February 2019

DETAILED ENERGY AUDIT REPORT

M/s Kozhikode Dairy Plant – Kerala Dairy Cluster

Submitted to
(Prepared under GEF-UNIDO-BEE Project)

Bureau of Energy Efficiency
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Prepared by

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Bureau of Energy Efficiency, 2019

This Detailed Energy Audit Report has been originally prepared by Confederation of Indian Industry as a part of Cluster level activities in Dairy Sector (Kerala & Sikkim Cluster) under the GEF-UNIDO-BEE project 'Promoting Energy Efficiency and Renewable Energy in selected MSME clusters in India'.

GEF-UNIDO-BEE Project, Bureau of Energy Efficiency, 2019

"Cluster level activities in Dairy Sector (Kerala & Sikkim Cluster) "

For more information

GEF-UNIDO-BEE PMU

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List of Abbreviations

BEE	Bureau of Energy Efficiency
BOP	Best Operating Practice Document
CS	Capital Structure
°C	°Celsius
CO_2	Carbon dioxide
CIP	Cleaning in Process
CMP	Common Monitorable Parameters
CPD	Central Products Dairy
DEA	Detailed Energy Audit
EE	Energy Efficiency
FCU	Fan Coil Unit
FI	Financial Institution
FO	Furnace Oil
GEF	Global Environmental Facility
HSD	High Speed Diesel
kW	Kilo Watt
LSP	Local Service Provider
MSME	Micro and Medium Scale Industries
OEM	Original Equipment Manufacturer
RE	Renewable Energy
TOE	Tonnes of Oil Equivalent
UNIDO	United Nations Industrial Development Organisation
VFD	Variable Frequency Drive

ACKNOWLEDGEMENT

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CII also thanks Mr. Jamshed P Umar, Cluster leader for Kerala Dairy cluster for the continuous support extended all throughout this activity.

We also take this opportunity to express our appreciation to the Original Equipment Suppliers and Local Service Providers for their support in giving valuable inputs and ideas for the completion of the Detailed Energy Audit Report.

We would also like to mention that the valuable efforts being taken and the enthusiasm displayed towards energy conservation by the Kerala Dairy Cluster is appreciable and admirable.

1. EXECUTIVE SUMMARY

Bureau of Energy Efficiency (BEE), a statutory body under Ministry of Power, Government of India, in collaboration with United Nations Industrial Development Organization (UNIDO) is executing a Global Environment Facility (GEF) funded national project "Promoting energy efficiency and renewable energy in selected MSME clusters in India".

The overall aim of the project is to develop and promote a market environment for introducing energy efficiency and enhanced use of renewable energy technologies in process applications in 12 selected energy-intensive MSME clusters across 5 sectors in India (with expansion to more clusters later). This will enable improvement in the productivity and competitiveness of units, as well as reduce overall carbon emissions and improve the local environment.

The major activities associated with project are

- Interact closely with cluster associations to identify their technology and service needs and mapping of the cluster units, based on which a pre activity workshop would be organized
- Assess the present capacity, strengths, weaknesses and training needs of MSME units from the perspective of their needs for EE/RE technologies
- A form will be prepared for inviting expression of interest from cluster units for carrying out energy audits
- Conduct detailed energy audits in MSME units decided in mutual agreement with the cluster association.
    - Make a final presentation to the respective units on energy audit findings seeking their consent on EE & RE findings
    - Prepare final report including the accepted findings
- Prepare cluster specific energy benchmarking report covering complete product range with comparison to available international standards.
- Identify and enumerate common regularly monitorable parameters (CMP) at the process level which have impact on energy performance. This will include:
    - List of appropriate instrumentation with 3 options including make, supplier, indicative costs, specifications and accuracy of measurements.
- Develop a high quality poster based on the CMP document to disseminate the information at unit level.
- Develop a cluster specific high quality ready to publish Best Operating Practices (BOP) document for the energy consuming equipment/ process in the industry cluster on the basis of:
    - Process / technology used in the cluster
    - Energy audit findings
    - Discussions with at least 3 subject matter experts in/around the cluster

    - Discussions with at least 2 equipment suppliers for each equipment
- Identify set of energy auditing instruments that should be used for carrying out periodic energy audits in the units. This will include:
    - Minimum 3 sets of options including make, supplier, indicative costs, specifications, accuracy of measurements including quotations.
- Conduct post energy audit training workshops in the cluster. For this:
    - The training programs would be customized based on the needs of the MSMEs, covering EE and RE topics
- Prepare and design ready to print case-studies prepared under the project based on the content provided by the PMU

Project deliverables, linked to the above activities, will be as follows:

- Proceedings of pre-activity workshop.
- Unit specific comprehensive energy audit reports, with copies submitted to unit and BEE.
- Cluster specific benchmarking report with complete product range with comparison to international standards.
- Cluster specific list of common regularly monitorable parameters with ranges and suggested instrumentation to monitor, and also compile the information in the form of high quality poster.
- Cluster specific custom designed ready to publish best operating practices document
- Cluster specific list of energy audit equipment along with minimum three quotations
- Proceedings of post energy audit training workshops
- Custom designed, ready to publish case-studies.

The main outcomes expected at the end of the project are,

1. Creating a scope for energy savings, by increasing the level of end-use demand and implementation of energy efficiency and renewable energy technologies
2. Improving the productivity and competitiveness of units
3. Reducing overall carbon emissions and improving the local environment
4. Increasing the capacity of energy efficiency and renewable energy product suppliers,
5. Strengthening policy, institutional and decision-making frameworks
6. Scaling up of the project to a national level

1.1 Brief Unit Profile

Table 1: Unit Details

Particulars	Details
Name of Plant	MRCMPU Ltd (Milma), Kozhikode Dairy
Name(s) of the Plant Head	Sri. Shajimon. K. K, Dairy Manager
Contact person	Sri. Chandralal T.R, Asst. Manager (Engg)
Constitution	Cooperative Society
MSME Classification	Medium Scale
Address:	MRCMPU Ltd, Milma, Kozhikode Dairy, Peringolam, Kunnamangalam P.O, Kozhikode - 673 571
Industry-sector	Dairy

The plant has incorporated several energy conservation aspects in the design stage itself resulting in energy efficient operation. Subsequently more measures have also been identified and implemented.
Some of the important energy conservation measures implemented are as below.

- Use of Screw Air Compressors with VFD
- Use of hot water heating in Curd Incubator
- Installation of Solar Thermal 10 KL
- Installation of Desuperheater
- Optimized Voltage at Main Incomer
- Maintaining PF close to unity
- Use of Briquette Fired Hot Water Generator
- Use of Screw Air Compressors
- Use of Pre Chiller for milk cooling

CII – Godrej GBC Energy Audit Team conducted Detailed Energy Audit at Kozhikode Dairy Main Plant from 05th December 2018 to 08th December 2018 and final presentation to plant team was given on 18th January 2019.

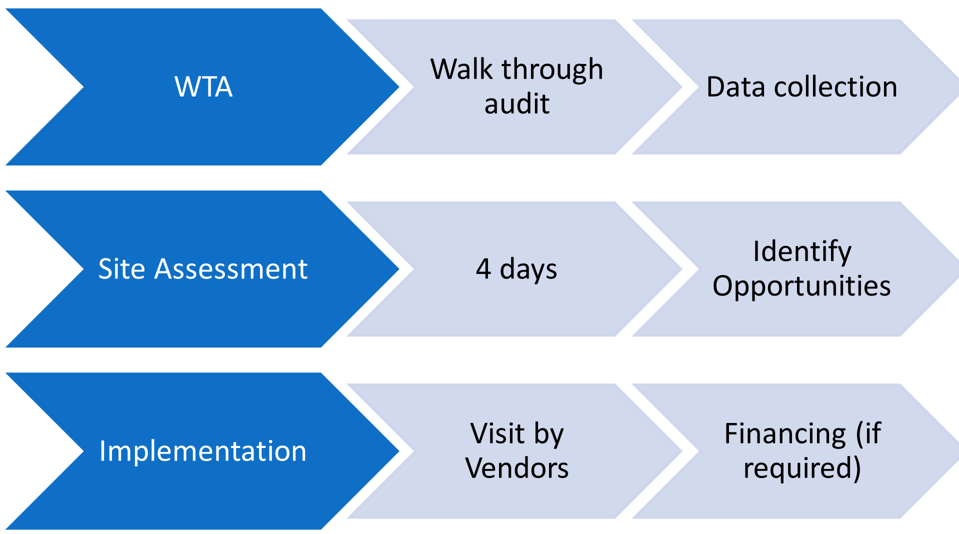
The energy audit included detailed data collection, power measurements of major electrical energy consumers, process measurements, analysis of data, and performance analysis of the equipment and identification of specific energy saving proposals.

Electricity energy for the plant is purchased from Kerala State Electricity Board. For thermal energy, plant is using Briquette, HSD, Furnace Oil as the fuels.

1.2 Methodology and Approach

The methodology adopted for energy audit starts from historical energy data analysis, power quality analysis, monitoring of operational practices, system evaluation and cost benefit analysis of the energy conservation opportunities and prepare plan for implementation. The proposals given in the report includes economical energy efficiency measures to reduce facilities unnecessary energy consumption and cost. The energy conservation options, recommendations and cost benefit ratio, indicating payback period are included in this report.

Approach for the energy audit adopted is shown below:



1.3 Summary of Savings

Kozhikode Dairy plant team and CII energy team have together identified an annual energy saving potential of Rs. 20.18 Lakhs with an investment of Rs 36.21Lakhs based on energy cost.

Table 2: Summary of savings

Details	No. of Proposals	Annual savings
Total Annual savings	18	20.18
Nil Investment Proposal	6	3.92
Investment Required (Rs. Lakhs)	12	36.21
Pay Back	Months	22

Table 3: Summary of fuel savings

Details	UOM	Annual savings
Total Electricity Savings	kWh	2,48,984
Total Fuel Savings (Briquette)	kgs	91,409
Annual TOE Savings	TOE	59.80
Annual TCO_2	$MTCO_2$	204.2

Table 4: Summary of Energy Saving Proposals

Sl. No.	ECM	Annual savings (lakhs)	Investment (lakhs)	Payback	Electricity Savings (kWh)	Fuel Savings (kg Briquette)	TOE savings	MTCO2 savings
1	Install VFD for Hot Water Circulation Pump	0.62	0.88	17	9519		0.82	7.8
2	Reduce pressure drop across APH of Hot Water Generator	0.42		0	7592		0.65	6.2
3	Reduce the draft pressure maintained in Hot Water Generator	0.42	0.75	21	7592		0.65	6.2
4	Improve combustion performance of Hot Water Generator	1.86	2	13		26630	11.18	0.0
5	Installation of VFD for Chiller Compressor	1.38	2.25	20	25200		2.17	20.7
6	Switch of Chiller Compressor 3	0.6		0	10950		0.94	9.0
7	Optimize the operation of Chilled Water Pumps	0.31		0	5737		0.49	4.7
8	Interlock of evaporator fans in Ice Cream Cold Storage with compressor	0.26		0	4785		0.41	3.9
9	Reduce Ice Cream Cold Store Temperature	2.19		0	39936		3.43	32.7
10	Pre-heating of incoming Raw Milk in Curd Section	4.6	3	8		64779	27.21	0.0
11	Optimize the operation of 20 KL Pre-chiller for milk cooling	1.16	1	10	21144		1.82	17.3
12	Replacement of existing condenser pump with energy efficient pump	2.67	1.5	7	48540		4.17	39.8
13	Installation of VFD for Diffuser fans in Milk Cold Storage	0.19	0.27	17	3449		0.30	2.8
14	Reduce the Generating Pressure of Identified Air Compressors	0.14		0	2655		0.23	2.2
15	Install VFD for Main Plant Compressor to avoid unloading	0.5	0.7	17	9722		0.84	8.0
16	Installation of AC Energy Savers	0.22	0.4	22	4000		0.34	3.3

17	Replacement of Ceiling fans with BLDC fans	0.24	0.56	28	4363		0.38	3.6
18	Installation of 30 kWp Solar Roof Top	2.4	22.9	115	43800		3.77	35.9
	Total	**20.18**	**36.21**	**22**	**248984**	**91409**	**59.8**	**204.2**

2. INTRODUCTION ABOUT KOZHIKODE DAIRY PLANT

2.1 Unit Profile

Malabar Regional Co-operative Milk Producers' Union (MRCMPU) Limited is a Union of more than 1000 village level dairy co-operative societies located in the six northern districts of Kerala State in South India and it is owned by the dairy farmers who are members of each affiliated society and who live in the area of operation of these societies.

The new Kozhikode dairy plant was commissioned in 1995, in place of the old dairy plant, which was functioning from 1965 at Beypore, near Kozhikode city. This dairy is located near Kunnamangalam, 15 KM away from Kozhikode city and near to the Union Head Office. The dairy has been expanded to 1,25,000 LPD during 1999-2000. The Dairy has a Milk Chilling Plant at Nilambur in Malappuram District. The dairy is procuring milk from Malappuram, Kozhikode and Palakkad (partial area) districts and selling milk and milk products at Kozhikode, Malappuram (partly) and Wayanad districts.

Table 5: Unit Profile

Particulars	Details
Name of Plant	MRCMPU Ltd (Milma), Kozhikode Dairy
Name(s) of the Plant Head	Sri. Shajimon. K. K, Dairy Manager
Contact person	Sri. Chandralal T.R, Asst. Manager (Engg)
Contact Mail Id	kkd.eng@malabarmilma.coop, kkddairy@malabarmilma.coop
Contact No	+91 9961046438
Constitution	Kozhikode
MSME Classification	Medium Scale
No. of years in operation	25
No of operating hrs/day	16
No of operating days/year	365
Address:	MRCMPU Ltd, Milma, Kozhikode Dairy, Peringolam, Kunnamangalam P.O, Kozhikode - 673 571
Industry-sector	Dairy
Type of Products manufactured	Milk & Milk Products

2.2 Production Details

The various products manufactured in Kozhikode Dairy are Liquid milk, Ice Cream, Curd, Butter milk. The graph below shows the milk processed during last one year:

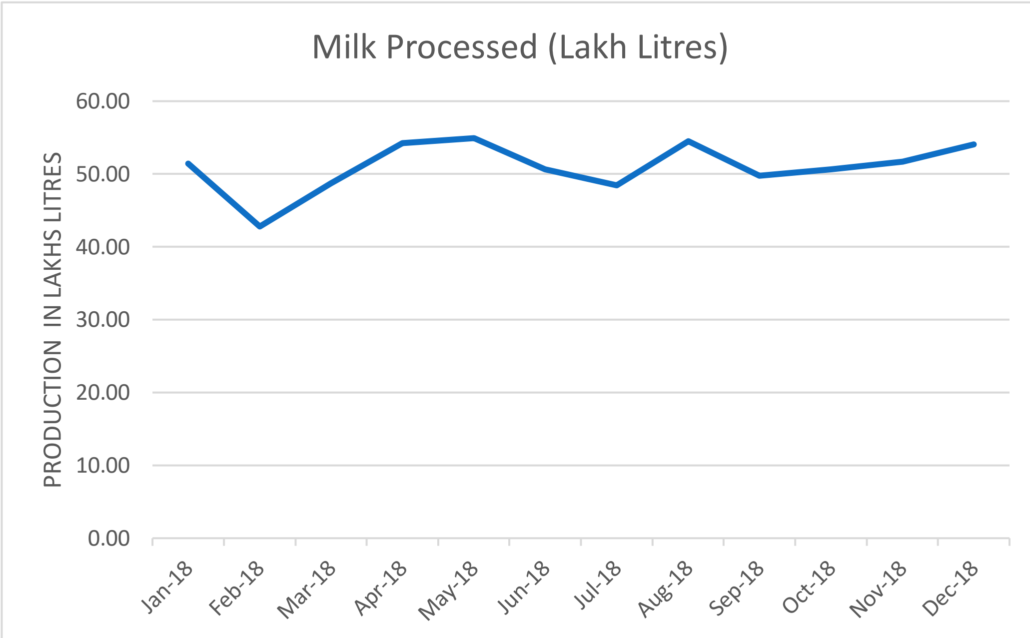


Figure 1: Milk Processed

2.3 Dairy Process Flow Diagram

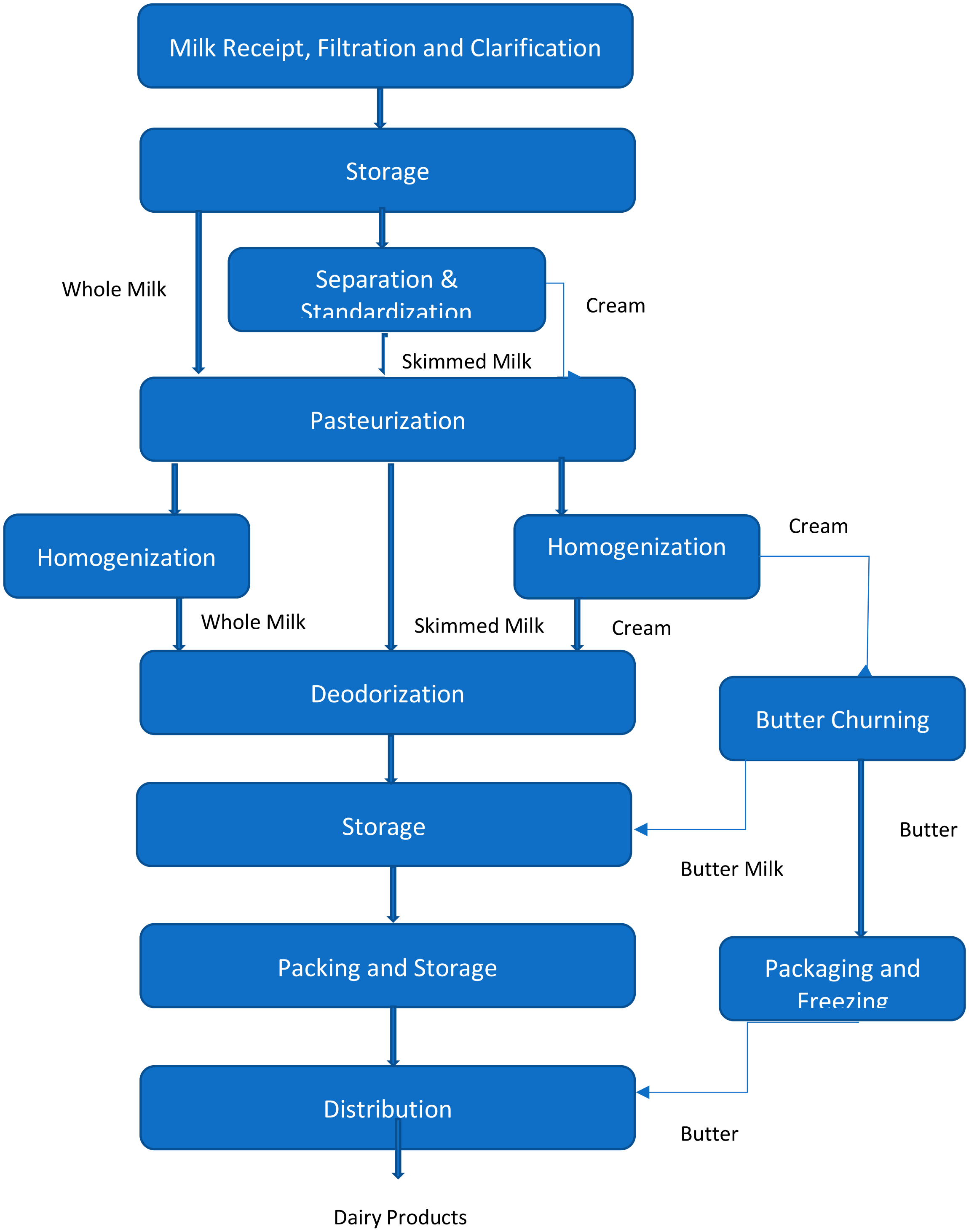


Figure 2: Typical process flow of Milk manufacturing

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

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 78°C for 15 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.

