February 2019

DETAILED ENERGY AUDIT REPORT

M/S MILMA, WAYANAD DAIRY
– Kerala Dairy Cluster

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

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Prepared by

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Bureau of Energy Efficiency, 2019

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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
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

Confederation of Indian Industry (CII) would like to express its sincere thanks to United Nations Industrial Development Organization (UNIDO), Global Environment Facility (GEF) and Bureau of Energy Efficiency (BEE) for the role played by them in guiding and steering this prominent assignment - “Promoting energy efficiency and renewable energy in selected MSME clusters in India”.

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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

Kerala Co-operative Milk Marketing Federation (KCMMF) was formed in 1980 as a state adjunct of the National Dairy Programme 'Operation Flood'. It is a three-tiered organization. At the grassroots level MILMA has 3206 Anand model primary milk co-operative societies as on 31.03.2015 with 9.24 lakh local milk producing farmers as members.

Wayanad Dairy is located at Kalpetta Ditrct of Wayanad with a processing capacity of 1 Lakh LPD. The dairy manufactures various products like curd, ghee, peda, paneer, palada etc.

Table 1: Unit Details

Particulars	Details
Name of Plant	MRCMPU Ltd, Wayanad Dairy
Name(s) of the Plant Head	S. Radhakrishnan (Dairy Manager)
Contact person	Thomas VJ
Constitution	Cooperative Society
MSME Classification	Medium Scale
Address:	MRCMPU Ltd, Wayanad Dairy, Chuzhali, Kalpetta P.O, Wayanad
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.

- Installation of Condensate Recovery System
- Installation of Solar Thermal
- Installation of Desuperheater
- Optimized Voltage at Main Incomer
- Maintaining PF close to unity
- Use of Briquette Fired Boiler
- Use of Screw Air Compressors
- Use of hot water for curd incubator
- Use of turbo-ventilators
- Proper installation of trap at main steam line

CII – Godrej GBC Energy Audit Team conducted Detailed Energy Audit at MILMA Dairy, Wayanad from 14th January 2019 to 18th January 2019 and final presentation to plant team was given on 18th January 2019.

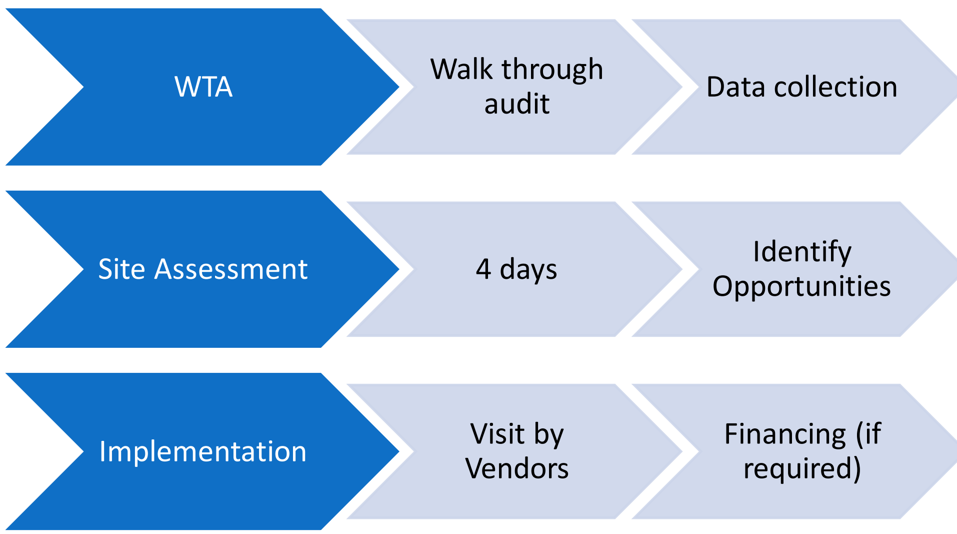
The energy audit included detailed data collection, power measurements of major electrical energy consumers, process measurements, analysis of data, and performance analysis of the equipment and identification of specific energy saving proposals.

Electricity energy for the plant is purchased from Kerala State Electricity Board. For thermal energy, plant is using Briquette and Firewood as 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

MILMA Dairy, Wayanad plant team and CII energy team have together identified an annual energy saving potential of Rs. 17.63 Lakhs with an investment of Rs 40.48 Lakhs based on energy cost.

Table 2: Summary of savings

Details	No. of Proposals	Annual savings
Total Annual savings	15	17.63
Nil Investment Proposal	1	0.20
Investment Required (Rs. Lakhs)	14	40.48
Pay Back	Months	28

Table 3: Summary of fuel savings

Details	UOM	Annual savings
Total Electricity Savings	kWh	1,60,446
Total Fuel Savings (Briquette+ Fire Wood)	kgs	2,21,676
Annual TOE Savings	TOE	83.6
Annual $MTCO_2$	TCO_2	131.60

Table 4: Summary of Energy Saving Proposals

Sl. No.	ECM	Annual savings (lakhs)	Investment (lakhs)	Payback	Electricity Savings (kWh)	Fuel Savings (kg Briquette & Firewood)	TOE savings	MTCO2 savings
1	Installation of Automatic Pumping Trap for Curd and CIP Section	1.08	2.4	27		32466	10.2	
2	Installation of Pressured Power Pumping Unit for efficient Condensate Recovery	2.61	3	14		78288	24.6	
3	Segregation of hot water sources	1.79	2	13		53615	16.8	0.0
4	Installation of VFD for FD and ID Fan of boiler	0.80	0.85	13	15266		1.31	12.5
5	Pre heating of incoming Raw Milk in Curd Section	3.19	3	11		57307	18.0	0.0
6	Optimize the operation of 20KL Prechiller for milk cooling	0.83	1	14	14750		1.27	12.1
7	Replacement of existing condenser pump 3 with energy efficient pump	0.90	0.65	9	15975		1.37	13.1
8	Installation of VFD for Chiller Compressor	1.55	2.25	17	27600		2.37	22.6
9	Installation of VFD for Diffuser fans in New Cold Room	0.22	0.25	14	3960		0.34	3.2
10	Reduce the Generating Pressure of Main Plant Compressor	0.2		0	3481		0.30	2.9
11	Install VFD for Main Plant Compressor to avoid unloading	1.03	0.9	10	18247		1.57	15.0
12	Replace Identified Motors with Energy Efficient Motors	0.25	0.65	31	4424		0.38	3.6
13	Replacement of existing T12 lamps with LED tube light	0.18	0.26	17	3499		0.30	2.9

14	Installation of AC Energy Saver for split AC	0.29	0.4	17	5244		0.45	4.3
15	Installation of 30 kWp Solar Roof Top PV	2.71	22.87	101	48000		4.13	39.4
	Total	**17.63**	**40.48**	**28**	**1,60,446**	**2,21,676**	**83.6**	**131**

2. INTRODUCTION ABOUT MILMA Dairy, Wayanad

2.1 Unit Profile

Kerala Co-operative Milk Marketing Federation (KCMMF) was formed in 1980 as a state adjunct of the National Dairy Programme 'Operation Flood'. It is a three-tiered organization. At the grassroots level MILMA has 3206 Anand model primary milk co-operative societies as on 31.03.2015 with 9.24 lakh local milk producing farmers as members.

Wayanad Dairy is managed by MRCMPU region and is located at Kalpetta, Wayanad. The plant is having design processing capacity of 1 Lakh litres per day. The dairy also manufactures various products like are Liquid milk, Ghee, Curd, Butter, Paneer, Butter milk, Peda, Palada, Milky Jack and Burfi.

Table 5: Unit Profile

Particulars	Details
Name of Plant	MRCMPU Ltd, Wayanad Dairy
Name(s) of the Plant Head	S. Radhakrishnan
Contact person	Thomas VJ
Contact Mail Id	wyddairy@malabarmilma.coop, wyd.eng@malabarmilma.coop
Contact No	9947791812
Constitution	Co-operative society
MSME Classification	Medium
No. of years in operation	10
No of operating hrs/day	Processing & Packing 16 Hrs & Refrigeraton &auxillaries 24Hrs/Day
No of operating days/year	365
Address:	MRCMPU Ltd, Wayanad Dairy, Chuzhali, Kalpetta P.O, Wayanad
Industry-sector	Dairy
Type of Products manufactured	Milk and milk products

2.2 Production Details

The various products manufactured in MILMA Dairy, Wayanad are Liquid milk, Ghee, Curd, Butter, Paneer, Butter milk, Peda, Palada, Milky Jack and Burfi. The graph below shows the milk processed during last one year:

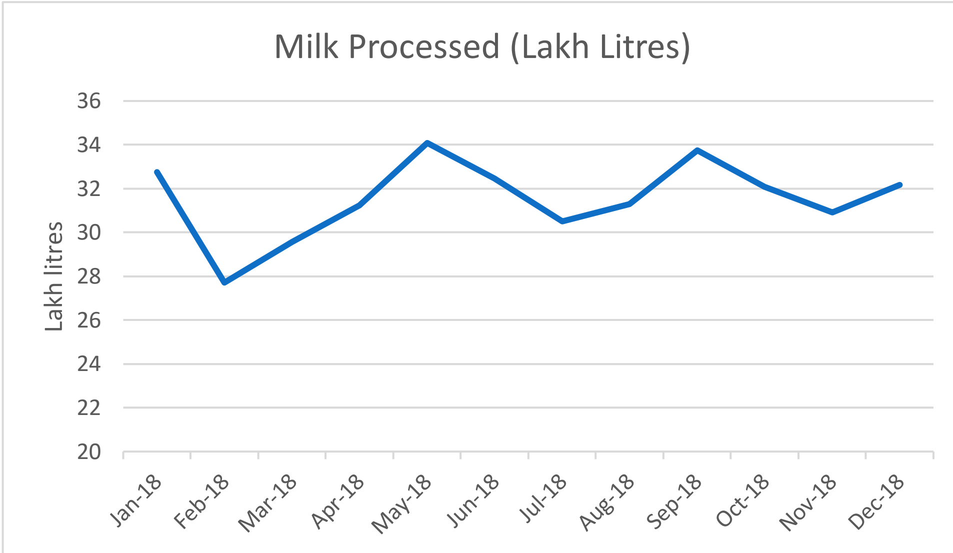


Figure 1: Milk Processed

2.3 Dairy Process Flow Diagram

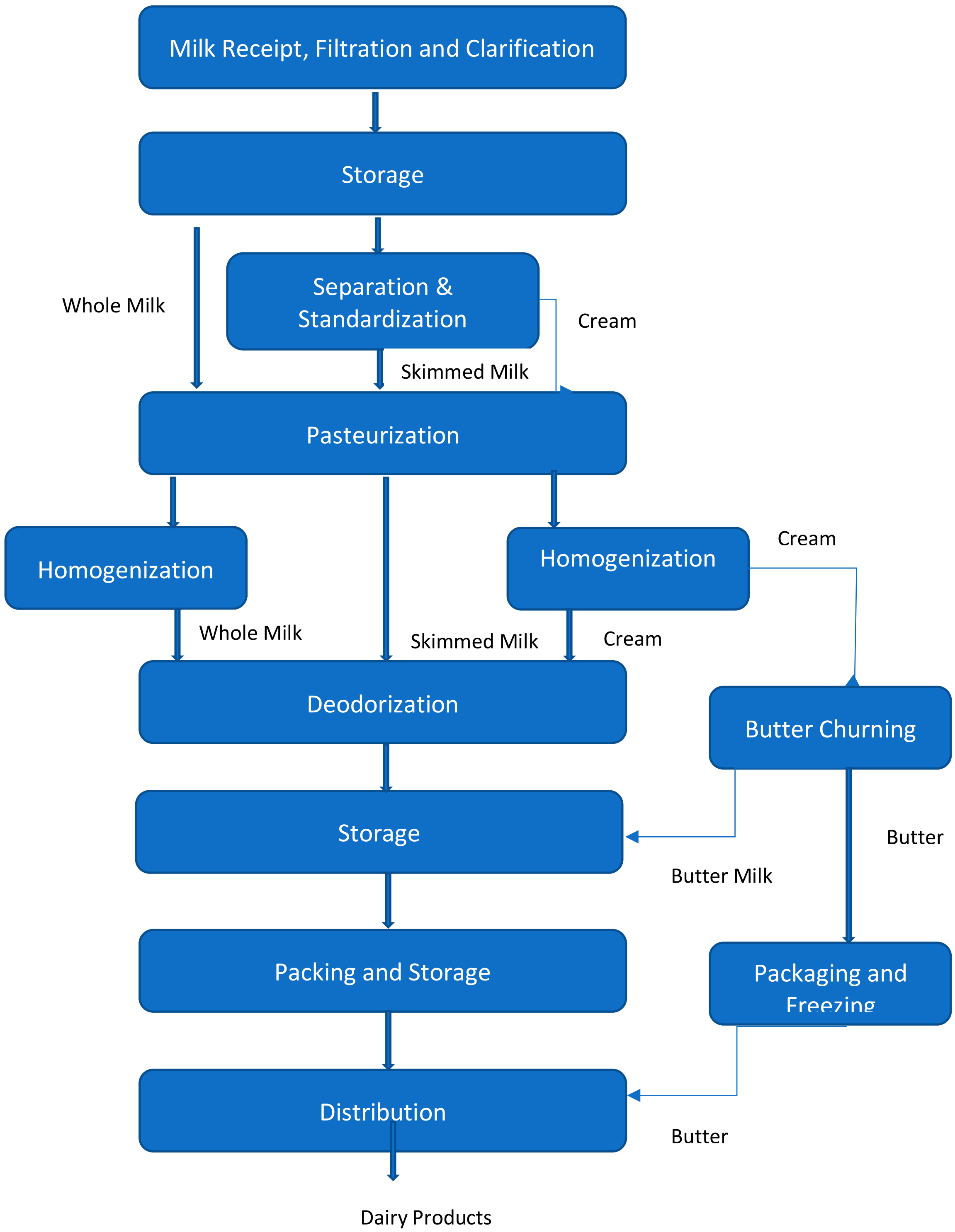


Figure 2: Typical process flow of Milk manufacturing

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 76°C for 16 seconds then quickly cooling it to 4°. This process slows spoilage caused by microbial growth in the food. Unlike sterilization, pasteurization is not intended to kill all micro-organisms in the food. Instead, it aims to reduce the number of viable pathogens so they are unlikely to cause disease.

