhya Pradesh, Haryana, Delhi and Andhra Pradesh. Some big private players include Aarey Milk, Britannia, Dynamix Dairy, Gowardhan dairy, Heritage Foods Ltd., Hatsun Agro Product Ltd., Tirumala Milk Products Ltd., Doodla Dairy Ltd., Metro Dairy Pvt. Ltd., Umang Dairies Ltd., Vidya Dairy, Modern Dairy, Nestle India Limited, Lactose India Pvt. Ltd., Kwality Dairy (India) Ltd., Vadilal Industries Ltd., Milk food Ltd., Parag Milk Foods Pvt. Ltd., V R S Foods Ltd. etc.

A state-wise consolidated capacity and market share data of private dairies is listed below:

Table 5 - Capacity and market share of private dairies [45]

Sr.No.	State	Number of plants	Capacity (TPD)	Market Share (%)
1	Andhra Pradesh	39	5,693	4.7
2	Bihar	2	400	0.3
3	Delhi	1	3,500	2.9
4	Goa	3	270	0.2
5	Gujarat	15	917	0.8
6	Haryana	31	2,417	2.0
7	Himachal Pradesh	4	545	0.5
8	Jammu and Kashmir	1	30	0.02
9	Karnataka	8	485	0.4
10	Kerala	10	373	0.3
11	Madhya Pradesh	35	4,012.5	3.3
12	Maharashtra	276	15,641	13.0
13	Orissa	2	75	0.1
14	Punjab	64	6,529	5.4
15	Rajasthan	20	3,361	2.8
16	Tamil Nadu	26	5,289	4.4
17	Uttar Pradesh	216	22,569	18.7
18	West Bengal	12	1,145	0.9
Total		**765**	**73,251.5**	**61**

[45] The Food Safety and Standards Authority of India, Ministry of Health and Family Welfare

2.9.3 Government controlled dairies

A state-wise consolidated capacity and market share data of Government controlled dairies is listed below:

Table 6 - Capacity and market share of Government controlled dairies [46]

Sr.No.	State	Number of plants	Capacity (TPD)	Market Share (%)
1	Delhi	1	500	0.4
2	Gujarat	2	400	0.3
3	Haryana	1	60	0.05
4	Maharashtra	33	3,086	2.6
Total		**37**	**4,046**	**3.4**

Government controlled dairy plants constitute only about 3% of total market share. The major contribution is from Maharashtra with 33 plants with about 3,086 TPD installed capacity under Government control.

2.10 Policy scenario

Some of the relevant policies favoring energy efficiency and technology improvements in the Indian Dairy sector are briefly discussed below:

❖ **Technology Mission on Dairy Development**

In 1989, the Government of India launched a Technology Mission on Dairy Development (TMDD) to coordinate input programs for the dairy sector. The objective of the mission was to accelerate the growth of rural incomes and employment through dairy development. To achieve this, the Operation Flood programmes were dovetailed into other development programmes, such as dairy research, processing technology and product manufacture, apart from programmes of state animal husbandry and dairying, poverty alleviation programmes and the programmes of Central Research Institutes, agricultural universities and the NDDB. The mission has identified several need-based research programmes and assigned them to various research institutions and the NDDB. This led to a number of private players, who were more aware and open towards adopting new efficient technology and equipment, entering the market.

❖ **Trade policy**

In the early 1990s, the Government of India introduced major trade policy reforms that favored increasing privatization and liberalization of the economy. The dairy industry was delicensed in 1991 with a view to encouraging private sector participation and investment in the sector. This led to a number of private players, who were more aware and open towards adopting new efficient technology and equipment, entering the market.

[46] The Food Safety and Standards Authority of India, Ministry of Health and Family Welfare

❖ Milk and Milk Product Order (MMPO), 1992

The Government of India promulgated the Milk and Milk Product Order (MMPO) 1992 in June 1992 consequent to de-licensing of the Dairy sector in 1991. As per the provisions of this order, any person/dairy plant handling more than 10,000 litres per day of milk or 500 MT of milk solids per annum needs to be registered with the registering authority appointed by the Central Government. The main objectives of the order are to:

- Maintain and increase supply of liquid milk of desired quality in interest of the general public

- Regulate the production, processing and distribution of milk and milk products.

Recognizing the necessity for suitable amendments in the MMPO 1992 for faster pace of growth in the Dairy sector, Government of India has amended it from time to time in order to make it more liberal and oriented to facilitate the dairy entrepreneurs. The Government of India has notified the amendment proposals in the official gazette on 26/03/2002. Now there is no restriction on setting up of new capacity, while noting that the requirement of registration is for enforcing the prescribed standards of quality and food safety.

❖ Intensive Dairy Development Programme

The Scheme 'Integrated Dairy Development Project (IDDP)[47] in Non-Operation Flood, Hilly and Backward Areas' was launched in 1993-94 on 100% grant-in-aid basis. The scheme was modified in March, 2005 and was named as 'Intensive Dairy Development Programme (IDDP)'. The scheme, which is for hilly and backward areas and districts, aims at creating better infrastructure for procurement, processing and marketing of milk along with facilitating development to other social and economic issues related to dairy sector.

47 DAHDF (http://www.dahd.nic.in/dahd/reports/compendium-of-schemes/intensive-dairy-development-programme.aspx)

3. ENERGY PERFORMANCE

3.1 Sectoral level energy performance in recent years

The dairy industry uses energy in the form of steam, hot air, and electricity in the processing of milk and milk products. The cost of energy sources used in the industry is increasing continuously, which in turn increases the processing expenses and, therefore, the product cost. Energy costs typically constitute 10-20 percent of overall manufacturing cost, with the exception of Gujarat where it is between 5-7 percent, because of huge capacities of dairy plants and the number of initiatives taken towards energy efficiency. [48]

3.2 International comparison

There are no benchmarks for energy consumption for Indian dairy plants or for individual dairy products. However there are a few global standards that are followed by different countries, as shown below:

Table 7 – International standards of SEC for different products [49]

Product	Mass load/unit	European Dairies	Swedish Dairies	Danish Dairies	Finnish Dairies	Norwegian Dairies	Industry Benchmark
Market Milk and Cultured products	kWh/l of processed milk	0.09–1.11	0.11–034	0.07–0.09	0.16–0.28	0.45	0.1–0.2
Cheese and Whey	kWh/l of processed milk	0.06–2.08	0.15–0.34	0.12–0.18	0.27–0.82	0.21	0.2–0.3
Milk Powder, Cheese/Liquid products	kWh/l of processed milk	0.85–6.47	0.18–0.65	0.30–0.71	0.28–0.92	0.29–0.34	0.3–0.4
Ice cream	kWh/kg ice cream		0.75–1.6				0.8–1.2

These standards, however, cannot be directly applied to Indian plants due to various reasons like varying climatic conditions, type of technology, loading, procurement etc.

The data collected from 36 Indian Dairy plants shows the range of energy consumed to vary from 0.015 kWh/l – 0.24 kWh/l .This wide range is due to the varied product mix; also plants do not monitor process or product specific energy data. Determining a plant level benchmark for the sector is slightly complex. There is potential to look into energy details to determine benchmarks for different dairy products in future, like in other countries.

48 PCRA

49 International finance corp. ; Environmental, Health, and Safety Guidelines DAIRY PROCESSING 2007

3.3 Technological developments

Dairy plants in India have seen significant improvement in the past 5-8 years due to increased levels of automation. This has helped in improving product quality and operating conditions while reducing product losses, maintenance time, manpower requirement and energy consumption.

Innovations like cooling of hot cream with chilled raw milk have been adopted to improve regeneration efficiency and, thereby, reduce energy consumption. The new, large dairy plants have implemented new process equipment, plate heat exchangers, cream separators, pumps and valves that meet European Hygienic Engineering and Design Group (EHEDG)[50] specifications. Automated, push water recovery systems are being provided in new dairy plants for better recovery of milk solids and less consumption of cleaning chemicals. Building designs now provide more natural light coupled with a natural ventilation system which has led to conservation of energy as well as improvements in operating conditions.

With respect to better shelf life, processing efficiency and wholesomeness of the processed product, the emerging technologies include ultra high temperature (UHT), High Hydrostatic Pressure (HHP), Pulsed Electric Field (PEF), Ohmic Heating and Membrane Technology and packaging interventions involving nanotechnology.[51]

Notable gains in the recent years include sophisticated equipment like:

- Electronic milk tester
- Evaporating and drying plant
- Cream separator
- Plate heat exchanger
- Homogenizer
- Small capacity packing machine
- Instruments and controls
- Bulk vending units
- Rail/road milk tankers
- Know-how to take responsibility for integrated milk projects
- Milk silo of 150,000 litre capacity and road milk tankers of 200,000 litres being made in the country

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50 The European Hygienic Engineering and Design Group (EHEDG) is a consortium of equipment manufacturers, food industries, research institutes as well as public health authorities and was founded in 1989 with the aim to promote hygiene during the processing and packing of food products. The principal goal of EHEDG is the promotion of safe food by improving hygienic engineering and design in all aspects of food manufacture.

51 NDRI vision 2030

3.4 Capacity utilization

Capacity utilization of dairies (collected as part of the primary research process during this project) is indicated in the table below.

Table 8 - Capacity Utilization [52]

Plant	Installed Capacity (TPD)	Production (TPD)	Capacity Utilization (%)
Plant 3	100	118	118
Plant 4	100	89.3	89
Plant 6	2500	1,797	72
Plant 9	1000	550	55
Plant 11	800	557	69.6
Plant 14	1400	1,180	84
Plant 15	160	144.5	90
Plant 16	165	118	71.5
Plant 26	200	235	117.5
Plant 27	500	154	30.8
Plant 28	1200	307	25.6
Plant 29	550	567	103
Plant 30	400	406	101.5
Plant 31	1200	660	55
Plant 32	3000	1,777	59
Plant 33	500	477.7	95.5
Plant 34	600	496	82.7
Plant 35	950	924.5	97
Plant 36	300	250	83

Please note that plants that have not disclosed their capacity utilization details are excluded from the above table.

The above data suggests an average capacity utilization of about 70% in a typical dairy plant. The same has been used in the report for estimating SEC of plants whose production data is unavailable.

3.5 Major energy consuming areas

Major energy consuming areas in a typical dairy plant are heating, cooling and utilities. Energy is used for running electric motors, pumps, process equipment, heating, evaporating and drying, cooling and refrigeration, and for the generation of compressed air. Data gathered shows that about 70% of a typical plant's energy needs is met by the combustion of fossil fuel (gas, furnace oil, diesel etc.) or biomass to generate steam and hot water for evaporative and heating processes.

[52] Data collected from individual plants (for full details of the data set of 36 plants refer table 14)

The remaining 30% is met by electricity for running electric motors, refrigeration, lighting, compressors and process related equipment. The percentage share of electrical energy consumption and thermal energy consumption of plants whose data has been gathered can be seen below:

Table 9 – Electrical and Thermal energy usage of individual plants [53]

Plant	Installed Capacity (TPD)	Production (TPD)	Electrical Energy Use (%)	Thermal Energy Use (%)
Plant 1	200	140	20	80
Plant 2	260	182	44	56
Plant 3	100	118	49	51
Plant 4	100	89.3	45	55
Plant 5	1,200	840	2	98
Plant 6	2,500	1,797	15	85
Plant 7	100	70	28	72
Plant 8	5,760	4,032	6	94
Plant 9	1,000	550	42	58
Plant 10	500	350	12	88
Plant 11	800	557	78	22
Plant 12	850	595	60	40
Plant 14	1,400	1,180	47	53
Plant 15	160	144.5	51	49
Plant 16	165	118	22	78
Plant 17	2,500	1,750	55	45
Plant 18-25 (cluster)	2,393.5	1,675.45	38	62
Plant 26	200	235	17	83
Plant 28	1,200	307	16	84
Plant 29	550	567	27	73
Plant 31	1,200	660	57	43
Plant 32	3,000	1,777	26	74
Plant 33	500	477.7	47	53
Plant 34	600	496	12	88
Plant 35	950	924.5	40	60
Plant 36	300	250	40	60

As seen in the above table, electricity usage varies from about 30-70% and thermal usage also varies in the range of 30-70% in different plants. A weighted average shows the ratio of thermal to electrical energy usage to be approximately 70%-30% in a typical dairy plant. However, as seen in the table, significant variance may exist between plants due to the kind of products processed, the fuel mix used, availability of fuel, cost of power, plant loading and technology used.