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.

The table below shows the production capacity of various section in plant daily

Table 6: Production Capacity

Sl No	Product	UOM	Quantity
1	Milk Processing	Lakh Litres per Day	1.2
2	Milk Packaging in Poly Pouches	Lakh Litres per Day	1.0
3	Curd Manufacturing	MT/day	17.5
4	Butter Milk 180ml	Packets/day	13500
5	Ice Cream Manufacturing	Litres/day	3000
6	Cup Curd / Lassi Curd	Litres/day	650

2.4 Energy Profile

Both electricity and thermal energy are used for carrying out various dairy processing activities. The following fuels are used in the plant:

Table 7: Type of fuel used

Sl. No.	Type of fuel/Energy used	Unit	Tariff	GCV (kCal/kg)
1	Electricity	Rs./kWh	5.5	-
2	High Speed Diesel	Rs/L	75	10867.68
3	Briquette	Rs/Kg	7.10	4200
4	Furnace Oil	Rs/L	35.29	9000

The table below shows the monthly consumption of various fuel used in the plant during the last one year. FO and Briquette is used for boiler and HSD is used as fuel for DG. Electricity is purchased from Kerala State Electricity Board and the contract demand of the plant is 750 kVA.

Table 8: Fuel Consumption Details 2017-18

Month	Electricity Consumption (kWH)	Fuel Consumption - Briquette (Tonnes)	Fuel Consumption - Furnace Oil (litre)	Fuel Consumption Fuel- HSD (litre)
Nov-17	2,32,134	74.261	790	2065
Dec-17	2,54,177	72.976	0	940
Jan-18	2,48,794	75.076	2250	940
Feb-18	2,40,996	57.573	5050	750
Mar-18	2,99,264	70.297	2550	1620
Apr-18	2,90,325	82.562	0	1870
May-18	2,63,431	83.304	850	4355
Jun-18	2,55,024	73.666	0	2835
Jul-18	1,92,997	68.887	2250	1200
Aug-18	2,36,166	90.942	0	7910
Sep-18	2,43,831	81.539	1250	3845
Oct-18	2,56,242	77.454	2000	1600
Nov-18	2,68,373	75.034	2650	700
Dec-18	2,71,243	76.631	0	85
Total	**3552997**	**1060.202**	**19640**	**30715**

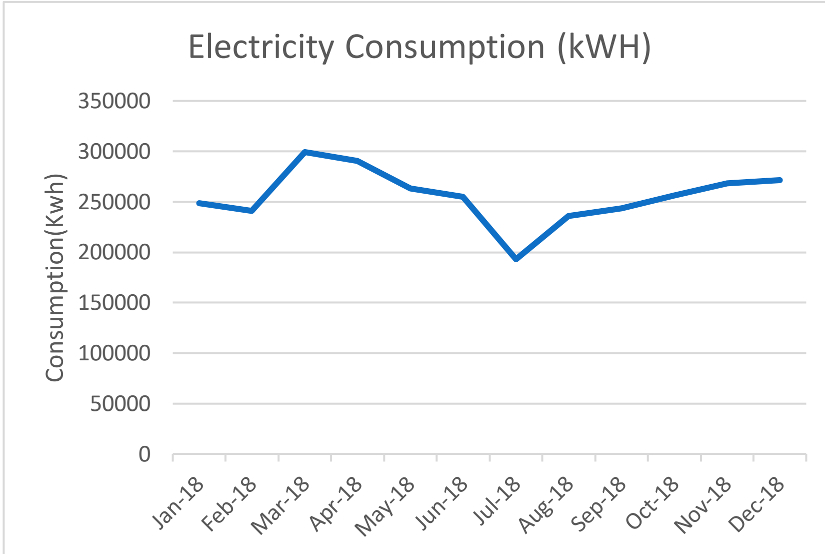


Figure 4 : Electricity consumption profile

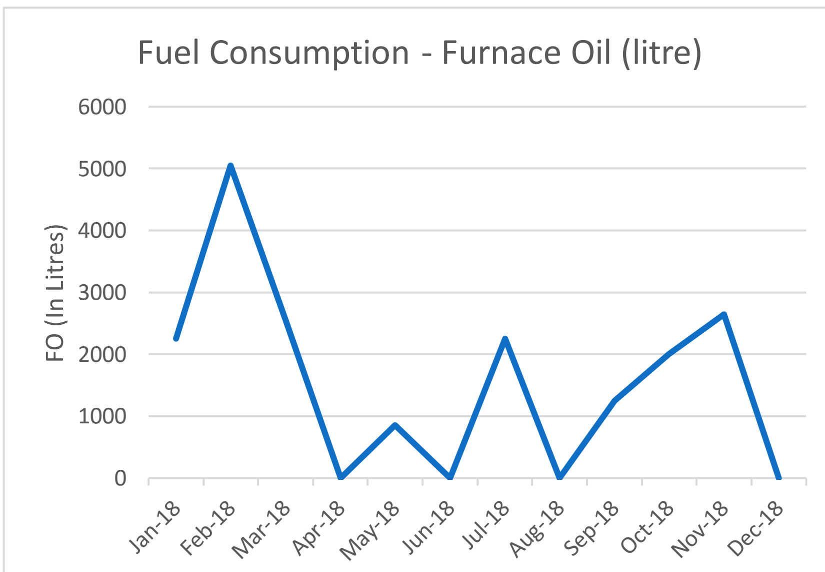


Figure 3: Furnace Oil consumption profile

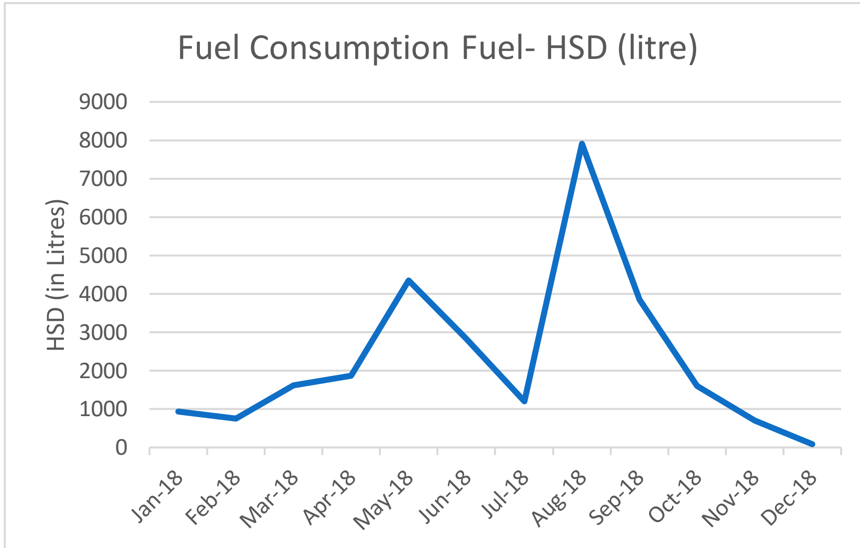


Figure 6: HSD consumption profile

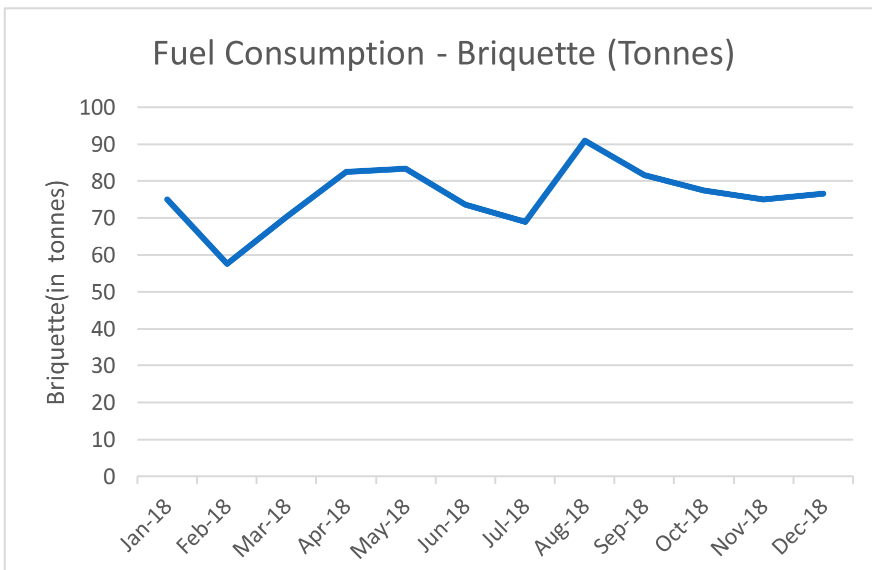


Figure 5: Briquette consumption profile

The energy consumption breakup of the plant both thermal and electrical is shown in the below table. Total energy consumption of the plant is 693 MTOE out of which 66% of the total energy is contributed by thermal and rest only 34% is contributed by electricity.

Table 9: Energy consumption breakup of plant

Sl No	Particulars	UOM	Value
1	Annual Electricity Consumption	kWh	3066686
2	Annual Electrical Energy Consumption	Kcal	2637349960
3	Annual Electricity Consumption	MTOE	263.734996
4	Annual Diesel Consumption	L	23553.5
6	Annual Diesel Energy Consumption	kcal	255971900.9
7	Annual Diesel Consumption	MTOE	25.59719009
8	Annual FO Consumption	Litre	18284.5
10	Annual FO Energy Consumption	kCal	164560500
11	Annual FO Consumption	MTOE	16.45605
12	Annual Briquette Consumption	kg	912965
14	Annual Briquette Energy Consumption	kcal	3880101250
15	Annual Briquette Consumption	MTOE	388.010125
17	Total Energy Consumption	kcal	6937983611
18	Total Energy Consumption	MTOE	693.79

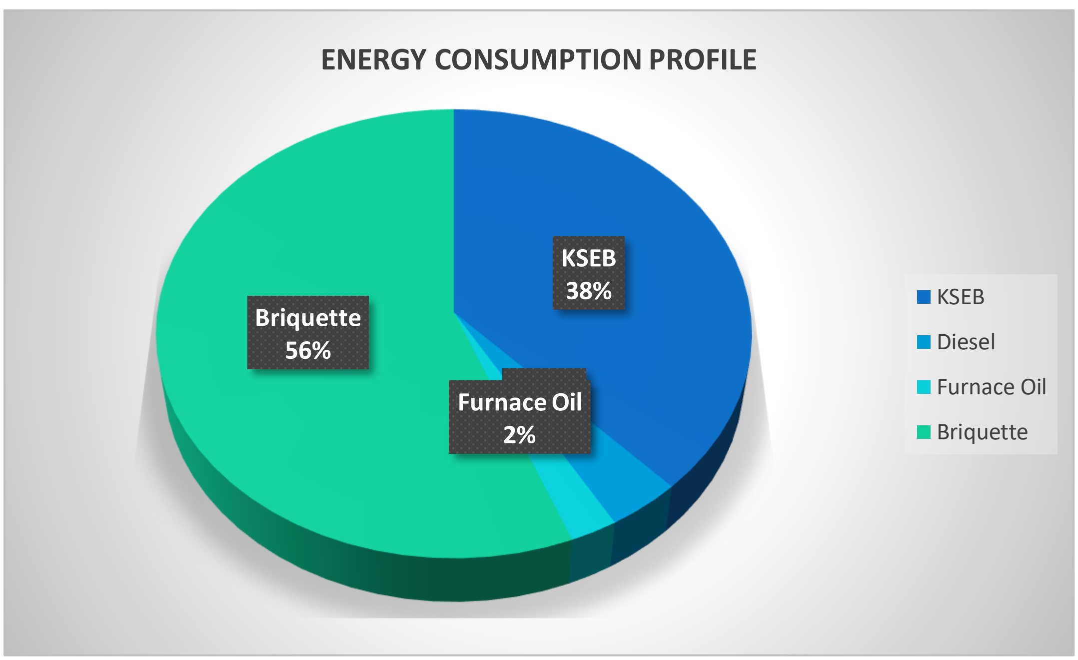


Figure 7: Energy Profile

Based on the data collected from the plant, the graph above shows the variation of fuel cost over the last one year. Average electricity cost is Rs 14.2 Lakhs/month whereas the average thermal energy cost is Rs 7.7 Lakhs/month.

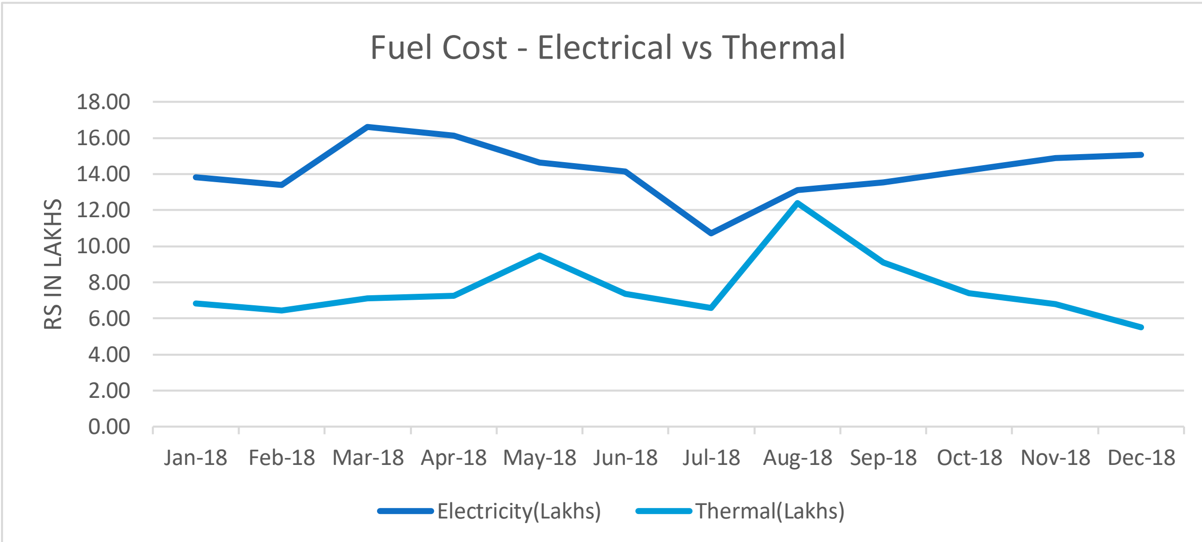


Figure 8: Variation of fuel cost

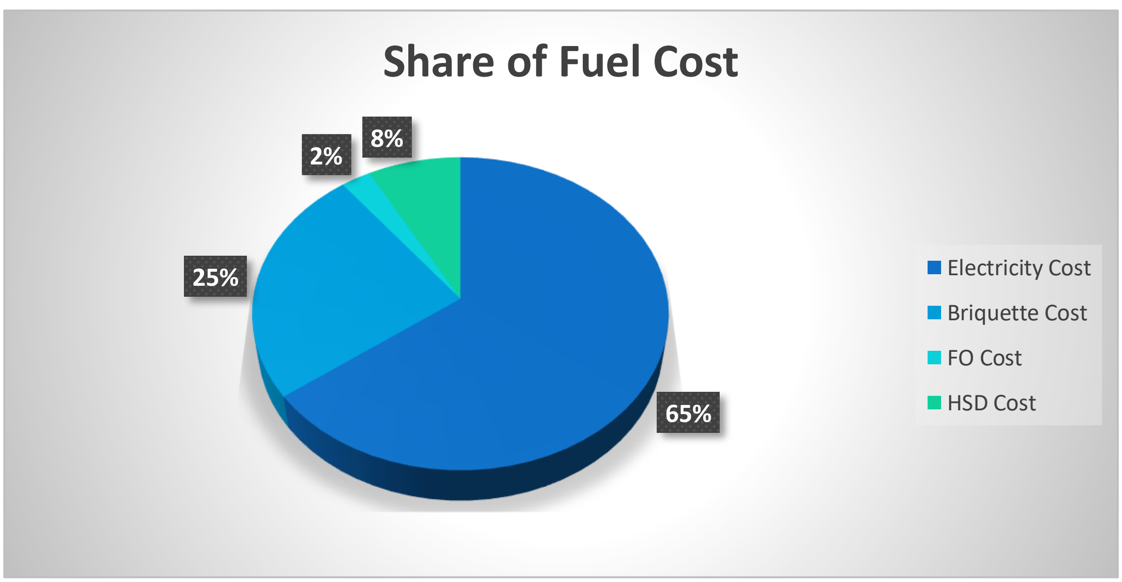


Figure 8: Percentage share of fuel cost

3. PERFORMANCE EVALUATION OF EQUIPMENT/PROCESS

3.1 List of equipment and process where performance testing done

CII during the detailed energy audit at Kozhikode Dairy carried out measurements and performance testing in the following equipment and process.

Refrigeration System

- Performance of refrigeration compressor
- Chilled water system
- Condenser circuit

Boiler and Steam System

- Boiler efficiency by direct method
- Steam mapping
- Flue gas measurements

Compressor

- Free Air Delivery test by pump up method (wherever possible to isolate the receiver and compressor from circuit).
- Leakage test during shut down (if any during the audit period).
- Identification of leakage points.
- Loading / unloading study

Pumps

- Efficiency estimation

Electrical

- Power Measurements
- AC Load analysis
- Transformer Measurements
- Lighting load

3.2 Result of Performance Testing

The table below shows electrical measurements done in the plant.