Homogenization (if required): Milk must then be homogenized. Without homogenization, the milk fat would separate from the milk and rise to the top. Milk fat is what gives milk its rich and creamy taste. Homogenization makes sure that the fat is spread out evenly in the milk so that every sip of milk has the same delicious flavour 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 re-joining. 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	1.1
2	Milk Packaging in Poly Pouches	Lakh Litres per Day	1
3	Ghee Manufacturing and Packaging	MT/day	1.5
4	Curd	MT/day	15
5	Butter	Kg/day	500
6	Paneer	Kg/day	250
7	Sipup/Lolly	KL/day	1.5

8	Butter Milk	KL/day	1.4
9	Kattimoru	KL/day	1
10	Peda	Kg/day	260
11	Palada	Kg/day	70
12	Milky Jack	Kg/day	22
13	Burfi	Kg/day	12

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	Briquette	Rs./kg	6.75	4000
3	Firewood	Rs./Kg	2.74	3000
4	HSD	Rs./L	72	10800
5	Weighted Avg (Briquette + Firewood)	Rs/kg	3.34	3151

The table below shows the monthly consumption of various fuel used in the plant during the last one year. Briquette and Firewood 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 450 kVA.

Table 8: Fuel Consumption Details 2016-17

Month	Electricity Consumption (kWH)	Fuel Consumption - Briquette (kgs)	Fuel Consumption - Wood (kgs)	Fuel Consumption Fuel- HSD (litre)
Apr-16	1,79,604	6,500	1,69,566	1400
May-16	1,69,266	7,093	1,71,901	2775
Jun-16	1,53,240	5,698	1,57,887	1930
Jul-16	1,63,110	8,909	1,75,554	2700
Aug-16	1,79,604	21,364	1,85,124	905
Sep-16	1,74,534	26,437	1,85,484	1570
Oct-16	1,77,720	14,470	1,69,033	1655
Nov-16	1,54,914	10,142	1,46,827	410
Dec-16	1,73,184	18,266	1,55,784	740
Jan-17	1,60,392	19,241	1,71,187	575
Feb -17	1,61,148	14,239	1,52,242	1095
Total	**18,46,716**	**1,52,359**	**18,40,589**	**15,755**

Table 9: Fuel Consumption Details 2018

Month	Electricity Consumption (kWH)	Fuel Consumption - Briquette (kgs)	Fuel Consumption - Wood(kgs)	Fuel Consumption Fuel- HSD (litre)
Jan-18	1,64,901	39,986	1,15,167	1,262
Feb-18	1,43,490	28,972	1,08,649	3,245
Mar-18	1,55,832	28,981	1,40,223	3,960
Apr-18	1,61,958	31,831	1,37,466	4,930
May-18	1,49,010	49,068	1,43,784	6,750

Jun-18	1,50,708	43,705	1,39,659	3,460
Jul-18	1,62,405	38,897	1,42,782	2,410
Aug-18	1,41,474	40,497	1,49,718	10,910
Sep-18	1,70,511	44,525	1,43,065	2,690
Oct-18	1,66,188	48,298	1,62,660	3,960
Nov-18	1,68,816	37,944	1,64,439	2,130
Dec-18	1,62,780	32,727	1,66,313	3,020
Total	**18,98,073**	**4,65,431**	**17,13,925**	**48,727**

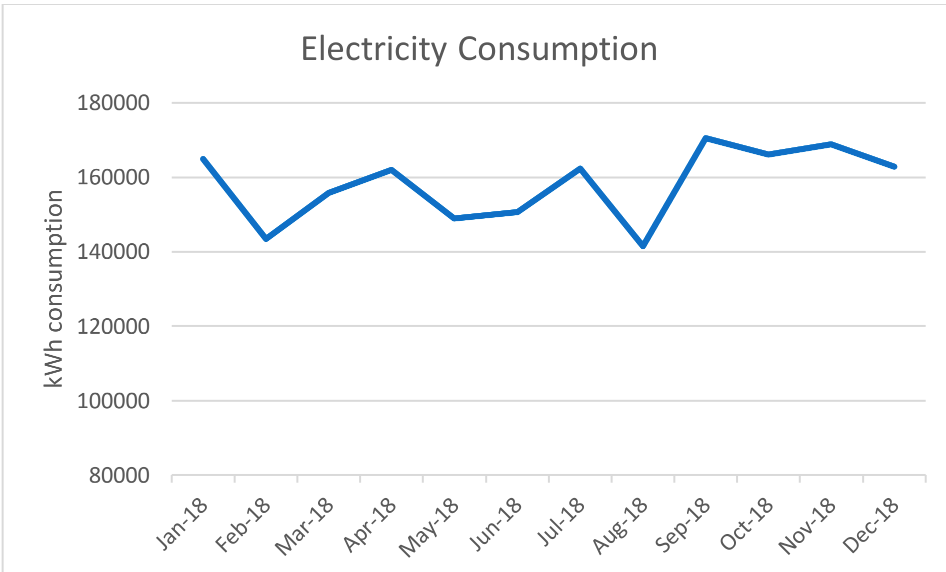


Figure 4 :Electricity consumption profile

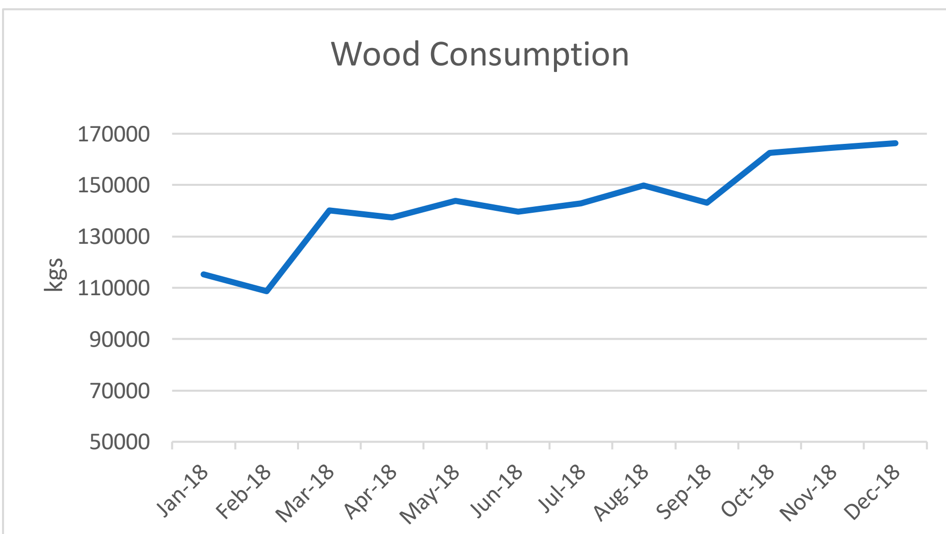


Figure 3: Wood consumption profile

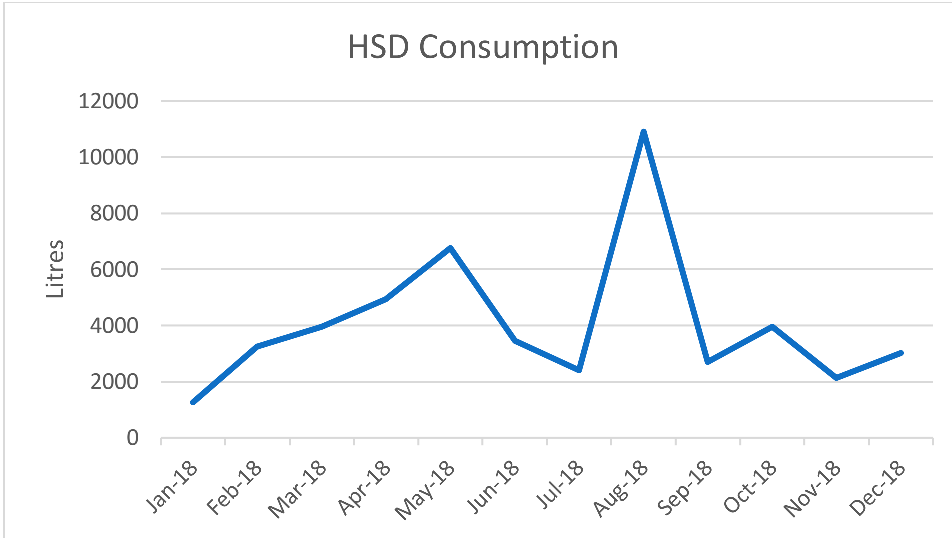


Figure 5: HSD consumption profile

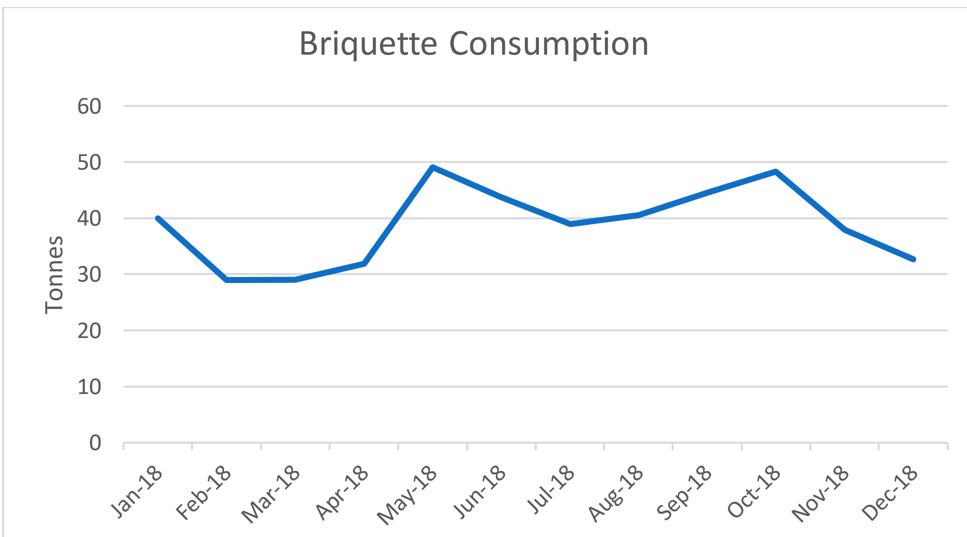


Figure 6: Briquette consumption profile

The energy consumption breakup of the plant both thermal and electrical is shown in the below table. Total energy consumption of the plant is 909 MTOE out of which 82% of the total energy is contributed by thermal and rest only 18% is contributed by electricity.

Table 10: Energy consumption breakup of plant

Sl No	Particulars	UOM	Value
1	Annual Electricity Consumption	kWh	18,98,073
2	Annual Electrical Energy Consumption	Kcal	1,63,23,42,780
3	Annual Electricity Consumption	MTOE	163.23
4	Annual Diesel Consumption	L	41,418

5	Annual Diesel Energy Consumption	kcal	45,01,17,027
6	Annual Diesel Consumption	MTOE	45.01
7	Annual Firewood Consumption	kg	17,13,925
8	Annual Firewood Energy Consumption	kCal	5,14,17,75,000
9	Annual Firewood Consumption	MTOE	514.18
10	Annual Briquette Consumption	kg	4,65,431
11	Annual Briquette Energy Consumption	kcal	1,86,17,24,000
12	Annual Briquette Consumption	MTOE	186.17
13	Total Energy Consumption	kcal	9,08,59,58,807
14	Total Energy Consumption	MTOE	909

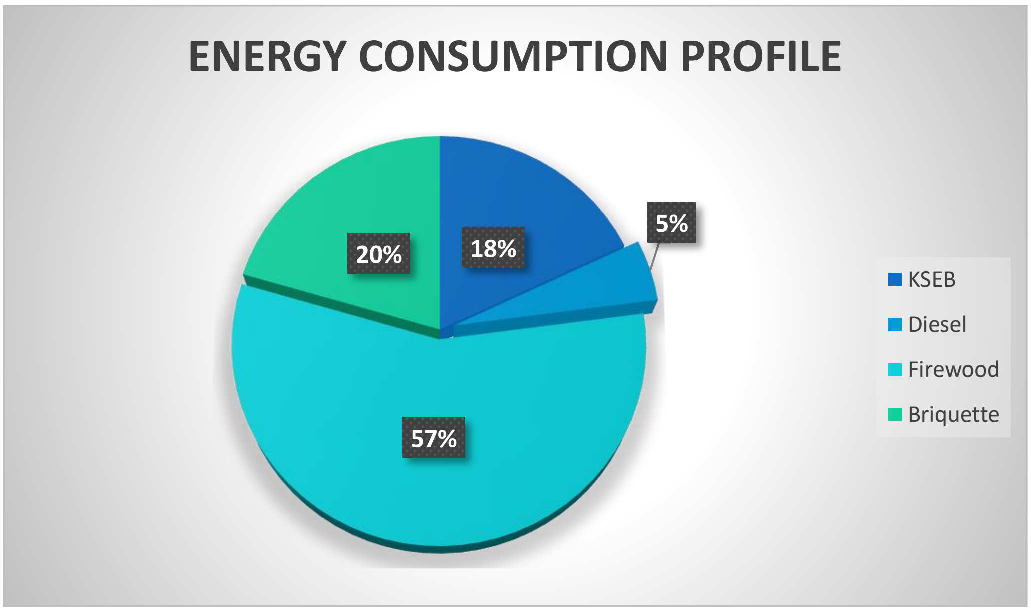


Figure 7: Energy Profile

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 8.80 Lakhs/month whereas the average thermal energy cost is Rs 9.50 Lakhs/month.

