February 2019

DETAILED ENERGY AUDIT REPORT

M/s Gangtok Dairy Plant – Sikkim Dairy Cluster

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

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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
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”.

CII is grateful to Mr. Milind Deore, Director, Bureau of Energy Efficiency, Mr. Sanjay Shrestha, Industrial Development Officer, Industrial Energy Efficiency Unit, Energy and Climate Branch, UNIDO, Mr. Suresh Kennit, National Project Manager UNIDO and Mr. Niranjan Rao Deevela, National Technology Coordinator, Energy Efficiency & Renewable Energy in MSMEs, UNIDO for their support and guidance during the project.

CII would like to give special gratitude to Sikkim Cooperative Milk Producers Union Ltd for supporting CII for carrying out this project at Sikkim Dairy Cluster and for their constant support and coordination throughout the activity. CII team is also grateful to the M/s Gangtok Dairy Plant especially Mr. Ragul K, Managing Director, Mr. Vishal Tewari, DGM and Mr. Saurav Sharma, Jr. Technical Officer for showing keen interest and providing their wholehearted support and cooperation for the preparation of this Detailed Energy Audit Report.

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 Sikkim Dairy Cluster is appreciable and admirable.

1. EXECUTIVE SUMMARY

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

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

The major activities associated with project are

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

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

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

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

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

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

1.1 Brief Unit Profile

Table 1: Unit Details

Particulars	Details
Name of Plant	Gangtok Dairy Plant
Name(s) of the Plant Head	Mr. Vishal Tewari, DGM
Contact person	Mr. Saurav Sharma, Jr. Technical Officer
Constitution	Cooperative Society
MSME Classification	Medium Scale
Address:	Sikkim Co-operative Milk Producers Union Ltd, 5th Mile Tadong, Gangtok, Sikkim
Industry-sector	Dairy

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

Some of the important energy conservation measures implemented are as below.

- Use of LED Lighting
- Installation of Evaporative Condenser
- High Speed Reciprocating Compressor
- Use of condensate for can cleaning by collecting in a tub
- New ETP
- ISO Certification
- Optimized voltage at Main Incomer

CII – Godrej GBC Energy Audit Team conducted Detailed Energy Audit at Gangtok Dairy Main Plant from 10th May 2018 to 12th May 2018 and final presentation to plant team was given on 26th May 2018.

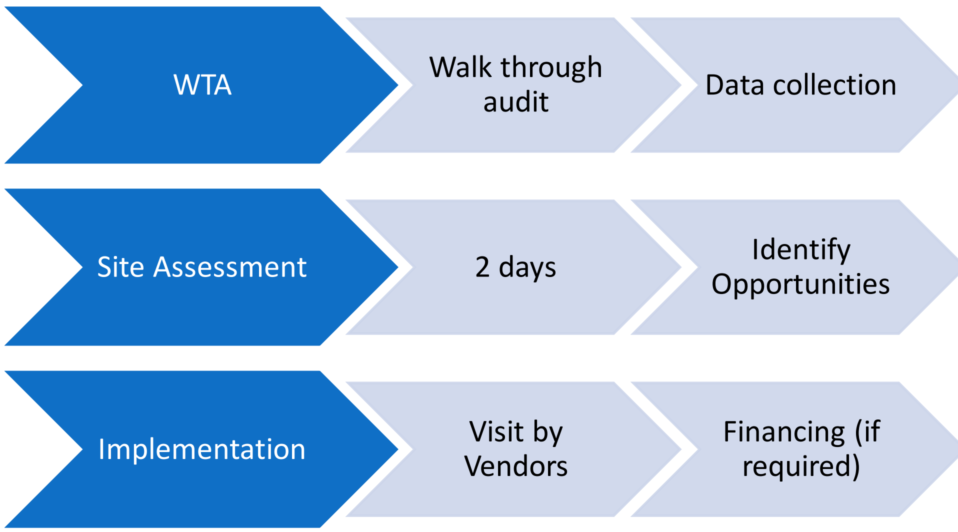
The energy audit included detailed data collection, power measurements of Major electrical energy consumers, process measurements, analysis of data, and performance analysis of the equipment and identification of specific energy saving proposals.

The major form of energy used in the plant is electricity which is from Energy and Power Department Govt. of Sikkim. For thermal energy, plant is using HSD as the main fuel.

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

Gangtok Dairy plant team and CII energy team have together identified an annual energy saving potential of Rs. 14.74 Lakhs with an investment of Rs. 39.63 Lakhs based on energy cost.

Table 2: Summary of savings

Details	No. of Proposals	Annual savings
Total Annual savings	08	14.74
Investment Required (Rs. Lakhs)	08	39.63
Pay Back	Years	2.7

Table 3: Summary of fuel savings

Details	UOM	Annual savings
Total Electricity Savings	kWh	88296
Total Fuel Savings (HSD)	Litres	18360
Annual TOE Savings	TOE	24.24
Annual TCO_2	TCO_2	121.60

Table 4: Summary of Energy Saving Proposals

Sl. No.	Energy Saving Proposals	Annual savings (lakhs)	Investment (lakhs)	Payback, Years	Electricity Savings (kWh)	Fuel Savings (HSD)	TOE savings	TCO2 savings
1	Installation of condensate recovery system	2.89	6.55	2.3		4320	3.92	11.6
2	Replacement of existing chilled water pump with energy efficient pump	0.18	0.98	5.4	4320		0.37	3.5
3	Waste heat recovery from chiller compressor	3.88	7.14	1.8		5793	5.26	15.5
4	Installation of VFD for chiller compressor	1.24	3	2.4	30960		2.66	25.4
5	Installation of Heat Pump for preheating boiler feed water	4.43	3.54	0.8		8247	7.48	22.1
6	Installation of temperature interlock control for EVAPCO fans	0.085	0.1	1.1	2126		0.18	1.7
7	Installation of 30 kWp Solar Roof Top	1.84	17.32	9.4	45990		3.96	37.7
8	Replacement of existing compressor with Screw Compressor	0.2	1	5	4900		0.42	4.0
	Total	**14.745**	**39.63**	**2.7**	**88296**	**18360**	**24.2**	**121.6**

2. INTRODUCTION ABOUT GANGTOK DAIRY PLANT

2.1 Unit Profile

Sikkim is among the lowest milk producing states in India, with a total production of 0.067 Million Tonnes of milk in 2015-16. There are mainly 2 dairies in Sikkim which are located in southern and eastern part of Sikkim. Gangtok Main Dairy Plan is located in the Tadong in Gangtok with daily milk processing of 30,000 to 35,000 litres per day.