Table 10: Electrical Measurements

Sl No	Feeder /Equipment	Voltage	Current	Power	PF
1	Circulation Pump Boiler	412	17.4	10.86	0.87
2	ID Fan	410	11	6.5	0.87
3	FD Fan	407	3.2	1.6	0.71
4	Air Compressor 2 Plant	412	13.8	8.68	0.87
5	Air Compressor 3 Plant	410	11.7	7.43	0.88
6	Crate Washing	404	15	6	0.58
7	Homogenizer	413	66.5	37.5	0.79
8	Ice Cream Plant Chiller Compressor 2	408	18.2	10.1	0.78
9	Ice Cream Plant Chiller Compressor 3	431	17.6	9.3	0.7
10	Ice Cream freezer 2	409	19.6	7.2	0.79
11	Ice Cream freezer 2 (Beater motor)	411	7	2.7	0.54
12	Plant Condenser Pump	409	19.4	11.7	0.85
13	Ice Cream Plant condenser pump			3.5	
14	Chilled Water Pump (2 Pump Running)	412	14.3	8.5	0.84
15	Ammonia Compressor 1	406	64.3	41.6	0.9
16	Ammonia Compressor 5	411	61.4	38.9	0.89
17	Ammonia Compressor 3	402	73	45.5	0.89
18	Ammonia Compressor 2	406	62	38.8	0.88
19	Etp Load	407.6	25.8	14.38	0.78
20	Aeration Blower	416	4.8	2.49	0.72
21	Agitator 1	412.3	7.2	3.95	0.76
22	Agitator 2	414	7.9	4.4	0.716
23	Curd Cold Store Fan1	407	2.2	1.12	0.72
24	Curd Cold Store Fan2	407	2.2	1.09	0.68
25	Curd Cold Store Fan3	408	2	1	0.69
26	Curd Cold Store Fan4	408	2.1	1.06	0.72
27	Milk Cold Store Fan 1	413	1.7	0.74	0.61
28	Milk Cold Store Fan 2	414	1.7	0.65	0.55
29	Milk Cold Store Fan 3	413	1.6	0.61	0.53
30	Cup Cold Store Fan 1	411	2.2	1.05	0.68
31	Cup Cold Store Fan 2	413	1.9	0.99	0.71
32	Cup Cold Store Fan 3	412	2	0.95	0.68
33	Curd Cold Storage Fan 1	414	1.9	0.94	0.7
34	Curd Cold Storage Fan 2	415	1.9	0.97	0.7
35	Incubation Room Fan 1	415	3.9	1.7	0.62
36	Incubation Room Fan 2	415	1.9	0.9	0.62
37	Deep Freezer Compressor 1	415	19	10.35	0.75
38	Deep Freezer Compressor2	417	18.2	8.85	0.87
39	Ice Cream Plant Compressor2	408	18.2	10.1	0.78
40	Ice Cream Plant Compressor3	408	17.6	9.3	0.7

41	Ice Cream Plant Compressor C1B Evap Fan	403	3.3	2.3	0.988
42	Ice Cream Plant Compressor C1 A	407	18.4	9.2	0.726
43	Ice Cream Plant Compressor C1 A Evaporator Fan	408	3	1.94	0.98
44	Ice Cream Plant Compressor C1 B	404.4	19.3	11.4	0.84
45	Ice Cream Plant Compressor 3A	406	16.2	8.1	0.711
46	Ice Cream Plant Compressor 4 Evaporator Fan	402	1.6	0.83	0.76
47	Ice Cream Plant Compressor C3A	409	13.6	6.39	0.66
48	Ice Cream Plant Compressor C3A Evaporator Fan	409	2.6	1.82	0.98
49	Ice Cream Plant Compressor C3B Evaporator Fan	408	1.1	0.77	0.98
50	Ice Cream Plant Compressor C4A Evaporator Fan	407	1.1	0.77	0.93
51	Ice Cream Plant Compressor C5A	399	21.7	10.5	0.703
52	Ice Cream Plant Compressor C5A Evaporator Fan	404	2.7	1.32	0.706
53	Milk Packing machine with VFD	415	2.8	1.2	0.68
54	Milk Packing machine without VFD	407	7	3.2	0.55
55	Curd Packing m/c1	400	3.6	1.54	0.62
56	Curd Packing m/c2	400	2.8	1.3	0.61
57	CIP	412	7.5	3.79	0.711
58	Pastuerizing Section			16.688	
59	Ice Cream Plant High Pressure Compressor			7.8	
60	Ice Cream Plant Instrumentation Compressor			7.5	

Table 11: Transformer Measurements

Tr2 315 kVA	Voltage	Current	Power	PF	VTHD	ITHD	kVA	% Loading
R	240	230	55	0.99	1.0	2.5	55.6	54.5
Y	242	232	56	0.99	1.2	3.6	56.6	
B	241	244	59	0.99	1.2	3.7	59.6	
Tr1 315 kVA	**Voltage**	**Current**	**Power**	**PF**	**VTHD**	**ITHD**	**kVA**	**% Loading**
R	241	218	54	0.96	1.1	2	56.3	55.0
Y	238	251	58.8	0.96	1.2	3	61.3	
B	238	240	54.2	0.97	1.1	3.2	55.9	
Tr3 500 kVA	**Voltage**	**Current**	**Power**	**PF**	**VTHD**	**ITHD**	**kVA**	**% Loading**
R	240	328	75.3	0.96	1.8	10	78.4	41.7
Y	238	292	67.8	0.98	1.7	9.8	69.2	
B	239	254	59	0.97	1.7	10.2	60.8	

- Harmonics are within the limits as per standard IEEE 519 -2014 (VTHD < 8% and ITHD < 15%). Harmonics on TR1 is slightly on higher side.
- Plant is operating at good power factor and monthly plant is getting incentive from electricity board

Table 12: Hot Water Generator Efficiency

Hot Water Generator Efficiency (Direct)		
Water I/L Temp	114	°C
Water O/L Temp	140	°C
Enthalpy difference	26	kCal/kg
Fuel Input	228	kg/hr
GCV of fuel	4200	kCal/kg
Enthalpy of feed water	26	kCal/kg
Feed Water Quantity	24000	kg/hr
Boiler Efficiency	65%	%
% boiler loading	62%	%

Table 13: Pump Measurements

Parameter	Plant Condenser Pump	Ice Cream Plant Condenser Pump
Power kW	11.5	3.50
Flow (m^3/h)	70	40
Head assumed (m)	19	18
Efficiency	36.88	62.29

Table 14: Performance of Air Compressor

Parameters	UOM	Plant Compressor 3	Plant Compressor 2	Ice Cream Plant Compressor 1	Ice Cream Plant HP Compressor
Rated capacity of compressor	CFM	33.81	33.81	38.75	33.81
Rated power of compressor	kW	7.5	7.5	7.5	7.5
Load Power	kW	7.6	8.6	7.5	7.8
Unload Power	kW	2.8	-	2.7	-
Load Pressure	bar	7.2	7	7	7.7
Unload Pressure	bar	8.0	8.0	8	9.7
Loading	%	54	100	22	100
Unloading	%	46	-	78	-

Table 15: Performance of Chiller Compressor

Parameters	UOM	
Rated size of compressor	kW	33
	TR	45
No of Compressors in operation	Nos	2
Compressor 1 Power	kW	41.60
Compressor 5 Power	kW	38.90
Suction Pressure Compressor 1	Psi	30
Suction Pressure Compressor 5	Psi	39
Discharge Pressure Compressor 1	Psi	196
Discharge Pressure Compressor 5	Psi	190
Discharge Temperature	ºC	92
Condensing Temperature	ºC	38
Total Operating Power	kW	80.50
Operating TR	TR	51.93
SEC	kW/TR	1.55

3.3 Energy Balance of Kozhikode Dairy

During the detailed energy audit at Kozhikode dairy the total load on the plant measured at transformer level was 550 kW. For major process/equipment measurements were carried out at individual feeders. The pie chart below shows the breakup of electricity consumption inside the plant.

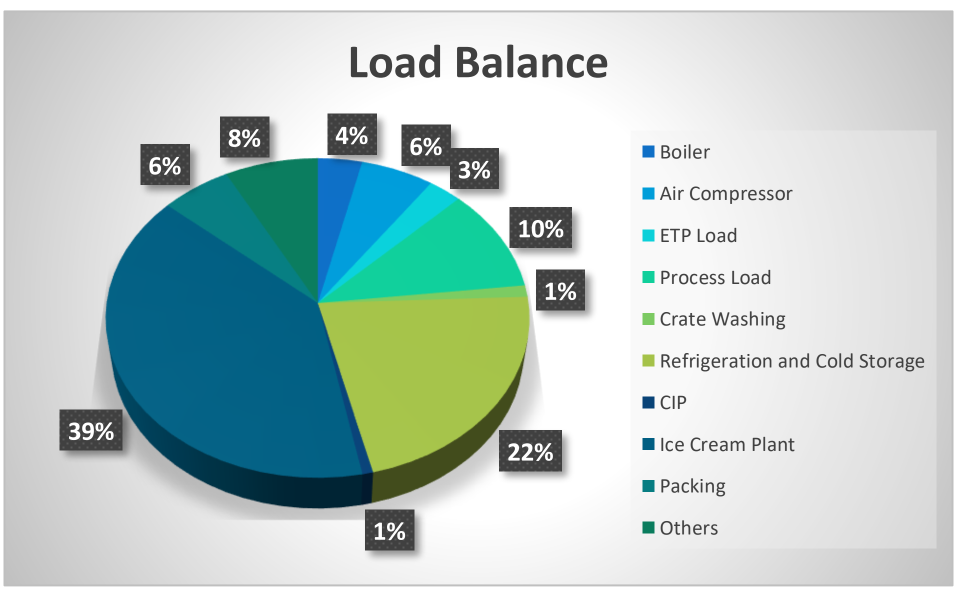


Figure 9: Equipment/Process wise energy breakup

figure below shows energy balance diagram of Kozhikode Dairy

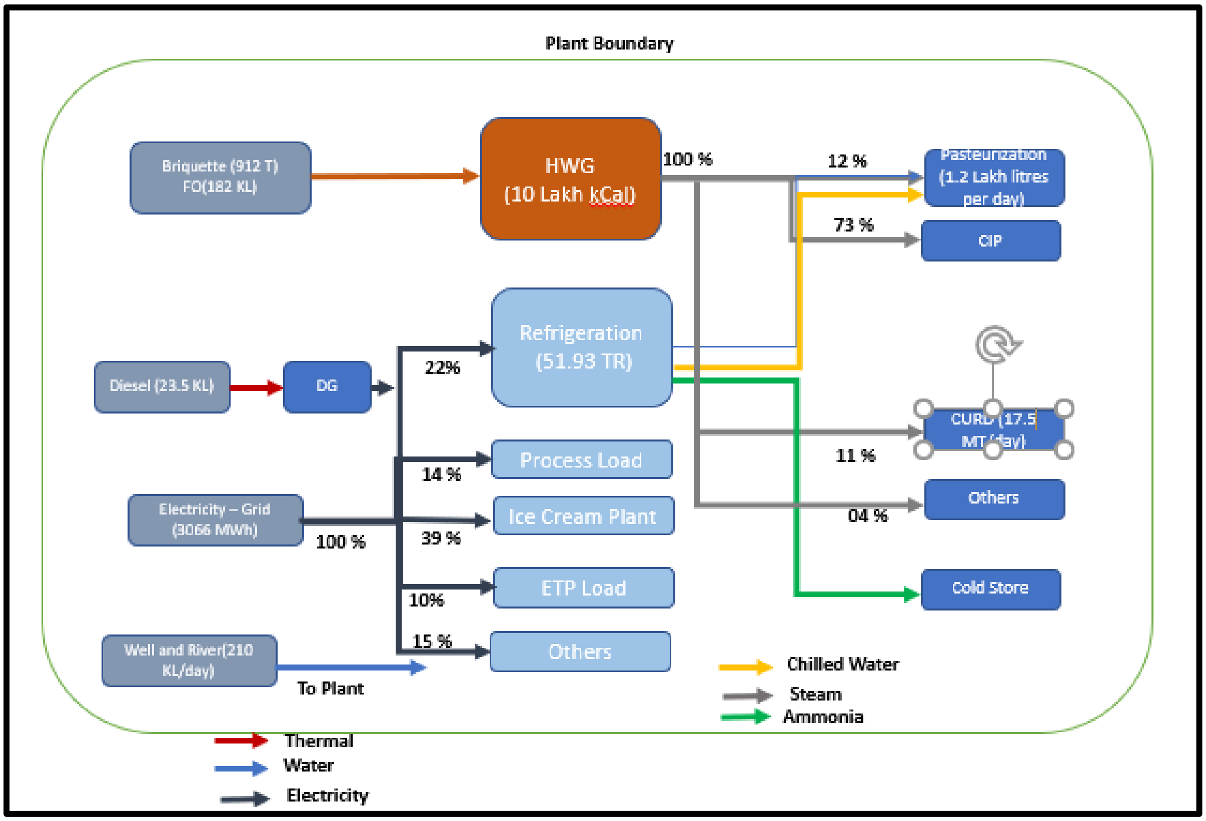


Figure 10: Energy Balance of Kozhikode Dairy

3.5 Water Profile of Kozhikode Dairy

Kozhikode Dairy is having a separate Borewell for the water requirement in the plant. The table below shows the monthly consumption of water in the plant.

Table 16: Monthly water consumption

Monthly Consumption	
	Kilo Litre
Jul-17	6111
Aug-17	6645
Sep-17	6369
Oct-17	6488
Nov-17	6570
Dec-17	6469
Jan-18	6446
Feb-18	6276
Mar-18	6978
Apr-18	7101

May-18	6656
Jun-18	5891
Jul-18	5321
Aug-18	6137
Sep-18	5777
Oct-18	5756
Nov-18	5450
Dec-18	6277
Total	1,12,718

Water is mainly used for process, cooling water make up and domestic applications. The daily report of water usage in the plant is given below:

Table 17: Daily consumption data

Water Data		
Water Source		River Water
Daily Average Consumption	KL	210
Daily average ETP Load	KL	200
Cost of Water	Rs/L	5.33
% Reused /Recycled	%	20

The section wise water consumption is shown in the below graph

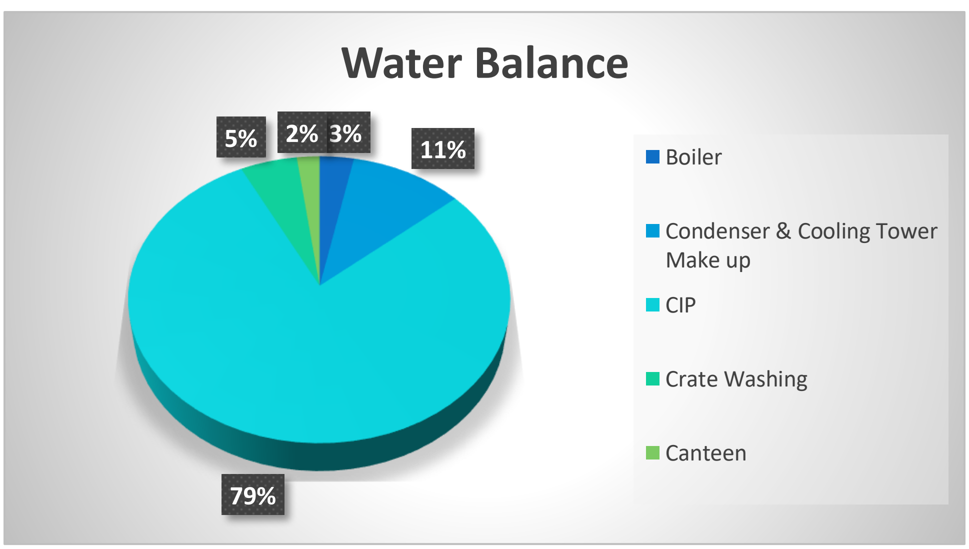


Figure 11: Water profile of Kozhikode Dairy

3.6 Specific Energy Consumption

Specific electricity and specific fuel consumption have been estimated based on the fuel data and production data given by the plant team.

Table 18: Specific energy consumption

Sl No	Particulars	UOM	Value
1	Annual Electricity Consumption	kWh	3066686
2	Annual Electrical Energy Consumption	Kcal	2637349960
3	Annual Electricity Consumption	MTOE	263.73
4	Annual Diesel Consumption	L	23553.5
6	Annual Diesel Energy Consumption	kcal	255971900.9
7	Annual Diesel Consumption	MTOE	25.59719009
8	Annual FO Consumption	Litre	18284.5
10	Annual FO Energy Consumption	kCal	164560500
11	Annual FO Consumption	MTOE	16.45
12	Annual Briquette Consumption	kg	912965
14	Annual Briquette Energy Consumption	kcal	3880101250
15	Annual Briquette Consumption	MTOE	388.01
17	Total Energy Consumption	kcal	6937983611
18	Total Energy Consumption	MTOE	693.79
19	Total Production	KL	61183.733
20	Overall Electrical SEC	kWh/KL of Milk	50.12
21	Overall Thermal SEC	MkCal/KL of Milk	0.07
22	Overall SEC	MkCal/KL of Milk	0.11

3.7 Performance Analysis of Major Processes

3.6.1 Pasteurizing Section

Table 19: Analysis of pasteurizing section

Pasteurisation		
Description	**Unit**	**Pasteuriser I**
Pasteurizer Capacity	KL/hr	10
No.of hours of operation per day	hours/day	7
No of Shifts	Nos	2
Average Shift Time	Hours	7
Average Milk Processed per shift	Litres/shift	50000
Average Milk Processed per day	Litres/day	100000
Incoming milk temperature from Silo	ºC	5
Heating Temperature	ºC	78
Holding time	Seconds	15
Regeneration Efficiency	%	91.6
Cooling Temperature	ºC	3
Chilled water temperature	ºC	1

Raw Milk Silo Temperature	ºC	6
Process Milk Silo Temperature	ºC	4
Specific Steam Consumption	Kg/KL	25.49

3.6.2 CIP Section

Table 20: CIP Section Analysis

Parameters	UOM	
Hot Water tank capacity	KL	3
Delta T of heating	ºC	45
Heating Time	mins	30
Steam Pressure	**kg/cm2g**	3.5
Hot Water Flow Rate for Hot Water tank per batch	kg/hr	533.6
Hot Water Qty required per batch	kg/hr	266.8
Number of batches per day	No.	3
Acid Water tank capacity	KL	3
Delta T of heating	ºC	40
Heating Time	mins	30
Steam Pressure	**kg/cm2g**	3.5
Hot Water Flow Rate for Acid Water tank per batch	kg/hr	474.3
Hot Water Qty required per batch	kg/hr	237.2
Number of batches per day	No.s	3
Alkali Water tank capacity	KL	3
Delta T of heating	ºC	40
Heating Time	mins	30
Steam Pressure	**kg/cm2g**	3.5
Hot Water Flow Rate for Alkali Water tank per batch	kg/hr	474.3
Hot Water Qty required per batch	kg/hr	237.2
Number of batches per day	No.s	2
Total Hot Water Required per day	Kg/day	1986.2
CIP Hot Water requirement per KL pasteurisation	Kg/KL	198.62

3.6.3 Curd Section

Table 21: Curd Section Analysis

Parameters	UOM	
Capacity	Litres	5000
Incoming Milk Temperature	ºC	3

Heating Temperature	ºC	110
Milk temperature after regeneration	ºC	86
Holding Time	Sec	5
Regeneration Efficiency	%	-
Incubation Temperature	ºC	45
Specific Steam Consumption	Kg/KL	47.71

3.6.4 Raw Milk Pre Chilling

Table 22: Raw Milk Prechilling Analysis

Parameters	UoM	
Capacity	KL	20
Incoming Raw Milk Temperature	ºC	5
Pre-Chilled Milk Temperature	ºC	3
Refrigeration requirement	TR/KL	0.66

3.6.5 Crate Washing

Table 23: Crate Washing Analysis

Description	Unit	Value
Crates washed per hour	No. / hour	2000
Hours of operation per day	hours	7
Hot Water requirement	Litre/hr	430
Hot Water temperature	ºC	70
Steam pressure	Kg/cm2 g	-
Specific Steam Consumption	kg/100 crate	1.48

3.6.6 Ice Cream Section

Table 24: Ice Cream Analysis

Description		UoM	
1	**Incoming Standardized Milk / Cream Temperature**	ºC	4
2	**Pre-heating Temperature**	ºC	55
3	**Pasteurization Temperature**	ºC	85
4	**Holding Time**	**Secongs**	25
5	**Heat requirement**	**Kcal/KL**	30000

4. ENERGY SAVING PROPOSALS

Energy Saving Proposal 1 – Install VFD for Hot Water Circulation Pump

Present System

Kozhikode Dairy Plant has installed two hot water circulation pumps from the hot water generator to various section of the plant. One pump was in operating condition and the other pump is in standby condition. The requirement for hot water finds applications in areas such as pasteurization, curd making, curd incubation room, ice cream plant, crate washing, etc. The hot water generator is briquette fired, with a manual fuel feeding system.