[53] (for full details of the data set of 36 plants refer table 14)

The breakdown of energy consumption in a typical milk processing plant is as shown below:

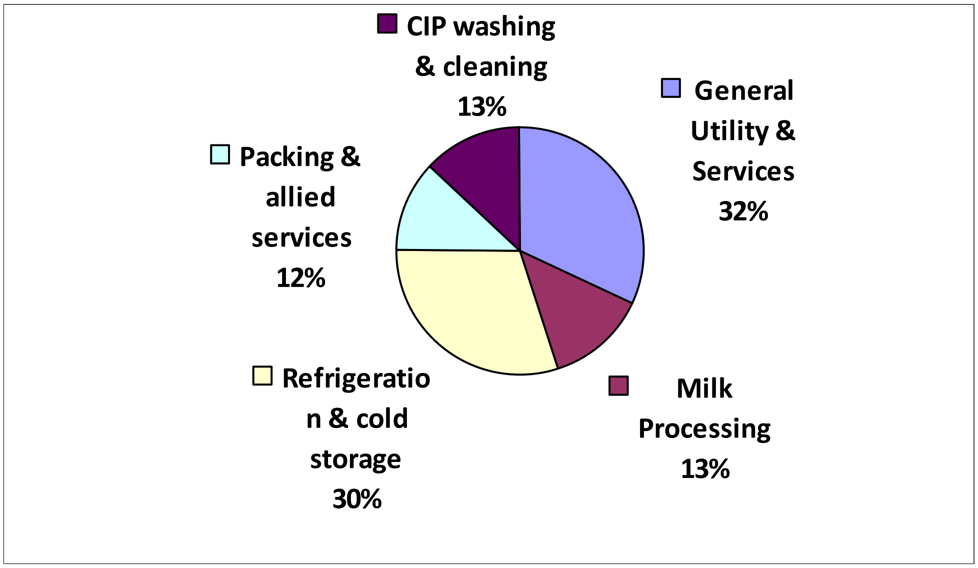

Figure 5 - Energy consumption breakdown of a typical plant[54]

It can be seen that a majority of the energy consumption in a typical dairy goes into refrigeration, general utility and services which include heating and steam generation. A certain portion of energy consumption goes into the cleaning operation and the processing activity.

The major energy consuming equipment includes Refrigeration System, Spray Dryers, Blowers, Air Compressors, Lightings, Pumps, Motors, homogenizers, evaporating plants, separator and clarifiers, effluent treatment plant, CIP and Boilers.

The table below provides some indicative figures of energy consumption of different dairy products, along with the breakup of percentage energy consumption in the processes involved. It is to be noted that these figures correspond to European dairy plants and are only indicative; they may, therefore, not be relevant to Indian dairy units.

Table 10- Average energy use per ton of product [55]

Product	Process	Energy Consumption (%)	Million kCal/ton of product
Butter	Refrigeration	66	0.31
	Compressed air	8	0.03
	Cleaning in Place	26	0.12
	Total	**100**	**0.47**

[54] BEE project report of WHRS in Gujarat Dairy cluster
[55] Adapted from energy use and energy efficiency in the European dairy industry2004

Cheese	Reception/thermization	19	0.17
	Cheese processing	14	0.13
	Cheese Treatment/Storage	24	0.22
	Refrigeration	19	0.17
	Compressed air	5	0.05
	Cleaning in Place	19	0.17
	Total	**100**	**0.93**
Fluid Milk	Reception/thermization	2	0.005
	Storage	7	0.017
	Centrifugation/homogenization/pasteurization	38	0.09
	Packing	9	0.02
	Refrigeration	19	0.04
	Compressed air	0.5	0.00008
	Cleaning in Place	9.5	0.02
	Process Water	6	0.02
	Space Conditioning	9	0.02
	Total	**100**	**0.24**
Milk Powder	Thermization/pasteurization/centrifugation	2.5	0.06
	Thermal concentration/evaporation	45	1.08
	Drying	51	1.23
	Packing	1.5	0.03
	Total	**100**	**2.41**

The dairy plants which responded to the questionnaires sent out to them as part of this project were unable to provide energy use per ton of any product. Therefore, a calculation of a similar estimate or average for energy use per ton of product for Indian dairies is not possible at this time.

3.6 Energy saving potential and major areas of saving

Our interactions with a number of plants, experts, technology suppliers, other stakeholders and many reports suggest that, in a typical dairy processing plant, 10 % saving can be achieved without any investment, merely by process control; about 15% can be saved by investing some amount with reasonable payback period; an additional 25% can be saved with higher investment and slightly longer payback period.[56]

[56] Dairy India Yearbook publication 2007,PCRI practical guide

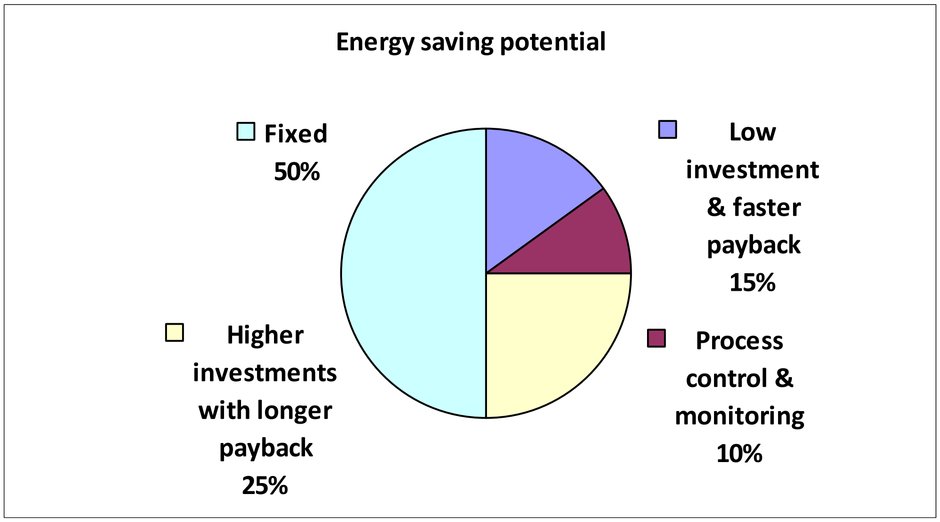

Figure 6 – Energy saving potential in a typical dairy[57]

The major energy consuming areas in a dairy processing plant are heating, refrigeration/chilling and utilities. Considering this, the approaches that can be taken towards energy efficiency in the dairy processing plants are discussed below:

3.6.1 Cogeneration

Thermal power plants are a major source of electricity supply in India. The efficiency of conventional power plants is only about 35% due to the inherent constraints of the different thermodynamic cycles employed in power generation.

Cogeneration or Combined Heat and Power (CHP) is the sequential generation of two different forms of useful energy from a single primary energy source, typically mechanical energy and thermal energy.

Mechanical energy may be used to drive an alternator for producing electricity, or for rotating equipment such as motor, compressor, pump or fan for delivering various services. Thermal energy can be used either for direct process applications or for indirectly producing steam, hot water, hot air for dryer or chilled water for process cooling. The overall efficiency of energy use in cogeneration mode can be up to 85 percent and above in some cases.

For example, a plant requires 24 units of electrical energy and 34 units of heat energy. Through separate heat and power routes, the primary energy input in power plant will be 60 units (24/0.40), and the fuel input to boiler (for steam generation) will be 40 units (34/0.85), together totalling 100 units. If the plant had cogeneration, then the fuel input will be only 68 units ((24+34)/0.85) to meet both electrical and thermal energy requirements. It can be observed that the loss, which was 42 units in the case of separate heat and power, has reduced to 10 units in cogeneration mode.

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[57] Dairy India Yearbook publication 2007,PCRI practical guide

Along with the saving of fossil fuels, cogeneration also allows to reduce the emission of greenhouse gases (particularly CO_2 emission). The production of electricity being on-site, the burden on the utility network is reduced and the transmission line losses are eliminated.

Cogeneration makes sense from both the macro and micro perspectives. At the macro level, it allows a part of the financial burden of the national power utility to be shared by the private sector; in addition, indigenous energy sources are conserved. At the micro level, the overall energy bill of the users can be reduced, particularly when there is a simultaneous need for both power and heat at the site, and a rational energy tariff is practiced in the country.

Cogeneration systems could be quite useful for the large integrated dairy plants whose electrical load is more than 1000 KVA and there exists high demand for steam due to powder plant. Additionally, huge savings could be achieved in case of availability of cheap fuel like wood, rice husk or any other agro fuel. A few large integrated dairies in the country like Mother Dairy (Gandhinagar), Parag Milk Food Pvt. Ltd. (Manchar) and Swaraj India Industries Ltd. (Nimbhore) have already installed co-generation systems in their plants and are reaping its benefits.

3.6.2 Trigeneration

Trigeneration is the simultaneous production of power/electricity, hot water and/or steam, and chilled water from one fuel. Basically, a trigeneration power plant is a cogeneration power plant that has added absorption chillers for producing chilled water from the heat that would have been wasted from a cogeneration power plant. Trigeneration plants can reach system efficiencies that exceed 90%. Trigeneration plants are very energy efficient, conserve natural resources and reduce fuel consumption as the system operates at such high efficiencies.

Trigeneration systems are ideal for dairy industry as dairies need power, steam and refrigeration and trigeneration systems can provide all these using a single fuel. Just like in cogeneration systems, there is a huge saving potential in case some agro based cheaper fuel is available. Such installations have already been adopted by few Indian dairies like Milk Foods (Patiala) and Nova Foods (Kasganj).

3.6.3 Desuperheaters

The refrigeration system normally used in a dairy plants or chilling centre is based on vapour compression cycle. A desuperheater, which is basically a heat exchanger, is installed between compressor and condenser, where some super heat is recovered before compressed refrigerant rejects it in the condenser. The heat recovery mainly consists of absorbing heat from the hot gases delivered by the compressor before they are condensed in the condenser. The quantity of heat recovered depends on the rate of flow of refrigerant in the system and the temperature at which system is operating. Generally the heat recovery varies from 17.5 to 21 % of the refrigeration plant capacity.

The heat recovery in a desuperheater is in the form of hot water at a temperature between 55 to 70 degree Celsius at a rate of around 50 litres/ hour/ TR, and this hot water can be used in the plant for a wide range of purpose such as for feeding to boiler or in a hot water mixing battery or in a crate/can washer etc.

The typical cost of desuperheating plants normally varies from Rs. 4,000 to Rs. 5,500 per TR, depending upon the refrigeration plant capacity and accordingly, the payback period varies from one and a half years to two and a half years.

Besides saving in fuel and electricity (due to reduced running hours of refrigeration plant compressors), the other benefits from desuperheater plants are reduced boiler hours, avoiding the use/ need of a boiler at chilling centre and lesser investment on condensing area (around 30% if used for a new installation).

3.6.4 Vapour absorption refrigeration

Dairy plants which have access to a good amount of waste heat and low cost steam (especially in cases of biomass fired boilers) have good potential to adopt VAR. The dairy industry's demand profile is characterised by simultaneous and significant heating, chilling and electricity demands for various operations. In most large and medium dairy plants the load profile is spread over the day thus there is an opportunity for incorporating VAR by utilizing the available heat for chilling purposes from the CHP. This trigeneration system, as mentioned earlier, will lead to reduced electricity consumption. Even in case of small and medium plants without cogeneration plants, the waste heat from boiler flue gas or the DG sets exhaust gases can be utilised as an energy source for chilling.

3.6.5 Variable Frequency Drive

Variable speed control is an important means of achieving energy savings in dairy plants. Generally, air/fluid control is affected by throttling dampers fitted at induced and forced draft fans. Though dampers are the simplest means of control, they lack accuracy, giving poor control characteristics at the top and bottom of the operating range besides wasting energy. In general, if the load characteristics of the boiler are variable, the possibility of replacing the dampers by a VSD should be evaluated.

In variable torque applications, the torque required varies with the square of the speed and the horsepower required varies with the cube of the speed, resulting in a large reduction of horsepower for even a small reduction in speed. Thus, a motor will consume only 25% as much energy at 50% speed as it will at 100%. Even a decrease in speed by 10% will save 19% energy.

There are a number of variable speed drives e.g. eddy current drives, variable frequency drives (VFD), slip power recovery system, fluid coupling etc. Of these, VFD is the most common and most energy efficient system for variable torque applications. With the help of VFDs, speed of a drive can be reduced up to 11% and increased up to 300% of full speed.

These VFDs must be used at all pumps, condenser fan motors, condenser pump motors, evaporator fans, and compressors in the plant.

3.6.6 Lighting

Lighting is an essential service in all the industries. The power consumption by the industrial lighting varies between 2 to 10 percent of the total power depending on the type of industry. Typical electrical load for lighting in a dairy is about 3-5 percent of total electricity consumption.

Innovation and continuous improvement in the field of lighting such as LED, CFL and T-5 based lighting has given rise to tremendous energy saving opportunities in this area.

Light Emitting Diodes: LED light bulbs use only 2-17 watts of electricity (1/3rd to 1/30th of incandescent lights or CFLs). LED bulbs used in fixtures not only save electricity but remain cool and save money on replacement costs since LED bulbs last 10 to 15 times longer than with incandescent bulbs.

T-5: T5 lamps are fluorescent lamps that are 16mm or 5/8" of an inch in diameter. These have a higher luminous efficacy[58] when compared to the older fluorescent lamps like T8 or T12 lamps. The luminous efficacy of T5 lamps is about 100 lm/ W, while those of T8 and T12 lamps are only about 80 lm/ W and 70 lm/ W, respectively. The higher the value, the more energy efficient the lamp is.

There exists energy saving potential even in the area of non-industrial purpose lighting in dairy plants. Motion sensors may be a possible way to save some energy by automatically turning off lights in unoccupied areas.