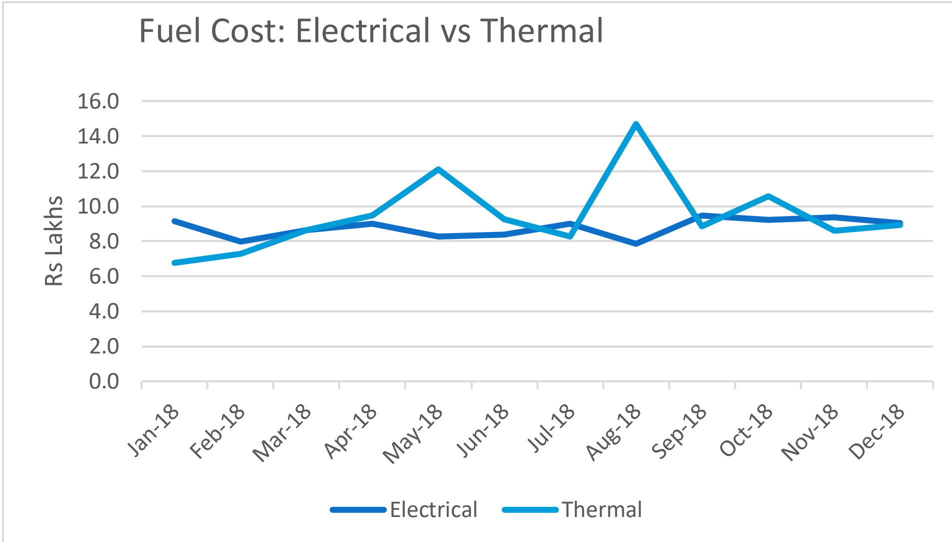


Figure 8: Variation of fuel cost

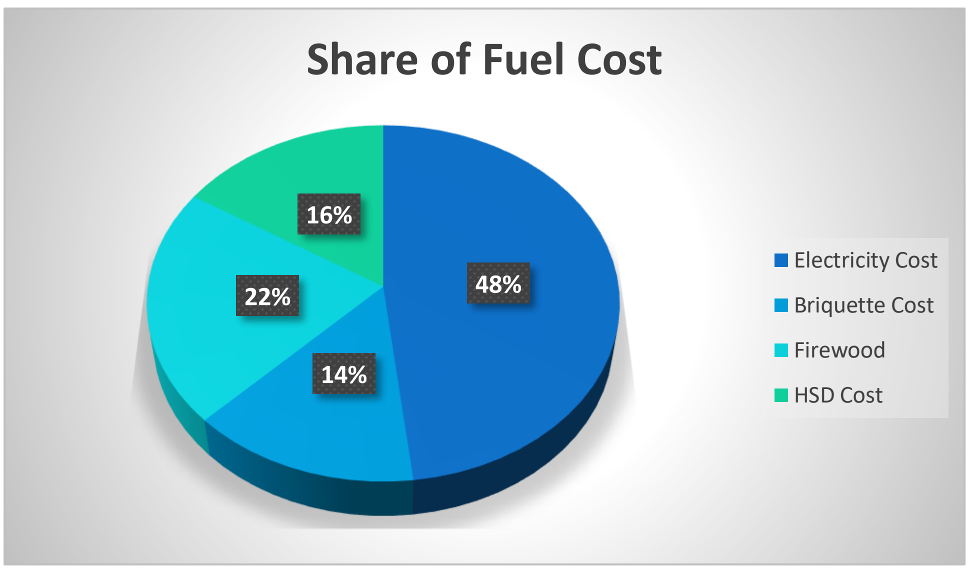


Figure 9: Share of fuel cost

3. PERFORMANCE EVALUATION OF EQUIPMENT/PROCESS

3.1 List of equipment and process where performance testing done

CII during the detailed energy audit at MILMA Dairy, Wayanad 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 11: Electrical Measurements

Description	Rated kW	Line Voltage (V)	Line current (A)	Power (kW)	Power factor
Effluent pump (new)	2.2	405.7	3.4	1.75	0.74

Aerator (ASP-1)	5.5	406.2	7.7	4.4	0.797
Aerator (ASP-2)	5.5	409.2	8.9	4.9	0.786
Feed pump	2.2	407.2	4	2.4	0.853
Effluent pump	2.2	406.7	2.6	1.23	0.66
Air blower	3.7	404.1	6.2	3.29	0.757
Agitator	0.37	405.6	1.1	0.17	0.221
Sludge pump	0.75	408.2	1.5	0.93	0.858
Well water pump	5.5	405.4	11.3	6.79	0.856
Sump water pump 1	7.5	407.3	17.1	10.7	0.88
Sump water pump 2	7.5	407.8	17.6	11.3	0.904
Boiler					
ID fan	11	418	16.7	9.02	0.74
FD fan	2.2	416.8	3.6	2.14	0.821
Feed water pump	3	416.6	5.6	3.49	0.872
Tray washing (Unit 1)					
Conveyor		408.5	1.8	0.38	0.314
Pre-rinse pump		406.8	2.7	1.52	0.787
Detergent pump	5.5	407.8	10.3	6.74	0.928
After-rinse pump	3.7	408.2	4.5	2.39	0.751
Tray washing (Unit 2)					
Conveyor	1.5	410.7	1.5	0.28	0.257
Pre-rinse pump	2.2	408.3	4.1	2.39	0.835
Detergent pump	2.2	408	3.6	2.01	0.796
After-rinse pump	2.2	407.8	5.5	3.5	0.906
Ghee					
Ghee filling section		410.8	3.6	1.31	0.516
Ghee VAT agitator		381.4	1.7	0.263	0.234
Ghee VAT exhaust		385.5	1.3	0.601	0.7
DG 1	320 kVA			162	0.82
DG 2	320 kVA			123	0.78
Homogeniser		407.1	74.1	43.28	0.831
Silo agitator (Silo-1)		419.4	1.6	1.01	0.86
Silo agitator (Silo-2)		419.2	1.7	1.05	0.85
Silo agitator (Silo-3)		419.4	1.6	1	0.865
HMST agitator 1		419.7	1.6	0.296	0.251
HMST agitator 2		419.8	1.55	0.281	0.248
HMST agitator 3		417.6	1	0.26	0.366
HMST agitator 4		417.5	0.95	0.25	0.36
Feed pump - Homogeniser	2.2	419.3	3.9	2.38	0.834

Hot water pump - to pasteuriser (tetra pack)	1.5	419.2	2.4	1.54	0.883
Feed pump - to pasteuriser (tetra pack)	3.7	390.1	4	2.55	0.945
Milk feed pump to balance tank	3.7	387.4	6.3	3.69	0.865
Curd section		381.3	11.8	5.22	0.665
AHU to clean room		385.2	10.7	6.9	0.97
Air comp. (PM 28)	15			6.6	
				17.5	
Deep freezer 2 (PM 43) first floor		407.8	18.9	9.74	0.732
Peda					
Agitator 1 for Peda VAT		408.1	1.2	0.2	0.253
Exhaust (Vapour hood 2)		409.3	6.2	3.525	0.814
Condensate recovery pump	0.37	235.7	2	0.447	0.973
Cold storage (old)					
Diffuser 1		407.6	1.6	0.734	0.644
Diffuser 2		407.6	1.6	0.713	0.631
Diffuser 3		413.6	1.5	0.707	0.648
Diffuser 4		412.6	1.4	0.753	0.754
Diffuser 5		412.3	1.2	0.58	0.658
Diffuser 6		412.5	1.4	0.68	0.69
Diffuser 7		412.4	1.5	0.82	0.766
Diffuser 8		411.3	1.4	0.78	0.778
Cold storage (new)					
Diffuser 1		406.5	2	1.06	0.733
Diffuser 2		406.9	1.9	0.94	0.689
Diffuser 3		406.8	1.9	0.98	0.718
Diffuser 4		406.6	2.1	1.2	0.826
Diffuser 5		408.7	2	1.12	0.78
Diffuser 6		407.8	2.3	1.29	0.79
PM 44 Deep freezer unit 1 (ground floor)		404.2	12.4	6.31	0.724
Ice cream cold storage					
Unit 3					
Compressor		405.3	6.8	3.5	0.73
Fans		233.5	2.2	0.49	0.937

Unit 4					
Compressor		404.6	7	4.01	0.8
Fans		234.5	2.3	0.509	0.931
Anti-room (Ice cream cold storage)					
Compressor		405.6	7.6	3.68	0.69
Fans		234.5	2.1	0.47	0.986
Cream seperator-1	11	405.4	26.4	15.5	0.841
Steam diffuser		391.7	1.6	0.186	0.173
CIP pump	5.5	395.2	13.1	8.35	0.932
Re-constitution pump - 1	3.7	382.2	2.5	1.37	0.83
Re-constitution pump - 2	5.5	390.6	7	3.76	0.8
Paneer unit					
Milk feed pump	3.7	400.8	2.4	1.369	0.808
Hot water pump	2.2	401.1	3.3	1.9	0.831
Citric acid pump		401.8	0.5	0.24	0.65
Cream pump to butter unit	2.2	396.9	1.9	1.3	0.986
Cooling water pump 1		418	9.6	5.3	0.76
Cooling water pump 2		420	8	4.08	0.7
Cooling water pump 3		419	9	4.6	0.71
Ammonia comp. - 5	55	418.6	74	46	0.861
Ammonia comp. - 4	55	418.7	72.8	43.3	0.81
Ammonia comp. - 3	45	408.6	66.9	41.01	0.864
Ammonia comp. - 2	45	406.2	72.1	46.02	0.9
Ammonia comp. - 1	45	412	70.1	43.43	0.85
Chilling water pump -1	7.5	419	17.5	11.8	0.924
Chilling water pump -2	7.5	419	17.5	11.7	0.91
Chilling water pump -3	7.5	419.4	17.8	11.9	0.92

Table 12: Transformer Measurements

Rated(kVA)	Transformer	Voltage (3 Phase)	Current	kW	kVA	PF	VTHD	ITHD
315	TR 1	389.3	253.1	167.4	170.29	0.983	2.4	8.2
315	TR2	386.5	154.5	103.1	104.03	0.991	2.5	5.9

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

Table 13: Boiler Efficiency

Boiler Efficiency Direct Method 3 TPH		
Feed Water Temperature	70	ºC
Calorific value of fuel	3151.52	kCal/kg
Feed Water Flow	1222.22	kg/hr
Fuel Firing Rate	366.67	kg/hr
Enthalpy of steam at 8kg/cm2	661	kCal/kg
Feed Water Enthalpy at 35 ºC	35	kCal/kg
Boiler Efficiency	66.21	%
Boiler Efficiency Direct Method 2 TPH		
Feed Water Temperature	70.00	ºC
Calorific value of fuel	3151.52	kCal/kg
Feed Water Flow	1100.00	kg/hr
Fuel Firing Rate	418.83	kg/hr
Enthalpy of steam at 8kg/cm2	661.00	kCal/kg
Feed Water Enthalpy at 70 ºC	70.00	kCal/kg
Boiler Efficiency	49.25	%

Table 14: Condenser and Chilled Water Pump Measurements

Parameter	Condenser Pump 1	Pump 2	Pump 3
Power kW	4.60	4.08	5.3
Flow (m3/h)	89.00	70.00	98.00
Head assumed (m)	7.00	7.00	7.00
Efficiency	**43.94**	**36.36**	**39.19**

Parameter	Chilled Water Pump 1	Chilled Water Pump 2
Power kW	11.8	11.7
Flow (m3/h)	84.00	86.00
Head assumed (m)	30.00	29.00
Efficiency	**64.66**	**64.54**

Table 15: Performance of Air Compressor (Screw)

Parameters	UOM	
Rated capacity of compressor	CFM	84
Rated power of compressor	kW	15
Load Power	kW	17.5
Unload Power	kW	6.6
Load Pressure	bar	7
Unload Pressure	bar	8

Table 16: Performance of Chiller Compressor

Parameters	UOM	
Rated size of compressor	kW	55
	TR	45
Voltage	Volts	418
Current	Amperes	74
Power Consumption of Compressor	kW	46
Power Factor	PF	0.86
Suction Pressure	Bar	30
Discharge Pressure	Bar	180
Discharge Temperature	°C	85
Condensing Temperature	°C	37
Operating Power	kW	46
Operating TR	TR	34
SEC	kW/TR	1.35

3.3 Energy Balance of MILMA Dairy, Wayanad

During the detailed energy audit at MILMA Dairy, Wayanad dairy the total load on the plant measured at transformer level near to 300 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.

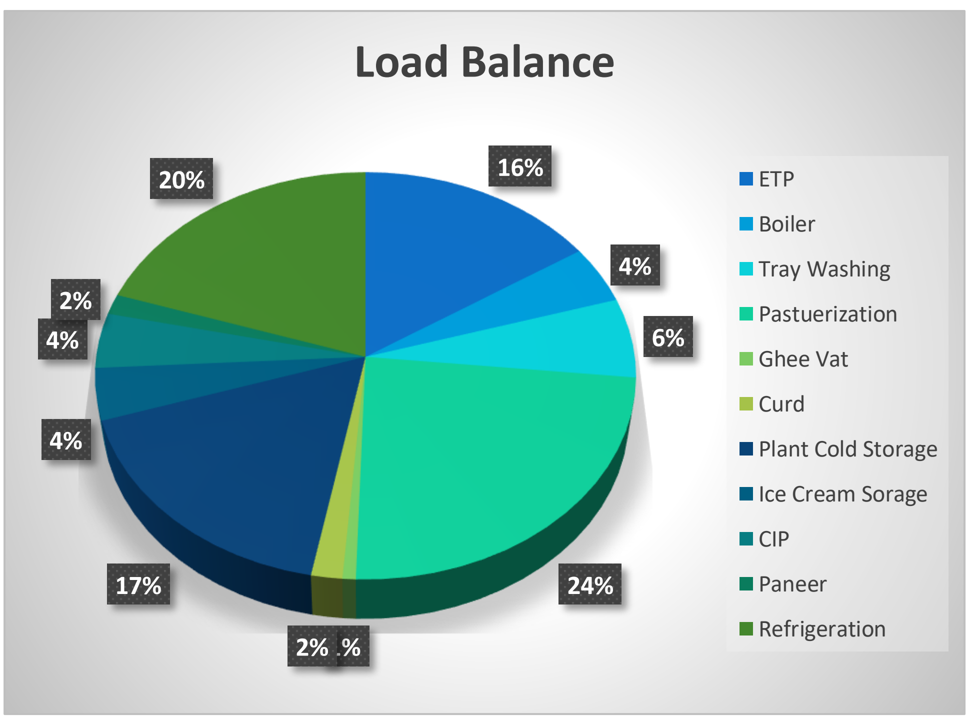


Figure 10: Equipment/Process wise energy breakup

The figure below shows energy balance diagram of MILMA Dairy, Wayanad dairy

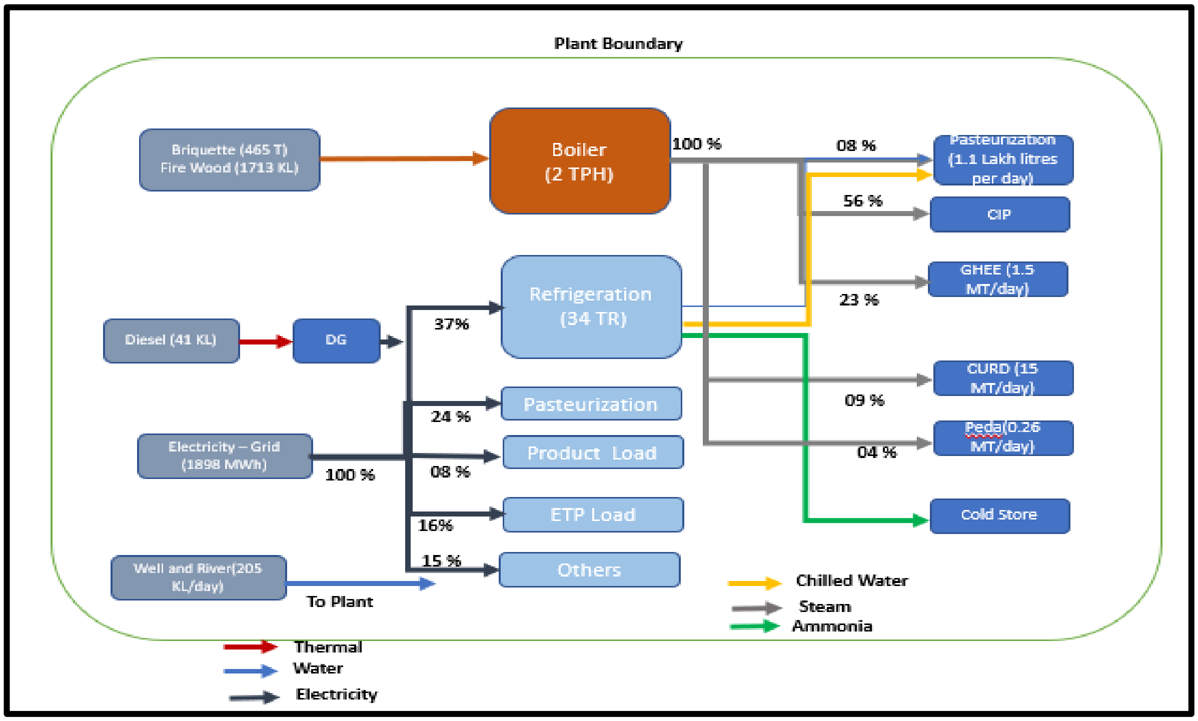


Figure 11: Energy Balance of Plant

3.4 Water Profile of MILMA Dairy, Wayanad

MILMA Dairy, Wayanad is having a separate bore well for supplying water to the plant. The table below shows the monthly consumption of water in the plant.