All the heating process in dairy is through indirect heating, wherein, all the applications do not operate continuously and is scheduled depending on the production demand. The table below shows the details of boiler installed in the plant.

Table 25: Boiler Details

Fuel Type	Design Capacity (kCal/Hr)	Make of the company	Operating Condition	Operating hrs
Briquette Fired	10,00,000	Thermax	Running	16

One of the major application of hot water is pasteurization and the curd making process where the milk is heated to 80°C and 110°C respectively. Hot water requirement in plant is shown in the below table:

Table 26: Hot Water Requirement in Plant

Point	Temperature Requirement	Application
Milk Pasteurizer – 1 (10,000 LPH)	Heating up to 74ºC – 78ºC	Through Heat exchanger converting to 90ºc hot water
Milk Pasteurizer –2 (10,000 LPH)	Heating up to 74ºC – 78ºC	Through Heat exchanger converting to 90ºc hot water
Curd Pasteurizer (5,000 LPH)	Heating up to 110ºc – 115ºc	Direct Primary hot water
Curd Incubation	Heating and maintaining temp at 44ºc	Direct Primary hot water

Ice cream mix Pasteurizer (3,000 LPH)	Heating up to 82ºC – 85ºC	Through heat exchanger converting to 90ºc hot water

The curd making process operates for significantly lesser number of hours compared to other processes. This variations results in fluctuation in circulation of hot water, resulting in the following outcomes:

- Increase in the delivery of excess amount of hot water to other processes
- Increase in operating pressure of the pump due to resulting back-pressure

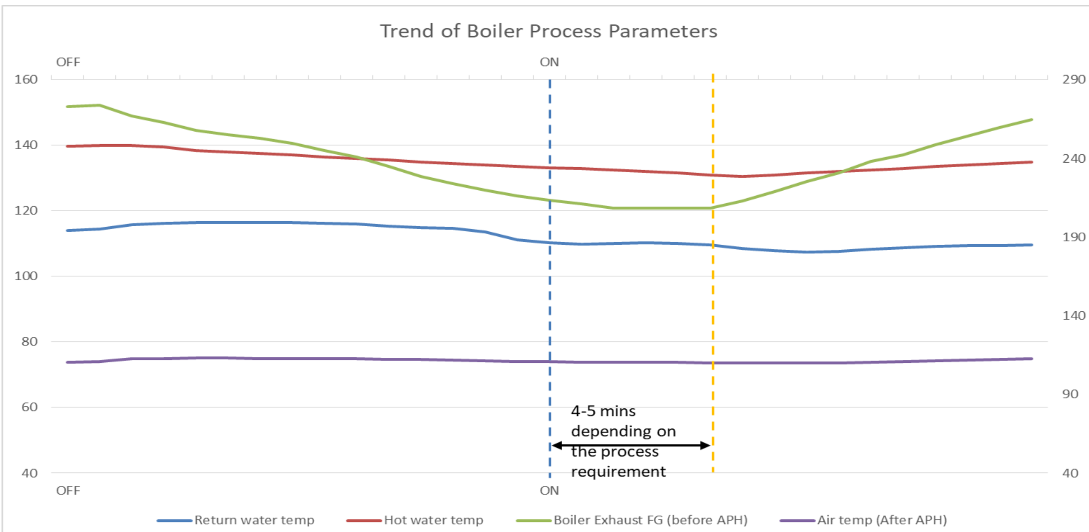


Figure 12: Trend of Boiler Process Parameters

Recommendation

It is recommended to install a VFD for the hot water circulation pump and interlock the VFD with the discharge pressure of the pump.

The VFD will operate to cater to the varying/fluctuating demand for hot water requirement in the process.

Savings

The energy saving potential by installation of VFD is **9,519 units annually**. The annual monetary saving for this project is ***Rs 0.62 Lakhs with an investment of Rs 0.88 Lakhs and payback for the project is 20 months.***

.

Detailed savings calculations are given in below table

Table 27: Savings calculation for installing VFD for HWC pump

Parameters	UOM	
Power consumed by the HWC pump	kW	10.86
% Energy savings by installing VFD	%	15
Energy saving potential	kW	1.63
Operating Hours	hrs	16
Operating Days	Days/year	365
Annual Energy Savings	kWh	9519
Monetary Savings	Rs Lakhs	0.52
Investment	Rs Lakhs	0.88
Pay Back	Months	18
NPV at 70% Debt	**Rs Lakhs**	**2.25**
IRR (%)	**%**	**81.85**
TOE Savings	**TOE**	**0.82**
TCO_2 Savings	**TCO_2**	**7.80**

Energy Saving Proposal 2 – Reduce pressure drop across APH of Hot Water Generator

Present System

Kozhikode Dairy Plant has installed a hot water generator to cater to the hot water requirements for various processes in the plant. The hot water generator is briquette fired, with a manual fuel feeding system, designed for a capacity of 10,00,000 kCal/hr.

During the course of the energy audit, pressure profiling of the flue gas path was carried out for the hot water generator. It was measured that the pressure before the Air Pre-Heater (APH) was -60 mmWC and after the APH was measured to be -175 mmWC. The pressure drop of 115 mmWC across the APH is considered to be high. Higher pressure drop results in increased ID fan power consumption.

The potential reasons for high pressure drop across the APH could be deposition of soot/ash on to the heat exchanging tubes of the APH, thereby creating additional resistance to the flow of the flue gas towards the ID fan.

Recommendation

It is recommended to carry out maintenance of the APH

Frequent and proper maintenance can reduce the pressure drop across APH, and therefore subsequently the operating pressure of the fan.

Arrest any possible leakages across the flue gas path.

Potential exists to reduce the overall pressure drop across the system by at least 50 mmWC

Energy Saving potential by reducing pressure drop is 1.30 kW.

Savings

The energy saving potential by reducing pressure drop is **1.30 kW**. The annual monetary saving for this project is ***Rs 0.42 Lakhs.***

The necessary investment for the maintenance activities is considered nil, as it is covered under regular maintenance costs for the plant.

Detailed savings calculations are given in below table

Table 28: Savings calculation for reducing pressure drop across APH

Parameters	UOM	
Pressure before APH	mmWC	-60
Pressure after APH	mmWC	-175
DP across APH	mmWC	115
Max possible reduction in DP	mmWC	50
% reduction in head	%	28.6
Power consumed by ID fan	kW	6.5
% savings by APH maintenance	%	20
kW savings	kW	1.30
Operating hrs	hrs	5840
Annual Energy Savings	kWh	7592
Unit Rate	Rs./kWh	5.5
Cost savings	Rs Lakhs	0.42
TOE Savings	**TOE**	**0.65**
TCO_2 Savings	**TCO_2**	**6.22**

Energy Saving Proposal 3 – Reduce the draft pressure maintained in Hot Water Generator

Present System

Kozhikode Dairy Plant has installed a hot water generator to cater to the hot water requirements for various processes in the plant. The hot water generator is briquette fired, with a manual fuel feeding system, designed for a capacity of 10,00,000 kCal/hr.

During the course of the energy audit, pressure profiling of the flue gas path was carried out for the hot water generator. It was measured that the pressure before the Air Pre-Heater (APH) was -60 mmWC. This is an indicative that the draft pressure maintained in the hot water generator is on the higher side.

Higher draft pressure reduces the residence time of the thermal energy from the combusted fuel. “Time” is considered to the one of the main elements for combustion of fuel. It is necessary to provide the required amount of residence time for the combusted fuel, so that the exerted thermal energy can be combusted and transferred to the water wall tubes.

Recommendation

It is recommended to install VFD for the ID fan

Interlock the VFD of the ID fan with the draft pressure of the hot water generator

Take trails at different frequencies and set optimum draft pressure as set point

Therefore, reducing the draft pressure of maintained in the hot water generator can reduce the operating pressure of the ID fan further by another 40 mmWC (in addition to the 50 mmWC as explained in the previous energy saving proposal)

Energy Saving potential by reducing pressure drop is 1.30 kW.

Savings

The energy saving potential by installing VFD for ID fan is **1.30 kW**. The annual monetary saving for this project is ***Rs 0.42 Lakhs with an investment of Rs 0.75 Lakhs and payback for the project is 21 months.***

Detailed savings calculations are given in below table

Table 29: Savings calculation for installing VFD for ID fan

Parameters	UOM	
Pressure after APH	mmWC	-175
Max Reduction of boiler draft	mmWC	40
% reduction in head		22.9
Power consumed by ID fan	kW	6.5
% savings by installing VFD		20.0%
kW savings	kW	1.30
Op hrs	hrs	5840
Unit Rate	Rs./kWh	5.5
Cost savings	Rs Lakhs	0.42
Investment	Rs Lakhs	0.75
Payback	Months	21
NPV at 70% Debt	**Rs Lakhs**	**1.77**
IRR (%)	**%**	**77.41**
TOE Savings	**TOE**	**0.82**
TCO_2 Savings	**TCO_2**	**7.80**

Energy Saving Proposal 4 – Improve combustion performance of Hot Water Generator

Present System

Kozhikode Dairy Plant has installed a hot water generator to cater to the hot water requirements for various processes in the plant. The hot water generator is briquette fired, with a manual fuel feeding system, designed for a capacity of 10,00,000 kCal/hr.

During the course of the energy audit, flue gas analysis of the flue gas path was carried out for the hot water generator. The following was observed from the flue gas analysis.

Table 30: Flue gas analysis of hot water generator

Flue Gas Analysis of Hot Water Generator	
Oxygen %	10.2
Carbon di-Oxide %	10.4
Carbon Monoxide (PPM)	2200
Heat loss due to dry flue gas %	15

The flue gas analysis indicated a higher percentage of CO, wherein the potential causes can be related to incomplete combustion of fuel, which is also a factor dependent on the larger fuel feed size being fed into the hot water generator.

Also, the higher percentage of oxygen content in the flue can potentially be attributed to various reasons such as higher draft pressure and leakages in air preheater. Therefore, the efficiency of the hot water generator is reduced.

Hence, by optimizing the combustion performance of the hot water generator, significant fuel savings can be achieved.

Recommendation

It is recommended to reduce the feed size of briquettes by crushing, thereby assisting to improve the combustion efficiency. The improvement in combustion efficiency is due to the increase in surface area of briquette available for combustion. This also helps to reduce the CO content in the flue gas.

It is also recommended to install O_2 and CO analyser at the exhaust of the flue gas analyser and continuously monitor the percentage of oxygen content in the flue gas.

It is suggested to maintain O_2 % of 4-5% and supply optimum quantity of air for combustion.

Reducing the excess air also decreasing the heat lost due to dry flue gas, thereby improving the boiler efficiency.

At least 2% improvement in efficiency can be obtained by optimizing combustion performance of the hot water generator.

Energy Saving potential by reducing pressure drop is 4.5 kg/hr.

Savings

The energy saving potential by optimizing boiler performance is **19152 kCal/hr,** which is equivalent to **4.56 kg/hr**. The annual monetary saving for this project is ***Rs 1.86 Lakhs with an investment of Rs 2.00 Lakhs*** *(for O_2 and CO analyser)* ***and payback for the project is 7 months.***

Detailed savings calculations are given in below table

Table 31: Savings calculation for optimizing boiler performance

Parameters	UOM	
O_2 %	%	10.4
CO_2 %	%	10.3
CO	ppm	2200
Improvement in boiler efficiency	%	2
Average Fuel flow rate	kg/hr	228
GCV of fuel	kCal/kg	4200
Total thermal energy utilized	kCal/hr	957600
Thermal energy saved	kCal/hr	19152
Fuel savings	kg/hr	4.56
Operating hrs	hrs	5840
Total fuel savings	kg	26630
Cost of briquettes	Rs./kg	7
Cost savings	Rs Lakhs	1.86
Investment (for O_2 analyser)	Rs Lakhs	2.00
Payback	Months	13
NPV at 70% Debt	**Rs Lakhs**	**8.51**
IRR (%)	**%**	**119.10**
TOE Savings	**TOE**	**11.18**

Energy Saving Proposal 5 – Installation of VFD for Chiller Compressor

Present System

Kozhikode Plant has installed five reciprocating chiller compressors of 33 TR high speed reciprocating compressor for the chilled water requirement and for the fan coil units at cold storage. Two compressors will be running during morning time and three compressor will run during night time to form ice on the IBT. For the refrigeration purpose vapor compression-based ammonia cycle is used. The performance of chiller compressor is shown below:

Table 32: Performance of Chiller Compressor

Parameters	UOM	
Rated size of compressor	kW	33
	TR	45
No of Compressors in operation	Nos	2
Compressor 1 Power	kW	41.60
Compressor 5 Power	kW	38.90
Suction Pressure Compressor 1	Psi	30
Suction Pressure Compressor 5	Psi	39
Discharge Pressure Compressor 1	Psi	196
Discharge Pressure Compressor 5	Psi	190
Discharge Temperature	°C	92
Condensing Temperature	°C	38
Total Operating Power	kW	80.50
Operating TR	TR	51.93
SEC	kW/TR	1.55

In a refrigeration cycle, when the compressor is run, the refrigerant starts flowing through the system i.e., the system starts it's working. The compressor continuously sucks low pressure, low temperature refrigerant vapors from the evaporator and pump these to condenser at high pressure and high temperature condition. While flowing through the condenser, the high temperature vapors release their heat to atmosphere and condense to high pressure liquid state. After condenser this high-pressure liquid enters the expansion valve where it is throttled to low pressure. On throttling the pressure and temperature of refrigerant (decreases and when this low pressure, low temperature throttled liquid flows through evaporator, it sucks heat and produce cooling. On absorbing heat in evaporator all the low-pressure liquid evaporates to low-pressure, low-temperature vapors, which are again sucked by compressor. In this way all these processes go on continuously and as long as the compressor runs, the system produces cooling around the evaporator.

During the course of study it was observed that the compressors are operating at a SEC of 1.55 kW/TR. Currently the reciprocating compressor is running continuously at full load irrespective of the load variations in the plant. The compressor is mainly used for maintaining the IBT temperature (close to 0^{o}C) and also for the Fan Coil units to maintain the temperature at cold storage. During the morning time when all the processes (mainly pasteurization and pre chilling of raw milk) are in operation the compressor is 80% to 100% loaded and consumes more power. Once the pasteurization process stops, compressor is running only to maintain the IBT temperature and also for the Fan coil units in cold storage units. During this time the total refrigeration load on the plant is less but still the compressor takes the same power as it was consuming during the peak load as there is no speed control mechanism.

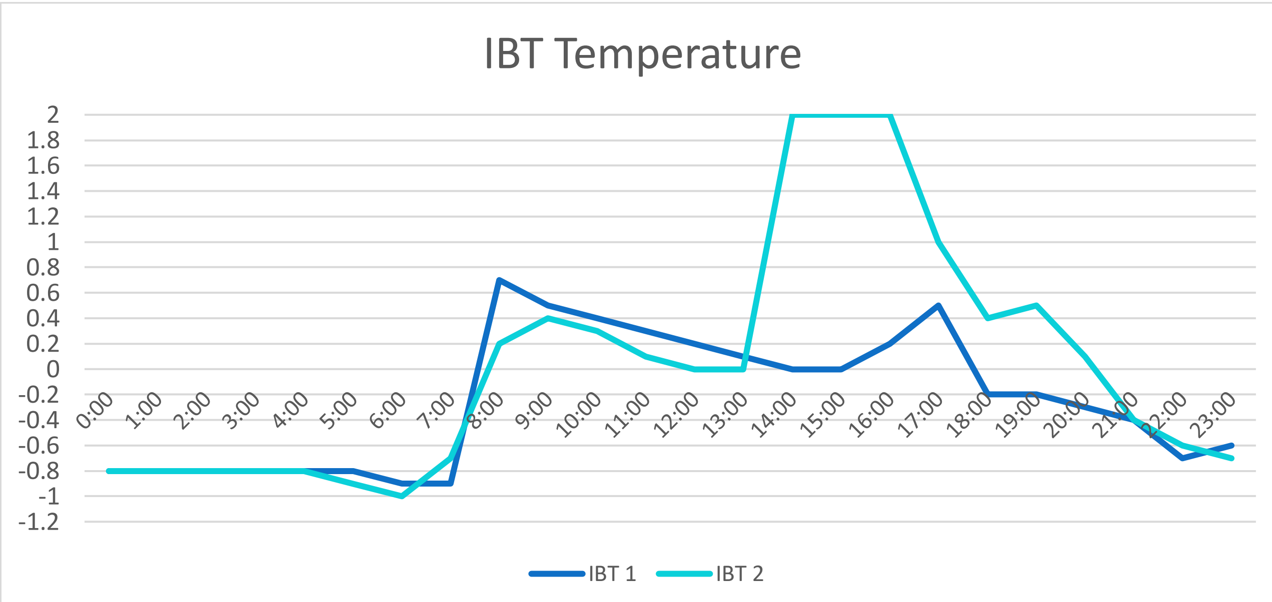


Figure 13: IBT temperature profile

figure above shows the temperature profile of IBT for a duration of 24 hrs. It is seen that at night ie from the temperature is subzero for IBT 2 and IBT 1. During this time compressor is running only maintain ice on the IBT and also for the cold store rooms. Plant is running two low speed compressor during night time without any speed control.

Total compressor power for a system is a function of its suction pressure, discharge pressure, total system load, part load controls and unloading (specifically in the case of screw compressors which do not unload linearly). A lower refrigerant temperature results in lower suction pressure and increased compressor power requirements. A lower condensing pressure, which is a function of the condenser capacity and operations, results in a lower compressor discharge pressure and less compressor power.

Once the evaporator gets wetted with the help of refrigerant and temperature is attained, if there is no speed control the compressor will do the same work to attain lower refrigerant temperature which results in lower suction pressure thereby consuming same power as it is loaded. In such cases VFD can reduce the power consumption with the help of speed control by proper feedback mechanism.

Recommendation

It is recommended to install VFD for one high speed compressor with suction pressure as the feedback. The VFD helps in smooth control of operation of the compressor and the high speed compressor can take care of the load, when suction pressure of the low speed compressor exceeds the set value. At this time, the compressor with VFD can take care of the additional demand due to increased suction.