Table 5: Unit Profile

Particulars	Details
Name of Plant	Gangtok Dairy Plant
Name(s) of the Plant Head	Mr. Vishal Tewari, DGM
Contact person	Mr. Saurav Sharma, Jr. Technical Officer
Contact Mail Id	milkgangtok@gmail.com
Contact No	+91 7679418591
Constitution	Cooperative Society
MSME Classification	Medium Scale
No. of years in operation	38
No of operating hrs/day	8
No of operating days/year	365
Address:	Sikkim Co-operative Milk Producers Union Ltd, 5th Mile Tadong, Gangtok, Sikkim
Industry-sector	Dairy
Type of Products manufactured	Milk ,Ghee, Dahi, Butter milk, Powder

2.2 Production Details

The various products manufactured in Gangtok Dairy Plant are liquid milk, butter, curd, paneer, churpi and ice cream. The graph below shows the milk processed during last one year:

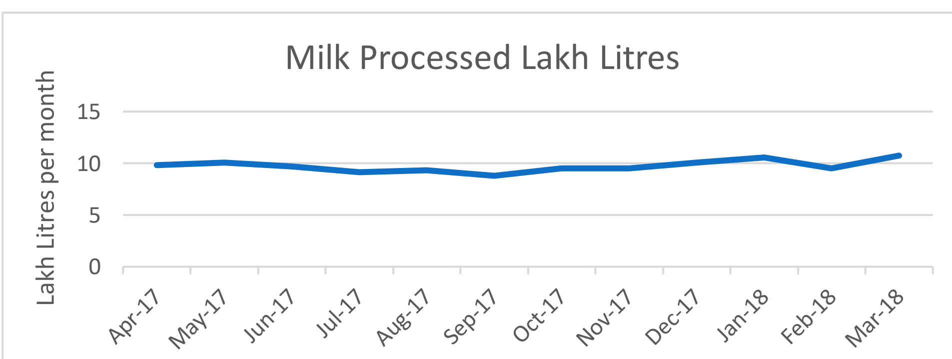


Figure 1: Milk Processed

2.3 Dairy Process Flow Diagram

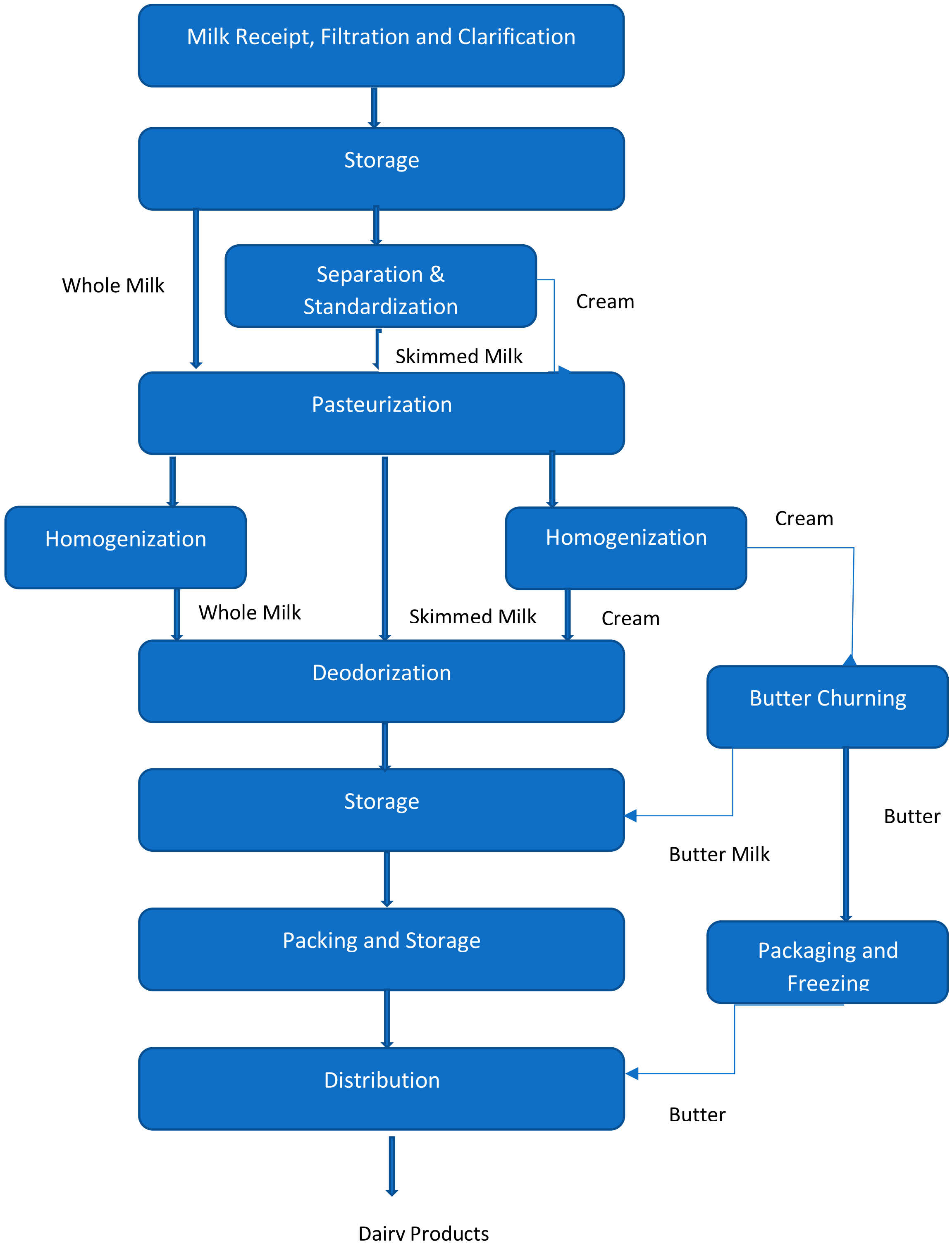


Figure 2: Typical process flow of Milk manufacturing

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

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

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	0.32
2	Milk Packaging in Poly Pouches	Lakh Litres per Day	0.32
3	Curd Manufacturing	Kg/day	972
4	Butter Manufacturing	Kg/day	16
5	Ice Cream Manufacturing[1]	Kg/day	16
6	Paneer Manufacturing[2]	Kg/day	3.19
7	Churpi Manufacturing	Kg/day	24

[1] Seasonal Product – manufactured only in summers
[2] Based on demand from market

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	4.00	-
2	High Speed Diesel	Rs/L	67	10800

The table below shows the monthly consumption of various fuel used in the plant during the last one year and the contract demand of the plant is 200 kVA.