Table 17: Monthly water consumption

Monthly Consumption	
	Litres
Jul-17	63,85,000
Aug-17	66,82,000
Sep-17	74,63,000
Oct-17	78,62,000
Nov-17	65,38,000
Dec-17	52,01,000
Jan-18	59,45,000
Feb-18	48,25,000
Mar-18	56,32,000
Apr-18	60,11,000
May-18	65,11,000
Jun-18	62,53,000
Jul-18	60,00,500

Aug-18	62,02,000
Sep-18	65,18,000
Oct-18	61,25,370
Nov-18	60,95,000
Dec-18	62,08,000
Total	11,24,56,870

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 18: Daily consumption data

Water Data		
Water Source		Well and River
Daily Average Consumption	KL	205
Daily average ETP Load	KL	167
Cost of Water	Rs/L	-
% Reused /Recycled	%	81

The section wise water consumption is shown in the below graph

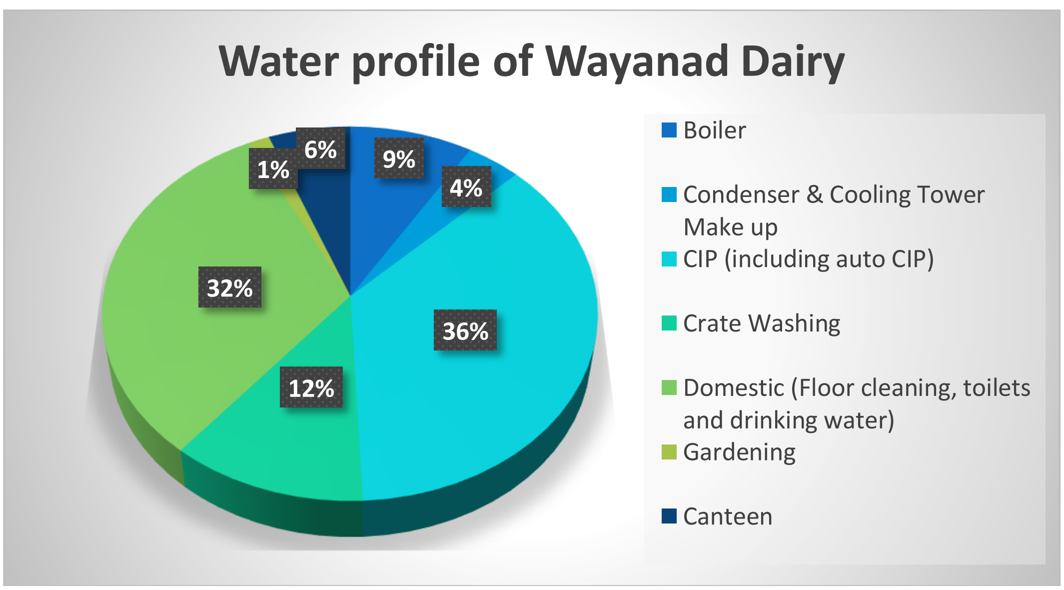


Figure 12: Water profile of MILMA Dairy, Wayanad

3.5 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 19: Specific energy consumption

Sl No	Particulars	UOM	Value
1	Annual Electricity Consumption	kWh	18,98,073
2	Annual Electrical Energy Consumption	Kcal	1,63,23,42,780
3	Annual Electricity Consumption	MTOE	163.23
4	Annual Diesel Consumption	L	41,418
5	Annual Diesel Energy Consumption	kcal	45,01,17,027
6	Annual Diesel Consumption	MTOE	45.01
7	Annual Firewood Consumption	kg	17,13,925
8	Annual Firewood Energy Consumption	kCal	5,14,17,75,000
9	Annual Firewood Consumption	MTOE	514.18
10	Annual Briquette Consumption	kg	4,65,431
11	Annual Briquette Energy Consumption	kcal	1,86,17,24,000
12	Annual Briquette Consumption	MTOE	186.17
13	Total Energy Consumption	kcal	9,08,59,58,807
14	Total Energy Consumption	MTOE	909
15	Total Production	KL	37,850
16	Overall Electrical SEC	kWh/KL of Milk	50
17	Overall Thermal SEC	MKcal/KL of Milk	0.197
18	Overall SEC	MKCal/KL of Milk	0.240

3.6 Performance Analysis of Major Processes

3.6.1 Pasteurizing Section

Table 20: Analysis of pasteurizing section

Pasteurisation		
Description	**Unit**	**Pasteuriser I**
Pasteurizer Capacity	KL/hr	10
No. of hours of operation per day	hours/day	16
No of Shifts	Nos	2
Average Shift Time	Hours	8
Average Milk Processed per shift	Litres/shift	55000
Average Milk Processed per day	Litres/day	110000
Incoming milk temperature from Silo	^oC	3
Heating Temperature	^oC	76

Steam Pressure	Kg/cm^2 g	3.5
Holding time	Seconds	16
Regeneration Efficiency	%	80
Cooling Temperature	°C	3
Chilled water temperature	°C	0
Raw Milk Silo Temperature	°C	2
Process Milk Silo Temperature	°C	3
Specific Steam Consumption	kg/KL	21.74

3.6.2 Ghee Section

Table 21: Analysis of Ghee Vat

GHEE Section			
Description	**Unit**	**VAT 1**	**VAT 2**
Ghee VAT Capacity	KL/hr	2	2
Incoming Cream Temperature	°C	40	40
Initial Heating Temperature until boiling starts	°C	38	38
Initial Heating Time until boiling starts	secs	0	0
Final heating temperature	°C	114	114
Holding time	mns	30	30
Steam Pressure	Kg/cm2 g	2	2
Holding time in settling tank	hrs	16	16
No. of hours of operation per day	hrs	8	8
No of Shifts	Nos	1	1
Average Shift Time	Hrs	8	8
Average Ghee Produced per shift	Litres	700	700
Average Ghee Produced per day	Litres	700	700
Specific Steam Consumption	Kg/KL	147.09	147.09

3.6.3 CIP Section

Table 22: CIP Section Analysis

Parameters	**UOM**	
Hot Water tank capacity	KL	3
Delta T of heating	°C	45
Heating Time	mins	30
Steam Pressure	kg/cm2g	3.5
Steam Flow Rate for Hot Water tank per batch	kg/hr	533.6
Steam 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	°C	40

Heating Time	mins	30
Steam Pressure	kg/cm2g	3.5
Steam Flow Rate for Acid Water tank per batch	kg/hr	474.3
Steam 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
Steam Flow Rate for Alkali Water tank per batch	kg/hr	474.3
Steam Qty required per batch	kg/hr	237.2
Number of batches per day	No.s	2
Total Steam Required per day	Kg/day	1986.2
CIP steam requirement per KL pasteurisation	Kg/KL	198.62

3.6.4 Curd Section

Table 23: Curd Section Analysis

Parameters	UOM	
Capacity	Litres	5000
Incoming Milk Temperature	ºC	4
Milk Temp after regenerative heating	ºC	85
Heating Temperature	ºC	110
Holding Time	Sec	9
Steam Pressure	Kg/cm2g	4
Regeneration Efficiency	%	-
Incubation Temperature	ºC	45
Specific Steam Consumption	Kg/KL	49.70

3.6.5 Raw Milk Pre Chilling

Table 24: Raw Milk Prechilling Analysis

Parameters	UoM	
Capacity	KL	10
Incoming Raw Milk Temperature	ºC	6
Pre-Chilled Milk Temperature	ºC	2
Refrigeration requirement	TR/KL	1.322

3.6.6 Crate Washing

Table 25: Crate Washing Analysis

Description	Unit	Value
Crates washed per hour	No. / hour	900
Hours of operation per day	hours	8
Hot Water requirement	Litre/hr	6,000
Hot Water temperature	ºC	60
Steam pressure	Kg/cm2 g	1.5
Specific Steam Consumption	kg/100 crate	31.937

4. ENERGY SAVING PROPOSALS

Energy Saving Proposal 1 – Installation of Automatic Pumping Trap for Curd and CIP Section

Present System

MILMA Dairy, Wayanad has installed two briquette and wood fired boiler for hot water requirement in process application like pasteurization, curd making, CIP, crate washing etc. All the heating process in dairy is through indirect heating. For all the processes hot water is generated using steam and condensate is drained out. Currently all the locations ball float traps are installed.

During the audit, steam distribution was studied in detail and it was observed that steam trap leakage is found at CIP and PEDA section. Also it is observed that there is some steam leakage at Curd section. Also TD trap is installed near CIP for the main steam line and steam is getting leaked at CIP section also. This happens when there is no sufficient delta P will be there across the inlet and outlet of trap for the trap to operate. As a result stalling happens and by pass valve opens and condensate starts flowing through this valve and also steam leakage is there. The figure below shows steam and trap leakage at various section in the plant.

Figure 13: Trap and Steam Leakage

The steam flow to the Heat Exchanger is regulated by a PID based Temperature Control Valve (TCV) which is taking feedback from the temperature. The steam flow to the Heat Exchanger is regulated by a PID based Temperature Control Valve (TCV) which is taking feedback from the temperature sensor (RTD) at the outlet hot water line. Now, as the set temperature of hot water is attained, the TCV tends to close position. This in turn causes the steam flow rate, and thus steam pressure be reduced, which in turn causes water logging at the steam trap due to the lack of required differential pressure across the trap. A steam trap will be operational only above the rated minimum differential pressure. Normally, operation of a steam trap requires a minimum differential pressure of 0.1 kg/cm2, however, this may vary with manufacturers. If the condensate flow pressure is lesser than the minimum required differential pressure, water logging happens which is also called stalling.

This leads to problems of hammering, reduction of thermal performance of heat exchanger, corrosion of heating surfaces, inevitably reducing the service life of exchanger. Now, to avoid this stall condition of steam traps, equipment operator normally operate the by-pass valve, either keeping bypass line partially open full time or intermittently opening and closing of bypass line. In both the cases, live steam loss occurs, thereby increasing the energy consumption. The orifice size of 15NB bypass valve open is 5 mm at 2.8 barg operating pressure. Through this orifice size steam loss is 30kg/hr from the steam loss chart.

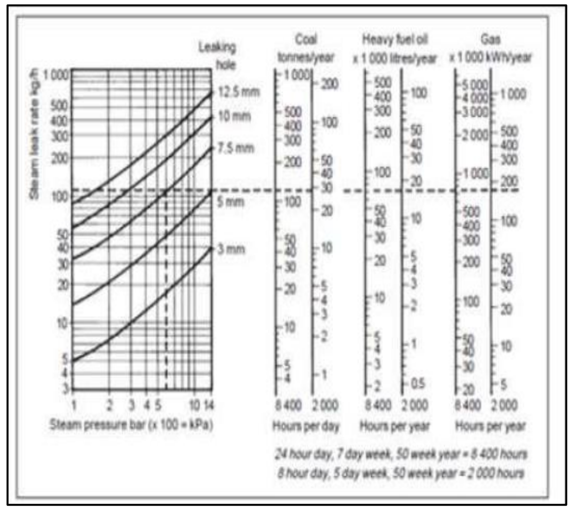


Figure 14: Steam Loss Chart

Recommendations

First arrest all the steam leakages in the pipeline and repair GHEE VAT traps. After this it is recommended to replace the install Steam Operated Pumping Trap (SOPT) for curd section and CIP section. With this system in place, whenever the condensate pressure is low, motive steam / air shall provide the additional thrust to make the condensate flow, and avoid any stalling. Under normal working conditions, the steam operated pump trap works as a normal float trap. During the stall situations, the condensate accumulation lifts the float to the maximum height and actuates the motive steam connection. The condensate accumulated inside is pumped out by the pressure of the motive steam.

Figure 15: SOPT Trap

Savings

The expected fuel savings by installation of steam operated pumping traps is 0.32 Lakhs of fuel annually. The annual monetary saving for this project is ***Rs 1.08 Lakhs with an investment of Rs 2.40 lakhs and payback for the project is 27 months.***

Detailed savings calculations are given in below table

Table 26: Savings Calculation SOPT

Parameters	UOM	Curd section	CIP section
Orifize Size	mm	6	6
Operating Pressure	bar	2.8	2.8
Steam loss through orifice	kg/hr	30	30
Considering 75% live steam leakage	kg/hr	22.5	22.5
Enthalpy of steam at 2.8 bar	kCal/kg	654	654
Total heat loss	kCal/hr	14715	14715

Fuel Loss	kg/hr	7.41	7.41
Fuel Cost	Rs/kg	3.34	3.34
GCV of fuel	kCal/kg	3151	3151
Annual Operating hrs	hrs	2190	2190
Annual Fuel Savings	kg	16233.62	16233.62
Monetary Savings	Rs Lakhs	0.54	0.54
Investment	Rs Lakhs	1.20	1.20
Pay Back	Months	27	27
NPV at 70% Debt	**Rs Lakhs**	**4.37**	
IRR (%)	**%**	**64.65**	
TOE Savings	**TOE**	**10.23**	

Energy Saving Proposal 2 – Installation of Pressured Power Pumping Unit for efficient Condensate Recovery

Present System

MILMA Dairy, Wayanad has installed two briquette and wood fired boiler for hot water requirement in process application like pasteurization, curd making, CIP, crate washing etc. All the heating process in dairy is through indirect heating. For all the processes hot water is generated using steam and condensate is drained out. Currently all the locations ball float traps are installed.

During the audit, steam distribution was studied in detail and it was observed plant is recovering condensate from various processes which is an excellent initiative by the plant team. The condensate collected different processes is at temperature ranging from 75ºC to 850ºC after the trap. The condensate recovered is collected and put into a recovery vessel as shown below:

Table 27: Condensate recovery vessel

It is observed that the condensate recovery vessel is not properly insulated and also the vessel is not covered properly with lid which is leading to flashing of condensate. Because of this a lot of useful heat energy is getting lost in the form of radiation losses as well as flashing. As a result temperature of condensate falling into feed water tank is 55ºC ie around 25ºC temperature drop from trap to feed water tank.