Savings

The expected electricity savings by installation of VFD for refrigeration compressor is 25,200 units annually. The annual monetary saving for this project is ***Rs 1.38 Lakhs with an investment of Rs 2.25 lakhs and payback for the project is 19 months.***

Savings calculation is given in the below table:

Table 33: Saving calculation for VFD for chiller compressor

Parameters	UOM	
Total Compressor Power	kW	80.50
Refrigeration Load	TR	51.93
SEC	kW/TR	1.55
VFD Power Savings	%	10
Power Savings on one compressor	kW	4.2
Operating hours	hrs	6000
Energy Savings	kWh	25200
Cost Savings	Rs Lakhs	1.38
Investment	Rs Lakhs	2.25
PB	Months	19
NPV at 70% Debt	**Rs Lakhs**	**5.99**
IRR (%)	**%**	**84.28**
TOE Savings	**TOE**	**2.17**
TCO_2 Savings	**TCO_2**	**20.64**

Energy Saving Proposal 6 – Switch of Chiller Compressor 3

Present System

Kozhikode Plant has installed five reciprocating chiller compressors of 33 TR high speed reciprocating compressor for the chilled water requirement and for the fan coil units at cold storage. Two compressors will be running during morning time and three compressor will run during night time to form ice on the IBT. For the refrigeration purpose vapor compression-based ammonia cycle is used. The performance of chiller compressor is shown below:

Table 34: Performance of Chiller Compressor

	SP (PSI)	DP (PSI)	Power
Comp 1	30	196	41.8
Comp 2	41	189	38.8
Comp 5	39	190	38.9

It is observed that compressor 1 is operating at low suction and it is taking more power compared to other two compressors at the same operating condition. The possible reason for low suction can be non functioning of suction valve, maintenance related problems , blockage in pipe line etc.

Recommendation

It is recommended to switch off ammonia compressor 1 and run compressor 5 continously as it is having high suction and taking less power compared to compressor 1. Check the pipe lines and suction valve after IBT and do proper maintenance of compressor 1.

Savings

The expected electricity savings by switching off refrigeration compressor is 10950 units annually. The annual monetary saving for this project is ***Rs 0.94 Lakhs with NIL investment.***

Table 35: Savings calculation for switching of compressor

Parameters	UOM	
Compressor 1 Power	kW	41.80
Compressor 5 Power	kW	38.9
Power Savings	kW	3
Operating hours	hrs	3650
Energy Savings	kWh	10950
Cost Savings	Rs Lakhs	0.60
TOE Savings	**TOE**	**0.94**
TCO_2 Savings	**TCO_2**	**8.90**

Energy Saving Proposal 7 – Optimize the operation of Chilled Water Pumps

Present System

Kozhikode Plant has installed six chilled water pumps with one pump equipped with VFD which is an excellent initiative by the plant team. All pump are high efficient pumps with design efficiency of 65%. The table below shows the chilled water requirement users in the plant:

Table 36: Chilled water requirement users in the plant

Point	Temperature Requirement
Milk Pasteurizer – 1 (10,000 LPH)	Less than 3ºC
Milk Pasteurizer – 2 (10,000 LPH)	Less than 3ºC
Milk Pre-chiller	Less than 3 ºc
Sambharam Chiller	Less than 8ºc (incoming at 44ºc)
RC Chiller	Less than 3ºC
Ice cream mix Pasteurizer (3,000 LPH)	Less than 5ºc
Ice cream plant room FCU	Less than 20ºc (Room air conditioning)
Cup Curd Clean room AHU	Less than 20ºc (Room air conditioning)
QC lab clean room AHU	Less than 20ºc (Room air conditioning)

During normal load condition one VFD pump and one non VFD is running continuously. During peak load time ie when there is requirement of chilled water at ice cream plant one VFD and two non VFD pump will run. In the current sequencing of pumping operation, the base load is met by VFD pump and varying load met by non VFD pump in such a way that

- First VFD pump will start and it will deliver the base load by sensing the temperature and discharge pressure and it will operate at 30Hz
- After that non VFD pump also will start to meet the actual load

For a load that can be met by non VFD pump alone, in the current sequencing is met by a non VFD pump and VFD pump running together.

Recommendation

It is recommended to change the sequencing of chilled water pumping operation in a such way that:

- First non VFD pump should be started to cater the base load

- VFD pump should come in line only when the discharge head builds up ie when the load increases

Savings

The expected electricity savings by optimizing chilled water system is 5737 units annually. The annual monetary saving for this project is ***Rs 0.31 Lakhs with NIL investment.***

Table 37: Savings calculation for optimization of chilled water system

Parameters	UOM	
Pump Power with VFD	kW	2.62
Pump Power without VFD	kW	3.7
Total Power	kW	6.32
Power Savings	kW	2.62
Operating hours	hrs	2190
Energy Savings	kWh	5737
Cost Savings	Rs Lakhs	0.31
TOE Savings	**TOE**	**0.67**
TCO_2 Savings	**TCO_2**	**6.31**

Energy Saving Proposal 8 – Interlock of evaporator fans in Ice Cream Cold Storage with compressor

Present System

During the detailed energy audit at Kozhikode dairy ice cream plant was studied in detail to find the potential energy saving opportunities. 6 Cold store rooms are there in ice cream plant for the storage of products. For C1 to C4 cold storage, 6 compressors are installed with each compressor having 3 evaporator fans each. C5 and C6 cold room have 4 evaporator fan each. During the audit it was observed that for C1 to C4 cold rooms even after the compressor is getting is switched off after reaching set point, evaporator fans were running continuously which includes 4 fans CS 3A & 3B, CS 4A and C1A. Also for cold store 5 and 6 proper interlock was given for evaporator fans to get switched off after compressor reaching set point.

Recommendation

It is recommended to interlock the evaporator fans with compressor operation such that fan should automatically switch off with a time gap of 10mn after the compressor stops.

Savings

The expected electricity savings by switching off refrigeration compressor is 4785 units annually. The annual monetary saving for this project is ***Rs 0.26 Lakhs with NIL investment.***

Table 38: Savings calculation for interlocking of evaporator fans with cold room compressor

Parameters	UOM	
Total Fan Power	kW	4.37
Operating hours	hrs	1095
Energy Savings	kWh	4785
Cost Savings	Rs Lakhs	0.26
TOE Savings	**TOE**	**0.41**
TCO_2 Savings	**TCO_2**	**3.92**

Energy Saving Proposal 9 – Reduce Ice Cream Cold Store Temperature

Present System

During the detailed energy audit at Kozhikode dairy ice cream plant was studied in detail to find the potential energy saving opportunities. 6 Cold store rooms are there in ice cream plant for the storage of products. 12 Compressors are installed for ice cream cold storage with 2 water cooled and 10 Air cooled compressors. The temperature inside cold room was maintained at -27^oC to -28^oC. The compressors were given a set point of -30^oC to stop and -27^oC to start. Normal cold room temperature maintained for ice cream is -23 to -25^oC as ice cream requires a temperature of -18^oC.

Recommendation

It is recommended to change the set point of compressors in Ice cream cold compressors in steps of 2^oCsuch that

- Compressor should start on -23^oC
- Compressor should stop on -25^oC

Savings

The expected electricity savings by reducing cold room temperature is 39,936 units annually. The annual monetary saving for this project is ***Rs 2.19 Lakhs with NIL investment.***

Table 39: Savings calculation for ice cream cold store temperature

Parameters	UOM	
Total Compressor Power	kW	45.59
Percentage Power Savings	%	10
Power Savings	kW	4.55
Operating hours	hrs	8760
Energy Savings	kWh	39936
Cost Savings	Rs Lakhs	2.19
TOE Savings	**TOE**	**3.43**
TCO_2 Savings	**TCO_2**	**32.74**

Energy Saving Proposal 10 – Pre-heating of incoming Raw Milk in Curd Section

Present System

MILMA Dairy, Kozhikode plant has installed one 5KL curd pasteurizer for the preparation of curd from raw milk. The incoming milk is coming at 8°C from silo and is heated to 110°C through steps of regenerative heating and indirect heating using steam. Holding time is 9 secs before it is cooled to 45°C using cooling water from the condenser and through regenerative cooling. The milk at 45°C and stored in a tank where culture is added and then pumped for filling. The cooling water after passing through the pasteurizer is at a temperature of 45°C and the water is going to the condenser where again it is getting cooled to 26°C.

Recommendations

It is recommended to use the available heat energy in the cooling water rather than dumping in into the condenser for preheating the incoming milk coming at 9°C. This will reduce the load on condenser and also reduces the steam consumption at this section as the raw milk is coming at a higher temperature compared to earlier to the pasteurizer.

Savings

The expected fuel savings by preheating of incoming milk is 64,779 kgs annually. The annual monetary saving for this project is ***Rs 4.60 Lakhs with an investment of Rs 3.00 Lakhs and payback for the project is 8 months.***

Savings calculation is given in the below table

Table 40: Savings calculation for pre heating of incoming milk

Parameters	UOM	
Inlet Temperature of water	°C	29
Flow of available	kg/hr	7200
GCV of Briquette	kCal/kg	4250
Fuel Cost	Rs/kg	7.1
Outlet temperature of water	°C	40
Heat available	kCal/hr	79200
Percentage heat recovery	%	70
Fuel Savings	kg/hr	29.58
Running hours per day	hrs	6
Operating days	days	365
Annual Fuel Savings	kgs	64779
Monetary Savings	Rs Lakhs	4.60
Investment	Rs Lakhs	3.00
Pay Back	Months	8
NPV at 70% Debt	**Rs Lakhs**	21.93
IRR (%)	**%**	182.73
TOE Savings	**TOE**	27.21

Energy Saving Proposal 11 – Optimize the operation of 20 KL Pre-chiller for milk cooling

Present System

MILMA Dairy, Kozhikode has installed one 20 KL pre-chiller for cooling the incoming milk collected from different BMCs using tankers. The temperature of incoming milk varies between 5°C to 7°C and the milk is passed through pre-chiller irrespective of the incoming milk temperature. The graph below shows the temperature profile of Raw milk silo:

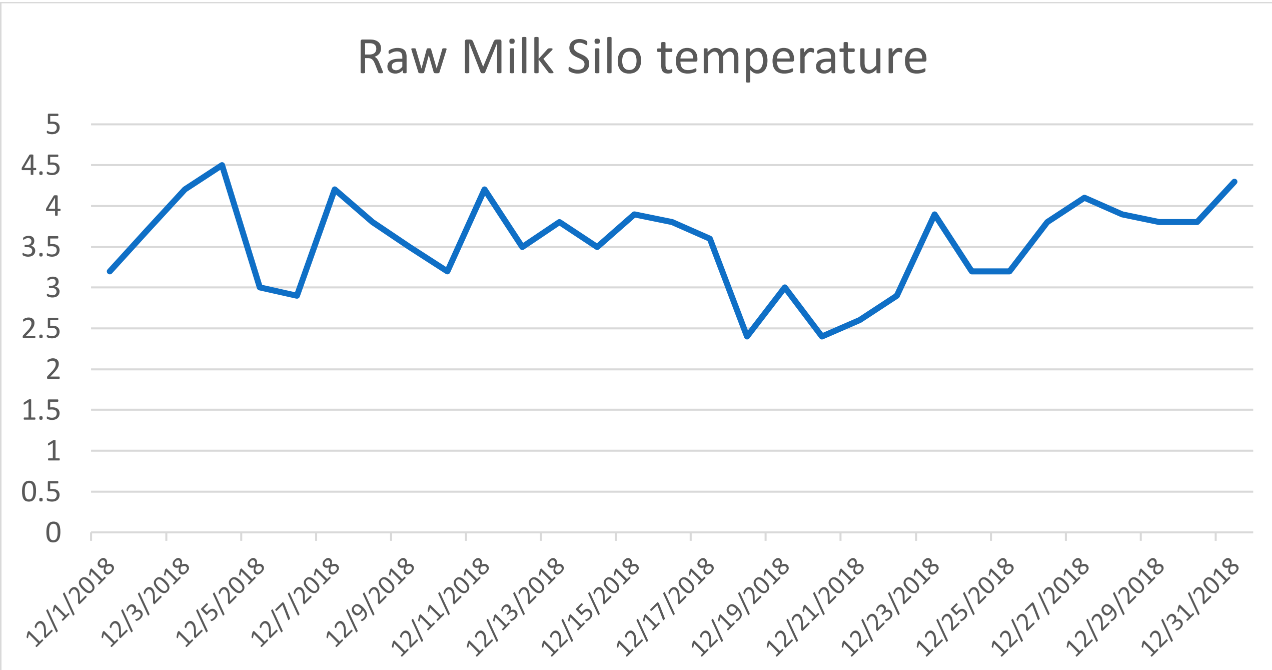


Figure 14: Temperature profile of milk in Raw milk silo

The above graph clearly shows that the temperature of Raw milk is below 4 °C most of the time. It is not required to reduce the temperature of Raw milk below 4 °C. This pre-chilling below 4 °C results in higher refrigeration load thereby increasing the power consumption of chiller.

Recommendations

It is recommended to optimize the operation of pre-chiller by installing an automatic control valve with PLC at the chilled water supply circuit. The PLC should be programmed in such a way that the valve should close when the temperature of raw milk reaches 4 °C.

Savings

The expected electricity savings by optimizing pre-chiller operation is 21,144 units annually. The annual monetary saving for this project is ***Rs 1.16 Lakhs with an investment of Rs 1.00 Lakhs and payback for the project is 11 months.***

Savings calculation is shown in below table:

Table 41: Savings calculation for optimisation of Pre-chiller operation

Parameters	UOM	
Quantity of Milk Processed	Litres	120000
Quantity of Milk Processed	kg	120000
Quantity of Milk Processed	kg/hr	9000
Incoming Milk Temperature	°C	4
Outgoing Milk Temperature	°C	3
CP of Milk	KCal/kg	0.93
Cooling Load	kCal/hr	8370
Cooling Load	TR	2.77
Power Consumption	kW	4.45
Operating hrs per day	**hrs**	**13.00**
Annual Energy Savings	kWh	21144
Savings	Rs Lakhs	1.16
Investment	Rs Lakhs	1.00
Pay Back	Months	11
NPV at 70% Debt	**Lakhs**	**5.42**
IRR (%)	**%**	**143**
TOE Savings	**TOE**	**1.82**
TCO_2 Savings	**TCO_2**	**17.33**

Energy Saving Proposal 9 – Increase the frequency of operation of Packing machine with VFD

Present Status

MILMA Dairy, Kozhikode has a total of 8 packing machines. Each machine has 2 headers that continuously produce packets of finished product. Out of the 8 machines, 3 machines are with VFD and the remaining 5 are without VFD. It was observed that the Packing machines without VFD operates more than the ones with VFD. The average Power consumption of a Packing machine with 2 headers running is 1.3 kW (with VFD) and 2.4 kW (without VFD). During the audit, only one machine with VFD was running.

Packer tag name	Remarks
AB	With VFD
CD	With VFD
EF	Without VFD
GH	Without VFD
IJ	Without VFD
KL	Without VFD
MN	With VFD
OP	Without VFD

Recommendation

It is recommended to operate Packing machine with VFD more often. Packing machines AB, CD and MN are with VFD and will operate with lesser power as compared to machine without VFD.

Savings

The expected electricity savings by frequently operating Packing machines with VFD is 4,727 units annually. The annual monetary saving for this project is ***Rs 0.26 Lakhs with Nil investment.***

Savings calculation is given in the below table:

Table 42: Savings calculation for VFD for diffuser fans

Parameters	UOM	
Power consumption of machine without VFD	kW	3.25
Power consumption of machine with VFD	kW	1.2
Power Savings on running machine with VFD	kW	2.05
Operating hours	hrs	2300
Energy Savings	kWh	4727
Cost Savings	Rs Lakhs	0.26
Investment	Rs Lakhs	Nil
PB	Months	Immediate
TOE Savings	**TOE**	**0.41**
TCO_2 Savings	**TCO_2**	**3.81**

Energy Saving Proposal 12 – Replacement of existing condenser pump with energy efficient pump

Present System

MILMA Dairy, Kozhikode has installed atmospheric condenser for ammonia refrigeration system. The compressor continuously sucks low pressure, low temperature refrigerant vapours from the evaporator and pump these to condenser at high pressure and high temperature condition. While flowing through the condenser, the high temperature vapours release their heat to atmosphere and condense to high pressure liquid state.

Water is pumped from the sump of condenser using a 11 kW pump to condenser for cooling the ammonia passing through the heat exchanger. The table below shows the details of condenser pumps performance installed in the plant.

Table 43: Pump Performance

Parameters	UOM	Pump 3	Design
Power Consumption	kW	11.70	11
Flow	m^3/hr	70	60
Head	m	19	20
Efficiency	%	37	

The design efficiency of the pump will be much higher than current operating efficiency. During the study, pump performance test was carried out to determine the efficiency of the pumps. The flow of the pump was measured using ultra sonic flow meter and head was determined to calculate the efficiency. The measured efficiency of the pump is 37 % which is lesser than the design efficiency. The reasons for low efficiency of pump is

- Poor operational practices
- Pumps operating point has been shifted away from its best operating point
    - Pump is delivering less flow at higher head which is not matching with the design parameters
- Pump is very old and undergone frequent maintenance
- Poor selection of pump

Recommendation

It is recommended to replace the old condenser water pump with energy efficient pump. The high efficient pump will consume less power than low efficiency pumps which will lead to energy saving. When a pump is installed in a system the effect can be illustrated graphically by superimposing pump and system curves. The operating point will always be where two curves intersect. Each centrifugal pump has a Best Efficiency Point (BEP) at which its operating efficiency is highest and its radial bearing loads are lowest. At or near its BEP, a pump operates most cost effectively in terms of both energy efficiency and maintenance. In practical applications, operating a pump continuously at its BEP is not likely, because pumping systems usually have changing flow rate and system head requirements and demands. Selecting a pump with a BEP that is close to the system's normal operating range can result in significant operating cost savings.