Table 8: Fuel Consumption Details

Month	Electricity Consumption (kWh)	Fuel Consumption – HSD (L)
Apr-17	7000	5926
May-17	18,000	5739
Jun-17	21,000	5561
Jul-17	21,000	5601
Aug-17	20,000	5688
Sep-17	25,000	6136
Oct-17	10,000	5767
Nov-17	19,000	5286
Dec-17	8000	5484
Jan-18	8000	5834
Feb-18	6000	5527
Mar-18	16,000	6563
Total	**1,79,000**	**69,111**

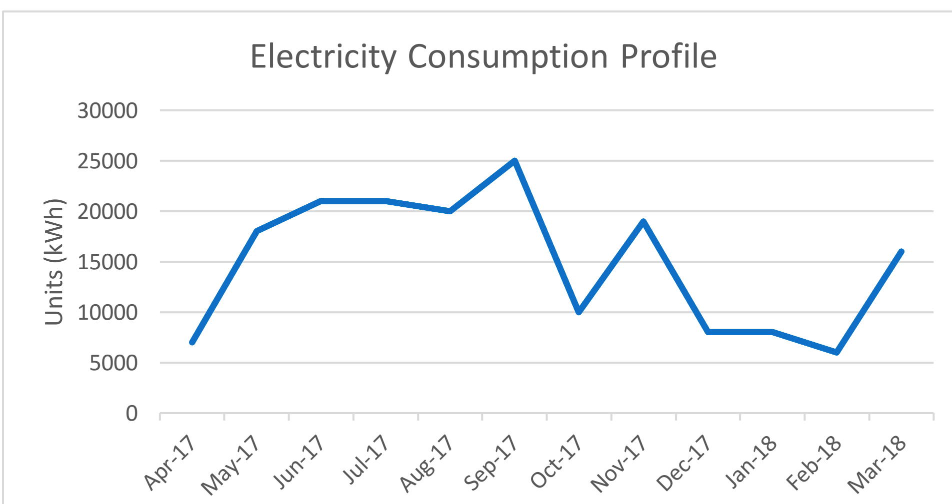


Figure 3: Electricity consumption profile

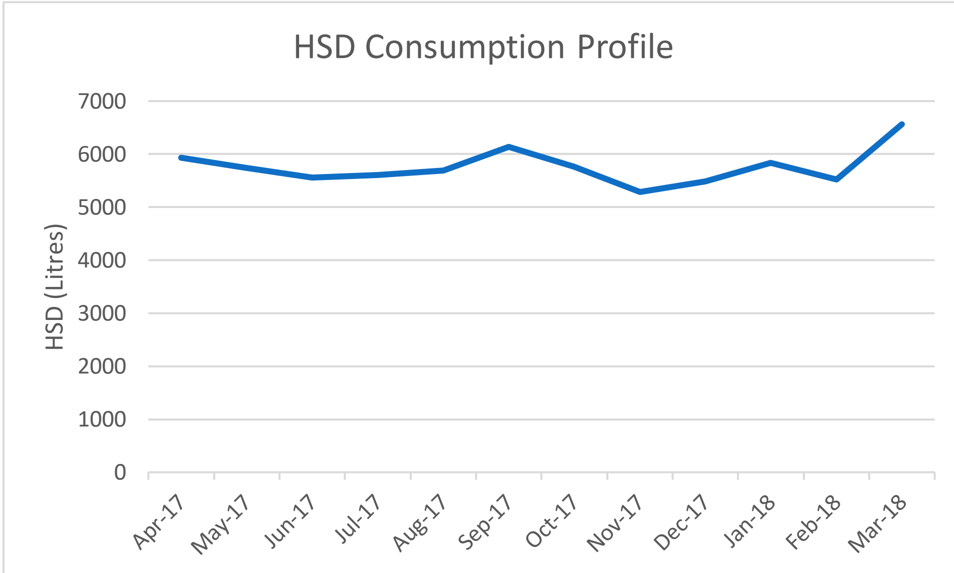


Figure 4: HSD consumption profile

The energy consumption breakup of the plant both thermal and electrical is shown in the below table. Total energy consumption of the plant is 78 MTOE out of which 80% of the total energy is contributed by thermal and rest only 20% is contributed by electricity.

Table 9: Energy consumption breakup of plant

Sl No	Particulars	UOM	
1	Annual Electricity Consumption	kWh	179000
2	Annual Electricity Consumption	kCal	153940000
3	Annual Electricity Consumption	MTOE	15.39
4	Annual Diesel Consumption	Litres	69111
5	Annual Diesel Consumption	kCal	621169668
6	Annual Diesel Consumption	MTOE	62.12
7	Total Energy Consumption	kCal	775109668
8	Total Energy Consumption	MTOE	78

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 0.60 Lakhs/month whereas the average thermal energy cost is Rs 3.85 lakhs/month.