Lighting is an area which provides major scope to achieve energy efficiency at the design stage and retrofitting, by incorporation of modern energy efficient lamps, luminaries and gears, apart from good operational practices.

3.6.7 Flash steam recovery

After process requirement, when hot pressurized condensate is discharged to a low pressure return line, part of it is re-evaporated; creating what is known as flash steam. This high temperature condensate contains high energy that cannot remain in liquid form at a lower pressure because there is more energy than that required to achieve saturated water at the lower pressure. The result is that some of the excess energy causes a percentage of the condensate to “flash”. This flash steam is important because it still contains a certain amount of heat. Recovering flash is a very effective way to improve the energy efficiency of the steam system.

This is done by installing of a flash tank and recovering the flash steam that is used in a heat exchanger, to heat air, water, or any other liquid, or it may be used directly in processes with lower-pressure steam requirements. Flash steam can be generated directly by discharging high-pressure condensate to a lower-pressure steam system. However, it is sometimes difficult to find a low pressure steam application to use this flash steam. A steam ejector allows the flash steam to be injected into higher pressure live steam. This solution is often used to re-inject the flash steam into the inlet of the heat exchanger that has generated the condensate. But a more sophisticated installation allows removing this “single application” constraint. Flash steam from the general condensate return line can be injected into the steam main line, thus making it available for any process requirement.

[58] luminous efficacy : indicates the amount of light a lamp generates from the energy it consumes

In such a case a new flash tank with appropriate sizing and design should be installed. Then, a mechanical pump can be used to remove the condensate from the bottom of the tank without the cavitation phenomenon. Finally a steam jet vacuum ejector installed at the vent line of the tank will be used to recover the flash steam.

This solution with steam ejector offers several advantages:

- No more flash steam losses to the atmosphere, flash steam being injected in the low pressure steam network thus leading to thermal energy saving.
- Lower back pressure in the condensate return and high velocity in heat exchangers
- Flash can constantly be used because of higher pressure reached due to the ejector

3.6.8 Evaporative condensers

Evaporative condensers must be used for the refrigeration plants in dairies over conventional air cooled condensers. Air cooled condensers are advantageous when compared with water cooled condensers with regard to water and space occupied. The disadvantage with air cooled condensers is that the compressor operates with higher specific power consumption as the condenser temperature and pressures are higher. Comparison between a typical water cooled and air cooled system would indicate a significant difference in specific power consumption. Typical figures are as follows.

- Air cooled system: 1.0 – 1.2 kW/ TR
- Water cooled system: 0.6 – 0.8 kW/ TR

Water cooled systems not only have higher heat transfer coefficients than the air cooled systems. The temperature of cooling water would be lesser than that of air. Because of these reasons the refrigerant in the chiller circuit can condense at lower pressure reducing the work requirement of the chiller compressor. Thus water cooled systems have lower specific power consumption than that of air cooled systems.

The latest trend is to install evaporative condensers which operate with even lower specific power consumption because of integrating the heat exchanger for condensing the refrigerant into the cooling tower. Evaporative condensers can cool refrigerant very close the wet bulb temperature.

Between conventional water-cooled condensers and evaporative condensers, power consumption of the auxiliaries in the case of evaporative condensers will be much lesser. The evaporative condensers consume only about 20% of the power consumption of a typical water-cooled condenser.

The advantages of the evaporative condensers are as below:

- Improved water to air contact
- Increased water flow over the refrigerant coil
- Enhanced heat transfer resulting in lower condensing temperature.
- Lower pumping power requirement for the cooling water

- Chiller systems fitted with Evaporative condensers are operating successfully in other plants with specific power consumption of about 0.6 – 0.7 kW / TR
- About 10-15% of energy saving of compressor can be achieved on its power requirement.

3.6.9 Automatic O_2 sensors for boiler

All combustion requires the correct measure of oxygen; too much or too little can cause undesirable effects. However, the error is almost always intentionally on the high-side (too much oxygen) because the main effect on the high side is low efficiency. Too little air results in carbon monoxide formation, sooting and even explosion if accumulated soot and other non-combusted suddenly get enough oxygen to rapidly burn.

When boiler burners are manually tuned on a periodic basis, they are typically adjusted to about 3% excess oxygen which is about 15% excess air. This is because there are many ambient and atmospheric conditions that can affect oxygen/air supply. For example, colder air is denser and contains more oxygen than warm air; wind speed affects every chimney/flue/stack differently; and barometric pressure further affects draft. Therefore, an excess oxygen/air setting at the time of tuning assumes there will still be enough oxygen available for complete combustion when conditions worsen.

From an efficiency standpoint, the excess O2 means there is more air in the combustion stream than there needs to be. That air also contains moisture and it all is heated and then lost up the stack. The amount of excess O2 thus leads to efficiency loss. Although it may be possible to monitor and adjust the burner on a daily basis, it is not practical. Automatic O2 systems continuously monitor the flue gases and adjust the burner air supply. They are generically called 'O2 Trim Systems'. Energy saving has been achieved at plants with such installations by reducing the inefficiency of the boiler by constantly controlling the excess O2 level automatically.

3.6.10 Renewable energy

3.6.10(a) Biomass

"Biomass" refers to raw organic material which can be used to generate a number of energy resources, including heat, liquid or gaseous fuels, and electricity. The chemical energy stored in biomass can be converted to heat by combustion . Biomass can also be converted to liquid or gaseous fuels or can be used to generate electricity in the same way that coal is used. The electricity generated can be used for small scale (e.g., to cook or make hot water in individual buildings) or large scale applications (e.g., to generate ethanol, biodiesel, biogas, or electricity for general distribution). Hence is suitable for any size of dairy plant.

The typical energy content in a few types of biomass:

- Wood chips: 4500 kCal/kg
- Rice husk: 3400 kCal/kg
- Sunflower husk: 4000 kCal/kg

- Firewood: 2000 kCal/kg
- Coconut shell: 5500 kCal/kg

Many dairies have installed biomass based boilers using a variety of products like firewood, rice husk, wood pallets, briquettes, sunflower husk, manure, municipal waste etc.

3.6.10(b) Manure

The methane contained in the biogas produced by cattle manure can be used at the village level milk collection and chilling centers as well as bulk milk coolers for lighting, heating water for cleaning or for cooling milk through VAM.

3.6.10(c) Waste

Digester technology installed in plants can be used to convert municipal solid waste and plant effluent to biogas. This biogas can be burnt to generate electricity and the heat produced in turn may also be used for pre-heating applications in the plant. This has a potential to reduce or/and replace conventional energy being used in dairy plants.

The conventionally used aerobic digester systems are highly energy intensive when compared to retrofitted anaerobic systems followed up by aerobic digesters. Most dairy plants are already using anaerobic digester followed by aerobic digester type of Effluent treatment plants (ETP) due to Pollution control board (PCB) norms for waste water discharge. This leads to lesser requirement of aeration energy when compared to the conventional aerobic systems. The major advantage of anaerobic digesters is the methane production which can be used as a source of energy. However, the existing trend of dairy plants shows that most plants even after installing up flow anaerobic sludge blanket (UASB) systems, do not use the methane produced. They allow the methane to just burn in flame. There is a large potential of using this renewable source as seen below for energy generation in dairy plants.

Potential of energy saving by utilizing methane generated from ETP:

Most dairy plants have ETP's installed due to the PCB norms. However it has been noticed that not many utilize the produced methane generated productively. These is a good potential to collect and utilize the methane in side the plant and to replace about 2-3% of conventional thermal energy usage as shown below:

Average BOD content in the discharge waste water of a typical Dairy plant=1500mg/lt effluent

Average BOD destruction by an anaerobic system = 75%.

Average methane generation by BOD destruction = 0.3 m^3/kg of BOD destructed.

Gross calorific value of methane = 5500 kCal/ m^3

BOD destroyed by Anaerobic digester = 0.75X1500 = 1125 mg/lt effluent

Methane generation = $\frac{0.001125 \times 0.3}{1}$ = 0.0003375 m^3/lt effluent

Energy available from methane = quantity of methane X gross calorific value

= 0.0003375 X 5500

= 1856 kCal/m^3 of effluent

In a typical dairy the fraction of energy used to run the ETP is not more than 5% in comparison to the overall operation of the dairy. Assuming 95% of energy is utilized for process and utility applications in the plant and 5% for ETP, about 1763kCal/m^3 of effluent or 2645 kCal/m^3 [59]of milk processed is available.

Some amount of energy load of a plant may be reduced by utilizing this methane from the ETP. It has been estimated that about 2-3 % energy reduction is possible with increased awareness, implementation and most importantly utilizing the methane generated in generating electricity/using as boiler fuel/substituting with LPG usage in plant etc. instead of burning it in flame.

Apart from energy saving, methane a green house gas contributes 23 times more than CO_2 to the global warming when released into the atmosphere. For instance by replacing the following fuels with generated methane for thermal energy requirement of 1 terajoule at a plant, the GHG emissions reduce from:

- ❖ LPG: 63 tonnes to 60.8 tonnes (3.5% reduction)
- ❖ Crude oil: 70.8 tonnes to 60.8 tonnes (14% reduction)
- ❖ Coal: 94.68 tonnes to 60.8 tonnes (35.5% reduction)

Thus utilizing the methane for in house requirements will not only save energy but reduce the GHG impact on the environment.

- ❖ Effluent generation from 1 MT milk processing = 1.5 MT
- ❖ Methane generation from 1 MT effluent treatment = 0.3375 m3
- ❖ Thermal energy by using methane generated from 1 MT milk processed = 2645 kCal/ MT
- ❖ Potential energy saving = 2-3% of overall energy consumption
- ❖ GHG emission reduction is achieved by utilizing methane generated

3.6.10(d)Agro based fuel

Use of fluidized bed combustion boilers using agro based briquettes can bring down cost of steam production by about 50% of furnace oil fired boilers, which will lead to direct thermal energy and cost saving. A large number of Indian dairy plants are shifting from oil fired to agro based fuels like wood pellets, rice husk, coconut shell and briquettes .Design modifications need to be incorporated in the coal-fired chain grate boilers to be modified to burn these bio fuels. However this has attractive pay pack periods of just about a year.

[59] Considering processing of 1 lt milk gives 1.5 lt of effluent in a typical dairy processing plant.

The key benefits of converting from conventional energy usage to renewable sources are fossil fuel saving and reduction in greenhouse gases apart from the obvious reduction in energy cost. The calorific value of bio fuels range from 3000 to 5000 kCal/ kg. The cost ranges from about Rs.16 (USD 0.29) to Rs.20 (USD 0.36) a kg which is about 2 to 3 times cheaper than conventional fuel. Although such a project requires initial investment, the opportunity for cost reduction and in turn utilizing a cleaner fuel makes it advisable.

3.6.10(e) Solar

Solar thermal systems can enormously contribute to driving the various thermal processes in the dairy industry which demand water at temperatures less than 120°C. Apart from this, solar PV systems can also contribute to saving electrical energy consumed during refrigeration.

Table below shows the various dairy processes along with different solar technologies that can be potentially used.

Table 11 - Potential areas for use of solar technology as per MNRE[60]

Process	Energy/Fuel being used	Application Media	Temperature required °C	Recommended solar technology
Washing and cleaning	Electricity and Boiler fuels like furnace oil, rice husk	Hot water	40–60	FPC
Chilling/Cold storage	Electricity and diesel		< 5	Solar thermal systems, driving absorption chillers
Sterilization/ Evaporation	Boiler fuels like furnace oil, rice husk	Process heat	100–120	ETC or solar concentrators
Spray drying	Boiler fuels like furnace oil, rice husk	Hot air	120	ETC (Air-based) or solar concentrators
Pasteurization	Boiler fuels like furnace oil, rice husk	Process heat	70	FPC

Vast potential exists in the dairy industry for installing various solar applications. An estimate of the total potential in the country has been made by considering the integration of solar energy systems with the existing energy supply systems in the industry by PwC. This has been estimated considering conservative and pragmatic estimate of the energy replacement potential given the limitations in the availability of solar energy all-round the year. [61]

[60] MNRE's report on Identification of Industrial Sectors Promising for Commercialization of Solar Energy
[61] MNRE's report on Identification of Industrial Sectors Promising for Commercialization of Solar Energy

Table 12- Estimated energy replacement by implementation of solar technologies [62]

Processes	Energy/Fuel being used	Energy replacement (ktoe/annum)	Estimated monetary savings (Rs Million/annum) / (USD Million)
Cleaning and washing	Furnace oil, rice husk	5	93 / 1.7
Boiler feed (Pasteurization, Sterilization and Evaporation	Furnace oil, rice husk	12	233 / 4.2
Pre heating for chemical processes	Electricity	8	50 / 0.9
Cold storage – chilling plants	Electricity	5	291 / 5.3
Spray drying	Electricity	4	249 / 4.5
Tot al		**27**	**916 / 16.65**

Based on an analysis in MNRE's report, total potential of energy saving by replacement of conventional to solar technology has been estimated at about 27,000 MTOE.

India, being in the tropical region, has an abundance of sunlight during the year; there is good potential use this solar energy in Boilers. There is also potential for solar energy based bulk milk coolers in India to be adopted widely even at village level. Hybrid (solar-cum-diesel) bulk milk cooler options may be explored for year round efficient cooling.