The parameters of proposed pump is given in the below table:

Table 44: Proposed pump parameters

Parameters	UOM	Proposed Pump Design
Power Consumption	kW	5.5
Flow	m^3/hr	70
Head	M	20
Efficiency	%	75

Savings

The expected electricity savings by installation of energy efficient condenser pump is 48540 units annually. The annual monetary saving for this project is ***Rs 2.67 Lakhs with an investment of Rs 1.50 lakhs and payback for the project is 7 months.***

Savings calculation is given in the below table:

Table 45: Savings calculation for EE condenser pump

Parameters	UOM	Present	Proposed Operating Condition
Power Consumption	kW	11.7	5.5
Flow	m3/hr	70	70
Head	m	19	20
Efficiency	%	37	75
Power Savings	kW	5.9	
Electricity Cost	Rs/kWh	5.5	
Annual Operating hrs	Hrs	8000	
Energy Savings	kWh	48540	
Cost Savings	Rs Lakhs	2.67	
Investment	Rs Lakhs	1.50	
Pay Back	Months	7	
NPV at 70% Debt	**Rs Lakhs**	**12.44**	
IRR (%)	**%**	**192.3**	
TOE Savings	**TOE**	**4.1**	
TCO_2 Savings	**TCO_2**	**39.80**	

Energy Saving Proposal 13 – Installation of VFD for Diffuser fans in Milk Cold Storage

Present Status

MILMA Dairy, Kozhikode has 8 diffuser fans running continuously for maintaining the temperature inside Milk cold storage. The total power consumption of these fans is 4.2 kW. Currently there is no speed control for these fans and these fans are running continuously irrespective of the temperature at cold storage. The figure shows the temperature profile of cold room for three days:

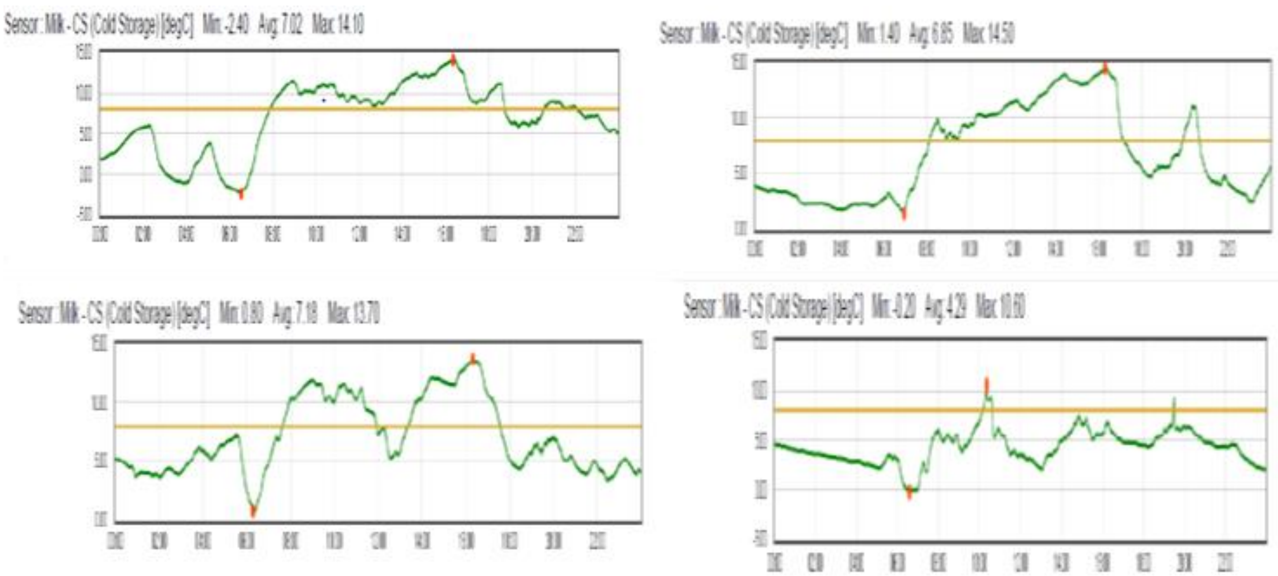


Figure 15: Milk Cold storage temperature profile

From the above graph it is clearly understood that the average temperature maintained at cold room 2 during night is 2.1 to 3ºC which very low and there is no heat ingress during night time due to opening of doors.

Recommendation

It is recommended to install VFD for 6 diffuser fans in cold room with temperature inside cold room as the feedback. Keep 3.5ºC as the cut off temperature for the VFD, if the temperature goes above this temperature the VFD will run at full speed to bring the temperature down and if temperature is below 3.5ºC the VFD will run the fan at reduced rpm.

Savings

The expected electricity savings by installation of VFD for diffuser fans 3,449 units annually. The annual monetary saving for this project is ***Rs 0.19 Lakhs with an investment of Rs 0.27 lakhs and payback for the project is 17 months.***

Savings calculation is given in the below table:

Table 46: Savings calculation for VFD for diffuser fans

Parameters	UOM	
Fan Power	kW	4.2
% Savings with VFD	%	25
Power Savings	kW	1.05
Operating hours	Hrs	3285
Energy Savings	kWh	3449.2
Cost Savings	Rs Lakhs	0.19
Investment	Rs Lakhs	0.27
PB	Months	17
NPV at 70% Debt	**Rs Lakhs**	**0.84**
IRR (%)	**%**	**94.22**
TOE Savings	**TOE**	**0.30**
TCO_2 Savings	**TCO_2**	**2.82**

Energy Saving Proposal 14 - Reduce the Generating Pressure of Identified Air Compressors

Present Status

During the audit, 2 Screw compressors were operating in the main plant and another 2 screw compressors in the Ice cream plant. These compressors cater the compressed air requirement in process and instrumentation. Pressure required is 6 kg/cm ^{2} for both main plant and the ice cream plant. Most of the machines are operating with pressure regulating valves (PRV) to match its exact pressure requirement.

The operating set points of the compressors during the course of audit were as follows:

Table 47: Operating set points for main plant and Ice cream plant compressor

Tag No	Average Pressure (Bar)	Operating kW	Suggested Pressure
Compressor 1 (Ice cream plant)	7.5	7.4	6.5
Compressor 3 (Main plant)	7.6	7.5	6.5

It was observed that the generating pressures of the compressors are in higher side and there exists a potential to reduce the generating pressure to a lower value since pressure drop in the line was not more than 0.3 bar. This will lead to significant power saving as the operating power is directly proportional to the generating pressure.

Recommendation:

It is recommended to reduce the pressure settings of the compressors in steps of 0.2 and the average final generating pressure should be as follows:

Main Plant and Ice cream plant

- Loading: 6kg/cm^2
- Unloading: 7 kg/cm^2

Savings:

The expected savings by reducing the generation pressure is 2655 units annually. The annual monetary saving for this project is ***0.14 Lakhs without any investment.***

Table 48 Savings calculation for compressor pressure reduction

Parameters	UOM	
Compressor 1 (Ice cream plant)		
Loading of Compressor	%	22
Operating Pressure	Bar	7.5
Power Consumption	kW	7.5
Percentage average pressure reduction in Ice cream plant compressor	%	11.76
Power saving in compressor	kW	0.19

Operating hrs	Hrs	2000
Annual Energy Savings	kWh	388
Compressor 3 (Main plant)		
Loading of Compressor	%	54
Operating Pressure	Bar	7.6
Power Consumption	kW	7.6
Percentage average pressure reduction in main plant compressor	%	12.79
Power saving in compressor	kW	0.52
Annual operating Hours	Hrs	4,320
Annual Energy Savings	kWh	2267
Total Annual Energy Savings (both compressors)	kWh	2655
Electricity Cost	Rs/kWh	5.5
Savings per year	Rs Lakhs	0.14
Investment	Rs Lakhs	Nil
Pay Back	Months	Immediate
TOE Savings	**TOE**	0.23
TCO_2 Savings	**TCO_2**	21.17

Energy Saving Proposal 15 - Install VFD for Main Plant Compressor to avoid unloading

Present Status

During the audit, 2 Screw compressors were operating in the main plant and another 2 screw compressors in the Ice cream plant. These compressors cater the compressed air requirement in process and instrumentation. During the detailed energy it was found that the main plant compressor 3 and Ice cream plant compressor 1 was unloading frequently.

The operating parameters of running compressors during the course of audit are as follows:

Table 49: Plant compressor loading pattern

Tag No	Loading %	Unloading %	Actual Load Power, kW	Actual Unload Power, kW
Compressor 1 (Ice cream plant)	22	78	7.5	2.7
Compressor 3 (Main plant)	54	46	7.6	2.8

The compressors have overall 78% and 46% unloading and during unload the compressors does not carry out any useful work. It consumes power to overcome its internal losses. Moreover, the unload power consumption of screw compressors is higher compared to reciprocating compressor. Generally, screw compressors are designed for 100% loading.

The unload time indicates excess capacity of the compressor. There is a good potential to optimize the capacity of the compressors. The capacity of the compressors can be optimized by installing VFD for one compressor in the interconnected loop of compressors. Capacity control of methods compressors are shown below:

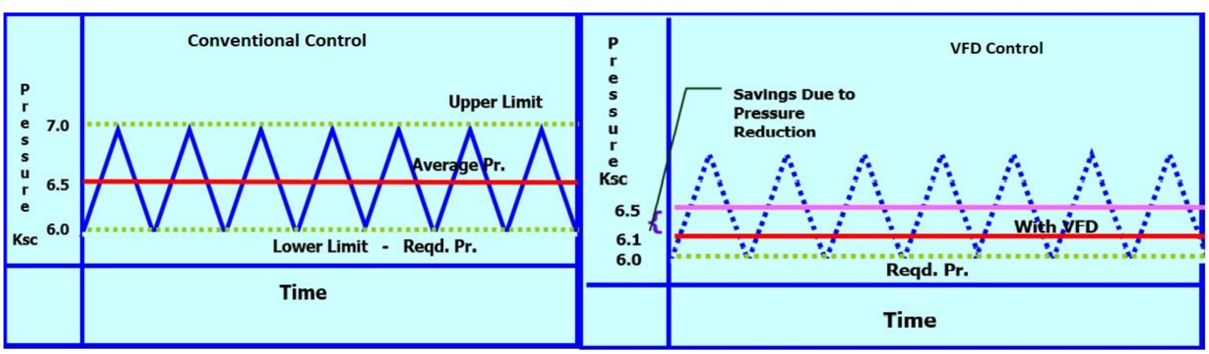


Figure 16: Capacity control of compressor

By installing VFD the average operating pressure can be set at ±0.1 bar of the required pressure.

Recommendation

It is recommended to install VFD and operate that with closed loop for all the above listed compressors to avoid the unloading of the compressors. The feedback for VFD can be given as required receiver pressure. By installing VFD the compressor can be operated in a pressure bandwidth of ±0.1 bar. Saving potential of 3.35 kW is available by means of installation of VFD in the Ice cream plant air compressor and Main plant air compressor.

Savings

The expected savings by installation of VFD in the 2 compressors is 9722 units annually. The annual monetary saving for this project is ***Rs 0.50 Lakhs with an investment of Rs 0.70 Lakhs and payback for the project is 17 months.***

Table 50: Savings calculation for VFD for air compressor

Parameters	UOM	
Compressor 1 (Ice cream plant)		
Unloading power of compressor	kW	2.7
Percentage unloading in the compressor	%	78
Power Saving	kW	2.07
Annual operating Hours	hrs	2000
Annual Energy Savings	kWh	4158
Compressor 3 (Main plant)		
Unloading power of compressor	kW	2.8
Percentage unloading in the compressor	%	46
Power Saving	kW	1.28
Annual operating Hours	hrs	4320
Annual Energy Savings	kWh	5564
Total Annual Energy Savings (both compressors)		9722
Electricity Cost	Rs/kWh	5.5
Savings per year	Rs Lakhs	0.50
Investment	Rs Lakhs	0.70
Pay Back	Months	17
NPV at 70% Debt	**Rs Lakhs**	**0.50**
IRR (%)	**%**	**0.70**
TOE Savings	**TOE**	**0.84**
TCO_2 Savings	**TCO_2**	**7.97**

Energy Saving Proposal 16 - INSTALLATION OF AC ENERGY SAVERS

Present Status

During the detailed energy audit at **MILMA Dairy, Kozhikode** Air Conditioning system was studied in detail to optimize the energy usage. It was found during the study that the plant had split AC's of 1.5 TR capacity at different locations such as admin office and site offices.

In Spit AC, compressor unit is normally controlled by relay or timer to achieve set temperature based on predefined algorithms for "hottest region". There is no close loop feedback so that compressor operation can be controlled based on ambient conditions.

Due to the standard loop in all the AC units there is a delay in compressor operation even after set temperature is achieved which results in an additional operation of AC compressor results in over cooling and thus higher SEC of AC units.

Some of the identified number of AC units with rated power consumption are as follows:

Table 51: List of AC units

Sl. No	Capacity of AC units	Power, kW	Nos.
1	1.5 TR	9.45	6

Recommendation

It is recommended to install AC energy saver to all identified ACs in the plant. The latest generation intelligent AC controller in split ACs have dual sensors which are provided in the controller and gets reference from room and coil temperature. The multiple algorithms in a" closed -loop circuit" ensure the high savings and adapts AC to ambient temperatures and climatic changes. The dual sensor can sense both room temperature and return air temperature. Always the return temperature will be 1 or 2°C more than room temperature. Normally for conventional AC only one sensor is there for sensing return air temperature. As a result, even if the room temperature is low based on the return air temperature compressor will operate and it will be in on condition for more time. But with the help of AC energy saver as it senses both room and return air temperatures, the operation of compressor can be precisely controlled and hence the running hours of compressor can be reduced.

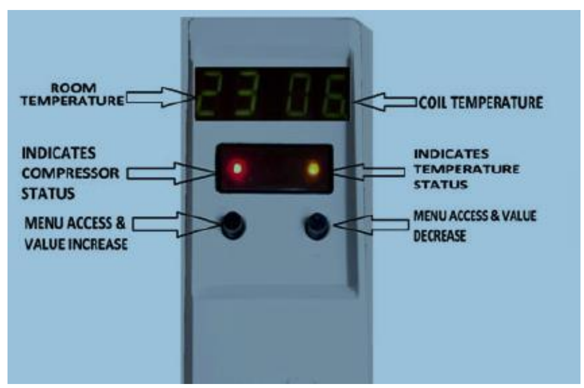


Figure 17: AC Remote controller

Savings

The expected saving after installation of AC energy saver is 4000 units annually. The annual monetary saving for this project is ***Rs 0.22 Lakhs with an investment of Rs 0.40 Lakhs and payback for the project is 22 months.***

Table 52: Saving calculation for AC Energy Saver

Parameters	UOM	
Total No of AC Units	Nos	6
Total AC units power consumption	kW	9.45
Conservative Power Saving after AC energy saver (15% Saving)	kW	1.4
Annual operating hrs	hours	2800
Annual Energy Savings	kWh	4000
Electricity Cost	Rs/kWh	5.5
Savings per year	Rs Lakhs	0.22
Investment	Rs Lakhs	0.40
Pay Back	Months	22
NPV at 70% Debt	**Rs Lakhs**	0.93
IRR (%)	**%**	76.72
TOE Savings	**TOE**	0.34
TCO_2 Savings	**TCO_2**	3.28

Energy Saving Proposal 17 – Replacement of Ceiling fans with BLDC fans

Present System

During the Detailed Energy Audit at **MILMA dairy, Kozhikode** detailed study was carried out for energy savings for replacement of conventional ceiling fans with BLDC fans. A total of 30 ceiling fans were installed in the plant.

Table 53: List of fans

Sl No.	No of Fans	Power Consumption per fan (Watts)	Total Power (kW)
1	30	75	2.25

Recommendation

It is recommended to install BLDC fans instead of conventional ceiling fans, latest technology BLDC fans which consumes only 28W. A brushless DC (BLDC) motor is a synchronous electric Motor powered by direct-current (DC) electricity and having an electronic commutation system, rather than a mechanical commutator and brushes. A BLDC motor has an external armature called the stator, and an internal armature called the rotor. The rotor can usually be a permanent magnet. Typical BLDC motor-based ceiling fan has much better efficiency and excellent constant RPM control as it operates out of fixed DC voltage. The proposed BLDC motor and the control electronics operates out of 24V DC through an SMPS having input AC which can vary from 90V to 270V. The operational block diagram of a BLDC motor is given below.

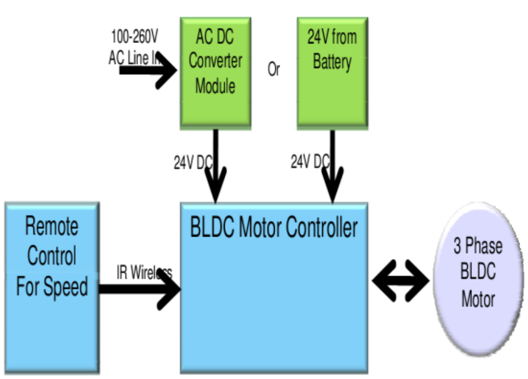


Figure 19: Schematic of BLDC fan

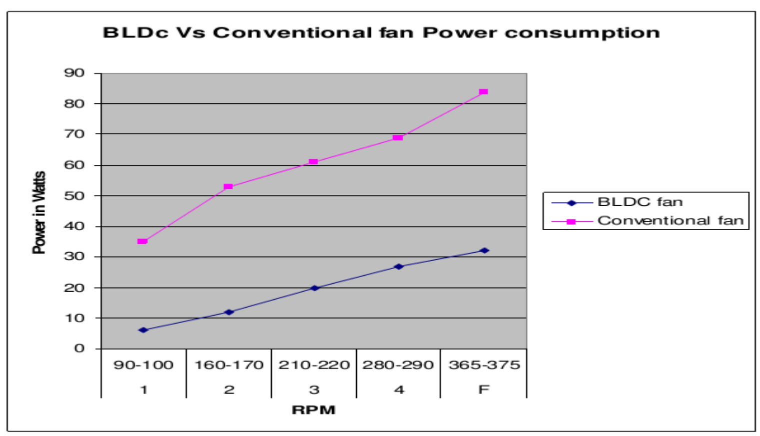


Figure 18: Comparison of normal fan vs BLDC fan

Savings

The expected savings by installation of BLDC fans is 4363 units annually. The annual monetary saving for this project is ***Rs 0.24 Lakhs with an investment of Rs 0.56 lakhs and payback for the project is 29 months.***

Detailed savings calculations are given in below table

Table 54: Calculations for BLDC Fan

Parameters	UOM	
No of Fans	Nos	30
Conventional Fan power	Watts	75
Total Power	kW	2.25
BLDC Fan Power	Watts	1050
BLDC Fan Power	kW	1.05
Savings	kW	1.2
Electricity Cost	Rs/kWh	5.5
Annual Energy Savings	kWh	4363.64
Annual Cost Savings	Rs Lakhs	0.24
Investment	Rs Lakhs	0.56
Pay Back	Months	29
NPV at 70% Debt	**Rs Lakhs**	**0.24**
IRR (%)	**%**	**0.56**
TOE Savings	**TOE**	**0.38**
TCO_2 Savings	**TCO_2**	**3.57**

Energy Saving Proposal 18 – Installation of 30 kWp Solar Roof Top

Present System

MILMA dairy, Kozhikode is purchasing electricity from grid for the operation of various equipment's in the plant. The contract demand of the plant is 750 kVA with electricity price of Rs 6.5/kWh with an average load of 550 kW.

Observation

During the course of study it was observed that plant has enough roof top area which can be utilized to install solar PV panel to harness solar energy and generate electricity.