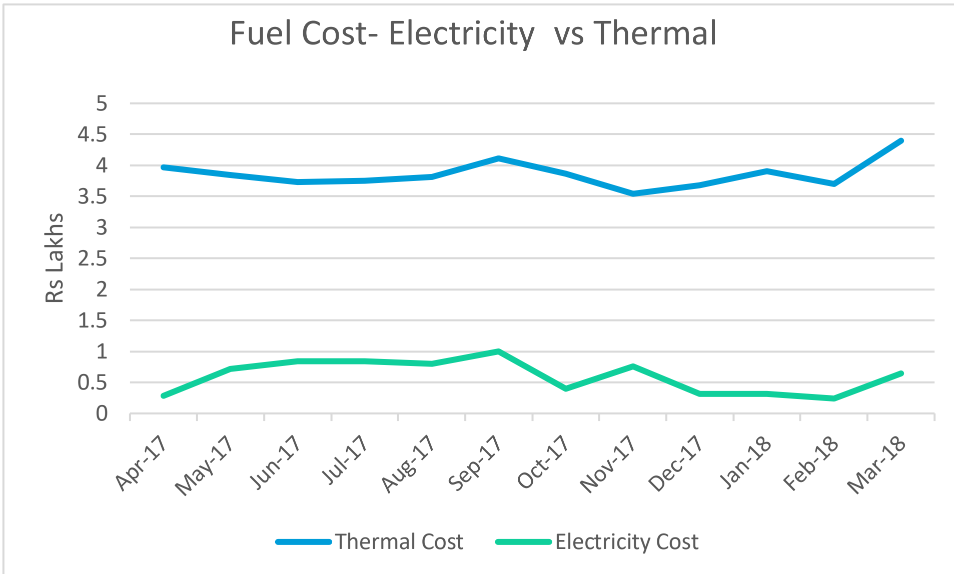


Figure 5: Share of fuel cost

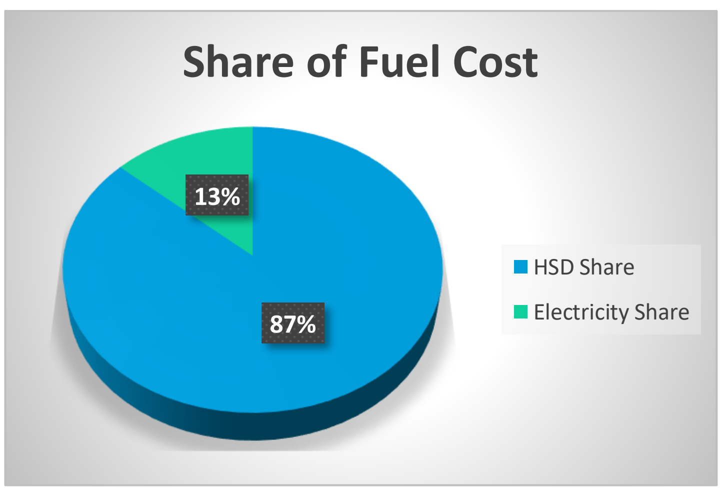


Figure 6: Fuel Cost Electrical vs Thermal

3. PERFORMANCE EVALUATION OF EQUIPMENT/PROCESS

3.1 List of equipment and process where performance testing done

CIII during the detailed energy audit at Gangtok dairy plant carried out measurements and performance testing in the following equipment and process.

Refrigeration System

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

Boiler and Steam System

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

Compressor

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

Pumps

- Efficiency estimation

Electrical

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

3.2 Result of Performance Testing

The table below shows electrical measurements done in the plant.

Table 10: Electrical Measurements

Sl No	Equipment/Feeder	Voltage	Current	Power	PF
1	Chiller Compressor	423	64	43	0.83
2	Chilled Water Pump	422	9.7	6	0.85
3	Boiler Feed Pump	422	3.5	2.0	0.78
4	Packing Machine 1 (2 header in line)	422	2.4	1.4	0.85
5	Packing Machine 03	423	1.1	0.6	0.84
6	Packing Machine 02	422	1	0.6	0.85
7	Evapco 1 Pump 1	423	3.1	1.6	0.75
8	Evapco 2 Pump 3	422	3.0	1.1	0.65
9	Evapco 1 CT Fans (2 Nos)	425	3.6	2.0	0.75
10	Evapco 2 CT Fans (2 Nos)	423	3.5	2	0.74
11	Cold Storage FCU 1	422	2.5	1.4	0.81
12	Cold Storage FCU 2	422	2.5	1.5	0.85
13	Air Compressor	423	9.9	6.1	0.84
14	Pastuerizing Section (Milk Pumps, Homogenizer, Hot water Pump)	424	63.1	38	0.82
15	Can Washing 1	423	8.5	5.3	0.85
16	Can Washing 1	423	9.1	5.6	0.84

Table 11: Transformer Measurements

Rating	Phases	Voltage	Current	Power	PF	VTHD	ITHD
250	R	245	180	34.6	0.77	1.2	3.5
	Y	244	185	36.8	0.80	1.1	3.6
	B	245	176	37.2	0.85	1.1	3.5

- Harmonics are within the limits as per standard IEEE 519 -2014 (VTHD < 8% and ITHD < 15%)
- Currently there is no penalty or rebate for Power factor improvement as the plant is coming under domestic category but still the PF can be improved and can be maintained close to unity by putting capacitor banks.

Table 12: Boiler Efficiency

Boiler Efficiency Direct Method		
Feed Water Temperature	22	deg C
Calorific value of fuel	10800	kCal/kg
Density of HSD	0.84	kg/l
Feed Water Flow	28.8	lpm
Feed Water Flow	472	lph
Feed Water Flow	472	kg/hr
O_2 % in flue gas	13.2	%
HSD Flow	42	LPH

HSD Flow	35.28	kg/hr
Enthalpy of steam at 6.5 kg/cm²	660	kCal/kg
Feed Water Enthalpy at 30 deg C	22	kCal/kg
Boiler Efficiency	79.03	%

Table 13: Pump Measurements

	Description	UOM	Chilled Water Pump
Design Parameters			
	Rated Motor Power	kW	5.50
	Rated Flow	m^3/hr	19.44
	Rated Head	m	45.00
	Design Efficiency	%	39.00
Measured Parameters			
	Power Measured	kW	6.00
	Flow	m^3/hr	15.50
	Head	m	40.00
Calculations	Hydraulic Power	kW	1.69
	Pump shaft Power	kW	5.40
	Efficiency of the pump	%	**31.29**
			Estimated head

Table 14: Performance of Air Compressor

Parameters	UOM	
Rated capacity of compressor	CFM	35
Rated power of compressor	kW	7.5
Free air delivery of compressor(FAD)	CFM	16
Operating power consumption of compressor	kW	6
Specific power consumption of compressor	kW/CFM	0.375
Volumetric Efficiency of compressor	%	45

Table 15: Performance of Chiller Compressor

Parameters	UOM	
Rated size of compressor	kW	55.87
	TR	50
Voltage	Volts	423
Current	Amperes	64
Power Consumption of Compressor	kW	43
Power Factor	PF	0.83
Suction Pressure	bar	1.5
Discharge Pressure	bar	190
Discharge Temperature	°C	105
Evaporator Temperature	°C	-2

Condensing Temperature	ºC	36
Operating Power	kW	43
Operating TR	TR	30
SEC	kW/TR	1.45

3.3 Energy Balance of Gangtok Dairy

During the detailed energy audit at Gangtok dairy the total load on the plant measured at transformer level was 109 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.