Recommendations

Install proper condensate recovery, that is to recover both flash steam and condensate separately. The condensate from the common condensate line has to be fed to flash vessel where the flash steam is separated and the condensate is then taken to steam operated pump, from where the condensate will be pumped using steam as the motive force.

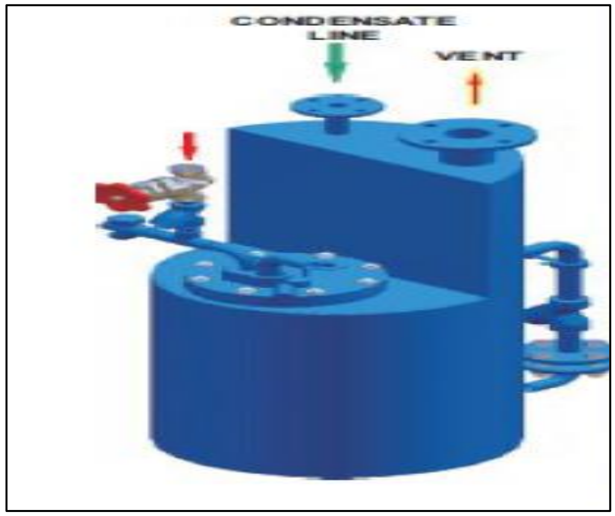


Figure 16: Compact condensate pump

It is recommended to install Pressure Powered Pump Packaged Unit (PPPPU) for efficient condensate recovery. Condensate recovery thro' Pressure Powered Pump Package Unit (PPPPU) Pressure Powered Pump Package Unit is recommended for efficient collection and easy handling to lift the condensate without the use of electricity. The Pressure Powered Pump operates on motive steam pressure. The steam consumption is approx. 3kg per 1000 kg of condensate pumped. Every 1 bar (g) of inlet pressure can lift the condensate to a height of +approximately 9m. The Pressure Powered Pump can operate with a minimum pressure of 0.35 bar (g) to a maximum of 8.7 bar (g), without any adjustment. Condensate can be pumped at 95 deg c to the boiler feed water tank which will increase the feed water temperature and result in monetary savings Recovery of flash steam – 10% Flash steam contains almost equal amount of energy as there in 90% of the condensate. recovery & Flash vessel for flash steam recovery before the PPPPU. Advantages will be avoiding the loss of pure water and avoiding the heat loss in the condensate, thereby raising the feed water temperature and quality.

Savings

The expected fuel savings by installation of steam operated pumping traps is 0.78 Lakhs of fuel annually. The annual monetary saving for this project is ***Rs 2.61 Lakhs with an investment of Rs 3.00 lakhs and payback for the project is 14 months.***

Detailed savings calculations are given in below table

Table 28: Savings calculations for Pressure Powered Pumping Unit

Parameters	UOM	
Condensate Temperature at F/W tank inlet	ºC	55
Condensate Available	kg/hr	1577
GCV of Fuel	kCal/kg	3151
Fuel Cost	Rs/kg	3.34

Condensate Temperature	°C	70
Heat Available from condensate	kCal/hr	23655
Fuel Savings	kg/hr	11.92
Annual Fuel Savings	kgs	78288.
Monetary Savings	**Rs Lakhs**	**2.61**
Investment	**Rs Lakhs**	**3.00**
Pay Back	**Months**	**14**
NPV at 70% Debt	**Rs Lakhs**	**11.85**
IRR (%)	**%**	**112.59**
TOE Savings	**TOE**	**24.67**

Energy Saving Proposal 3 – Segregation of Hot Water Sources

Present System

MILMA Dairy, Wayanad has installed desuperheater for waste heat recovery from chiller compressor and 5KL Solar Thermal System which is an excellent initiative by the plant team. The hot water generated is used for various processes like crate washing , CIP , can cleaning etc. The figure below shows the schematic of hot water generation and distribution by the secondary sources:

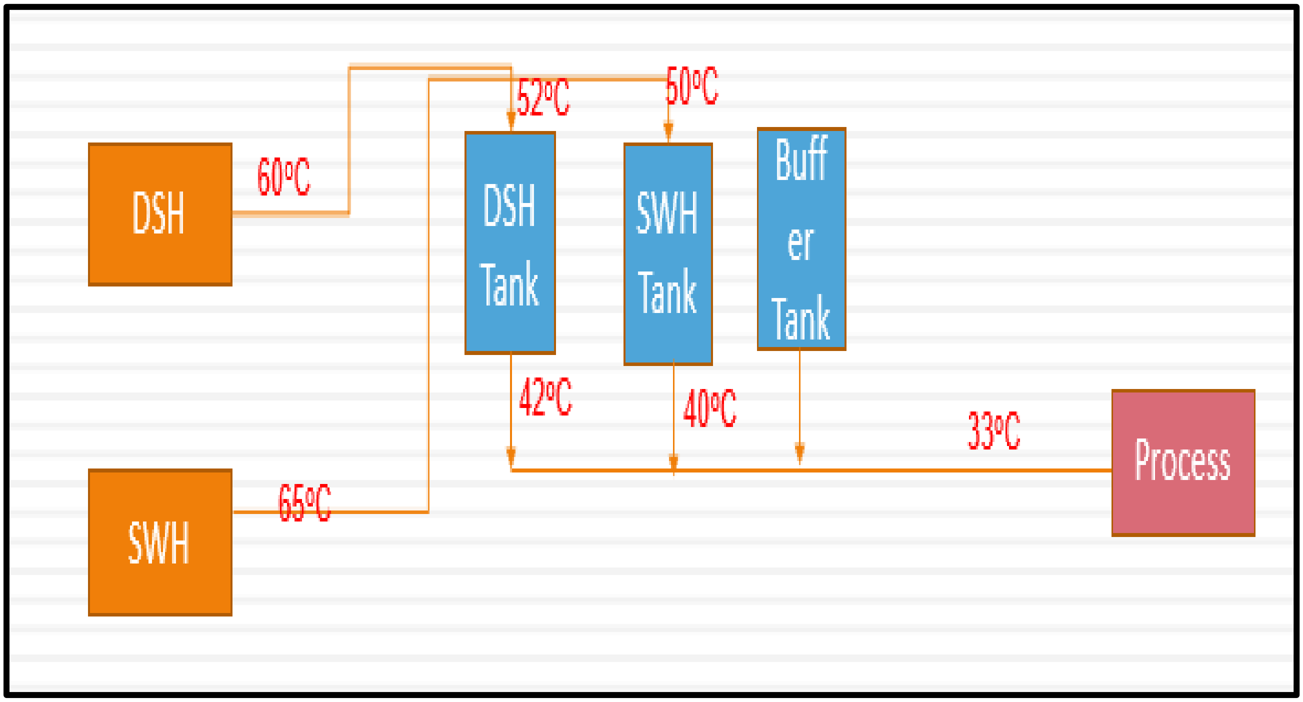


Figure 17: Secondary hot water generation in plant

- Plant is having two secondary hot water generation sources, desuper heater is generating hot water at 60°C and solar thermal system is generating hot water at 65°C.
- Hot Water generated is put into a buffer tank which is little far from the sources and temperature of water entering the buffer tank from de superheater and solar water thermal are 52°C and 50°C respectively. There is a temperature drop of 10 -15°C across the pipe line
- The hot water is stored in two buffer tank and it is observed that water leaving the tanks is 42°C and 40°C which clearly shows that there is a temperature drop of 10°C inside the tank. One reason for this operator at crate washing section unknowingly opening both valves which result in back flow of fresh water at ambient temperature towards the hot water tank
- Also at the user side , temperature was observed to be 33°C. which is another 7 – 8°C drop across the line.
- The overall temperature drop for the secondary hot water system from generation to user end is around 30°C

The reasons for the temperature drop are:

- Long pipe lines laid for hot water
- Poor insulation in pipe lines
- Poor insulation for buffer tank
- Operator unknowingly opening the valves near crate washing

Recommendations

- As a first step proper insulation should be done for pipelines and buffer tank
- Put a NRV for fresh water pipe at crate washing section so that fresh water do not return back to hot water tank.
- Plant can also segregate the secondary hot water users in a such way that de super heater water can be either used as boiler feed water or can be used in CIP locally for hot water heating
- Water from solar thermal can be used for crate washing and can cleaning

Savings

The expected fuel savings by segregating hot water sources is 53,615 kgs annually. The annual monetary saving for this project is ***Rs 1.79 Lakhs with an investment of Rs 2.00 lakhs and payback for the project is 09 months***

Table 29: Savings calculations for segregation of hot water sources

Parameters	UOM	DSH	Solar Thermal
Inlet Temperature	°C	33	33
Flow of available	kg/hr	400	800
GCV of fuel	kCal/kg	3151	3151
Fuel Cost	Rs/kg	3.34	3.34
Outlet temperature	°C	60	60
Heat Available	kCal/hr	10800	21600
Annual Fuel Savings	kg/hr	5.44	10.88
Annual Fuel Savings	kgs	29786.46	23829.17
Monetary Savings	**Rs Lakhs**	**0.99**	**0.80**
Investment	**Rs Lakhs**	**1.00**	**1.00**
Pay Back	**Months**	**12**	**15**
NPV at 70% Debt	**Rs Lakhs**	**8.15**	
IRR (%)	**%**	**115.31**	
TOE Savings	**TOE**	**16.89**	

Energy Saving Proposal 4 – Installation of VFD for FD and ID Fan of boiler

Present System

MILMA Dairy, Wayanad plant has installed one briquette fired boiler and one FO fired for the process application like pasteurization, curd making, CIP, crate washing etc. Briquette fired boiler is running and others are standby. All the heating process in dairy is through indirect heating. Boiler is installed with a 9.3 kW ID Fan for pushing the flue gases through chimney and a 2.2 kW FD fan for giving fresh air to the boiler. During the audit it was observed that the fan is installed with a damper which is 50 % open for controlling the flow of flue gases. Damper control is a conventional method of controlling the flow, by this an additional head is developed across the fan which results in excess power consumption of fan. Also the fan is operated in frequent ON/OFF mode.

Recommendations

- Open the damper fully
- It is recommended to install VFD for the ID as well as FD fan to minimize the losses across the damper thereby eliminating the additional head developed. The feedback of the VFDs should be pressure developed by the fans. Based on the change in flow of flue gas the head developed by fans change and thereby speed of the fans can be controlled using VFDs.

Savings

The expected electricity savings by installing VFDs in ID fan and FD fan is 15266 units annually. The annual monetary saving for this project is ***Rs 0.80 Lakhs with an investment of Rs 0.85 lakhs and payback for the project is 13 months***

Detailed savings calculations are given in below table

Table 30: Savings calculation for VFD in ID and FD fan

Parameters	UOM	ID fan	FD fan
Fan Power	Rated kW	9.3	2.2
Fan Running Power	kW	9.02	2.14
Power Savings	%	20	20
New Power	kW	7.21	1.71
Power Savings	kW	1.80	0.428
Power Cost	Rs/kWh	5.65	5.65
Energy Savings	kWH	12339	2927
Cost Savings	Rs Lakhs	**0.65**	**0.15**
Investment	Rs Lakhs	**0.65**	**0.14**
PB	Months	**12**	**11**
NPV at 70% Debt	**Rs Lakhs**	**3.69**	
IRR (%)	**%**	**126**	
TOE Savings	**TOE**	**1.31**	
TCO_2 Savings	**TCO_2**	**12.51**	

Energy Saving Proposal 5 – Pre heating of incoming Raw Milk in Curd Section

Present System

MILMA Dairy, Wayanad plant has installed one 5KL curd pasteurizer for the preparation of curd from raw milk. The incoming milk is coming at 9ºC from silo and is heated to 110ºC through steps of regenerative heating and indirect heating using steam. Holding time is 9 secs before it is cooled to 45ºC using cooling water from the condenser and through regenerative cooling. The milk at 45ºC 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 40ºC and the water is going to the condenser where again it is getting cooled to 26ºC.

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 9ºC. 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 57,307 kgs annually. The annual monetary saving for this project is ***Rs 3.19 Lakhs with an investment of Rs 3.00 Lakhs and payback for the project is 11 months.***

Savings calculation is given in the below table

Table 31: Savings calculation for pre heating of incoming milk

Parameters	UOM	
Inlet Temperature of water	ºC	26.7
Flow of available	kg/hr	5400
GCV of Briquette	kCal/kg	3151
Fuel Cost	Rs/kg	3.34
Outlet temperature of water	ºC	40
Heat available	kCal/hr	71820
Percentage heat recovery	%	60
Fuel Savings	kg/hr	21.71
Running hours	hrs	8
Operating days	days	330
Annual Fuel Savings	kgs	57307.52
Monetary Savings	Rs Lakhs	1.91
Investment	Rs Lakhs	3.00
Pay Back	Months	19

NPV at 70% Debt	**Rs Lakhs**	**8.30**
IRR (%)	**%**	86.00
TOE Savings	**TOE**	**18.06**

Energy Saving Proposal 6 – Optimize the operation of 20KL Prechiller for milk cooling

Present System

MILMA Dairy, Wayanad plant has installed one 20 KL pre chiller for cooling the incoming milk collected from different BMCs. The temperature of incoming milk varies between 4°C to 7°C and the milk is passed through prechiller irrespective of the incoming milk temperature. The graph below shows the temperature profile of milk coming from different tankers:

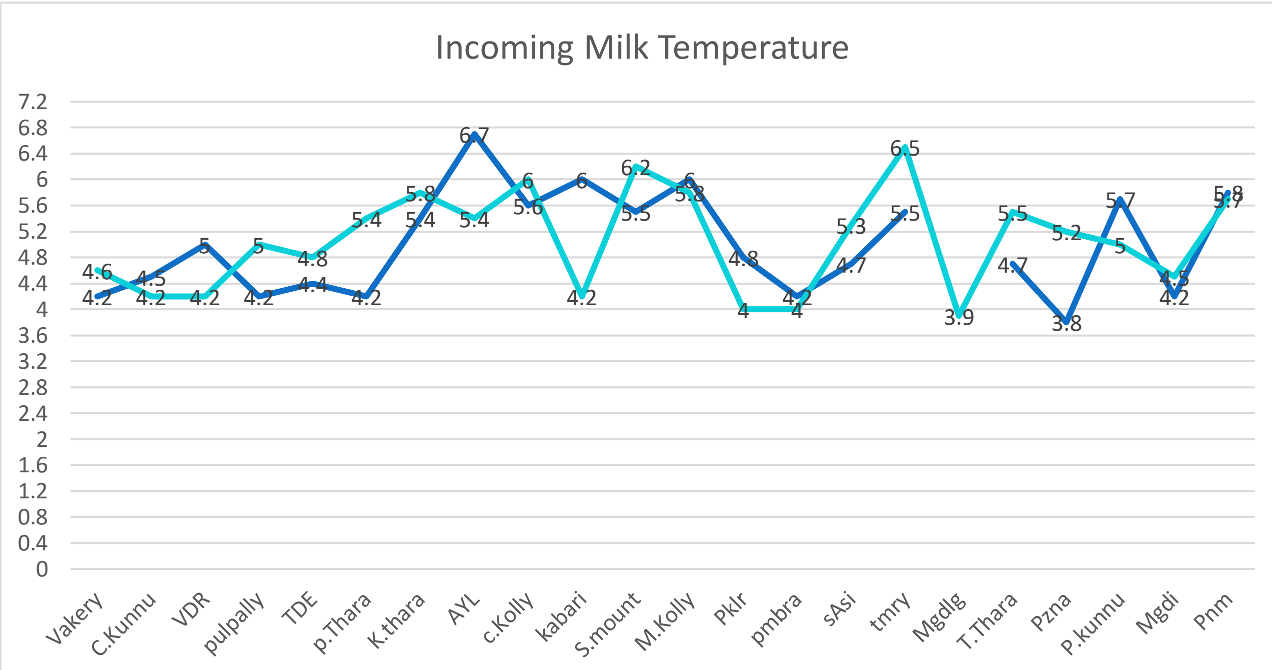


Figure 18: Temperature profile of incoming milk

It is observed that out of 22 receptions on a daily average 10 – 11 tankers have temperature less than 5°C. This clearly shows that even if the incoming milk temperature is less but still milk is prechilled which 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 a automatic control valve with PLC at the chilled water supply circuit. The PLC should be programmed in such a way that if the valve should open only if the incoming milk is above 5°C and chilled water flow can be controlled. If the temperature of milk is less than 5°C, the pre chiller can be bypassed.