Table 55: Site Specifications

Parameters	
Effective Rooftop available, sq. ft	3000
Location	Latitude: - 11° 17' 21" N, Longitude: - 75° 52' 47" E
Altitude above sea level, m	1
Annual in plane irradiation	5.08 kWh/m2/day

Net Metering Business Model

The net metering based rooftop solar projects facilitate the self-consumption of electricity generated by the rooftop project and allows for feeding the surplus into the grid network of the distribution by licensee. The type of ownership structure for installation of such net metering based rooftop solar systems becomes an important parameter for defining the different rooftop solar models. A rooftop photovoltaic power station, or rooftop PV system, is a photovoltaic system that has its electricity-generating solar panels mounted on the rooftop Industry building. The various components of such a system include photovoltaic modules, mounting systems, cables, solar inverters and other electrical accessories. Rooftop mounted systems are small compared to ground-mounted photovoltaic power stations with capacities in the megawatt range. A grid connected rooftop photovoltaic power station, the generated electricity can sometimes be sold to the servicing electric utility for use elsewhere in the grid. This arrangement provides payback for the investment of the installer. Many consumers from across the world are switching to this mechanism owing to the revenue yielded. A commission usually sets the rate that the utility pays for this electricity, which could be at the retail rate or the lower wholesale rate, greatly affecting solar power payback and installation demand.

Recommendation

As per the site feasibility study it was found that plant can install a 30 kWp Solar PV power plant which will generate an average of around 0.43 Lakhs electrical units annually. It is a grid connected net metering based rooftop solar system which is a new concept for MSME industries And in grid connected rooftop or small SPV system, the DC power generated from SPV panel is converted to AC power using power converter and is fed to the grid either of 33 kV/11 kV three phase lines or of 440V/220V three/single phase line depending on the local technical and legal requirements. These systems generate power during the day time which is utilized by powering captive loads and feed excess power to the grid. In case, when power generated is not sufficient, the captive loads are served by drawing power from the grid.

The net metering based rooftop solar projects facilitates the self-consumption of electricity generated by the rooftop project and allows for feeding the surplus into the network of the distribution licensee. The type of ownership structure for installation of such net metering based rooftop solar systems becomes an important parameter for defining the different rooftop solar models. In the international context, the rooftop solar projects have two distinct ownership arrangements.

Savings

The expected savings by installation of 30 kWp solar roof top is 43800 units of electricity annually. The annual monetary saving for this project is ***Rs 2.40 Lakhs with an investment of Rs 22.90 lakhs and payback for the project is 10 years.***

Detailed savings calculations is given in below table

Table 56: Savings calculation for solar roof top

Parameters	UOM	
Proposed Roof top Solar installation	kW	30
Annual units generation per kW of Solar PV	kWh per kW/year	1460
Total Energy Generation Per Annum	kWh/year	48,000
Electricity Cost	Rs/kWh	5.5
Cost Savings	Rs Lakhs	2.4
Investment	Rs Lakhs	22.9
Payback period	Years	10
NPV at 70% Debt	**Rs Lakhs**	1.68
IRR (%)	**%**	13.56
TOE Savings	**TOE**	3.77
TCO_2 Savings	**TCO_2**	35.91

5. MANAGEMENT ASPECTS AND CONCLUSIONS

THE OBJECTIVES OF KOZHIKODE DAIRY PLANT SHOULD BE

- To make energy conservation a permanent activity at the plant
- To achieve power consumption reduction possible in the unit
- To reduce the electrical and thermal energy consumption to the minimum
- To have a firm top management commitment, so that, the company achieves energy conservation on a time bound basis.
- To implement the recommended proposals and reap the maximum benefits

5.1 Approach to an Energy Conservation Idea

Each energy conservation idea should be seen as an opportunity for improvement. The approach must be on how to implement each proposal and overcome the problems, if any. It is easier to say that a proposal is not possible or not implementable, but the benefit comes from the actual implementation, which needs a lot of courage, conviction, will power and perseverance to implement.

5.2 Specific Recommendations

Kozhikode Dairy should form an energy conservation committee. The committee should consist of senior operating, electrical and maintenance personnel.

The committee should meet once in a month with a specific agenda to review the progress of implementation of proposals and to guide the implementation team. Thiruvananthapuram Dairy Main Plant should also select a senior person as energy manager and he should coordinate all the implementation activities. The main responsibility of implementing the proposals and achievement of savings should be with the concerned operating and maintenance personnel and not with the energy manager.

The immediate task of Kozhikode Dairy should be to implement the identified proposals and get the savings.

We would recommend Kozhikode Dairy to introduce a suggestion scheme for energy conservation. The energy conservation committee should review all suggestions and good proposals should be implemented. The originator for the good suggestion, which has been successfully implemented, has to be rewarded.

5.3 Assign Specific Responsibility

While the overall responsibility for energy conservation rests with the top management, the concerned plant operating, electrical & maintenance personnel should implement and report progress on energy saving proposals.

Therefore, each energy saving proposal should be assigned to a specific operating/ maintenance personnel for implementation and monitoring. The suggested format is enclosed as Annexure – B.

Specific time bound action plan is required for implementation and monitoring of energy saving proposals.

5.4 Monitoring of Proposals

All the implemented proposals are to be monitored on a proposal-by-proposal basis for actual achievement of savings on a monthly basis.

5.5 Motivational Aspects

The successful management of energy depends on motivation of technical personnel and their commitment. For this reason, Kozhikode Dairy should carry out the following motivational aspects to sustain energy conservation activities.

- Send operating, electrical and maintenance personnel for training programs in specific areas like:
  - Pumps
  - Refrigeration Compressor
  - Air Compressors
  - Motors
  - Boiler and Steam System
- Organise visits for executives to similar units to know the energy conservation / process development, etc.

5.6 Conclusions

- Kozhikode Dairy Main Plant and CII – Godrej GBC teams have jointly identified **18** energy saving proposals worth an annual saving potential of **Rs. 20.18Lakhs**. The investment required for implementation of energy saving proposals is **Rs. 36.21 Lakhs**. The total investment will have a simple payback period of **22 months.**

Table 57: Summary of savings

Details	No. of Proposals	Annual savings
Total Annual savings	18	20.18
Nil Investment Proposal	6	3.92
Investment Required (Rs. Lakhs)	12	36.21
Pay Back	Months	22

Table 58: Summary of fuel savings

Details	UOM	Annual savings
Total Electricity Savings	kWh	2,48,984
Total Fuel Savings (Briquette)	kgs	91,409
Annual TOE Savings	TOE	59.8
Annual TCO_2	$MTCO_2$	204.2

Table 59: Summary of Energy Saving Proposals

Sl. No.	ECM	Annual savings (lakhs)	Investment (lakhs)	Payback	Electricity Savings (kWh)	Fuel Savings (kg Briquette)	TOE savings	MTCO2 savings
1	Install VFD for Hot Water Circulation Pump	0.62	0.88	17	9519		0.82	7.8
2	Reduce pressure drop across APH of Hot Water Generator	0.42		0	7592		0.65	6.2
3	Reduce the draft pressure maintained in Hot Water Generator	0.42	0.75	21	7592		0.65	6.2
4	Improve combustion performance of Hot Water Generator	1.86	2	13		26630	11.18	0.0
5	Installation of VFD for Chiller Compressor	1.38	2.25	20	25200		2.17	20.7
6	Switch of Chiller Compressor 3	0.6		0	10950		0.94	9.0
7	Optimize the operation of Chilled Water Pumps	0.31		0	5737		0.49	4.7
8	Interlock of evaporator fans in Ice Cream Cold Storage with compressor	0.26		0	4785		0.41	3.9
9	Reduce Ice Cream Cold Store Temperature	2.19		0	39936		3.43	32.7
10	Pre-heating of incoming Raw Milk in Curd Section	4.6	3	8		64779	27.21	0.0
11	Optimize the operation of 20 KL Pre-chiller for milk cooling	1.16	1	10	21144		1.82	17.3

12	Replacement of existing condenser pump with energy efficient pump	2.67	1.5	7	48540		4.17	39.8
13	Installation of VFD for Diffuser fans in Milk Cold Storage	0.19	0.27	17	3449		0.30	2.8
14	Reduce the Generating Pressure of Identified Air Compressors	0.14		0	2655		0.23	2.2
15	Install VFD for Main Plant Compressor to avoid unloading	0.5	0.7	17	9722		0.84	8.0
16	Installation of AC Energy Savers	0.22	0.4	22	4000		0.34	3.3
17	Replacement of Ceiling fans with BLDC fans	0.24	0.56	28	4363		0.38	3.6
18	Installation of 30 kWp Solar Roof Top	2.4	22.9	115	43800		3.77	35.9
	Total	**20.18**	**36.21**	**22**	**248984**	**91409**	**59.8**	**204.2**

5.7 Kozhikode Dairy should

- Assign specific responsibility for implementation of proposals
- Monitor savings achieved on proposal by proposal basis
- Monitor overall auxiliary power consumption and reduction in energy consumption equipment-wise
- Have the goal of becoming the best energy efficient unit in the country

6. ANNEXURE

6.1 Common Monitorable Parameters in Dairy

Sl No.	Section	Area	Parameter	Purpose	Monitoring Method	Measurement Unit	Measurement	Reference Range	Actual Operating Value
1	BOILER - STEAM & CONDENSATE	STEAM GENERATION	Steam Pressure	For quality of steam produced	By using Pressure Gauge at MSV outlet	Kg/cm2 g	Hourly	Nearer to boiler rated pressure	
			Steam Temperature		By using Temperature Gauge at MSV outlet	Deg C	Hourly	Nearer to boiler rated temperature	
			Boiler Water TDS / Conductivity	For proper blow down	By using TDS / Conductivity sensor	ppm / microS/cm	Hourly	3200 - 3500 ppm / 4000 - 4500 uS/cm	
			Oxygen Level in Flue Gas	For proper fuel combustion	By using O2 analyzer	%	Weekly	FO/NG fired – 2.5% – 3% O2 and Briquette/Wood fired – 4% O2	
			Flue gas temperature	For proper fuel combustion	By Using Thermocouple	Deg C	Weekly	> 120 deg C & < 180 deg C for package boilers	
			Steam to Fuel Ratio / Evaporation Ratio	For estimating boiler efficiency	Kg Steam / Kg Fuel	Ratio	Weekly	Dependent on fuel: 2 - 3.5 for biomass fired boilers 4 - 7 for coal fired boilers 11 - 14 for oil /gas fired boilers	
		STEAM DISTRIBUTION	Main Steam line Traps conditions	For any trap leakage / choking	Visual	-	Weekly	Zero Tolerance	
			Main steam line valves conditions	For any gland / internal leakage	Visual / Using IR Temperature Gun	-	Weekly	Zero Tolerance	

		STEAM UTILIZATION	Specific Steam consumption at each process	For monitoring SEC values	By using Steam Flow Meters	Kg steam / KL milk	Daily	Indirect: 22 - 25 Kg steam / KL milk pasteurization Direct: 17 - 21 Kg steam / KL mil Pasteurization	
		CONDENSATE RECOVERY	Process equipment steam traps conditions	For any trap leakage / choking	Visual / Using IR Temperature Gun	-	Weekly	Zero Tolerance	
			Feed Water temperature	For better boiler operation	By Using Thermocouple	Deg C	Hourly	Above 85 deg C	
2	**REFRIGERATION SYSTEM**	**CHILLED WATER**	Chilled Water Supply Temperature	For estimating cooling load	Using IR Temperature gun / EMS	Deg C	Hourly	As per plant operations	
			Chilled Water Return Temperature	For estimating cooling load	Using IR Temperature gun / EMS	Deg C	Hourly	As per plant operations	
			Difference in Chilled Water supply & return	For estimating cooling load	Using IR Temperature gun / EMS	Deg C	Hourly	As per plant operations	
		CONDENSER WATER	Condenser Water supply Temperature	For estimating heat rejection	Using IR Temperature gun / EMS	Deg C	Hourly	As per plant operations	
			Condenser Water return Temperature	For estimating heat rejection	Using IR Temperature gun / EMS	Deg C	Hourly	As per plant operations	
			Difference in Condenser water suppy & return	For estimating heat rejection	Using IR Temperature gun / EMS	Deg C	Hourly	As per plant operations	
		COOLING TOWER	Range of Cooling Tower	For comparison of CT performance	Using IR Temperature gun / EMS	Deg C	Bi-weekly	9 - 12 deg C	
			Approach of Cooling Tower	For comparison of CT performance	Using IR Temperature gun / EMS	Deg C	Bi-weekly	3 - 4 deg C	
		REFRIGERATION COMPRESSOR	Suction Pressure	For compressor performance	Pressure Guage	Kg/cm2 g	Hourly	As per capacity of compressor	
			Discharge Pressure	For compressor performance	Pressure Guage	Kg/cm2 g	Hourly	As per capacity of compressor	

			Discharge Temperature	For compressor performance	Thermocouple	Deg C	Hourly	As per capacity of compressor	
			SEC Value	For compressor performance	Power Consumption per TR delivered	kW/Ton	Per Shift	0.8 - 0.9 kW/Ton for Screw Compressors 1.1 - 1.3 kW/Ton for Reciprocating Compressor	
		IBT and COLD ROOM	Temperature	For refrigeration compressor performance	Thermocouple	Deg C	Hourly	IBT Temperature - 0 deg C - 0.5 deg C Cold Room temperature based on product stored	
		ELECTRICAL	Electrical input to individual Compressors	For power input estimates	Using Power Analyzer / Panel / EMS	kW	Hourly	Dependent on load	
			Electrical input to individual Condenser pumps	For power input estimates	Using Power Analyzer / Panel / EMS	kW	Hourly	Dependent on load	
			Electrical input to individual Chilled Water pumps	For power input estimates	Using Power Analyzer / Panel / EMS	kW	Hourly	Dependent on load	
			Electrical input to Cooling Tower Fans	For power input estimates	Using Power Analyzer / Panel / EMS	kW	Hourly	Dependent on load	
3	**Compressed Air System**	**GENERATION**	Generation Pressure	For keeping lowest pressure possible	Using Pressure gauge at discharge line / Panel	Kg/cm2 g	Hourly	Closest possible to user requirement	
			Loading %	For proper planning of usage	From Panel / By manually noting time	%	Per Shift	7 0 - 90%	
			Unloading %	For proper planning of usage	From Panel / By manually noting time	%	Per Shift	10 - 30 %	
			Air Flow Rate	For compressor performance	From Panel	CFM	Per Shift	Dependent on demand	
			Electrical Energy input to Compressor	For compressor performance	Using Power Analyzer / Panel	kW	Per Shift	Dependent on compressor performance	

			SEC Value	For compressor performance	Power Consumption per unit Air Flow	kW/CFM	Per Shift	0.18 KW/CFM for Screw Compressors 0.14 KW/CFM for Reciprocating Compressor	
		DISTRIBUTION	Line Leakages	For immediate rectification	Visual	-	Weekly	Zero Tolerance	
			Leakage at Compressed Air Vessel Condensate line	For immediate rectification	Visual	-	Weekly	Zero Tolerance	
		UTILIZATION	Leakage at Valves	For immediate rectification	Visual	-	Weekly	Zero Tolerance	
			Leakage at AFRs	For immediate rectification	Visual	-	Weekly	Zero Tolerance	
			Leakage at equipments	For immediate rectification	Visual	-	Weekly	Zero Tolerance	
4	Process & Utility	PASTEURIZATION	Raw milk inlet temperature	For Regeneration Efficiency Calculation	Using Thermocouple / Panel	Deg C	Monthly	4 - 7 deg C	
			Temperature after pre-heating by Regeneration		Using Thermocouple / Panel	Deg C	Monthly	9 - 10 deg lesser than pasteurization T	
			Pasteurization Temperature		Using Thermocouple / Panel	Deg C	Monthly	75 - 79 deg, depending on holding time	
			Temperature after pre-cooling by Regeneration		Using Thermocouple / Panel	Deg C	Monthly	15 - 20 deg C	
			Chilled Milk Temperature		Using Thermocouple / Panel	Deg C	Monthly	3 - 4 deg C	
		MOTORS	Electrical Parameters	For Motor performance	Using Power Analyzer	kW,V, I, A, PF	Quarterly	Voltage +/-5% of rated voltage Within +/-5% of rated current Motor Loading > 80% for better efficiency range	

		PUMPS	Pressure	For Pumps performance	Using Pressure Gauges at suction and discharge	Kg/cm2	Quarterly	As per manufacturers recommendation	
			Flow Rate	For Pumps performance	Using flow meter	LPH	Quarterly	As per manufacturers recommendation	
			Power Consumption	For Pumps performance	Using Power Analyzer	kW	Quarterly	As per manufacturers recommendation	
5	**Raw Energy**	**ELECTRICAL**	Electrical Parameters	For estimating transformer loading, voltage profile, current and voltage imbalances	Using Power Analyzer	kW,V, I, A, PF, Harmonics	Monthly	Plant LT voltage should be 410 V -415 PF close to unity Transformer loading - 50% -60% VTHD < 8% at 415 V side ITHD < 15% at 415 V side	
		FUEL	Fuel Consumption / Unit Production	For estimating Thermal System Efficiency	Using Load Cells / Flow Meters	Kg/KL	Monthly	As per equipment supplier recommendation	
			Fuel Calorific Value	For estimating fuel quality	From 3rd party report	Kcal/Kg	Monthly	As per supplier specification	

6.2 Supplier Details

Sl.No	Equipment	Supplier Name	Contact Person	Contact Number	Mail Address
1	**AC Energy Saver**	Magnetron International	Mr Kishore Mansata	9748727966	indiaenergysaver@gmail.com
2	**AC Energy Saver**	Gloabtel Convergence Ltd	Mr Chirag Morakhia	9324176440	chirag@gloabtel.com
3	**Active Refrigerent Agent**	CITC	Mr Bala S Mocherla	9885293896	m.bala@citcusa.com
4	**Aluminium pipe lines**	Legris Parker	Mr. Joy Dewan	8800452020	joy.dewan@parker.com
5	**Aluminium pipe lines**	Godrej & Boyce Mfg Co. Ltd.	Mr Kiron Pande	9820348824	kcp@godrej.com
6	**APFC**	Crompton Greaves Limited.	Mr Ashok Kulkarni	9713063377	ashok.kulkarni@cgglobal.com
7	**APFC**	In phase Power	Mr Kamalakannan Elangovan	9901599953	kamal.elangovan@inphase.in
8	**APFC**	Process Technique Electronic Pvt ltd	Mr.Venkatesh	9448077736	support@processtechnique.com
9	**ATCS**	Shaw Energy Saving Solutions	Mr.Dilip Shaw	9396661892	shawenergysavingsolutions@gmail.com
10	**ATCS**	ECO GREEN SYSTEMS LLP	Mr Sachin Deshpande	8390525050	sachind@ecogreensys.com
11	**Auto Drain Valves - Level Based**	Summits Hygronics Pvt Ltd	Mr Balakannan S	9600910170	design@airdryer.in
12	**Auto Drain Valves - Level Based**	Beko Compressed Air Technologies Pvt Ltd	Mr Madhusudan Masur	040-23081106	Madhusudan.Masur@bekoindia.com
13	**Automatic voltage controller /Stabiliser**	Jindal Electric & Machinery Corp.		0161-2670250	jemc@jindalelectric.com
14	**BLDC Ceiling Fans**	Atomberg Technologies Pvt Ltd	Ms Roshni Noronha	9987366655	roshninoronha@atomberg.com
15	**BLDC Ceiling Fans**	Versa Drives	Mr Sathish	94885 94382	sathish@versadrives.com