- **Solar PV modules based on multi-crystalline technology**

The Government of India has launched eight Missions as part of the National Action Plan on Climate Change (NAPCC) in specific areas which include assessment of the impact of climate change and actions needed to address climate change.

The Jawaharlal Nehru National Solar Mission is one of the eight Missions, and has set the ambitious target of deploying 20,000 MW of grid connected solar power by 2022. This is aims at reducing the cost of solar power generation in the country, along with providing long term energy and ecological security. State Governments have already announced attractive policies and initiatives, driving an aggressive transition towards solar power generation in various industrial sectors.

Heritage Foods Limited is one such plant that has synchronized its first solar photo-voltaic plant of 2.34 MW capacity in Medak district of Andhra Pradesh, as part of the company's clean energy initiatives. Spread across a 14-acre site, the plant comprises of 9,360 solar PV modules based on multi-crystalline technology. The power thus generated from the plant will be used for captive purpose for its dairy unit located in Hyderabad. This plant is equipped to supply more than 4 million units of clean and green energy annually. The power unit is expected to displace nearly 3,300 MT of carbon dioxide annually.

[62] MNRE's report on Identification of Industrial Sectors Promising for Commercialization of Solar Energy

4. ANALYSIS OF ENERGY CONSUMPTION

4.1 Methodology

In order to estimate the energy consumption of this sector the following methodology has been followed:

- Initial desk research was conducted to gather information from secondary sources like annual reports, reports and websites of Government Ministries (DAHF and MOFP), organizations (IDA, NDDB, NDRI, NABARD etc.) and other stakeholders.

- Dairy processing plants were visited to understand the extent of technology adoption, energy consumption, type of fuels used, product mix, existing level of energy efficiency practices and constraints faces by them in taking up energy efficiency at their plants.

- A questionnaire was formulated and sent out to more than 50 dairy plants across the country to collect data related to production, energy consumption, fuels used, energy saving potential, energy saving measures undertaken and constraints faced by the plants. Plants contacted ranged from small to large sizes and with different product mixes' to have a larger representation of the sector. Energy consumption data for 36 plants has been collected through these questionnaires and annual reports of various plants.

- Interacted with technology suppliers (ETP suppliers, steam system suppliers etc.), organizations like IDA and NDDB and other experts from this sector to understand their perspectives.

- After the first draft report, a stakeholder consultation workshop was organized to discuss views of the participants on the existing trend and future prospects of energy efficiency in this sector. It was attending by representatives from different dairies and IDA. The experienced stakeholders from this sector during the workshop provided many more inputs regarding the trends and constraints faced by the sector. These input have been also been incorporated.[63]

- Energy consumption data collected for the 36 plants of different sizes and product mix has been used to analyze and estimate the sector's existing energy consumption level.

[63] List of participants has been included in the annexure

Assumptions used for calculations:

1. Processing capacity of Indian dairy sector = 120,548 TPD [@]
2. Average capacity utilization[#] = 70%
3. 1 MT of milk *= 1000lt of milk
4. 1 kWh = 860 kCal
5. All dairies run throughout the year. Therefore operational days considered to be 365.

[@] Food Safety and Standards Authority of India, Ministry of Health and Family Welfare (Installed capacity of all registered plants)

[#] Average capacity has been calculated based on data collected from 36 plants – See section 3.4

* Density of milk = 1.028kg/lt. however to simplify calculations it has been considered as 1kg/lt.

In order to calculate MTOE consumption of individual units the following method has been used:

a) Electrical energy

Total electrical energy (kCal) = Total electricity consumed (kWh) X 860

b) Thermal energy

Total thermal energy (kCal) = (Fuel 1 X Gross calorific value) + (Fuel 2 X Gross calorific value) +…

c) Specific electrical energy consumed

SEC = total electricity (kWh) / MT of processed milk

d) Specific thermal energy consumed

SEC = total thermal energy (kCal) / MT of processed milk

e) Total energy consumption for each plant (MTOE)

$$\text{Total energy consumption} = \frac{\text{Total electrical energy (kCal)} + \text{Total thermal energy (kCal)}}{10{,}000{,}000}$$

f) MTOE of the entire sector[64]

Energy consumption data has been collected for 36 plants through questionnaires, plant visits and publically available reports. SEC and MTOE of each individual plant have been calculated[65] as indicated above, and the same is presented in the table below.

[64] The Metric tonne of oil equivalent (MTOE) is a unit of energy: considered as 10,000,000 kCal

[65] Table 10 contains individual plant details

Table 13- SEC variation in individual plants [66]

Plant	Installed Capacity (TPD)	SEC (E) (kWh/MT)	SEC (T) (kCal/MT)
1	200	42	145380
2	260	32	34750
3	100	26	24000
4	100	72	77145
5	1,200	9	358731.9
6	2,500	20	102867.9
7	100	45	99000
8	5,760	52	103630
9	1,000	32	37347.43
10	500	19	120955
11	800	48	11843.42
12	850	54	30621.07
13	500	62	53.62106
14	1,400	24	23400
15	160	43	34532.6

Plant	Installed Capacity (TPD)	SEC (E) (kWh/MT)	SEC (T) (kCal/MT)
16	165	25	75424.61
17	2,500	12	8718.6
18-25 (cluster)	2,394	26	36300
26	200	51	208040.2
27	500	82	0
28	1,200	93	404193.5
29	550	40	95257.45
30	400	50	0
31	1,200	75	49844.36
32	3,000	56	137668.5
33	500	68	65553.54
34	600	55	18491.16
35	950	26	33915.61
36	300	67	85800

[#] The energy data for plant 27 and plant 30 has been provided only in terms of kWh

* Consolidated data for all 8 plants given

Individual SEC is based on actual production data disclosed by plants. For plants whose production details are unavailable, production has been considered to be 70% of installed capacity, as mentioned in section 3.4.

A huge variance has been noticed in SEC of individual plants as seen in the table above, that range between:

SEC (electrical) – 25 kWh/MT and 60 kWh/MT

SEC (thermal) – 20,000 kCal/MT and 90,000 kWh/MT

A weighted average approach for these 36 plants (full details in table 14 and names provided in Annexure E) has been used to arrive at the following average SEC figures. These have been used to estimate the overall sector's energy consumption.

[66] (for full details of the data set of 36 plants refer table 14)

Average SEC

- **SEC (electrical) – 40kWh/MT**
- **SEC (thermal) – 60,000kCal/MT**

=> MTOE/MT = 0.0095

India's processing capacity being 120,548[67] TPD, and considering capacity utilization of about 70%[68], the sector's overall energy consumption is calculated to be 0.29 million MTOE using 0.0095 MTOE/MT as SEC.

The overall energy consumption of the Indian dairy sector is thus estimated to be about 0.29 million MTOE.

4.2 Plants and their energy consumption data

Energy consumption data of 36 plants has been collected from plant visits, questionnaires, annual reports and other technical reports. The data collected accounts to only 24.79% of the market and contributes to 0.11 million MTOE of energy consumption. The following table shows the individual plant-wise capacity, production and energy consumption data.

Table 14 – Collected data set (36 Plants and their energy consumption)

Plant	Capacity (TPD)	Production (TPD)	Market share	SEC (E) (kWh/MT)	SEC (T) (kCal/MT)	MTOE	Source
Plant Visits							
Plant 1	200	150	0.17	41.7	145,380	926	Plant visit
Plant 35	950	924.5	0.79	26.3	33,915.6	1,909	plant visit
Plant 36	300	250	0.25	67.1	85,800	1,310	plant visit
Plant 9	1000	550	0.83	31.8	37,347.4	1,299	Plant visit
Annual Reports / Energy Management Training / other reports							
Plant 4	100	89.3	0.08	72.4	77,145	455	Annual Report (AR) -12
Plant 5	1200	900	1.00	6.1	251,112.3	11,228	AR-12
Plant 3	100	118	0.08	26.3	24,000	201	SEC on website
Plant 8	5760	4320	4.78	52.0	103,630	35,597	AR-12
Plant 10	500	375	0.41	13.1	84,668.5	1,751	AR 2009
Plant 13	500	375	0.41	43.2	37.5	679	AR 2008
Plant 17	2500	1875	2.07	8.6	6,103	1,235	AR 2006
Plant 2	260	182	0.22	31.8	34,750	413	Energy Manager Training (EMT)2012
Plant 12	850	637.5	0.71	37.8	21,434.7	1,674	EMT 2004

[67] Food Safety and Standards Authority of India, Ministry of Health and Family Welfare
[68] Data set collected for 36 plants
* Estimated based on average SEC of 40kWk/MT and 69000kCal/MT

Plant 14	1400	1180	1.16	24.1	23,400	1,901	EMT 2012
Plant 15	160	144.5	0.13	42.5	34,532.6	375	EMT 2010
Plant 16	165	118	0.14	24.6	75,424.61	416	EMT 2011
Plant 7	100	75	0.1	45.0	99,000	352	Contacted
Plants 18-25	2393.5	1675.45	2	26.0	36,300	3,587	BEE Gujarat cluster report on WHRS
Questionnaires Received							
Plant 6	2500	1797	2.07	20.5	102,868	7,903	Questionnaire received (QR)
Plant 11	800	557	0.66	47.8	11,843.4	1,076	QR
Plant 26	200	235	0.17	50.8	208,040.2	2,159	QR
Plant 27	500	154	0.41	25.3	0	398	QR
Plant 28	1200	307	1.00	92.8	404,193.5	5,424	QR
Plant 29	550	567	0.46	40.2	95,257.45	2,686	QR
Plant 30	400	406	0.33	50.3	0	641	QR
Plant 31	1200	660	1.00	75.4	49,844.36	2,763	QR
Plant 32	3000	1777	2.49	55.7	137,668.5	12,034	QR
Plant 33	500	477.7	0.41	67.6	65,553.5	2,157	QR
Plant 34	600	496	0.50	55.4	18,491	7,436	QR
Total	**29,888.5**		**24.79**	**Weighted Avg. : 40 (kWh/MT)**	**Weighted Avg. : 60,000 (kCal/MT)**	**110,451**	

4.3 Plant Vs Energy Consumption (MTOE)

The energy consumption calculated for individual plants (MTOE) has been plotted against each plant in the figure below:

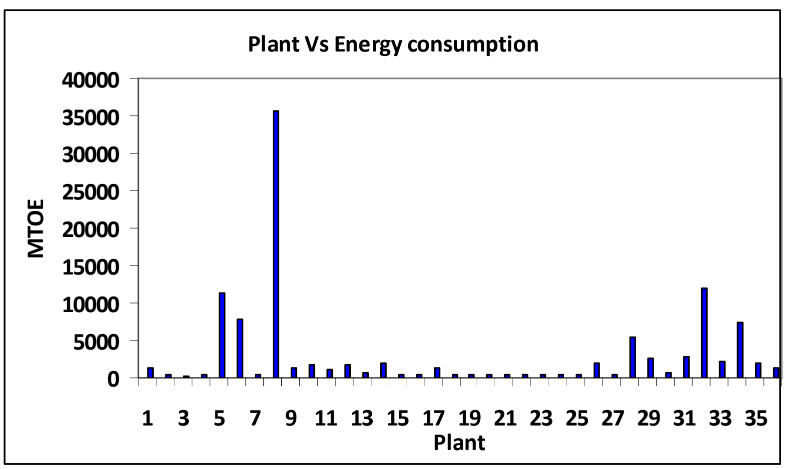

Figure 7- Plant Vs MTOE[69]

[69] (for full details of the data set of 36 plants refer table 14)

4.3.1 Reasons for wide variation of SEC in different plants

As seen in table 13 earlier, the SEC of each plant varies widely even within the same subsector.

- Product mix: The energy consumed depends on the range of products being produced. Processes which involve the concentration and drying of milk, whey or buttermilk for example, are very energy intensive. The production of market milk on the other hand involves only some heat treatment and packaging, and therefore requires considerably less energy. For instance at a large integrated plant of Amul (Gujarat) it has been seen that the avg. SEC of processing milk products alone is about 50 kWh/MT, whereas SEC for ice cream production alone is about 300kWh/MT[70]. Thus the production of ice cream increases the overall SEC of the plant. Thus the product mix plays a vital role in variation in SEC from plant to plant.

- Fuel/Energy mix: Due to unavailability to primary energy plants are shifting to secondary forms of energy like FO, LDO etc. This not only affects the cost of energy but also leads to change in SEC of the plants. For example, due to unavailability of continues power supply, DG set are being operated to compensate for the electricity needs. This increases the operating cost along with increasing the energy consumption. Say, for 1 unit of electricity from grid is taken as 860 kCal/kWh. But when a DG operated to generate about 3.5kWh/lt, it consumes about 3000kCal/kWh. This clearly indicated increase in energy consumption.

  More the unavailability of electricity from grid, higher will be the SEC. Similarly reduced availability of coal in the market has been driving plants to switch their fuel consumption to LDO, HSD, FO, Biomass etc which affects their energy cost. Thus variation in the fuel mix in different plants also affects the specific energy consumption of plant.