Savings

The expected electricity savings by optimizing pre chiller operation is 14,750units annually. The annual monetary saving for this project is ***Rs 0.83 Lakhs with an investment of Rs 1.00 Lakhs and payback for the project is 14 months.***

Savings calculation is shown in below table:

Table 32: Savings calculation for pre chilling of incoming milk

Parameters	UOM	
Quantity of Milk Processed	Litres	117000
Quantity of Milk Processed	kg	117000
Quantity of Milk Processed	kg/hr	9000
Incoming Milk Temperature	°C	5
Outgoing Milk Temperature	°C	3
CP of Milk	KCal/kg	0.93
Cooling Load	kCal/hr	16740
Cooling Load	TR	5.54
Power Consumption	kW	8.08
Operating hrs	**hrs**	**5.00**
Annual Energy Savings	kWh	14750
Savings	Rs Lakhs	0.83
Investment	Rs Lakhs	1.00
Pay Back	Months	14
NPV at 70% Debt	**Lakhs**	**3.75**
IRR (%)	**%**	**108.22**
TOE Savings	**TOE**	**1.27**
TCO_2 Savings	**TCO_2**	**12.00**

○

Energy Saving Proposal 7 – Replacement of existing condenser pump 3 with energy efficient pump

Present System

MILMA Dairy, Wayanad dairy 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 6.4 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 33: Pump Performance

Parameters	UOM	Pump 3	Design
Power Consumption	kW	5.3	6.4
Flow	m^3/hr	98	72
Head	m	7	19.5
Efficiency	%	39	61

The design efficiency of the pump is 61% which is high. 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 39 % 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 34: Proposed pump parameters

Parameters	UOM	Proposed Pump Design
Power Consumption	kW	5.5
Flow	m^3/hr	100
Head	M	8
Efficiency	%	75

Savings

The expected electricity savings by installation of energy efficient condenser pump is 15975 units annually. The annual monetary saving for this project is ***Rs 0.90 Lakhs with an investment of Rs 0.65 lakhs and payback for the project is 9 months.***

Savings calculation is given in the below table:

Table 35: Savings calculation for EE condenser pump

Parameters	UOM	Present	Proposed Operating Condition
Power Consumption	kW	5.3	3.3
Flow	m3/hr	98	100
Head	m	7	8
Efficiency	%	39	75
Power Savings	kW	1.99	
Electricity Cost	Rs/kWh	5.65	
Annual Operating hrs	Hrs	8000	
Energy Savings	kWh	15975	
Cost Savings	Rs Lakhs	0.90	
Investment	Rs Lakhs	0.65	
Pay Back	Months	09	
NPV at 70% Debt	**Rs Lakhs**	**4.57**	
IRR (%)	**%**	**176**	
TOE Savings	**TOE**	**1.37**	
TCO_2 Savings	**TCO_2**	**13.09**	

Energy Saving Proposal 8 – Installation of VFD for Chiller Compressor

Present Status

Wayanad Dairy Plant has installed five reciprocating chiller compressors for the chilled water requirement and for the fan coil units at cold storage. Three low speed 33TR compressors and two high speed 45 TR compressor are used for the refrigeration purpose out of which one high speed compressor will be running during morning time and two low speed compressor will run during night time to form ice on the IBT. For the refrigeration purpose vapor compression-based ammonia cycle is used. The table below shows the details of existing compressor in the plant. The table below shows the operating parameters of compressor in the plant.

Table 36: Performance of refrigeration compressor

Parameters	UOM	High Speed Compressor	Low Speed Compressor
Rated size of compressor	kW	55	45
	TR	45	33
Voltage	Volts	418	408
Current	Amperes	74	66.9
Power Consumption of Compressor	kW	46	41
Power Factor	PF	0.86	0.86
Suction Pressure	Psi	30	30
Discharge Pressure	Psi	180	175
Discharge Temperature	°C	85	90
Condensing Temperature	°C	37	37
Operating Power	kW	46	41
Operating TR	TR	34	27.33
SEC	kW/TR	1.35	1.50

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 1.35 kW/TR and 1.50 kW/TR respectively. 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°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.

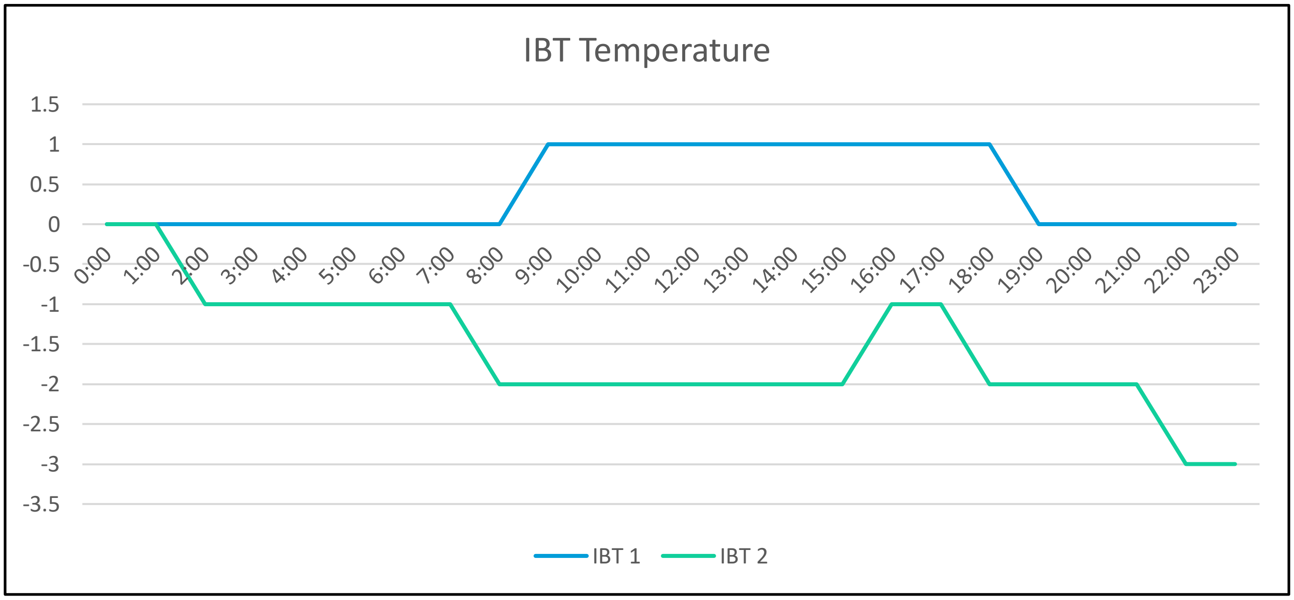


Figure 19: IBT temperature profile

The 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 0°C for 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 the 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 27,600 units annually. The annual monetary saving for this project is ***Rs 1.55 Lakhs with an investment of Rs 2.25 lakhs and payback for the project is 17 months.***

Savings calculation is given in the below table:

Table 37: Saving calculation for VFD for chiller compressor

Parameters	UOM	
Compressor Power	kW	46
Refrigeration Load	TR	34.07407
SEC	kW/TR	1.35
VFD Power Savings	%	10
Power Savings	kW	4.6
Operating hours	hrs	6000
Energy Savings	kWh	27600
Cost Savings	Rs Lakhs	**1.55**
Investment	Rs Lakhs	**2.25**
PB	Months	**17.3**
NPV at 70% Debt	**Rs Lakhs**	**6.82**
IRR (%)	**%**	**92.56**
TOE Savings	**TOE**	**2.37**
TCO_2 Savings	**TCO_2**	**22.63**

Energy Saving Proposal 9 – Installation of VFD for Diffuser fans in New Cold Room

Present Status

Wayanad Dairy Plant has installed 6 diffuser fans for the maintaining the temperature at cold storage new . The total power consumption of these fans is 6.6 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:

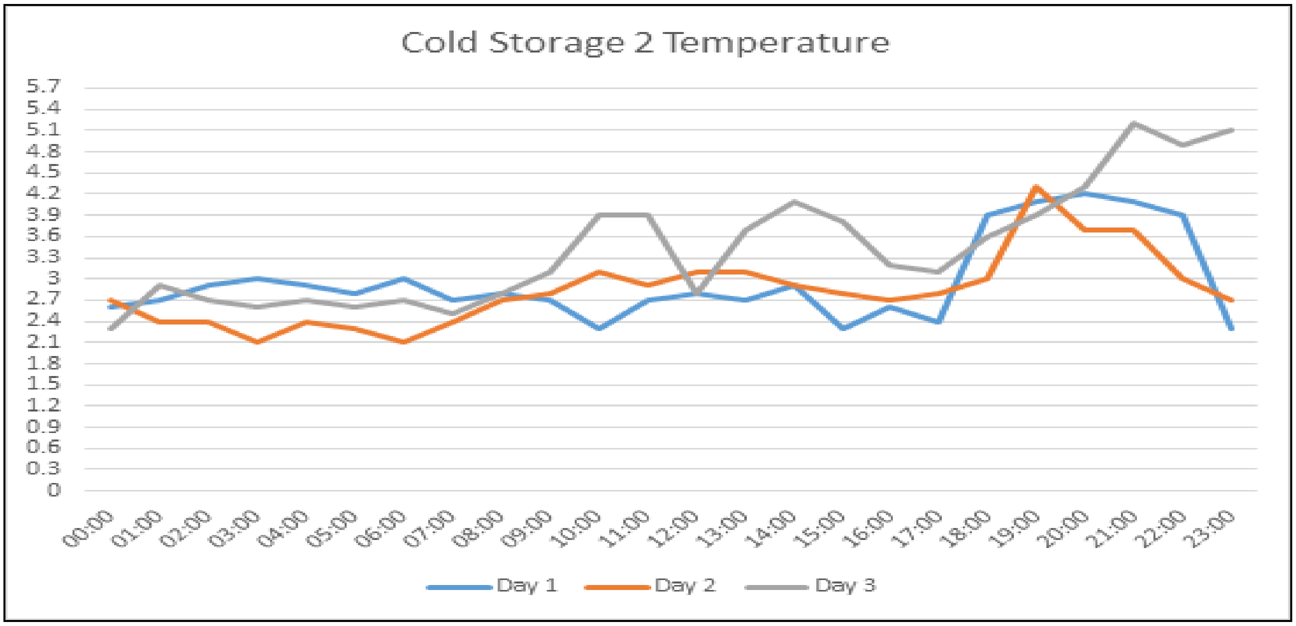


Figure 20: Cold room temperature profile

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

Recommendation

It is recommended to install VFD for four diffuser fans in cold room with temperature inside cold room as the feed back. Keep 3.5°C 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 3.5°C the VFD will run the fan at reduced rpm.

Savings

The expected electricity savings by installation of VFD for diffuser fans 3,960 units annually. The annual monetary saving for this project is ***Rs 0.22 Lakhs with an investment of Rs 0.25 lakhs and payback for the project is 13 months.***

Savings calculation is given in the below table:

Table 38: Savings calculation for VFD for diffuser fans

Parameters	UOM	
Fan Power	kW	6.6
% Savings with VFD	%	20
Power Savings	kW	1.32
Operating hours	Hrs	3000
Energy Savings	kWh	3960
Cost Savings	Rs Lakhs	0.22
Investment	Rs Lakhs	0.25
PB	Months	13
NPV at 70% Debt	**Rs Lakhs**	**1.00**
IRR (%)	**%**	**113.68**
TOE Savings	**TOE**	**0.34**
TCO_2 Savings	**TCO_2**	**3.24**

Energy Saving Proposal 10 - Reduce the Generating Pressure of Main Plant Compressor

Present Status

Screw compressor (15 kW, 84 cfm) installed in plant cater the compressed air requirement in process and instrumentation. In main plant maximum pressure required is 6kg/cm ^{2} and for dairy products the maximum pressure required is 7kg/cm^2. Most of the machines are operating with pressure regulating valves (PRV) to match the exact requirement of the machine.

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

Table 39: Operating set points for main plant and product plant compressor

Tag No	Average Pressure (Bar)	Operating kW	Suggested Pressure
Main Plant compressor	7.6	17.5	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

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

Savings:

The expected savings by reducing the generation pressure is 3481 units annually. The annual monetary saving for this project is ***0.20 Lakhs without any investment.***

Table 40 Savings calculation for compressor pressure reduction

Parameters	UOM	
Loading of Compressor	%	36
Operating Pressure	Bar	7.5
Power Consumption	kW	17.5
Percentage average pressure reduction in main plant compressor	%	12.79
Power saving in main compressor	kW	0.81
Annual operating Hours	hrs	4,320
Annual Energy Savings	kWh	3,481

Electricity Cost	Rs/kWh	5.65
Savings per year	Rs Lakhs	0.20
Investment	Rs Lakhs	Nil
Pay Back	Months	Immediate
TOE Savings	**TOE**	**0.30**
TCO_2 Savings	**TCO_2**	**2.85**

Energy Saving Proposal 11 - Install VFD for Main Plant Compressor to avoid unloading

Present Status

A 15 kW screw compressors is installed in to cater the compressed air requirement in process and instrumentation. In main plant maximum pressure required is 6kg/cm ^{2} and for dairy products the maximum pressure required is 7kg/cm^2.During the detailed energy it was found that the main plant compressor was unloading frequently.