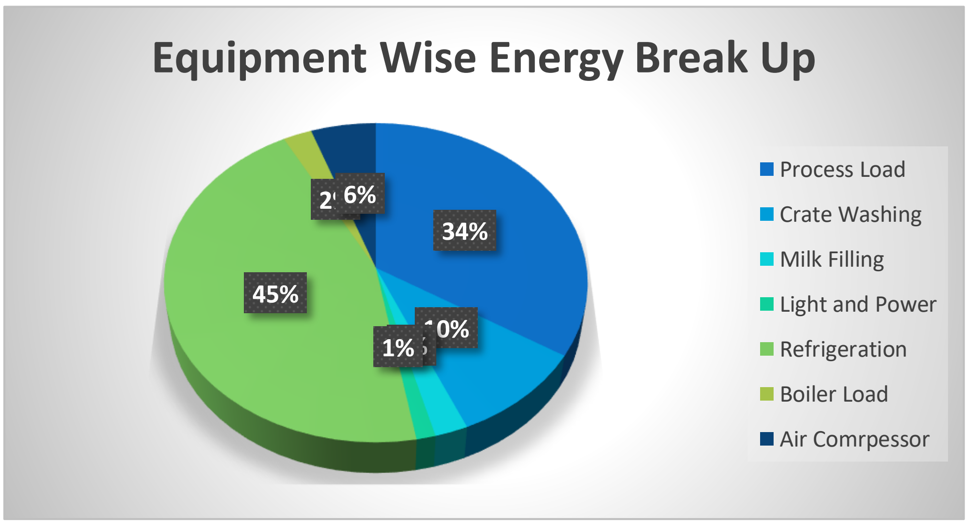


Figure 7: Equipment/Process wise energy breakup

3.4 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.

Sl No	Particulars	UOM	
1	Annual Electricity Consumption	kWh	179000
2	Annual Electricity Consumption	MTOE	15.39
3	Annual Diesel Consumption	Litres	69112
4	Annual Diesel Consumption	MTOE	62.12
5	Total Energy Consumption	MTOE	78
6	Annual Production	Kilo Litres	11680
7	Overall Electrical SEC	kWh/KL	15
8	Overall Thermal SEC	MkCal/KL	0.054
9	Overall SEC	MkCal/KL	0.067

4. ENERGY SAVING PROPOSALS

Energy Saving Proposal 1 – Installation of condensate recovery system

Present System

Gangtok Dairy Plant has installed two HSD boilers for the process application like pasteurization, curd making, CIP, crate washing etc. One boiler is running and one is standby. All the heating process in dairy is through indirect heating.

The table below shows the details of boiler installed in the plant.

Table 16: Boiler Details

Boiler	Fuel Type	Design Capacity (TPH)	Make of the company	Operating Pressure (bar)	Operating Condition	Operating hrs
Boiler 1	HSD Fired	0.6	Ross Boiler	5	Standby	-
Boiler 2	HSD Fired	0.7	Energy Solutions	6	Running	6

One of the major application of steam is pasteurization process where the milk is heated to 72°C for 16 seconds then quickly cooling it to 4°C. This process slows spoilage caused by microbial growth in the food. Hot water at around 70°C to 80°C is used for indirect heating in the pasteurization process.

The condensate after the process heating is currently drained or used in cleaning crates. As the condensate has some heat available which can be utilized in the boiler or any other indirect heating for the processes like CIP, crate washing etc.

During the course of detailed energy audit steam mapping and estimation of condensate that can be recovered was undertaken. Following figure provides the overview of steam usage in the plant:

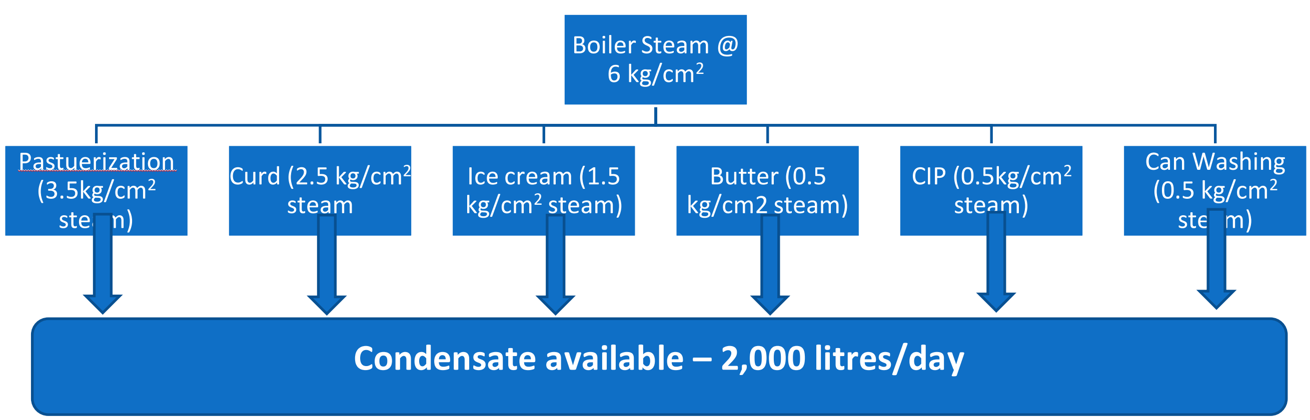


Figure 8: Steam Mapping

The following figures shows the condensate available at different locations:

Figure 9: Condensate from CIP

Figure 10: Condensate from pastuerization

Figure 12; Condensate from curd making

Figure 11: Condensate from hot water tank

Total condensate available for recovery from all the processes is 2000 litres per day at 65°C to 70 °C.