- Loading or capacity utilization: Loading capacity varies daily and seasonally within individual plants. For instance production of ice-cream, lassi and buttermilk is high during summers compared to winters. The capacity utilization also varies from lean to flush seasons based on availability of milk and other market related factors and in turn the energy consumption. For instance SEC (electrical) variation from 60kWh/MT to 40kWh/MT has been seen at the Amul-Mother Dairy plant in Gujarat due to variation in loading capacity.

- Technology: New energy efficient technology is available in the market for dairy plants. Plants using these technologies benefit by saving energy as well as improving the quality of their product. Old plants operating with old and inefficient equipment, on the other hand, consume a lot more energy. The level of automation in a plant is another factor that affects SEC. Plants producing powdered milk for instance exhibits a wide range of energy efficiencies, depending on the type of evaporation and drying processes that are used. Energy consumption depends on the number of evaporation

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70 Amul plant visit

effects, called a Multiple Effect Evaporator system (the number of evaporation units that are used in series) and the efficiency of the powder dryer. Two plants in Andhra Pradesh with 250 TPD capacity and similar product mix have been seen to have SEC figures of about 47 kWh/MT[71] and 67 kWh/MT[72]. The first plant is new, automated and uses newer energy efficient technology compared to the second older plant, whose operations used comparatively old technology.

However identifying the extent to which each of these factors affects the SEC of a plant is unclear due to lack of accurate process and equipment level data at plants or Indian standards for dairy processing plants/products.

Direct extrapolation method of collected data has not been used for sectoral energy consumption estimation due to two reasons. Firstly the data collected accounts for a very small share (i.e. 24.79%) and thus will not exactly represent the real scenario. The variance in size of plants and large variation in SEC as mentioned above would lead to an incorrect result. A weighted average approach for SEC, which represents the sector more accurately, has been used.

The sector's overall energy consumption as mentioned in section 4.1 is an estimate, based on the SEC of a typical dairy plant that has been calculated using a weighted average approach and India's overall installed capacity. The actual figure might, however, deviate from this, since the data available corresponds only to about 24.79 % of market share. Established energy consumption standards for plants or products of this sector are unavailable to arrive at a more accurate figure. Thus a more precise method needs to be formulated in order to arrive at energy benchmarks by analyzing individual plants and arriving at some standard figures for different products. This has been elaborated in the section 4.5.2.

4.4 Possible energy efficiency measures for key processes/systems

There exists an overall potential of about 15-25 percent of energy saving which include low and medium investments and adopting various steps towards energy efficiency at dairy plants. Here are a range of energy efficiency measures (process and utility related) that can be implemented in dairy processing plant:

4.4.1 Process related energy efficiency measures

4.4.1 (a) Pasteurization

- Improving the thermal regeneration efficiency of the pasteurizer by using more energy efficient plate-type heat exchangers (PHE's). Pasteurizers up to 93% regeneration efficiency are available now. Improving the pasteurizer efficiency reduces the thermal energy wastage at plants. Heating being once of the major energy consuming areas in a typical dairy plant, it is advised that all dairies adopt efficient PHE's.
- Up to 14% of the energy for pasteurization is used during extended periods of circulation. Tuning off the cooling section during hibernation reduces the heating and cooling load leading to energy saving.

71 Tirumala Dairy
72 Creamline Dairy

- Low temperature microbial destruction process can substitute the existing system of thermal pasteurization. This can be done by using UV light, pulsed traditional light, high pressure pasteurization and pulsed electric field pasteurization. However, these are yet to be established fully and hence are not in actual use at dairies. Three potential pasteurization technologies at varying stages of development are microfiltration, high hydrostatic pressure, and electrical field effects.
- Maintain the optimum pasteurization temperature of milk at 72°C. As, for each degree rise in pasteurization temperature, roughly 10% of steam/hot water consumption and 8% of refrigeration load will increase. Thus it is recommended to maintain the temperature using advanced process control techniques.
- Maximum energy in a typical dairy plant goes into reprocessing. Reprocessing is the multiple heating and cooling operations carried out on pasteurized milk for the different products to be manufactured in the plant. Not only does the energy consumption increase due to reprocessing, the quality of milk handled reduces too. R&D initiatives are needed to make milk processing more efficient by reducing the number of times the milk is reprocessed. For instance, steps can be taken to cool down produced milk at farm level itself and to efficiently maintain it till it reaches the processing plant to reduce some amount of reprocessing. Regeneration potential can be explored further to reduce the energy consumed in reprocessing. Reprocessing energy consumption is a major area in any dairy plant since the heating and cooling loads are very high.
- A new energy efficient technology is photo purification which is a potential alternative to thermal pasteurization of milk. The technology has recently been approved by the Indian Food Safety regulatory body (FSSAI), which involves milk that comes out of the cows at 37° Celsius, being passed through the photo-purification machine. This machine consists of about 40 tubes, each with a lamp emitting UVC band light (a micro biocidal wavelength), and 1000 joules is passed through the milk in each of the 40 tubes which deactivates any bacteria before the milk is cooled to 4° Celsius in the holding tank. This will lead to a higher thermal energy saving compared to conventional thermal pasteurizing.[73]

4.4.1 (b) Homogenization

- The homogenizer throughput may be reduced by homogenizing only the fat-enriched phase from the separator, and mixing this with the low-fat phase, this would save more energy compared with homogenizing the full milk throughput. The power required for pumping may be greater in order to carry out homogenization of the fat enriched phase; however this is offset by the saving achieved by passing a small fraction of milk through the homogenizer.

[73] http://www.georgeherald.com/news.aspx?id=3930,
http://thebovine.wordpress.com/2010/07/16/new-pasteurization-technology-being-proposed-even-for-human-breast-milk/,
http://finance.yahoo.com/news/surepure-announces-regulatory-approval-surepures-133900882.html,
http://www.fnbnews.com/article/detnews.asp?articleid=34068andsectionid=1

- To reduce fat globule size the energy needed to drive a homogenizer is proportional to the pressure at which the system runs and the flow rate. The working pressure of the homogenizer can be reduced by innovative orifice design which reduces the electricity consumed to drive the system as well

  The power may be calculated as[74]:

  Effective kW = (Flow rate of homogenizer x homogenization pressure in bar) / 30,600.

  Upgrading the homogenizer head to more efficient pressure design (180bar down to 120bar) could reduce electrical consumption up to one third. Reductions however will depend on the equipment installed at each site.

- About 9 to 27 percent of the homogenizer energy use is towards CIP operation and this accounts for about 63% of the power needed by the homogenizer pump. Thus by controlling the volume of liquid needed to achieve the right standard of cleanliness, the CIP liquid may be reduced which in turn leads to reducing pump load and energy consumption. Using alternative CIP processes may be another option to reduce energy consumption.[75]

4.4.1 (c) Cleaning in Place (CIP) optimization

- It is important to understand what constitutes clean in order to avoid unnecessary level of cleaning for a required standard of hygiene. Knowing how much energy is used to heat the fluid used for CIP enables to calculate potential energy savings from alternative forms of CIP that do not involve the heating of large amounts of caustic and acid for cleaning.

- Reduction of CIP water volume and/or temperature will improve the energy consumption of CIP systems. Reduction in volume may be obtained by increased monitoring and testing. Regulating the CIP flow is based on the microbial levels in the pipes and not the temperature of the fluid.

- Design of the CIP system also affects the energy consumed by the system. Design modifications may be looked into to reduce energy consumption of the system.

- Plants with high number CIP units have high CIP load, which can be reduced by either increasing the usage of the plant keeping the CIP schedule same or by reducing the frequency of operation of CIP wherever possible. Since CIP is primarily driven by time, the higher the plant operation, proportionally the less CIP carried out per unit output.

- Cleaning of CIP detergent solution with membrane technology reduces the amount of hot solution that gets wasted into the drain after becoming too contaminated to return to the main tanks.

- Use of Enzyme-based cleaners lead to more efficient working of the CIP system.

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[74] Carbon Trust
[75] Carbon Trust

4.4.2 Utility related energy efficiency measures

4.4.2 (a) Fuel oil handling

- To enhance the efficiency of combustion the oil needs to be preheated to about 105^0 to 110^0C at the burner tip.

- It is a more fuel efficient option to have parallel fuel oil pumps of smaller capacity than one larger capacity pump to avoid unnecessary re-circulation of huge quantity of the fuel.

4.4.2 (b) Boiler and accessories

- Utilization of steam generation boilers only for steam and installing separate heaters for hot water generation purpose will avoid unnecessary heating and thus reducing wastage of thermal energy.

- In most dairies boilers are overdesigned, consuming a lot more energy than required when not utilized properly. Dairy plants must consider splitting the boiler capacity instead of running an oversized boiler for short bursts of time to save fuel.

- Install efficient flash steam recovery systems. Dairy plants of all sizes must introduce this into their plants for achieving energy saving by reducing the load on their heating system.

- Control excess air and avoid air ingress by maintaining recommended oxygen percentage at flue gas stack.

  - Coal – 4 to 5% O_2
  - Natural Gas/Methane based fuel – 2 to 3% O_2
  - Biomass – 3 to 4% O_2

  Flue gas analysers (portable or system integrated) can be used to measure O_2 and CO percentages, which can aid in taking necessary actions to control excess air and air ingress. This will primarily help in reducing the power consumption of fans along the flue gas circuit. Avoiding excess O_2 percentage will also help in augmenting the potential for waste heat recovery.

- Waste heat from flue gas which is at a range of above 400^0C can be recovered by installing air pre-heater of required capacity to pre-heat the air. This will lead to saving fuel by reducing the gap to which the air has to be heated.

- The general trend of condensate recovery varies from 30% - 70% from plant to plant. Condensate recovery from pasteurizers, ghee boilers, and spiral butter melter can be used for boiler as feed water or for hot water requirement for cleaning. Based on existing level of technology available there is potential of recovering up to 80% of condensate.

- Automatic blow down system should be installed to maintain TDS level in boiler.

- Steam consumption can be reduced by making sure the scales are removed. This improves the heat transfer in boilers.

4.4.2 (c) Insulation

- Steam and boiler feed water lines need to be insulated properly, checked regularly and repaired immediately id required to reduce heat loss.

- Insulate flanges, control valves, non-return valves etc with open able pads to save insulation losses in steam, hot water and chilled water lines.

4.4.2 (d) Chilling systems and Cooling tower operation

- Optimum temperature should be maintained by controlling cooling tower fan.

- Using VFD's in the cooling tower fans is a better option than on-off control to save energy.

- Explore the option of evaporative cooling by integrating the condenser with the cooling tower as described in section 3.6 to achieve more efficient cooling.

- Optimize cooling tower fan blade angle on a seasonal and/or load basis. Correct excessive and/or uneven fan blade tip clearance and poor fan balance.

- Blow down water should be taken from return water header and sent to other uses or to the sewer to reduce effluent treatment load.

4.4.2 (e) Compressed air systems

- Compressed air is used in dairy plants for instrumentation, conveying, powder plant, pouch packing, air actuators etc. Most dairies generate compressed air at high pressures of 7 kg/cm^2-8 kg/cm^2. It is recommended to segregate the compressors based on pressure requirements of the users. This will reduce the unloading time and also save energy unnecessarily consumed to deliver higher pressure.

- Compressed air leakage must be checked for and arrested.

- Retrofitting old with new EE equipment has proved to show immense results in terms of energy saving at plant level. Even with slightly higher of investments, the amount energy saving achieved, ultimately saves running cost thus making it economical. The saving achieved by retrofitting with EE equipment is clearly noticeable during the lean season of any dairy plant when the loading is low. DMS has seen a 20% reduction in energy consumption just by replacing their old Reciprocating compressors with screw compressors.

- Installation of Centrifugal compressors as base load, for plants with requirement of more than 1500 cfm. The variable loads can be catered with a screw compressor fitted with a Variable Frequency Drive. This is served as the best combination for lower energy consumption.

4.4.2 (f) Motors

- Replace the old and overloaded motors with energy efficiency and correctly sized motors.
- Use auto del-stars to save electricity based on loading of motors.

4.4.2 (g) Contract Demand/Transformer loading/power factor

- Demand controller with an alarm provision should be provided in case it exceeds contracted demand. Steps must be taken to review and reduce the contract demand.
- Maintain all transformers at a loading of 70 to 80 % of rated capacity to minimize loss component (no load losses).
- A separate transformer must used for lighting where voltage can be kept low.
- Improve power factor by regular checking of current of all the capacitors and their timely replacement. Automatic power factor correction devices must be installed to maintain power factor of 0.99-1.00

4.4.2 (h) Processing and Packaging of Milk and Milk Products

- Automation in processing and CIP helps in reducing milk and energy losses and hence should be used for dairy processing plants. In case of larger volumes, mechanization and automation not only helps in reducing energy consumption in manufacturing and packaging of milk products but improves quality also.
- Solar water heating system must be explored for hot water generation to be used in steam-water batteries, CIP, can and crate washers, boiler feed water etc. Even at milk chilling centres hot water can be obtained by using solar water heaters and/or de-super heaters.
- The refrigeration load will reduce by installing milk chillers with two sections, where first section can be used as well water section.
- Mechanical packaging machines or machines requiring lesser air/pressure should be preferred over machines required more air or higher pressures during installation.
- In case of large producers continuous production machines must be used since they require less energy per kg of production as compared to batch production.
- Agitators at milk storage tanks/silos should be used only when required. Plants should consider installation of root blowers for agitation of milk storage tanks.
- Incase of products which require incubation like dahi, steam or hot water operated air handling units are much more energy efficient as compared to electrically operated AHUs.