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

Table 41: Plant compressor loading pattern

Tag No	Loading %	Unloading %	Actual Load Power, kW	Actual Unload Power, kW
Plant Air Screw Compressor	36	64	17.5	6.6

The compressor has overall 64% unloading and during unload the compressor 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:

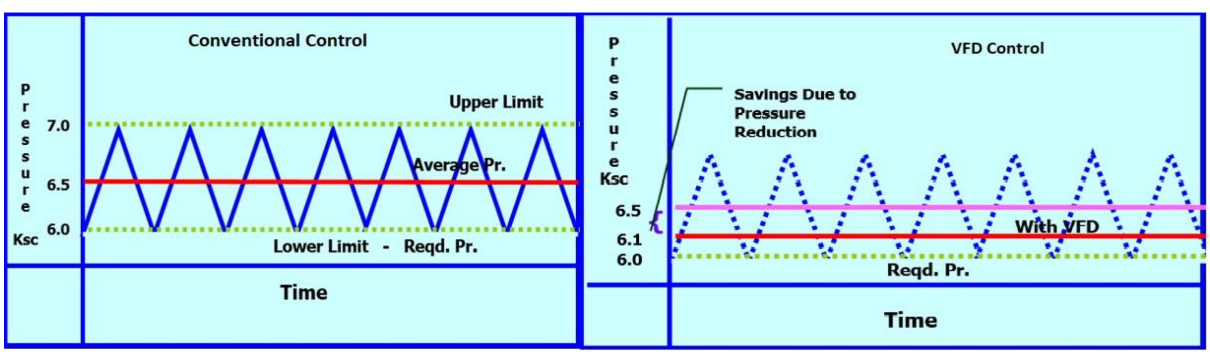


Figure 21: Capacity control of compressor

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 compressor to avoid the unloading of the compressor. 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 4.2 kW is available by means of installation of VFD in the Main plant air compressor.

Savings

The expected savings by installation of VFD in the compressor is 18247 units annually. The annual monetary saving for this project is ***Rs 1.03 Lakhs with an investment of Rs 0.90 Lakhs and payback for the project is 11 months.***

Table 42: Savings calculation for VFD for air compressor

Parameters	UOM	
Unloading power of compressor	kW	6.6
Percentage unloading in the compressor	%	64
Power Saving	kW	4.22
Annual operating Hours	hrs	4320
Annual Energy Savings	kWh	18,247
Electricity Cost	Rs/kWh	5.65
Savings per year	Rs Lakhs	1.03
Investment	Rs Lakhs	0.9
Pay Back	Months	11
NPV at 70% Debt	**Rs Lakhs**	**4.81**
IRR (%)	**%**	**142**
TOE Savings	**TOE**	**1.57**
TCO_2 Savings	**TCO_2**	**14.96**

Energy Saving Proposal 12 - Replace Identified Motors with Energy Efficient Motors

Present Status

During the audit at MILMA Dairy, Wayanad, electrical parameters of motor were measured and analysed. It was observed that ammonia compressor motor is old and has been rewound more than 3 times. The list of motors that can go for higher efficiency class is given below:

Table 43: Measurements of motor to be replaced

Name	Rated kW	Running Power
Well Water Pump	5.5	6.79
Sump water pump 1	7.5	10.75
Sump water pump 2	7.5	11.3

It has been found that there is a potential of increasing the efficiency of the motor by replacing the existing ones with the new energy efficient motors.

The following are the disadvantages for old and re winded motors:-

- ➢ Motor burning and bearing failure
- ➢ Quality of insulation between stampings deteriorates
- ➢ Eddy current losses increases
- ➢ Magnetic property deteriorates
- ➢ Air gap becomes uneven
- ➢ Net torque developed is low

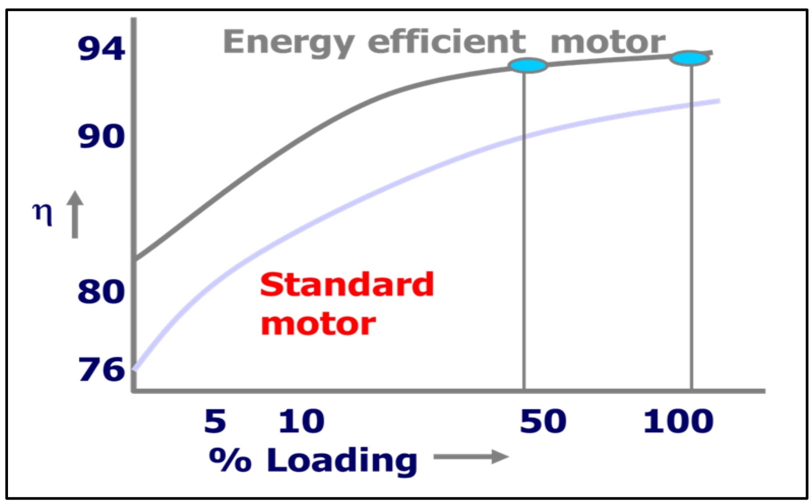


Figure 22: Loading Vs Efficiency curve

Recommendation

It is recommended to replace the ammonia compressor motor with energy efficient motor. The energy efficient motors are available at efficiencies as high as 94 to 95 % depending upon the capacities which are relatively prominent with respect to the standard counterparts.

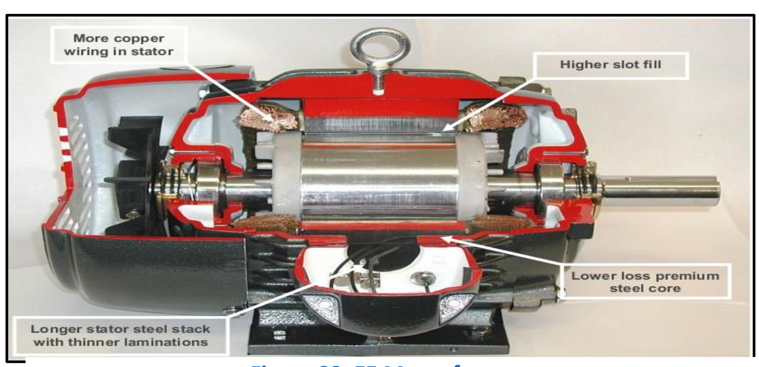


Figure 23: EE Motor features

The motors also retain more or less the same efficiencies in the range of 50-100% loading. The figure below shows the features of energy efficient motor.

The graph below shows the comparison of different class of motors based on efficiency

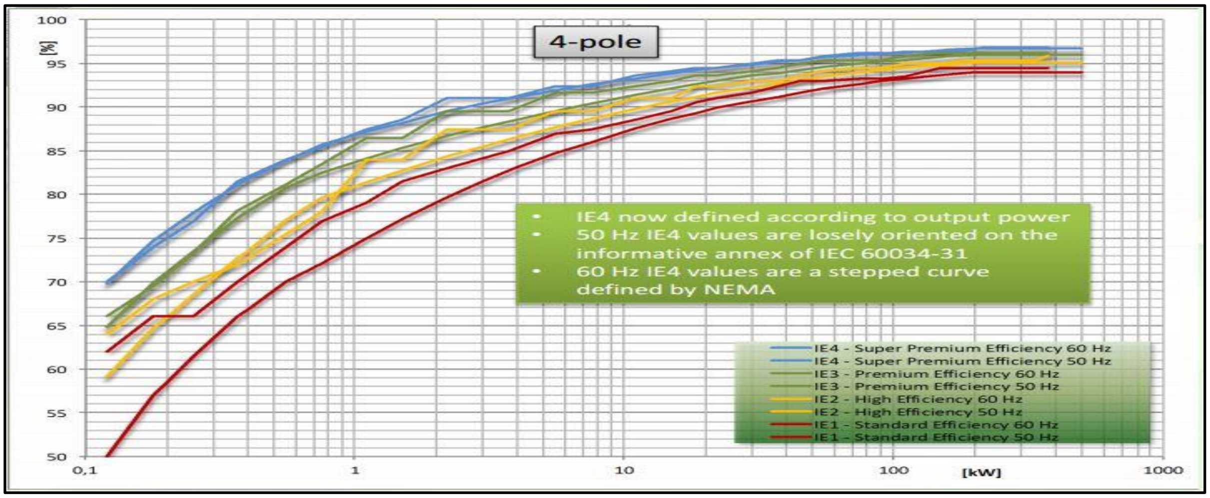


Figure 24: Losses in different classes of motors

Efficiency limit values acc. to IEC 60034-30; October 2008 standard; based on IEC 60034-2-1; 2007 standard

Pot. nominale	Standard Efficiency (IE1, 50 Hz)			High Efficiency (IE2, 50 Hz)			Premium Efficiency (IE3, 50 Hz)		
Rated power	Number of poles			Number of poles			Number of poles		
kW	2	4	6	2	4	6	2	4	6
0.75	72.1	72.1	70	77.4	79.6	75.9	80.7	82.5	78.9
1.1	75	75	72.9	79.6	81.4	78.1	82.7	84.1	81
1.5	77.2	77.2	75.2	81.3	82.8	79.8	84.2	85.3	82.5
2.2	79.7	79.7	77.7	83.2	84.3	81.8	85.9	86.7	84.3
3	81.5	81.5	79.7	84.6	85.5	83.3	87.1	87.7	85.6
4	83.1	83.1	81.4	85.8	86.6	84.6	88.1	88.6	86.8
5.5	84.7	84.7	83.1	87	87.7	86	89.2	89.6	88
7.5	86	86	84.7	88.1	88.7	87.2	90.1	90.4	89.1
11	87.6	87.6	86.4	89.4	89.8	88.7	91.2	91.4	90.3
15	88.7	88.7	87.7	90.3	90.6	89.7	91.9	92.1	91.2
18.5	89.3	89.3	88.6	90.9	91.2	90.4	92.4	92.6	91.7
22	89.9	89.9	89.2	91.3	91.6	90.9	92.7	93	92.2
30	90.7	90.7	90.2	92	92.3	91.7	93.3	93.6	92.9
37	91.2	91.2	90.8	92.5	92.7	92.2	93.7	93.9	93.3
45	91.7	91.7	91.4	92.9	93.1	92.7	94	94.2	93.7
55	92.1	92.1	91.9	93.2	93.5	93.1	94.3	94.6	94.1
75	92.7	92.7	92.6	93.8	94	93.7	94.7	95	94.6
90	93	93	92.9	94.1	94.2	94	95	95.2	94.9
110	93.3	93.3	93.3	94.3	94.5	94.3	95.2	95.4	95.1
132	93.5	93.5	93.5	94.6	94.7	94.6	95.4	95.6	95.4
160	93.8	93.8	93.8	94.8	94.9	94.8	95.6	95.8	95.6
200-375	94	94	94	95	95.1	95	95.8	96	95.8

Figure 25:Efficiency class of IE1, IE2 and IE3 motors

Savings

The expected savings by replacement of ammonia compressor motor is 4424 units annually. The annual monetary saving for this project is ***Rs 0.25 Lakhs with an investment of Rs 0.65 Lakhs and payback for the project is 31 months.***

Table 44: Saving calculation for EE Motors

Parameters	UOM	Well water pump	Sump pump 1	Sump pump 2
Rating of Motor	kW	5.5	7.5	7.5
Power Consumption	kW	6.79	10.75	11.3
Current Efficiency	%	84	85	85
Proposed Efficiency	%	89	90.4	90.4
Total Power Saving based on improved efficiency	kW	0.45	0.76	0.79
Annual operating hrs	hours	3600	1800	1800
Annual Energy Savings	kWh	1635	1360	1429
Electricity Cost	Rs/kWh	5.65	5.65	5.65
Savings per year	Rs Lakhs	0.092	0.077	0.081
Investment	Rs Lakhs	0.19	0.23	0.23
Pay Back	Months	25	36	34
NPV at 70% Debt	**Rs Lakhs**	**0.97**		
IRR (%)	**%**	**56.49**		
TOE Savings	**TOE**	**0.38**		
TCO_2 Savings	**TCO_2**	**3.62**		

Energy Saving Proposal 13- Replacement of existing T12 lamps with LED tube light

Present Status

MILMA Dairy, Wayanad plant is having lighting DB's where the entire lighting load is supplied. Already the process of replacing the conventional light with LED's have already started which is an excellent initiative by the plant team. The lighting load of the load is shown in the below table:

Table 45: Plant lighting details

Type of Fixture	Total Nos	Wattage (W)	Total kW	LED (Wattage)
36 W T12	60	36	2.16	1.08

Recommendation

It is recommended to replace the identified T12 lamps in the plant with 18 W LED.

Latest Design in Lighting

The latest trend in lighting is to utilize the right amount of pupil lumen. The pupil lumen also considers the variation in sensitivity of the eye in relation to the environment. The sensitivity of the eye varies between daytime lighting and night time lighting as shown in the figure below.

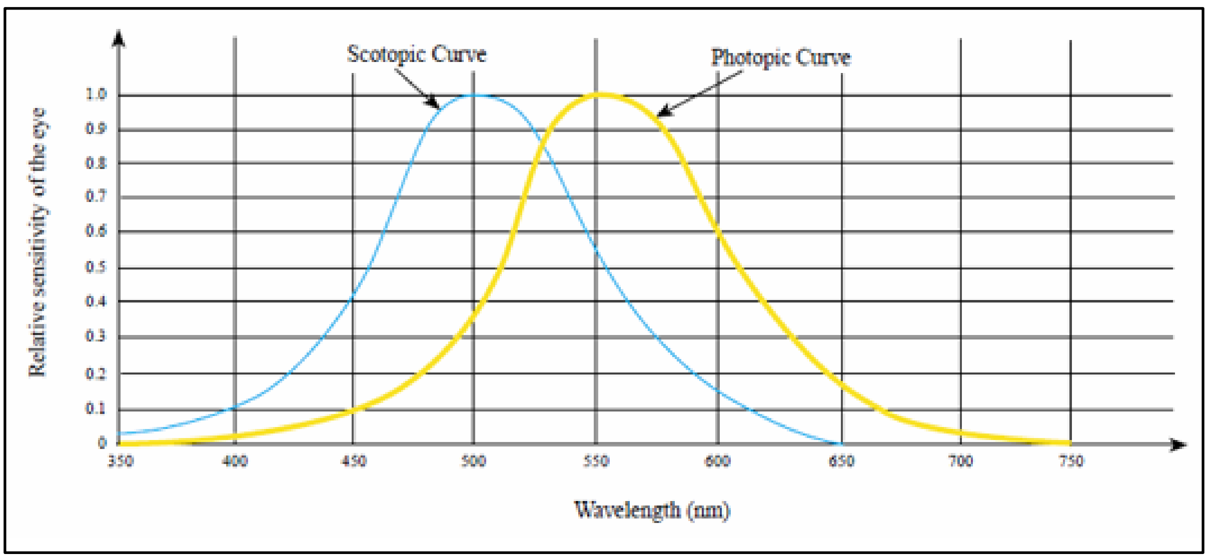


Figure 26: Eye sensitivity curve

The photopic curve and scotopic curve mention the day-time lighting and night-time lighting respectively. The eye colour is more sensitive towards the green colour for photopic curve and is correspondingly for blue colour in the case of scotopic vision. This data of relative sensitivity of eye helps us in designing the correct colour of the lamp required for different lighting conditions. The scotopic vision is well suited for night environment such as street lights, basements, closed rooms where sunlight is not available. The photopic on the other hand will be closer to day-time environment. The earlier system of lighting wherein the quantity of light delivered was mentioned in lumen and not in pupil lumen considered only the photopic curve.