Recommendation

It is recommended to install condensate recovery system to recover all the condensate from various processes. Condensate recovery is a process to reuse the water and sensible heat contained in the discharged condensate. Recovering condensate instead of draining it can lead to significant savings of energy, chemical treatment and make-up water.

The system includes a positive displacement condensate pump which can recover (suck) hot condensate and flash steam from the steam pipeline and feed the same into the boiler feed water tank or a separate receiver of 3000 L capacity. The pump may also be equipped with an in-built receiver for condensate which eliminates the need for a separate storage tank. High pressure condensate is at almost the same pressure as same pressure as steam and contains around 15 to 20% heat of fuel. This heat if recovered shall reduce fuel consumption to the extent of 20%.

The recovered condensate can be used for

- As feed water at 65°C which can be directly used in boiler – Currently the feed water temperature of boiler is 22°C.
- Used in CIP process
- Used for crate washing

Savings

The expected fuel savings by installation of condensate recovery system is 4,320 litres of HSD annually. The annual monetary saving for this project is ***Rs 2.89 Lakhs with an investment of Rs 6.55 lakhs and payback for the project is 2.3 years.***

Detailed savings calculations are given in below table

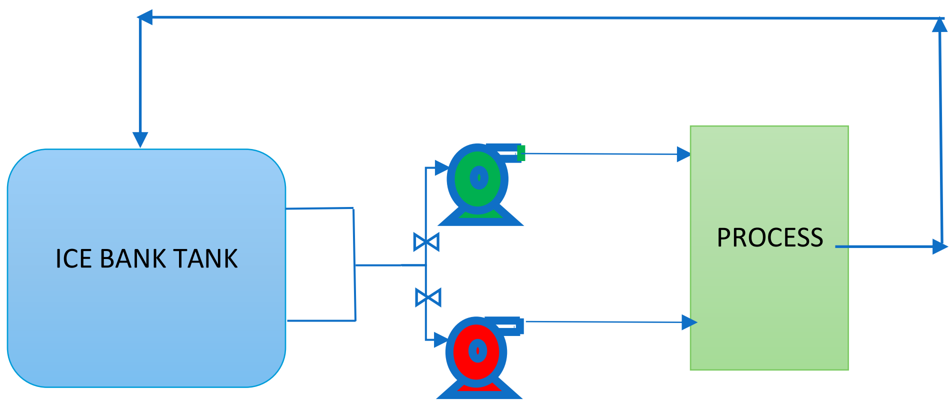
Table 17: Savings Calculation for condensate recovery

Parameters	UOM	
Feed Water Temperature	°C	22
Condensate Available	LPD	2000
GCV of HSD	kCal/kg	10800
Fuel Cost	Rs/L	67
Condensate Temperature	°C	65
Boiler Efficiency	%	79
Heat Available from condensate	kCal	86000
Fuel Savings	kg/day	10.08
Density of HSD	kg/L	0.84
Fuel Savings	LPD	12.00
Operating Days	Days/year	360
Annual Fuel Savings	Litres	4320
Monetary Savings	Rs Lakhs	2.89
Investment	Rs Lakhs	6.55
Pay Back	Years	2.3
NPV AT 70% Debt	**Rs Lakhs**	11.54
IRR (%)	**%**	63.20
TOE Savings	**TOE**	3.92
TCO_2	**TCO_2**	11.60

Energy Saving Proposal 2 – Replacement of existing chilled water pump with energy efficient pump

Present System

Gangtok Dairy Plant has installed two chilled water pumps for pumping chilled water from IBT to process in which one is running and second one is standby. The chilled water is mainly used in pasteurization process and pre chiller where the milk is cooled to 4^{o}C. The figure below shows the schematic of chilled water system in the plant.



Ice bank tank contains chilled water and small quantity of ice almost all time of day, the temperature of IBT is maintained close to zero degree all time with the help of refrigeration compressor. The chilled water required for the various processes are pumped using two pumps of 5.5 kW capacity. Chilled water is mainly used in the pre chiller – cool the incoming milk received from Bulk Milk Coolers by tankers to 4^{o}C to 5^{o}C before going to pasteurization process and also in pasteurization process to cool the milk to 4^{o}C. After the process the return water is coming at 6^{o}C to 8^{o}C The table below shows the details of chilled water pumps performance installed in the plant.

Figure 13: Old Chilled Water Pumps

Table 18: Pump Performance

Parameters	UOM	Design	Measured
Power Consumption	kW	5.5	6
Flow	m^3/hr	19.44	15.5
Head	m	45	40
Efficiency	%	39	31

The design efficiency of the pump is 39% which is very low. 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 31% which is lesser than the design efficiency. The reasons for low efficiency of pump is

- Poor operational practices
- Pump is very old and undergone frequent maintenance
- Poor selection of pump

Recommendation

It is recommended to replace the old chilled 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:-

Parameters	UOM	Present	Proposed Operating Condition
Power Consumption	kW	6	4.5
Flow	m^3/hr	15.5	16
Head	m	40	45
Efficiency	%	31	51