- Increase in number of effects in an evaporating plant improves the steam economy of the multiple effect evaporator system, reducing the energy consumption. But beyond a certain cut-off for number of stages, an increase of a stage can lead to higher investment than savings. Hence, a life cycle cost approach needs to taken while deciding on the number of stages to be established.

- Cost effective automation to cut off temperature based on exact temperature requirement of the process. This will reduce wastage of fuel.

4.4.2 (i) Operation

- Efficient equipment does not necessarily mean efficient operation of the same equipment. Plants must emphasize on the efficient operation of equipment to ensure energy saving and avoid wastage of energy. This may be done by either adopting automation or active monitoring. Cost effective automation to modulate flow, temperature or pressure with feedbacks based on process requirement will lead to large amount of reduction in energy wastage.

  SEC variation of two plants with similar product mix and capacity but varying level of automation can be seen below:

Table 15 – SEC variation due to varying levels of automation (example)

Plant	Plant A	Plant B
Capacity	200 TPD	300TPD
Production	200 TPD	250TPD
Product mix	Milk , flavored milk, curd, lassi, ice cream, ghee, butter	Milk , flavored milk, curd, lassi, ice cream, ghee, butter
Automation level	High , effective monitoring	Medium , less effective monitoring
SEC	SEC-E = 47 kWh/MT SEC-E = 145380 kCal/MT (completely from Biomass)	SEC – E = 67 kWh/MT SEC- T = 85800 kCal/MT (Coal)

4.5 Challenges and Recommendations

4.5.1 Challenges faced

- **Lack of Awareness**

- There are more than 1065[76] registered dairy plants spread throughout the country, of which only 248 have a milk handling capacity more than 200TPD. This indicates that a large portion of the sector consists of small and medium sized dairy plants. The plants, especially the small and older ones, lack awareness regarding energy efficiency and latest technology.

[76] Food Safety and Standards Authority of India, Ministry of Health and Family Welfare

- Small and medium dairies are profit/production driven. There isn't much support/initiative/awareness and drive to take up energy related activities. For instance IDA had initiated an award during 2009-10 to identify companies based on best maintained plants, however response was disappointing. The cost of energy for small scale dairy plants, which only process and sell packaged milk, is typically 1% -3 % of the total manufacturing cost, making energy conservation low priority.

- **Reluctance to share data**

- Most dairies are reluctant to share data. Some smaller scale ones do not record energy related data.

- **Lack of financial support**

- Energy efficient technology is clearly available in India; however replacing old technology with new tends to be an expensive proposition for small dairies in villages. There is lack of funding and financial support from the government or funding organizations for the small and medium plants in this sector (unlike other food processing Industries) to implement the latest technology.

- **Lack of encouraging policies**

- With rising prices of natural gas, plants are looking for a change in policy to encourage dairies to use such cleaner fuels.

- Electricity cost is high. Action needs to be taken by the Government in the form of subsidies to provide electricity at lower prices.

- There is no support for this sector from the Government in terms of policies or funding to help encourage small and medium dairies to invest in energy efficient equipment. There is a need for policies on waivers or subsidies from the Government on more efficient new equipment/technology, since the high cost discourages them.

- **Technology prices**

- It has been seen that energy efficient equipment in the market are priced very high compared to the conventional or less efficient equipment. This also leads to longer pay backs. This discourages small players from opting for the more efficient equipment.

- Small plants operate at the small profit margins and do not have the funds to invest in expensive equipment. Unless the prices are reduced or they are provided support in the form of new policies or funding by Government or other funding organizations, they are reluctant towards adopting energy efficient technology which requires slightly high investment.

4.5.2 Recommendations

❖ **Data collection, establishing standards and assessment**

In terms of energy consumption, when compared to industries like steel, cement and chemicals, Dairy industry is not a large consumer of energy. In terms of fuel bills, it is representative of the middle range of industries and ranks 20th in 129 industrial sectors listed in the Standard Industrial Classification.[77] However, considering the growth expected in the future, the dairy industry is beginning to assume importance as one with a high potential for energy saving. Energy consumed in most of the processes in dairy industry is associated with heating and cooling. This could make it comparatively easy in terms of heat recovery. So the dairy industry can easily become a "demonstration platform" for some energy conservation technologies. It is estimated that on an average, 10-15 percent of energy can be saved very easily in dairy plants.

The sector is extremely diversified and seasonal in terms of its product mix. Also due to lack of awareness little energy consumptions details are available to compare dairy processing plants.

With this background, the following measures are suggested to set energy consumption targets for dairy processing plants.

In order to establish energy consumption targets for the dairy sector, dairies may be categorised into four segments:

- Mainly fluid milk
- Mainly fluid milk with some common dairy products
- Fluid milk with large scale butter, ghee, ice cream and other common products
- Integrated bigger/ dairy plants having all types of common dairy products (cheese, butter, ice cream etc.), dried products (such as whey powder, casein, isolated etc.) and UHT plant.

Plant may further be classified into slabs based on milk processing capacity

- Less than 100 TPD – slab 1 (small)
- 100 to 200 TPD – slab 2 (medium)
- More than 200 TPD – slab 3 (large)

3 approaches for Energy consumption assessment of plants and the data required to be collected in each case are mentioned below:

[77] PCRA- practical guide to energy conservation in dairy industry

Plant Level Assessment

This assessment may be based on the overall electrical and thermal energy used by each plant or specific energy consumed per litre of milk processed. Based on data collected from different plants an SEC threshold may be set for plants corresponding to different processing capacity slabs. The performance of individual plants may then be assessed based on the threshold SEC value for corresponding capacity slabs of each segment.

❖ The following data needs to be collected from all milk processing plants for this approach

Table 16 – Recommendation (plant level assessment)

Parameter	Units	Capacity	Production
Total Milk handling capacity	TPD		
Powder Plant Capacity	MT/day		
Butter Making capacity	MT/day		
Ghee Making capacity	MT/day		
Cheese making capacity	MT/day		
Ice Cream making capacity	MT/day		
Milk Packaging capacity	TPD		
Other Products with details			
Electrical energy consumption	kWh or kWh/l milk processed		
Thermal energy consumption	kCal or kCal/l milk processed		

Process-block Level Assessment

This is an individual process-step energy data analyse (this is specific to the type of plant layout and method of production planning and schedule). Energy details for each process block must be collected, i.e. for milk, butter, cheese and powder from all plants. Based on existing energy consumption trends a threshold is to be fixed for each process block for each of the capacity slabs. Individual plants may then be assessed based on the fixed threshold value.

❖ The following data needs to be collected from all milk processing plants for this approach

Table 17 – Recommendation (process-block level assessment)

Parameter	Units	Capacity	Production	SEC (E) kWh/MT	SEC (T) kCal/MT
Total Milk handling capacity	TPD				
Powder Plant Capacity	MT/day				
Butter Making capacity	MT/day				
Ghee Making capacity	MT/day				
Cheese making capacity	MT/day				
Ice Cream making capacity	MT/day				
Milk Packaging capacity	TPD				
Other Products with details					
Electrical energy consumption	kWh or kWh/l milk processed				
Thermal energy consumption	kCal or kCal/l milk processed				

Process Level Assessment

This requires more detailed energy data for each process step. Energy details of each process step have to be collected from plants i.e. Pasteurization, homogenization, CIP, Cream extraction, Cheese making, Butter making, Yogurt processing etc. This would however require a very detailed process level monitoring which is not practiced in most Indian dairies.

Then a threshold level of energy consumption needs to be set for plants corresponding to different slabs for each of these steps. Individual plants may then be assessed on their energy performance based on set threshold limit for each slab under each segment.

- The following data shown for milk needs to be collected from all milk processing plants for this approach

Table 18 – Recommendation (process level assessment of milk)

Milk	Process	SEC-E (kWh/MT)	SEC-T (kCal/MT)
Milk reception	Reception / heating		
	Storage		
	Cleaning in process (CIP)		
Milk treatment	Standardization (separation)		
	Homogenization		
	Pasteurization / Sterilization / UHT		
	Cleaning in process (CIP)		
Fermentation	Inoculation		
	Incubation		
	Stirring		

Cream treatment	Standardization		
	Homogenization		
	Pasteurization / Sterilization / UHT		
Packing	Filling / Packing		
Supporting processes	Pressurized air		
	CIP		
	Cooling / refrigeration		
	Water provision		
	Building / HVAC		
	Other		

Table 19 - Recommendation (process level assessment of butter)

Butter	Process	SEC-E (kWh/MT)	SEC-T (kCal/MT)
Milk reception	Reception / Thermization		
	Storage		
	Cleaning in process (CIP)		
Milk treatment	Standardization (separation)		
	Homogenization		
	Pasteurization / Sterilization / UHT		
	Cleaning in process (CIP)		
Cream treatment	Standardization (separation)		
	Homogenization		
	Pasteurization / Sterilization / UHT		
	Cleaning in process (CIP)		
Butter making	Inoculation, ripening		
	Churning		
	Working / Standardizing		
	Homogenization		
	Cleaning in process (CIP)		
Packing	Filling / Packing		
Supporting processes	Pressurized air		
	CIP		
	Cooling / refrigeration		
	Water provision		
	Building / HVAC		
	Other		

Similarly data for each product has to be collected and analysed to set a threshold at a detailed process level.

With the present level of awareness and data monitoring at dairies, the plant level assessment methodology may be the first step towards setting some national standards for energy consumption in the Indian dairy processing units.

Collecting data from the large state cooperatives like Gujarat, Andhra Pradesh, Maharashtra, Tamil Nadu, Karnataka, Punjab, Uttar Pradesh and Rajasthan would be a good start since they alone account for about 30 % of the total milk processed in India. The next step would be to target the major private players since many of them execute detailed data monitoring.

Based on the data collected a method needs to be formulated to establish SEC standards for plants under each of the three slabs of each segment, based on typical product mix.

During the stakeholder workshop held by CII, it was agreed that there should be a platform where plants can furnish the energy data or share the same in the public domain to help each other improve. Another way is that the Government may ask for such details to be submitted every year during their factory license renewal. Once these details are available, these can be used to estimate the present level on energy consumption in dairies, explore the potential to reduce the same in future and formulate India specific standards.

- **Capacity building**

One of the major issues in taking up energy efficiency initiatives in dairy plants is the lack of awareness and knowledge, since a large number of players are from small and medium sized plants. Capacity building initiatives are needed, especially in smaller dairies. Missions must be organized to take representatives from different dairies to plants with new and efficient technology. As has been the case in many other sectors, experiencing first-hand the advantages of these technologies in one plant will encourage other plant representatives to implement the same at their plant. Best practices relevant to the sector needs to be made more publically available in the form of manuals or reports for knowledge exchange.

- **Creating vendor-user platforms**

Creating a platform for continuous interaction of vendors and users to meet may also drive plants towards adopting new energy efficient technology. A platform like this could be especially useful since the sector has many players from smaller villages who may not have adequate exposure to the latest technology in the market.

The possibilities of exploring facilitation of developing a turnkey package of energy efficiency in dairies must also be looked into.

- **Technology**

Technologies for primary processing like refrigerated chilling centers; compact milk chilling units etc. are available in the country, though not much in use. The processing of liquid milk is largely done by pasteurization whereas advanced technologies like Ultra High Temperature (UHT) treatment and aseptic packaging, Modified Atmosphere Packaging (MAP), bacteriocin usage, high pressure processing, irradiation, utilization of inherent antimicrobial system in milk (lactoperoxidase, lactoferrin and xanthine oxidase), bactofugation, bactocatch and bactotherm process are yet to be widely used.[78]

[78] Dairy year Book

Energy efficient technology is available in the market but the investment required is high for small players. Most large scale plants have already adopted the latest technology. These large players may take up the initiative along with their technology suppliers to demonstrate the working of the equipment and the savings achieved at their plant. This may drive smaller players to see the savings for themselves and implement it at their end.

- **Financing**

As mentioned earlier, the major market share is in the hands of small players who cannot afford large investments. One of the major reasons for the lack of interest towards moving from old to newer technology is the financial aspect for these players. There is no support in terms of financing for plants from the government. Creating a fund for dairy energy efficiency by the government or other funding agencies, similar to the textile technology up gradation fund would definitely help push the sector towards implementing energy efficiency measures.

- **Policies**

Policies to encourage dairies to take up energy saving measures are not in place. Incentives/disincentive based schemes or other financially supportive schemes for improving energy efficiency are a need of the hour. This will encourage this sector which is in its nascent stages of activity towards energy to grow at a sustainable rate. Subsidies and other incentives may be introduced for plants adopting energy efficient equipment and technology.