Comparison of Lamps

The table below shows a brief comparison of all the lamps. LED is the latest energy efficient technology in lighting. Compared to the conventional lamps, it offers significant advantages in terms of energy consumption along with other benefits. The latest trend is to go for LED lamps. These LED lamps have very high scotopic to photopic ratio of 2.4. This is very well suited for lighting in dark surroundings. Eg: street lighting, Closed rooms with low sunlight.

Table 46: Comparison of different type of lighting fixtures

Sl.No	Parameter	LED	HPSV	CFL	Metal Halide	FTL T8
1	**Life**	50000 Hours +	15,000-20,000 Hours	6000-8000 Hours	10,000-12,000 Hours	8000 Hours
2	**Lamp Efficacy**	90-100	90-140	60-65	65 to 90	60-68
3	**Lumen Depreciation**	30% @ 50,000 Hours	Upto 40% @ 15000 Hours	15-20% till end of life	Upto 40% @ 12000 Hours	15-20% till end of life
4	**CRI**	70-90	22- 25	65-85	65-90	60-72
5	**Color**	Variety	Yellow	White	White	White
6	**Color temperature**	2100-10000K	2100K-3000K	3000-6000K	4000-5000K	3000-6500K
7	**S/P Ratio**	Upto 2.4	0.62	1.3-2.2	1.6	1.3
8	**Warm up time 90% Lumen**	Instant	4 minutes	1 minute	5 minutes	10-50 Seconds
9	**Flicker free**	yes	No	No	No	No

Advantages of LEDs

As identified from the above table, LED lamps offer the following advantages

- Lower energy consumption
- High S/P ratio
- Longer life time
- Faster switching
- Greater durability and reliability
- Good Color Rendering Index (CRI)
- More focused light and reduced glare
- Does not contain pollutants like mercury
- Highly compatible for solar lighting as low-voltage power supply is sufficient for LED illumination

- Higher Light Output Ratio (LOR): The Light Output Ratio indicates the actual amount of light that can be obtained after considering the losses in luminaire. As can be seen from the figure below, the light output also depends on the light fixture. In the first fixture, certain amount of light is lost. The second fixture has a mirror finish reflecting the light lost to the ceiling in the first case is directed downwards and the loss of light is low in comparison to the fixture on left. The light fixtures that house LED lamps are latest and hence the loss of light is low. LED fixtures have an LOR close to 100%.

Savings

The expected savings by replacement of FTL with LED lights is 3499 units annually. The annual monetary saving for this project is ***Rs 0.18 Lakhs with an investment of Rs. 0.26 Lakhs and payback for the project is 18 months.***

Table 47: Saving calculation for lighting replacement

Parameters	UOM	
Total conventional Lighting load	kW	2.16
Total LED lighting load	kW	1.08
Power Saving	kW	1.08
Annual operating hrs	hours	3240
Annual Energy Savings	kWh	3499.2
Electricity Cost	Rs/kWh	5.65
Savings per year	Rs Lakhs	0.18
Investment	Rs Lakhs	0.26
Pay Back	Months	18
NPV at 70% Debt	**Rs Lakhs**	**0.79**
IRR (%)	**%**	**92.94**
TOE Savings	**TOE**	**0.30**
TCO_2 Savings	**TCO_2**	**2.86**

Energy Saving Proposal 14 – Installation of AC Energy Saver for split AC

Present Status

During the detailed energy audit at MILMA Dairy, Wayanad, 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 TR and 1.5 TR capacity at different locations such as lab, server rooms and peda section.

In Spit AC and packaged units 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 48: List of AC units

S.No	Capacity of AC units	Nos.	Total Power, kW
1	1 TR	1	1.05
2	1.5 TR	5	7.875

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.

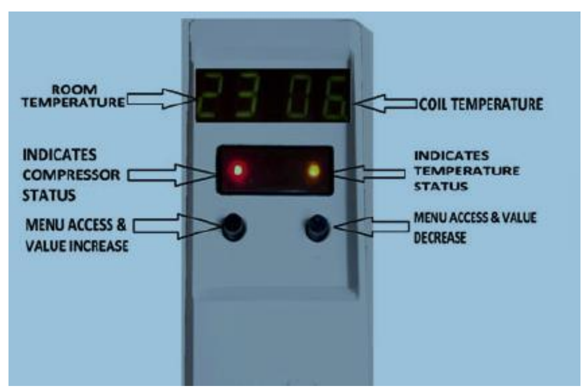


Figure 27: AC Remote controller

Savings

The expected saving after installation of AC energy saver is 5244 units annually. The annual monetary saving for this project is ***Rs 0.29 Lakhs with an investment of Rs 0.40 Lakhs and payback for the project is 17 months.***

Table 49: Saving calculation for AC Energy Saver

Parameters	UOM	
Total No of AC Units	Nos	6
Total AC units power consumption	kW	8.925
Conservative Power Saving after AC energy saver(15% Saving)	kW	1.338
Annual operating hrs	hours	3900
Annual Energy Savings	kWh	5244
Electricity Cost	Rs/kWh	5.65
Savings per year	Rs Lakhs	0.29
Investment	Rs Lakhs	0.40
Pay Back	Months	17
NPV at 70% Debt	**Rs Lakhs**	1.29
IRR (%)	**%**	96.2
TOE Savings	**TOE**	0.45
TCO_2 Savings	**TCO_2**	4.30

Energy Saving Proposal 14 – Installation of 30 kWp Solar Roof Top PV

Present Status

Wayanad Dairy Plant is purchasing electricity from grid for the operation of various equipment's in the plant. The contract demand of the plant is 450 kVA with electricity price of Rs 5.65/kWh with an average load of 150 kW to 200 kW.

Observation

During 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 50: Site Specifications

Parameters	
Effective Rooftop available	250 sqm true south
Location	Latitude: - 11.61° N, Longitude: - 76.08° E
Altitude above sea level, m	780
Direct Normal Irradiance	4.66 kWh/m2/day
Wind	6 m/sec
Humidity	66%
Pressure	1007 hPA

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 0.48 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 48,000 units of electricity annually. The annual monetary saving for this project is ***Rs 2.71 Lakhs with an investment of Rs 22.87 Lakhs and payback for the project is 8 years***

Detailed savings calculations is given in below table

Table 51: 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	1600
Total Energy Generation Per Annum	kWh/year	48,000
Electricity Cost	Rs/kWh	5.65
Cost Savings	Rs Lakhs	2.7
Investment	Rs Lakhs	22.9
Payback period	Years	8
NPV at 70% Debt	**Rs Lakhs**	3.61
IRR (%)	**%**	17.20
TOE Savings	**TOE**	4.13
TCO_2 Savings	**TCO_2**	39.36

5. MANAGEMENT ASPECTS AND CONCLUSIONS

THE OBJECTIVES OF MILMA DAIRY, WAYANAD 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

MILMA Dairy, Wayanad 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 MILMA Dairy, Wayanad should be to implement the identified proposals and get the savings.

We would recommend MILMA Dairy, Wayanad 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, MILMA Dairy, Wayanad 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 Conclusion

- MILMA Dairy, Wayanad plant and CII – Godrej GBC teams have jointly identified **15** energy saving proposals worth an annual saving potential of **Rs. 17.63 Lakhs**. The investment required for implementation of energy saving proposals is **Rs. 40.48 Lakhs**. The total investment will have a simple payback period of **28 months.**

Table 52: Summary of savings

Details	No. of Proposals	Annual savings
Total Annual savings	15	17.63
Nil Investment Proposal	1	0.20
Investment Required (Rs. Lakhs)	14	40.48
Pay Back	Months	28

Table 53: Summary of fuel savings

Details	UOM	Annual savings
Total Electricity Savings	kWh	160446
Total Fuel Savings (Briquette+ Fire Wood)	kgs	221676
Annual TOE Savings	TOE	83.6
Annual $MTCO_2$	$MTCO_2$	131.60

Table 54: Summary of Energy Saving Proposals

Sl. No.	ECM	Annual savings (lakhs)	Investment (lakhs)	Payback	Electricity Savings (kWh)	Fuel Savings (kg Briquette & Firewood)	TOE savings	MTCO2 savings
1	Installation of Automatic Pumping Trap for Curd and CIP Section	1.08	2.4	27		32466	10.2	
2	Installation of Pressured Power Pumping Unit for efficient Condensate Recovery	2.61	3	14		78288	24.6	
3	Segregation of hot water sources	1.79	2	13		53615	16.8	0.0
4	Installation of VFD for FD and ID Fan of boiler	0.80	0.85	13	15266		1.31	12.5
5	Pre heating of incoming Raw Milk in Curd Section	3.19	3	11		57307	18.0	0.0
6	Optimize the operation of 20KL Prechiller for milk cooling	0.83	1	14	14750		1.27	12.1
7	Replacement of existing condenser pump 3 with energy efficient pump	0.90	0.65	9	15975		1.37	13.1

8	Installation of VFD for Chiller Compressor	1.55	2.25	17	27600		2.37	22.6
9	Installation of VFD for Diffuser fans in New Cold Room	0.22	0.25	14	3960		0.34	3.2
10	Reduce the Generating Pressure of Main Plant Compressor	0.2		0	3481		0.30	2.9
11	Install VFD for Main Plant Compressor to avoid unloading	1.03	0.9	10	18247		1.57	15.0
12	Replace Identified Motors with Energy Efficient Motors	0.25	0.65	31	4424		0.38	3.6
13	Replacement of existing T12 lamps with LED tube light	0.18	0.26	17	3499		0.30	2.9
14	Installation of AC Energy Saver for split AC	0.29	0.4	17	5244		0.45	4.3
15	Installation of 30 kWp Solar Roof Top PV	2.71	22.87	101	48000		4.13	39.4
	Total	**17.63**	**40.48**	**28**	**1,60,446**	**2,21,676**	**83.6**	**131**

5.7 MILMA Dairy, Wayanad 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	Parameter	Purpose	Monitoring Method	Measurement Unit	Frequency	Reference Range
1	BOILER - STEAM & CONDENSATE	Steam Generation Pressure	For quality of steam produced	By using Pressure Gauge at MSV outlet	Kg/cm2 g	Hourly	Nearer to boiler rated pressure
		Steam Generation 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		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	By using Steam Flow Meters	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
		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

		Feed Water temperature	For better boiler operation	By Using Thermocouple	Deg C	Hourly	Above 85 deg C
2	**REFRIGERATION SYSTEM**	Chilled Water Supply and Retrun Temperature	For estimating cooling load	Using IR Temperature gun / EMS	Deg C	Hourly	As per plant operations
		Condenser Water Supply and Return temperature	For estimating heat rejection	Using IR Temperature gun / EMS	Deg C	Hourly	As per plant operations
		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		Using IR Temperature gun / EMS	Deg C	Bi-weekly	3 - 4 deg C
		Compressor Suction Pressure	For compressor performance	Pressure Guage	Kg/cm2 g	Hourly	As per capacity of compressor
		Compressor Discharge Pressure		Pressure Guage	Kg/cm2 g	Hourly	As per capacity of compressor
		Compressor Discharge Temperature		Thermocouple	Deg C	Hourly	As per capacity of compressor
		SEC Value		Using Power analyzer	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
3	**Compressed Air System and Pumps**	Compressor Generation Pressure	For keeping lowest pressure possible	Using Pressure gauge at discharge line / Panel	Kg/cm2 g	Hourly	Closest possible to user requirement
		Compressor Loading %	For proper planning of usage	From Panel / By manually noting time	%	Per Shift	7 0 - 90%

		Compressor Unloading %		From Panel / By manually noting time	%	Per Shift	10 - 30 %
		Air Flow Rate	For compressor performance	Conducting FAD	CFM	Per Shift	Dependent on demand
		SEC Value		Using Power Analyzer	kW/CFM	Per Shift	0.18 KW/CFM for Screw Compressors 0.14 KW/CFM for Reciprocating Compressor
		Line Leakages	For immediate rectification	Visual	-	Weekly	Zero Tolerance
		Leakage at Compressed Air Vessel Condensate line		Visual	-	Weekly	Zero Tolerance
		Pump Discharge Pressure	For Pumps performance	Using Pressure Gauges at suction and discharge	Kg/cm2	Quarterly	As per manufacturers recommendation
		Pump Flow Rate		Using flow meter	m3/hr	Quarterly	As per manufacturers recommendation
		Pump Power Consumption		Using Power Analyzer	kW	Quarterly	As per manufacturers recommendation
4	**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 pasterization 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
5	**Raw Energy**	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 V PF close to unity Transformer loading - 50% -60% VTHD < 8% at 415 V side ITHD < 15% at 415 V side
		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@bharatbijlee.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	**Heat Pump**	Aspiration Energy	Mr. Sudharshan	98406 19252	sudharsan.r@aspirationenergy.com
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

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

6.3 ESP Implementation Format

FORMAT FOR MONITORING THE IMPLEMENTATION OF ENERGY SAVING PROPOSALS							
Sl. No.	**ECM**	**Annual savings (lakhs)**	**Investment (lakhs)**	**Payback**	**Person Responsible**	**Target Date**	**Remarks**
1	Installation of Automatic Pumping Trap for Curd and CIP Section	1.08	2.4	27			
2	Installation of Pressured Power Pumping Unit for efficient Condensate Recovery	2.61	3	14			
3	Segregation of hot water sources	1.79	2	13			
4	Installation of VFD for FD and ID Fan of boiler	0.80	0.85	13			
5	Pre heating of incoming Raw Milk in Curd Section	3.19	3	11			
6	Optimize the operation of 20KL Prechiller for milk cooling	0.83	1	14			
7	Replacement of existing condenser pump 3 with energy efficient pump	0.90	0.65	9			
8	Installation of VFD for Chiller Compressor	1.55	2.25	17			
9	Installation of VFD for Diffuser fans in New Cold Room	0.22	0.25	14			
10	Reduce the Generating Pressure of Main Plant Compressor	0.2		0			

11	Install VFD for Main Plant Compressor to avoid unloading	1.03	0.9	10			
12	Replace Identified Motors with Energy Efficient Motors	0.25	0.65	31			
13	Replacement of existing T12 lamps with LED tube light	0.18	0.26	17			
14	Installation of AC Energy Saver for split AC	0.29	0.4	17			
15	Installation of 30 kWp Solar Roof Top PV	2.71	22.87	101			
	Total	**17.63**	**40.48**	**28**			

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