16	**Blowers**	Vacunair Engineering Co. Pvt. Ltd.	Mr. Manan Vadher	9904048822	manan.vadher@vacunair.com
17	**Blowers**	Kay blowers	Mr Garg	011-27671851 // (Direct) 27673016	pkgarg@kayblowers.com
18	**Blowers**	Aerotech Equipments & Projects (p) Ltd.	Mr Vikas Saxena	9810162210	sales@aeppl.com
19	**Blowers**	Envirotech Engineers	Mr Sham Bagde	98235 55397	envirotech_pune@yahoo.com
20	**Boiler Consultant/Pressure Part Supplier**	Venus energy audit system	Mr.K K Partiban	98431 13111	parthi2006@hotmail.com
21	**Continous Emission Monitoring System**	Opsis Gas Monitoring Systems	Mr Kishore Kumar	94440 33220	kishor@opsis.se
22	**Continous Emission Monitoring System**	Chemtrols Industries Ltd.	Mr K Nandakumar	9821042703	nandakumar@chemtrols.co.in
23	**Chemical Free Descaling System**	Mac2Pro Engineers	Mr.Vijayan Lakshmanan	7032178655	vijayanlpr@mac2pro.in
24	**Chillers**	Johnson Controls	Mr Nanthagopalan	9900766800	nantha.gopalan@jci.com
25	**Chillers**	Trane HVAC Systems & Services	Mr. Kallol Datta		kallol_datta@trane.com
26	**Chillers**	Trane HVAC Systems & Services	Mr.Venkatesan Krishna	9963799200	K_Venkatesan@trane.com
27	**Falling Film Chiller for IBT**	Omega Ice Chill	Mr Abhishek Jindal	9990425111	abhishek.jindal@omega-icehill.in
28	**VAM**	Thermax	Mr. Navneetha	9092877626	navaneethakrishnan.R@thermaxglobal.com
29	**Compressors**	Indo Air Compressors	Mr.Kamlesh Bhavsir	9824403616	tech@indoair.com
30	**Compressors**	Kaeser Compressors I Pvt Ltd.	Mr Mohan Raaj	9840844438	mohan.raj@kaeser.com
31	**Compressors**	Ingersoll Rand	Mr Parameswaran Narayanan	080 22166198	vijay_venkatraman@irco.com
32	**Compressors**	Atlas Copco	Mr Latesh	9346280052	latesh.k@in.atlascopco.com

33	**Compressors**	ELGI Equipments	Mr Urjit Joshi	9701990930	urjitj@elgi.com
34	**Compressors**	Kaeser Compressors I Pvt Ltd.	Mr Mohan Raaj	044- 26200425/42172278	mohan.raj@kaeser.com
35	**Compressors**	Denvik Technology Private Limited	Vijay Krishna	9840851800	vijay@denvik.in
36	**Compressors**	Godrej & Boyce Mfg Co.	Mr Swapnil Patade	9819622663	spatade@godrej.com
37	**Compressors**	Kirloskar Pneumatic	Mr Avinash Prabhumirashi	9881495506	prabhu@kpcl.net
38	**Cooling Towers**	Flow Tech Air Pvt Ltd	Mr Ritwick Das	7838978768	ritwickdas@flowtechair.com
39	**Cooling Towers**	Inductokool Systems (P) Ltd	Mr Dilip Govande	9440608322	inductokool@gmail.com
40	**Cooling Tower Fills**	Brentwood	Mr Shravan Misra	9909974878	
41	**Evaporative Condenser**	BAC	Mr Saurin Dave	97270 12111	saurin@vinienterprise.com
42	**Demand Side Controller**	Godrej & Boyce Mfg Co.	Mr Swapnil Patade	9819622663	spatade@godrej.com
43	**EC Fans for AHU**	EBM Papst	Mr.Venkatesh	9551070034	venkatesh.j@in.ebmpapst.com
44	**EMS**	Elmeasure	Mr.Sagar	9963471135	venkatasagar@elmeasure.com
45	**EMS**	Device Concepts	Mr Srinivasan & Mr Ebby Thomas	9901491267; 9705072036	srigsan@yahoo.com
46	**EMS**	E-cube energy	Mr Umesh	9831012510	umesh@eetpl.in
47	**EMS**	Atandra	Ms Sangeetha Mallikarjuna	97902 26888	sangeetha.rm@atandra.in
48	**Energy Efficient Fan**	Reitz India	Mr A Sengupta	9390056162	asg@reitzindia.com
49	**Energy Efficient Fan**	Howden Solyvent (India) Private Limited	K. Krishna Kumar	7358381115	k.krishnakumar@howden.com
50	**Energy Efficient Fan**	Aerotech Equipments & Projects (p) Ltd	Mr. Vikas Saxena	9810162210	sales@aeppl.com
51	**Energy Efficient Fan**	Dustech Engineers Pvt Ltd	Mr Gagan Gupta	9811205058	
52	**Energy Efficient motors**	Kirloskar Electric Company Limited	Mr. Ashok Kshirsagar	9561091892	ashok@pna.vrkec.com

53	**Energy Efficient motors**	Siemens Limited	Mr Parameswaran	9819657247	parameswaran.td@siemens.com
54	**Energy Efficient motors**	ABB India Ltd.	Mr Madhav Vemuri	9901490985	madhav.vemuri@in.abb.com
55	**Energy Efficient motors**	Crompton Greaves Limited	Mr Ashok Kulkarni	9713063377	ashok.kulkarni@cgglobal.com
56	**Energy Efficient motors**	Bharat Bijilee Limited	Mr Saurav Mishra		Saurav.Mishra@bharatbijilee.com
57	**Energy Efficient motors**	Bharat Bijilee Limited	Mr Anil Naik	9821862782	Anil.Naik@bharatbijlee.com
58	**Energy Efficient motors**	WEG Electric	Mr. Satyajit Chattopadhyay	080-4128-2007/2008/2005	chatto@weg.net
59	**Energy Efficient motors**	Baldor Electric India Pvt Ltd	Mr Bhanudas Chaudhari	97663 42483	bchaudhari@baldor.com
60	**Energy Saving Coatings**	Espee India Pvt Ltd	Mr.pradip Vaidya	8975090551	espee@espeeindia.com
61	**Energy Saving Coatings**	Innovative Surface Coating Technologies	Mr.Pankaj Patil	9326605194	patilpankaj08@yahoo.com
62	**Flat Belts**	Elgi Ultra Industries Ltd.		(422) 2304141	info@elgiultra.com
63	**Flat Belts**	Habasit-Iakoka Pvt. Ltd		422-262 78 79	habasit.iakoka@habasit.com
64	**FRP Fans**	Encon India	Bhavesh Chauhan	9022144400	bc@encongroup.in
65	**Harmonic Filters**	Digicon Automation Pvt Ltd	Mr Sandip Shah	9978903949	sandip@digicon.in
66	**Heat Exchangers**	Alfa Laval	Mr Himanshu Sheth	9552544801	himanshu.sheth@alfalaval.com
67	**Heat Exchangers**	Alfa Laval	Ms Varsha Tambe	7774097375	varsha.tambe@alfalaval.com
68	**Heat Exchangers**	Alfa Laval	Mr D.Rama Mohan	9822373561	rammohan.d@alfalaval.com
69	**Heat Pump**	Mechworld eco	Rohit Singhi	9930301188	rohit.singhi@mechworldeco.com

70	**Heat Pump**	Thermax Ltd	Mr.Rohit Prabhakaran	9948076450	rohit.prabhakarakaran@thermaxglobal.com
71	**Insulation**	Permacel	Mr.Venkatesh Kulkarni	9892513453	vkulkarni@prs-permacel.com
72	**Insulation**	Lithopone insulation paint	Mr Rahman		rahman@choiceorg.com
73	**Insulation**	U P Twiga Fiberglass Limited	Mr Biswajit Roy	011-26460860	biswajit@twigafiber.com
74	**Insulation**	Rockwool India Pvt Ltd	Mr Kevin Pereira		kpereira@rockwoolindia.com
75	**IOT**	ITC Infotech Pvt Ltd	Mr.Uma Shankar	9900765078	Umashankar.SM@itcinfotech.com
76	**IOT**	E-cube energy	Mr.Umesh	9831012510	umesh@eetpl.in
77	**IOT**	Vermigold Eco Tech	Mr.Jaideep Saptarshi	9867300840	jd@vermigold.com
78	**LED**	OSRAM Lighting Pvt. Ltd.	Mr Nitin Saxena	+91 124 626 1300	N.saxena@osram.com
79	**LED**	Kwality Photonics Pvt. Ltd.	Mr. K. Vijay Kumar Gupta	+ 91 40 2712 3555	kwality@kwalityindia.com
80	**LED**	Havells India Ltd	Mr. Sunil Sikka	0120-4771000	sunil.sikka@havells.com
81	**LED**	Surya Roshi Ltd	Mr Sen	011-47108000/25810093-96	v.sen@ho.surya.in
82	**LED**	Reckon Green Innovations Pvt Ltd	Mr Krishna Ravi	9985333559	krishna@reckongreen.com
83	**LED**	E view Global PVt Ltd	Mr Rajiv Gupta	9757158328	rajiv@eviewglobal.com
84	**LED**	SYSKA LED	Mr. Swapnil Shinde	+91 20 40131000	
85	**LED**	Philips Lighting India Limited (ESCO model available)	Mr. Mohan Narasimhan		Mohan.Narasimhan@philips.com
86	**LED**	FortuneArt Lighting (ESCO model available)	Mr Prasad	98851 15511	arvlines@gmail.com

87	**LED**	Avni Energy Solutions Pvt Ltd (ESCO model available)	Mr Sandip Pandey	76762 06777	sales@avnienergy.com
88	**LED**	Venture Lighting	Mr Karthikeyan	+91 (44) 2262 5567 / 2262 3094 Extn-6200	karthikeyan@vlindia.com
89	**LED**	EESL	Mr Chandra Shekar	9985594441	ybchandrashekar34@gmail.com
90	**Light Pipe**	E-View Global Pvt Ltd	Mr.Rajiv Gupta	9769421112	rajiv@eviewglobal.com
91	**Light Pipe**	Sky Shade	Mr.Paresh Kumar	9394366885	paresh@skyshade.in
92	**Lighting Energy Saver/ Lighting Transformer**	BEBLEC (INDIA) PVT. LTD.			mktg@beblec.com
93	**Lighting Energy Saver/ Lighting Transformer**	Servomax India Limited	Mr Pavan	98484 62496	pavankumar@servomax.net
94	**Lighting Energy Saver/ Lighting Transformer**	Consul Neowatt Private Limited	NA	+91 44 4000 4200	sri@consulneowatt.com
95	**Low Grade WHR**	Promethean Energy Pvt. Ltd.	Mr Ashwin KP	+91 9167516848	ashwinkp@prometheanenergy.com
96	**Low Grade WHR**	Oorja Energy Engg. Services	Mr.Madhusudhan Rao	9000332828	madhu@oorja.in
97	**Online Flow Meters**	Chandak Instruments Pvt. Ltd.	Mr Rohit Chandak	9371270655 / 9860088074	rohit@chandakinstruments.com
98	**PF Boiler Combustion optimizer**	Greenbank Group	Mr Vivek Savarianandam	7880710722	v.savarianandam@greenbankgroup.com
99	**PID Loop Optimisation**	Akxa Tech Pvt Ltd	Mr.Raghu Raj	9243209569	raghuraj.rao@akxatech.com
100	**PID Loop Optimisation**	Akxa Tech Pvt Ltd	Nagesh Nayak	9320266009	nagesh.nayak@akxatech.com
101	**Pumps**	Grundfos Pumps India Pvt. Ltd.,	Ms Mahathi Parashuram	44 45966896	mahathi@grundfos.com
102	**Pumps**	Grundfos Pumps India Pvt. Ltd.,	Mr.Shankar		shankar@grundfos.com
103	**Pumps**	UT Pumps & Systems Pvt. Ltd	Mr Athul Gupta	0129-4045831	atulgupta@utpsl.in

104	**Pumps**	KSB India	Mr Arora	0120 2541091 - 93 / 2542872 (D)	rajesh.arora@ksb.com
105	**Pumps**	Kirloskar Brothers Limited	Ashish Shrivastava	20-2721 4529 Mobile : 7774049493	Ashish.Shrivastava@kbl.co.in
106	**Pumps**	CRI Pumps India Pvt. Ltd.	Mr Rajesh Magar	804227 9199	rajeshmagar.v@cripumps.com
107	**Pumps**	Shakti Pumps	Mr. Alpesh Kharachriya	7600030825	alpesh.kharachariya@shaktipumps.com
108	**Pumps**	Crompton Greaves	Mr. Vaibhav Jain	9654125359	vaibhav.jain@cgglobal.com
109	**Pumps**	Sulzer Pumps India Ltd	Mr Arvind singh	9971152020	arvind.singh@sulzer.com
110	**Servo voltage Stabiliser**	Globe Rectifiers	Mr Manoj Singh	9818222380	gr@globerectifiers.com
111	**Servo voltage Stabiliser**	Servomax India Pvt Ltd	Mr Pavan	98484 62496	pavankumar@servomax.net
112	**Solar**	Megawatt Solutions Pvt Ltd	Mr.Arjun Deshwal	9205476722	adeshwal@megawattsolutions.in
113	**Solar**	Megawatt Solutions Pvt Ltd	Mr.Siddharth Malik		smalik@megawattsolutions.in
114	**Solar**	Ohms Energy Private Limited	Mr Dhawal Kapoor	9987788335	dhawal.kapoor@ohmsenergy.com
115	**Solar**	Energy Guru®, SharperSun	Ms. Geetanjali Patil Choori	9970319054	uchoori@energy-guru.com
116	**Solar**	Tangent Technologies	Mr. Anurag Gupta	0265-2291264/ 2291568	anurag.gupta@tangent.in
117	**Solar BOOT Model**	Amplus Solar	Ms Ritu Lal	NA	ritu.lal@amplussolar.com
118	**Solar BOOT Model**	Cleanmax	Mr Pritesh Lodha	9920202803	pritesh.lodha@cleanmaxsolar.com
119	**Solar BOOT Model**	Jakson Power	Mr Vaibhav Singhal	9412227430	vaibhav.singhal@jakson.com

120	**Solar BOOT Model**	Think Energy partners	Mr.Kunal	9560004324	kunal.pragati@thinkenergypartners.com
121	**STP**	DCS Techno services	Mr.Madhu Babu	9676939103	madhu@dcstechno.com
122	**Boiler & Steam Systems**	Thermax Ltd	Mr Ashish Vaishnav	8552822277	ashish.vaishnav@thermaxglobal.com
123	**Boiler & Steam Systems**	Forbes Marshall Pvt. Ltd.	Mr Thomas	9895041210	dkuvalekar@forbesmarshall.com
124	**Transvector Nozzle**	General Imsubs P. Ltd	Mr Kaushalraj	9327030174	air@giplindia.com
125	**Turbines**	Arani Power Systems Limited	Mr K Ch Peraiah	040 23040854	peraiahkch@aranipower.com
126	**Turbo Blowers**	Aerzen India	Mr Shailesh Kaulgud		shailesh.kaulgud@aerzenindia
127	**Vaccum Pumps**	Kakati Karshak Industries	Mr.Srikanth	9701863246	srikanth.chepyala@kakatipumps.com
128	**Vaccum Pumps**	Atlas Copco	Mr Vigneswaran	8975090551	n.vigneswaran@in.atlascopco.com
129	**VAM**	Transparent Energy Systems Pvt. Ltd	Mr Ajit Apte	020 24211347	ajit.apte@tespl.com
130	**VFD**	Yaskawa	Mr Sree Kumar	9573770123	sreekumar_n@yaskawa.in
131	**VFD**	Danfoss	Mr Nagahari Krishna	9500065867	Nagahari@danfoss.com
132	**VFD**	Siemens	Mr Shanti Swaroop	9000988322	santhiswaroop.m@siemens.com
133	**VFD**	Schneider Electric India Pvt. Ltd.	Mr Amresh Deshpande	0124 - 3940400	Amresh.Deshpande@schneider-electric.com
134	**VFD**	Rockwell Automation India Pvt. Ltd. (Allen-Bradley India Ltd.)	Ms Ruchi Mathur	9711991447	rmathur@ra.rockwell.com
135	**VFD**	ABB Ltd	Mr Madhav Vemuri		madhav.vemuri@in.abb.com
136	**Bio Gas**	FOV Bio Gas	Mr Joseph	9940159968	joseph@nordcleantech.com

FORMAT FOR MONITORING THE IMPLEMENTATION OF ENERGY SAVING PROPOSALS

Sl. No.	ECM	Annual savings (lakhs)	Investment (lakhs)	Payback	Person Responsible	Target Date	Remarks
1	Install VFD for Hot Water Circulation Pump	0.62	0.88				
2	Reduce pressure drop across APH of Hot Water Generator	0.42					
3	Reduce the draft pressure maintained in Hot Water Generator	0.42	0.75				
4	Improve combustion performance of Hot Water Generator	1.86	2				
5	Installation of VFD for Chiller Compressor	1.38	2.25				
6	Switch of Chiller Compressor 3	0.6					
7	Optimize the operation of Chilled Water Pumps	0.31					
8	Interlock of evaporator fans in Ice Cream Cold Storage with compressor	0.26					
9	Reduce Ice Cream Cold Store Temperature	2.19					
10	Pre-heating of incoming Raw Milk in Curd Section	4.6	3				
11	Optimize the operation of 20 KL Pre-chiller for milk cooling	1.16	1				
12	Replacement of existing condenser pump with energy efficient pump	2.67	1.5				
13	Installation of VFD for Diffuser fans in Milk Cold Storage	0.19	0.27				
14	Reduce the Generating Pressure of Identified Air Compressors	0.14					
15	Install VFD for Main Plant Compressor to avoid unloading	0.5	0.7				
16	Installation of AC Energy Savers	0.22	0.4				
17	Replacement of Ceiling fans with BLDC fans	0.24	0.56				
18	Installation of 30 kWp Solar Roof Top	2.4	22.9				
	Total	**20.18**	**36.21**				

138	**Refrigeration Compressor**	Frick India	Mr T Krishnamoorthy	9444818846	ttk@frickmail.com

6.3 ESP Implementation Format

6.4 List of Energy Audit Equipment

Sl No.	Description	Purpose	Serial No
1	Power Analyzer	Power Measurement	ALM 10 - Krykard
2	Flue Gas Analyzer	Flue Gas Analysis	Optima 7
3	Hygrometer	Cooling Tower DBT, WBT	HD 500
4	Water Flow Meter	Flow Measurement	Precision Flow 190 PD
5	Pyrometer	Temperature Profiling	Fluke 62

6.5 Format for maintaining records

Motor rewinding records

Sr. No	Motor No.	Purchased/Installed Date	Design Eff.	Rated Output (kW)	Rewinding 1 Date	Rewinding 2 Date	Rewinding 3 Date	Rewinding 4 Date

Energy Monitoring

Sr. No	Date	Shift	Energy Consumption (kWh)	Fuel Consumption (Litres)	Production (kg)	KPI	Benchmark	Remarks

Water Consumption

Sr. No	Date	Shift	Water Consumption (litres)	Production (kg)	KPI	Benchmark	Remarks