5. APPLICABILITY OF EXTENDING THIS SECTOR INTO PAT SCHEME

5.1 MTOE threshold and Issues

In the PAT cycle 1, the lowest threshold limit for a plant to be a designated consumer was 3,000 MTOE, for the textiles sector. This was also the lowest energy consuming sector compared to the others included in the PAT cycle 1.

This lowest threshold level of 3,000 MTOE has been considered for assessment of the dairy sector as a potential PAT designated consumer. The data set collected for the 36 plants shows only 6 plants fall above this threshold.

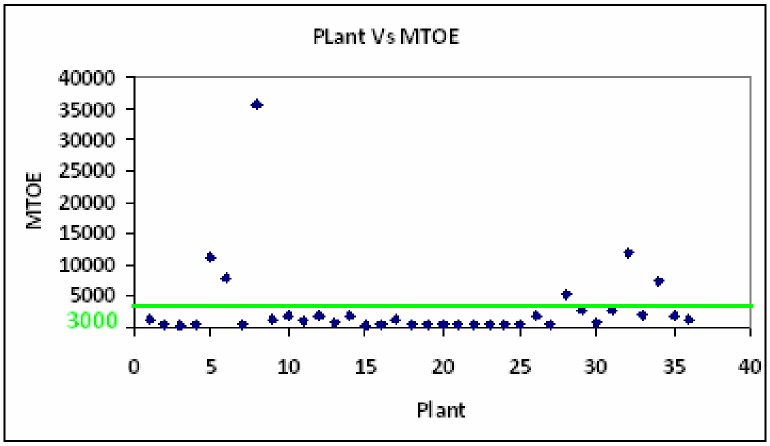

Figure 8 – Plants above threshold

Based on data collected, interaction with plants personnel and experts, we may assume that plants with a milk processing capacity of 500 TPD and above will potentially have energy consumption above the 3,000 MTOE threshold.

Out of the 1065[79] registered dairy plants, only 248[80] are registered under Central Registration Authority (CRA)[81], while 817 [82] under State Registration Authority (SRA)[83]. These CRA registered plants have a consolidated milk processing capacity of 84242.5 TPD[84]. The estimated energy consumption of these is 0.2 million MTOE[85], which accounts for about 70% of the overall energy consumption in the sector.

Assuming 20% of these 248 CRA registered plants (extrapolating the same percentage as 6 plants out of 31 plants[86]) have an installed capacity above 500 TPD, the estimated number of plants falling above the 3,000 MTOE threshold is 50. These 50 plants together would consume slightly more that 20% of the estimated 0.2million MTOE consumption of plants registered under CRA. This is because these 50 consumers will include dairies with large

[79] Food Safety and Standards Authority of India, Ministry of Health and Family Welfare
[80] Food Safety and Standards Authority of India, Ministry of Health and Family Welfare)
[81] Plants with capacity > 200 TPD are to be registered under CRA
[82] Food Safety and Standards Authority of India, Ministry of Health and Family Welfare)
[83] Plants with capacity < 200TPD are to be registered under SRA
[84] Food Safety and Standards Authority of India, Ministry of Health and Family Welfare)
[85] Based on avg. sec of 40kWh/MT and 60000 kCal/MT
[86] Only 31 plants out of 36 have > 200TPD

installed capacities and large variation in product mix. However it has been assumed that all 50 plants have a capacity of 500 TPD for the purpose of calculation. The capacity utilization for these plants has been assumed to be 80%, a little higher than average (70%), since most of these large plants use latest technology & equipment with higher capacity utilization. Estimated energy consumed by these 50 designated consumers is about 0.07million MTOE [87].This accounts for about 24% of the overall sector's estimated energy consumption.

It must however be noted that this may not be the case with all plants. Based on the level of automation and product mix, the energy consumption might vary. Moreover the installed capacity and energy consumption details of individual registered plants are unavailable in public domain. Thus, arriving at the exact number of plants that will fall over the 3,000 MTOE threshold cannot be concluded with complete accuracy at this point.

It is however estimated that 50 dairy plants may be potential designated consumers with a threshold of 3000 MTOE. Contributing to about 0.07 million MTOE, which is about 24 % of overall sector's energy consumption.

5.2 Potential saving incase extended to PAT Scheme

Based on CII's experience and stakeholder consultation in the dairy sector, we believe that plants in the dairy sector has energy savings potential of about 15-20% by implementing energy efficiency measures mentioned in this report.

The potential energy saving from the dairy sector assuming a 5% reduction potential is about 0.0145 million MTOE.

Estimation of potential savings in the dairy sector, in case of its inclusion into the PAT scheme, is based on the following assumptions:

- 50 plants above the 3,000 MTOE threshold
- Each plant consumes 3,000 MTOE (for estimating potential saving)
- These 50 contribute to 24 % energy consumption of sector i.e. 0.07 million MTOE
- Typical dairy plants have 15-20% potential to save energy
- Assuming reduction target of 5% for each plant

  => 0.05 X 0.07
  => 3500 MTOE

[87] Assuming these 50 plants have a capacity of 500TPD and SEC of 40 kWh/MT and 69000kCal/MT. capacity utilization has been assumed to be 80% here since experience during this project shows bigger plants use more advanced technology & equipment

- **The potential energy saving from the dairy sector assuming a 5% reduction potential is about 0.0145million MTOE.**

- **The estimated annual energy reduction potential from designated consumers of this sector if included in PAT will be to the tune of only 3,500 (0.0035 million) MTOE.**

6. CONCLUSION

In a typical dairy plant, a major part of the energy is consumed for heating and cooling operations. The sector is characterized by the varying product mix, which is the major reason for widely varying specific energy consumption from plant to plant. Other reasons include the level of technology, loading and fuel mix.

The energy saving potential of this sector is estimated to be 10-15 percent without investments, and an additional 15% with investments.

High scope for improving energy efficiency in dairies exists in the areas of heating and cooling by adopting co- generation technology, de-supers heater technology, evaporative cooling systems, utilization of renewable energy; biomass fired boilers and increased automation.

The energy consumption of the overall sector is estimated to be 0.29 million MTOE.

Out of 1065 registered dairy plants close to 80% are small players, together contributing only 30% of overall sectors energy consumption. Thus individually they contribute very little to the overall sector's energy consumption.

The estimated number of plants above 3,000 MTOE (the lowest threshold in PAT cycle 1 assigned for textile sector) is 50[88]. This has been arrived at by assuming that plants with installed capacity greater than 500 TPD will consume more than 3,000 MTOE.

The energy saving potential of the overall sector at 5% reduction is estimated to be 0.0145million MTOE.

The energy saving achieved if these 50 estimated plants are brought under PAT scheme with a 5% target reduction is estimated to be only 0.0035 million MTOE.

Since the energy intensity and estimated savings is quite low, we recommend that the dairy sector not be included under the second cycle of PAT.

The sector lacks awareness towards energy efficiency and lacks financial or policy related support from the Government to encourage movement towards energy efficiency. Another major issue is non-existence of energy consumption standards specific to India dairy plants. Plants do not measure operational or product level energy consumptions data. This is a major concern in comparing the performance of dairies due to the large variation in product mix.

Energy data is to be collected from all players, followed by establishing a product or process level benchmarks. Capacity building initiatives by creating a platform for technology suppliers and plants to meet and sharing best practices implemented by larger players is required. The sector, which is dominated by smaller players, requires financial support and encouraging policies from the Government to adopt energy efficient technology.

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[88] This is only an approximate number, since SEC depends on the product mix. For example, a plant with installed capacity as high as 1000 TPD but producing less energy intensive products, may consume only 1300 MTOE. Similar trends have been seen in other plants. Therefore, the number of plants above 3,000MTOE may be lesser than estimated.

The sector may not be energy intensive enough to be recommended for inclusion under PAT. Nonetheless, it does consume electrical and thermal energy for its operations. Moreover the sector has been growing at a rate of 3.6 % and thus the energy consumption is also going to increase over the years. With the existing scenario of availability of natural resources it is important for the sector to become increasingly aware, build their capacity by increased data/technology sharing and head towards energy efficiency at individual plant level.

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8. ANNEXURE

Annexure-A: Process flow

This section outlines the processes followed in a typical dairy plant. Milk collection and chilling are processes that happen outside the dairy, but these are also included here for completeness.

Milk collection and chilling center

The process at milk chilling center is basically to collect the milk, segregation based on type of animal (cow or buffalo), weighing, quality study, milk chilling and dispatch to the dairy. Milk collection process involves grading, weighing (milk is recorded in kilograms), chilling, dumping, sampling, loading in tanker and dispatch to main processing plant. Most of the chilling centers are located in remote villages to collect the milk from various local 'Mandalis'. Currently, 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 and placed in various remote places.

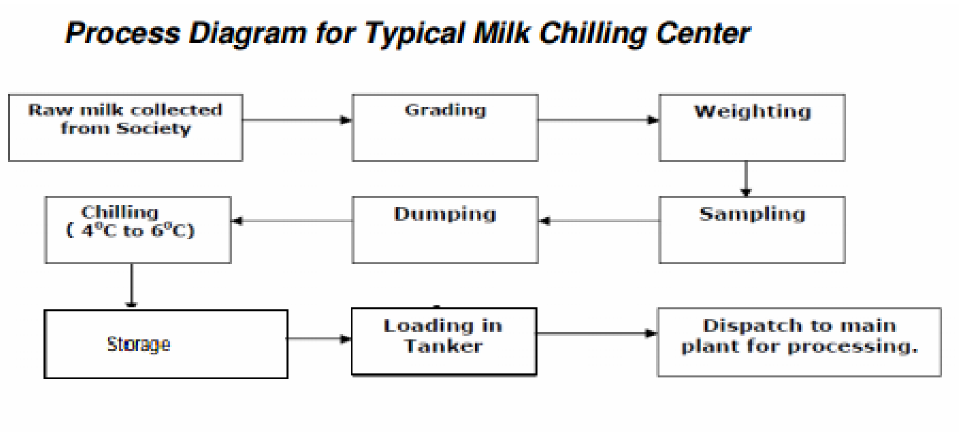


Figure 9 – Process diagram for typical milk chilling plant

Milk Production

The processes taking place at a typical milk plant after receiving and filtration of milk from the chilling units include:

Separation: After being held in storage tanks at the processing site, raw milk is heated to separation temperature in the regeneration zone of the pasteurizer. The milk (now hot) is standardized and homogenized by sending it to a centrifugal separator where the cream fraction is removed. The skim is then usually blended back together with the cream at predefined ratios so that the end product has the desired fat content. Surplus hot cream is cooled and usually processed in a separate pasteurizer ready for bulk storage and transportation to a cream packing plant.

Pasteurization is a process of heating milk to 72°C for 16 seconds then quickly cooling it to 4°. This process slows spoilage caused by microbial growth in the food. Unlike sterilization, pasteurization is not intended to kill all micro-organisms in the food. Instead, it aims to reduce the number of viable pathogens so they are unlikely to cause disease

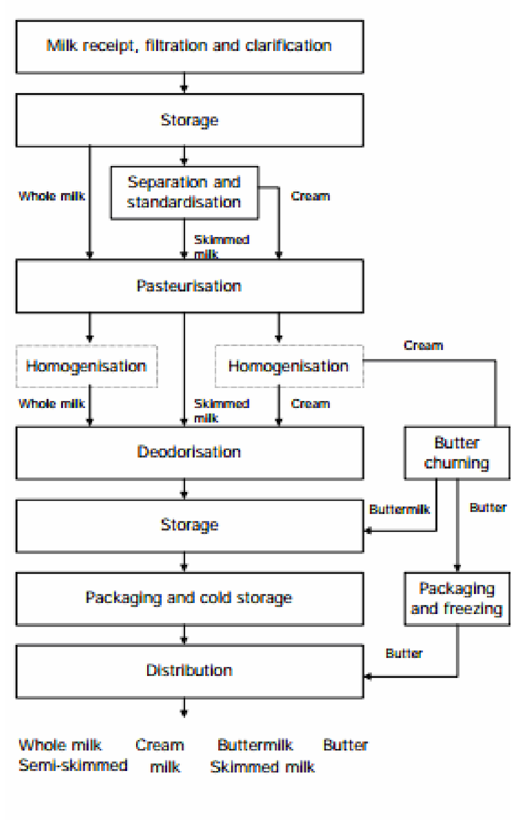
Homogenization (if required): Milk must then be homogenized. Without homogenization, the milk fat would separate from the milk and rise to the top. Milk fat is what gives milk its rich and creamy taste. Homogenization makes sure that the fat is spread out evenly in the milk so that every sip of milk has the same delicious flavor and creamy texture. Milk is transferred to a piece of equipment called a homogenizer. In this machine the milk fat is forced, under high pressure, through tiny holes that break the fat cells up in to tiny particles, 1/8 their original size. Protein, contained in the milk, quickly forms around each particle and this prevents the fat from rejoining. The milk fat cells then stay suspended evenly throughout the milk.

Deodorization may be carried out if required.

Further product-specific processing

Packaging and storage: Milk is pumped through automatic filling machines direct into bags, cartons and jugs. The machines are carefully sanitized and packages are filled and sealed without human hands. This keeps outside bacteria out of the milk which helps keep the milk stay fresh. During the entire time that milk is at the dairy, it is kept at 1°-2°C. This prevents the development of extra bacteria and keeps the milk fresh.

Distribution of final products



Flow diagram for processes occurring at a typical milk plant

Figure 10- Flow diagram of processes in a typical milk plant

The figure above is a flow diagram outlining the basic steps in the production of whole milk, semi-skimmed milk and skimmed milk, cream, butter and buttermilk. In such plants, yogurts and other cultured products may also be produced from whole milk and skimmed milk.

Butter

The flow diagram outlining the basic processing system for a butter-making plant is shown above. The initial steps, (filtration/clarification, separation and pasteurization of the milk) are the same as described in the previous section. Milk destined for butter making must not be homogenized, because the cream must remain in a separate phase.

After separation, cream to be used for butter making is heat treated and cooled under conditions that facilitate good whipping and churning. It may then be ripened with a culture that increases the content of diacetyl, the compound responsible for the flavor of butter.

Alternatively, culture inoculation may take place during churning. Butter which is flavor enhanced using this process is termed lactic, ripened or cultured butter. Although the product is claimed to have a superior flavor, the storage life is limited. Butter made without the addition of a culture is called sweet cream butter. Both cultured and sweet cream butter can be produced with or without the addition of salt. The presence of salt affects both the flavor and the keeping quality.

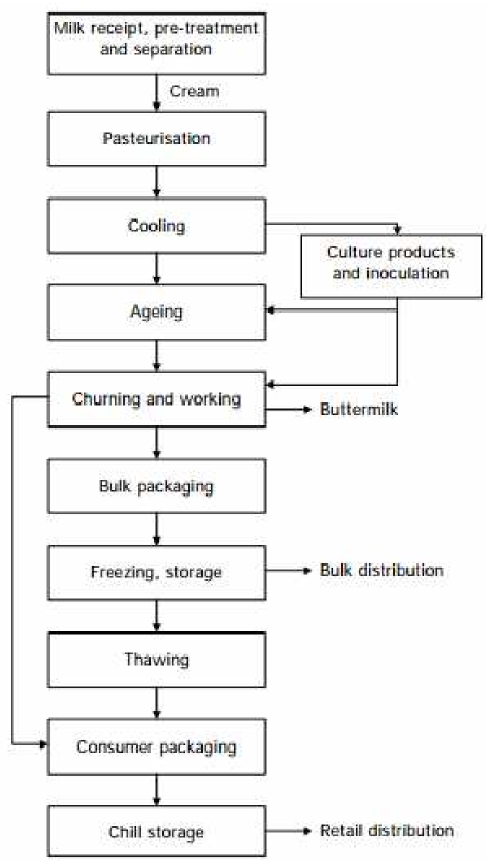
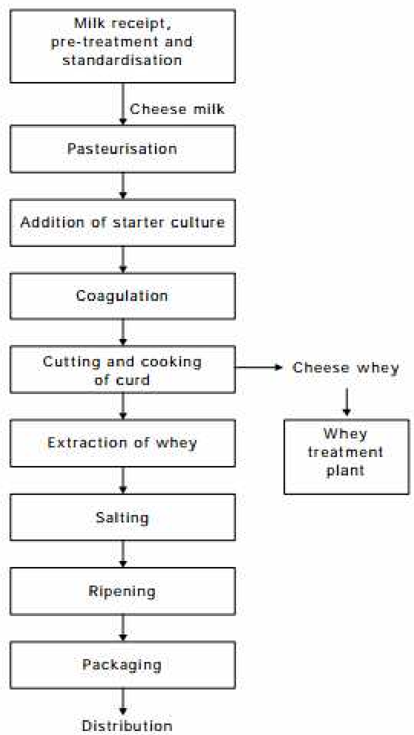


Figure 11- flow diagram of a butter plant

Cheese

Virtually all cheese is made by coagulating milk protein (casein) in a manner that traps milk solids and milk fat into a curd matrix. This curd matrix is then consolidated to express the liquid fraction, cheese whey. Cheese whey contains those milk solids which are not held in the curd mass, in particular most of the milk sugar (lactose) and a number of soluble proteins.



Flow diagram for a typical cheese plant

Figure 12 - flow diagram for cheese plant

The above figure outlines the basic processes in a cheese-making plant. All cheese-making processes involve some or all of these steps.

Milk Powder

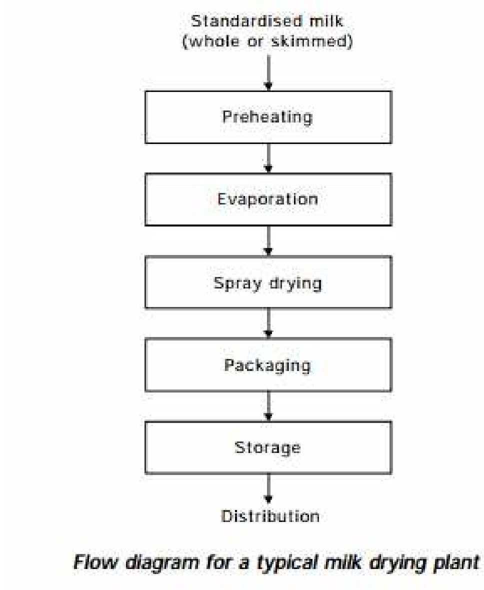


Figure 13- Flow diagram for a milk drying plant

Milk used for making milk powder, whether it is whole or skim milk is not pasteurized before use. The milk is preheated in tubular heat exchangers before being dried. The preheating temperature depends on the season (which affects the stability of the protein in the milk) and on the characteristics desired for the final powder product.

The preheated milk is fed to an evaporator to increase the concentration of total solids. The solids concentration that can be reached depends on the efficiency of the equipment and the amount of heat that can be applied without unduly degrading the milk protein.

The milk concentrate is then pumped to the atomizer of a drying chamber. In the drying chamber the milk is dispersed as a fine fog-like mist into a rapidly moving hot air stream, which causes the individual mist droplets to instantly evaporate. Milk powder falls to the bottom of the chamber, from where it is removed. Finer milk powder particles are carried out of the chamber along with the hot air stream and collected in cyclone separators.

Annexure-B: Stakeholder consultation workshop

We would like to thank the following people for participating and sharing their views on the existing trends of energy efficiency in the Dairy sector during the stakeholder consultation workshop held at Delhi on the 16th of August 2013.

1. Mr. APS Sawhney, Delhi Milk Scheme
2. Mr. B.K. Rana, (OSD Project), Dudhmansagar (Mehsan union)
3. Mr. K L Arora, Member, Central Executive Committee, Indian Dairy Association (IDA)
4. Mr. M.P.Mathur, Sr. General Manager (Projects), VRS Foods (Paras dairy)
5. Mr. Paritosh Kumar Sarkar, Mother dairy Gandhinagar
6. Mr. Raj Kumar Khilnani, M D Energy Tech Consultants Pvt. Ltd.
7. Mr. Ravi, Forbes Marshall
8. Mr. R.S Mann, (Deputy Manager Engg.), Dudhmansagar
9. Mr. Sanjay, Delhi Milk Scheme
10. Mr. A P S Sawhney, Delhi Milk Scheme
11. Mr. Umesh Chopra, Mother Dairy Delhi

Annexure-C: Questionnaire sent to dairy plants

Questionnaire							
Confederation of Indian Industry							
Plant Details							
Name of plant							
Name of Coop. Federation/Group							
Ownership ***(Public/ Private/ Cooperative)***							
Complete Address							
Contact person							
Phone and Mobile Numbers							
Email Id							
Milk Handling/Product Details							
	Installed capacity in KL/MT per day			**Total milk handled/Production in KL/MT**			**Remarks**
Product Name	**2010-11**	**2011-12**	**2012-13**	**2010-11**	**2011-12**	**2012-13**	
Total Milk handling							
<Product 1>							
<Product 2>							
<Product 3>							
Please add more rows if there are more than 3 products							
Energy Details							
					2010-11	**2011-12**	**2012-13**
Contract demand (KVA)							
Electrical energy consumed from grid (kWh)							
Self generation DG set (kWh)							
Self generation from turbine (kWh)							
Self generation from any other source (kWh)							
(please mention the source)							

Fuel consumed (Indicate calorific value if available)	**Fuel**		**Calorific value** (Kcal/kg or Kcal/L)					
	Coal (MT)							
	Diesel (kL) other than DG sets							
	FO/LDO (kL)							
	CNG in Nm^3							
	Others/Bio Mass							
	(Please specify)							
Weighted power factor for the year								
Whether electricity billing from grid was in kVAh or kWh								
Energy cost as a % of manufacturing cost								
Energy saved at your plant due to implementation of Energy Conservation Measures in the past three years								
Energy saved in the year					**2010-11**	**2011-12**	**2012-13**	
Electrical energy saved in units in the year								
Percent saving of total electricity consumed								
Thermal Energy saved in Kcal in the year								
Percent saving of total thermal energy consumed								
LIGHTING Details								
Present total lighting load in kW -								
Annual electricity consumption on lighting in units in 2012-13								
Type of lighting used in interior lighting								
Type of lighting used in exterior lighting								
Trigeneration/Cogeneration details if in use								
In case turbine being used for generation of electricity, then, its rated capacity in kW								
In case VAM is in use then its rated capacity in TR								

ETP Details									
Present capacity of ETP installed in KLPD									
Total electrical load of ETP in kW -									
Annual electricity consumption at ETP in units for 2012-13									
Is it only aerobic or combination of aerobic and anaerobic (Has UASB digester)?									
If it has UASB digester, then, how you are using the methane being produced?									
Not collecting/burning in flame/using as LPG substitute/using in Boiler/any other use (Please specify)									
Approximate generation of methane in Kg or Lit/day									
Please give details of Variable Frequency Drives in use at your plant on motors more than 10 kW.									
Your views on Policy Issues									
Please mention your views on possible reforms for Indian dairy plants w.r.t to policy, technology and finance to match international dairy standards in terms of energy efficiency									
1. Are there any policy issues being faced by dairy industry related to energy in India? Please comment.									
2. Are there any technological barriers in implementing energy efficiency measure/technologies in your plant? Please comment.									
3. Are there any financial barriers faced by Indian dairy industry in implementing energy efficiency measures? Please comment.									

Annexure-D: List of dairies who responded to the questionnaires

1. Amul, Gandhinagar
2. Baroda district cooperative milk producers' union ltd.
3. Danfoss
4. Doodla Dairy, Nellore
5. Dudhmansagar Dairy, Delhi
6. Glow green tech lighting
7. Milk food ltd., Patiala
8. Modern Dairies Ltd., Karnal
9. Panchmahal Dairy
10. Parag Dairy, Pune
11. Paras Dairy, Bhind MP
12. Shri Warana Sahakari Dudh Utpadak, Gujarat
13. Umang Dairy, Gajraulla
14. Verka Dairy, Ludhiana
15. VRS Foods Ltd.

Annexure-E: Names of plants whose data was collected from publically available sources

Plant No.	Name	Source
Plant 4	Vidya Dairy	Annual Report (AR) -12
Plant 5	Kwality Dairy	AR-12
Plant 3	Sudha,Samastipur District	SEC on website
Plant 8	Vadilal	AR-12
Plant 10	Milk Specialities	AR 2009
Plant 13	Cepham Delhi	AR 2008
Plant 17	Mother Dairy, Kolkatta	AR 2006
Plant 2	Heritage Dairy, Chittoor	Energy Manager Training (EMT)2012
Plant 12	Mother Dairy, Delhi	EMT 2004
Plant 14	SUMUL	EMT 2012
Plant 15	Shimogha Union	EMT 2010
Plant 16	Raichur Union	EMT 2011
Plant 7	MILMA	Contacted

Shakti Sustainable Energy Foundation

Shakti Sustainable Energy Foundation works to strengthen the energy security of the country by aiding the design and implementation of policies that encourage energy efficiency as well as renewable energy. Based on both energy savings and carbon mitigation potential, it focuses on four broad sectors: Power, Transport, Energy Efficiency and Climate Policy. Shakti acts as a systems integrator, bringing together key stakeholders including government, civil society and business in strategic ways, to enable clean energy policies in these sectors.

Shakti is part of an association of technical and policy experts called the ClimateWorks Network. For more information, please visit http://www.shaktifoundation.in/

Confederation of Indian Industry (CII)

The Confederation of Indian Industry (CII) works to create and sustain an environment conducive to the growth of industry in India, partnering industry and government alike through advisory and consultative processes. CII is a non-government, not-for-profit, industry led and industry managed organization, playing a proactive role in India's development process. Founded over 116 years ago, it is India's premier business association, with a direct membership of over 8,100 organizations from the private as well as public sectors, including Small and Medium Enterprises (SMEs) and multinationals, and an indirect membership of over 90,000 companies from around 400 national and regional sectoral associations. For more information, please visit www.cii.in

CII - Sohrabji Godrej Green Business Centre (CII - Godrej GBC), a division of CII is India's premier developmental institution, offering advisory services to the industry on environmental aspects and works in the areas of green buildings, energy efficiency, water management, environment management, renewable energy, green business incubation and climate change activities. For more information, please visit www.greenbusinesscentre.com