<u>Pump Curves for the new pump</u>

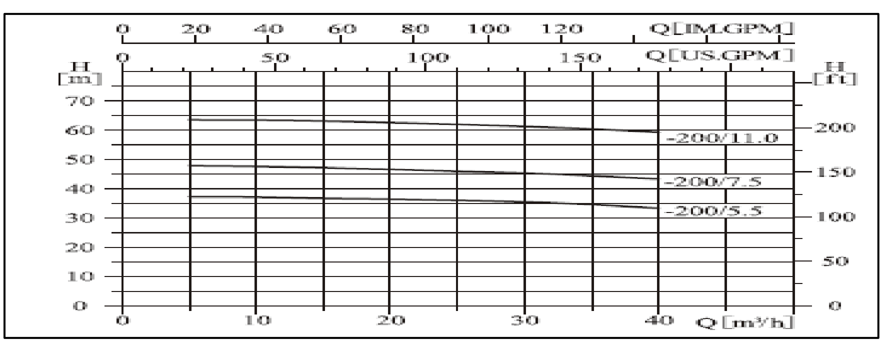


Figure 14: Head vs Flow

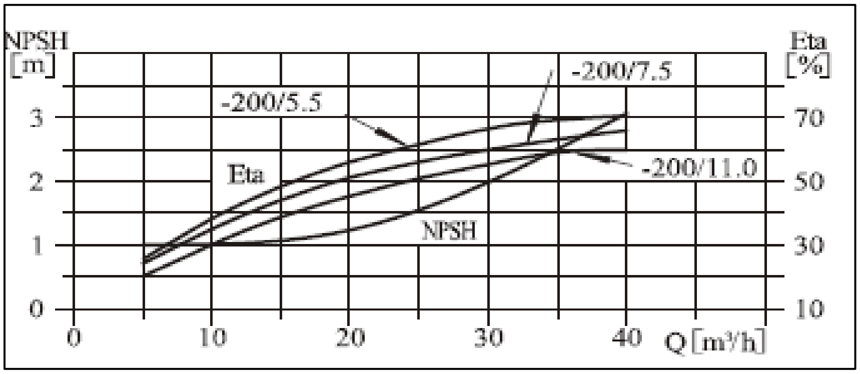


Figure 15: NPSH vs Flow

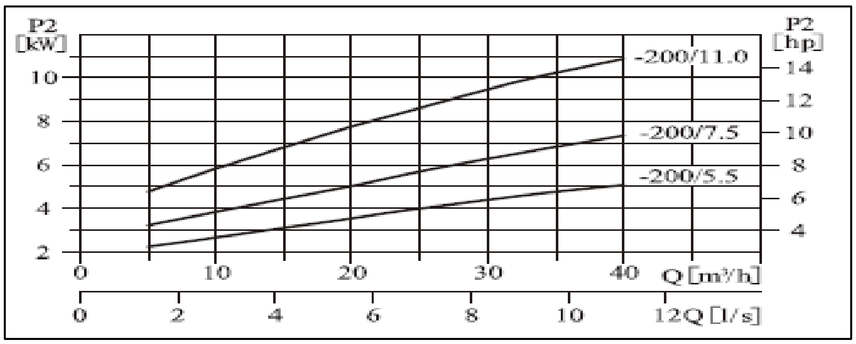


Figure 16: Power vs Flow

Savings

The expected electricity savings by installation of energy efficient chilled water pump is 17,250 units annually. The annual monetary saving for this project is ***Rs 0.18 Lakhs with an investment of Rs 0.98 lakhs and payback for the project is 5.6 years.***

Detailed savings calculations is given in below table

Table 19: Savings Calculation for pump replacement

Parameters	UOM	Present	Proposed Operating Condition
Power Consumption	kW	6	4.5
Flow	m^3/hr	15.5	16
Head	m	40	45
Efficiency	%	35	51
Power Savings	kW	1.5	
Electricity Cost	Rs/kWh	4	
Operating hrs	hrs/day	8.00	
Operating days	Days/year	365	
Energy Savings	kWh	4320	
Cost Savings	Rs Lakhs	0.18	
Investment	Rs Lakhs	0.98	

Pay Back	Years	5.6
NPV AT 70% Debt	**Rs Lakhs**	0.46
IRR (%)	**%**	28.04
TOE Savings	**TOE**	0.37
TCO_2	**TCO_2**	3.54

Energy Saving Proposal 3 – Waste heat recovery from chiller compressor

Present System

Gangtok Dairy Plant has installed reciprocating chiller compressors of 50 TR capacity for the chilled water requirement in the plant. The main compressor is running continuously and there is a booster compressor which runs based on the requirement mainly when ice cream production is there in the plant. For the refrigeration purpose vapor compression-based ammonia cycle is used.

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. It is so constructed that a control quality of refrigerant flows (due to expansion valve) from one necessary steps to another at definite and predetermined pressure. On throttling the pressure and temperature of refrigerant (like ammonia, R-22 etc.) 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. A block diagram of a vapour compression refrigeration system is shown below :

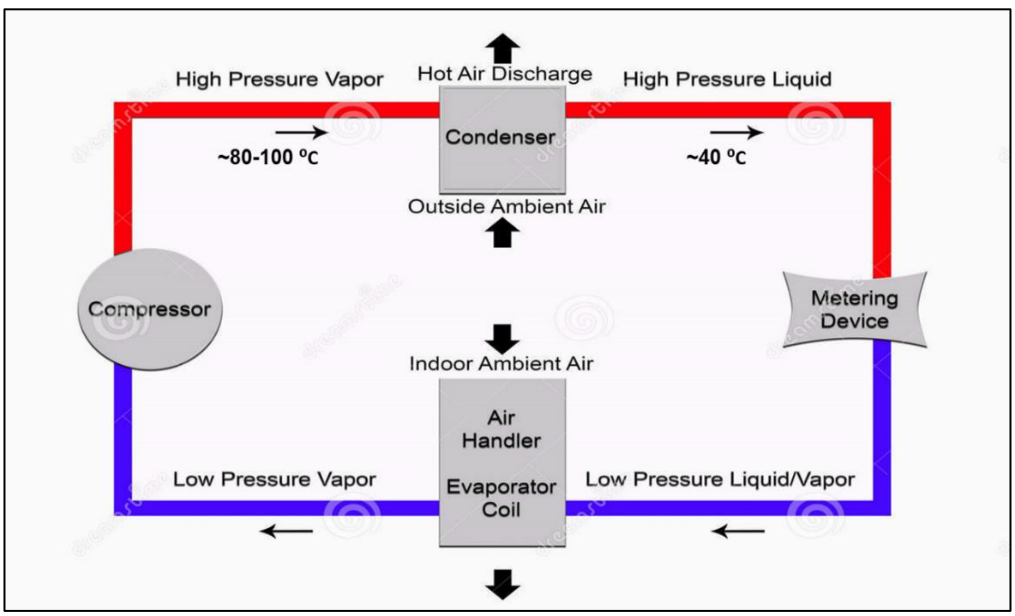


Figure 17: Vapor Compression Cycle

Refrigeration plants with air-cooled and water-cooled condensers produce a lot of waste energy by dumping the condensation energy to the ambient air. By installing a de superheater, a large proportion of this waste energy can be turned into hot water that may be used for many purposes such as:

- CIP
- Boiler feedwater heating
- Process heating for processes like Curd and Ghee preparation
- Crate washing and can washing in chilling center

Recommendation

De-super heater is proposed to be installed on chiller compressors to harness waste heat of ammonia gas. De superheater is installed on discharge side of NH_3 compressor. The temperature of NH_3 gas observed to be 95°C. This ammonia gas is expected to be cooled to 60°C and the recovered heat will be used to heat water from 22 °C to 70 °C. This hot water is proposed to be used in the boiler feedwater. The design of the de superheater has to ensure that you recover adequate heat with the required temperature lift. Apart from the direct energy saving after getting hot water, the heat load on condenser is expected to come down, and if the design is done appropriately, the condensing pressures can also marginally reduce, leading to reduction in power consumption of compressors.

De-superheater units are located between the compressor and condenser to utilize the high-temperature energy of the superheated refrigerant gas. By using a separate heat exchanger to utilize the high temperature of the discharge gas, it is possible to heat water to a higher temperature than would be possible in a condenser.

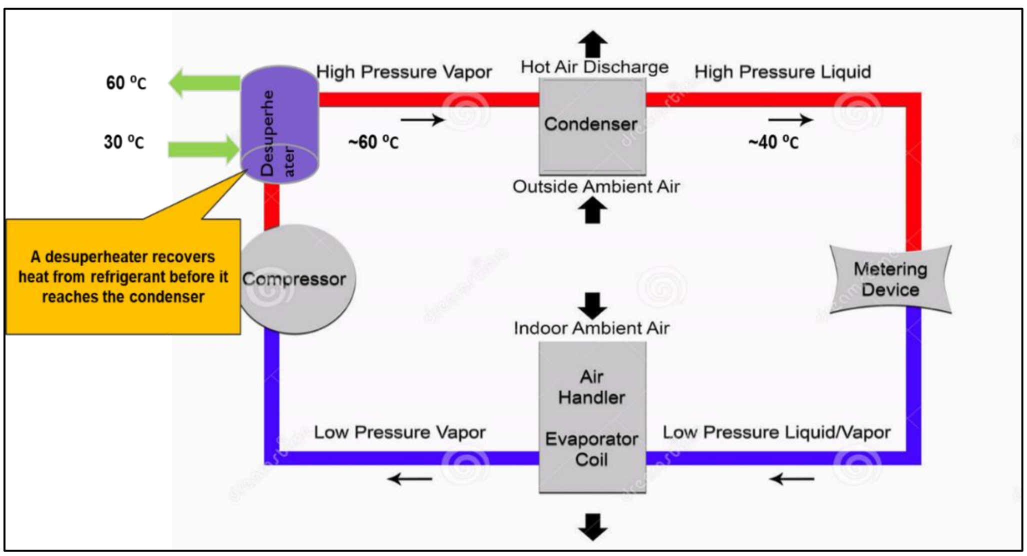


Figure 18: Refrigeration system with desuperheater

Some key technical parameters for the heat recovery system are given below:

Table 20: Technical parameters of desuperheater

Item	Value
Temperature of ammonia gas in/out	110 °C/60 °C
Temperature of water in/out	22 °C /70 °C
Amount of water that can be heated	440 lit/hr
Heat load recovered	22.35 kW

Savings

The expected savings by installation of de super heater is 5,793 litres of HSD annually. The annual monetary saving for this project is ***Rs 3.88 Lakhs with an investment of Rs 7.14 lakhs and payback for the project is 1.8 years.***

Detailed savings calculations are given in below table

Table 21: Savings Calculation for waste heat recovery

Parameters	UOM	
Size of compressor	kW	55.875
Heat Recovery possible	kW	22.35
Heat Recovery possible	kCal/hr	19221
Amount of hot water available for process (from 22 to 70°C)	litre per hour of water at 70°C	400
Hours of operation	hours per day	6
Days of operation	days per year	360
Total heat recovery possible	kCal/year	41517360
Cost of diesel	INR/litre	67
Calorific value	kCal/kg	10800
Boiler efficiency	%	79%
Fuel Savings	kg/year	4866
Density of HSD	kg/litre	0.84
Annual Fuel Savings	Litres/year	5793
Cost of HSD	Rs/Litre	67
Annual Cost Savings	Rs Lakhs	3.88
Investment	Rs Lakhs	7.14
Pay Back	Years	1.8
NPV AT 70% Debt	**Rs Lakhs**	16.29
IRR (%)	**%**	75.85
TOE Savings	**TOE**	5.26
TCO_2	**TCO_2**	15.5

Energy Saving Proposal 4 – Installation of VFD for chiller compressor

Present System

Gangtok Dairy Plant has installed reciprocating chiller compressors of (75 Hp 50 TR) for the chilled water requirement. The main compressor is running continuously and there is a booster compressor which runs only when ice cream production is there. For the refrigeration purpose vapor compression based ammonia cycle is used. The table below shows the details of existing compressor in the plant:

Figure 19: Chiller Compressor

Table 22: Performance of compressor

Parameters	UOM	
Rated size of compressor	kW	55.87
	TR	50
Voltage	Volts	423
Current	Amperes	64
Power Consumption of Compressor	kW	43
Power Factor	PF	0.83
Suction Pressure	bar	1.5
Discharge Pressure	bar	190
Discharge Temperature	ºC	105
Evaporator Temperature	ºC	-2
Condensing Temperature	ºC	36
Operating Power	kW	43
Operating TR	TR	30
SEC	kW/TR	1.45

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.

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^oC) 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. But during afternoon 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.

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 a 75 Hp VFD for the existing reciprocating compressor with suction pressure as the feedback for speed control. Based on the refrigeration load the refrigerant temperature required will varies and hence the suction pressure. During the light load condition ie afternoon when the pasteurization process stops compressor runs only to maintain IBT temperature and to maintain the temperature in cold storage. During this time with suction pressure as the feedback. Once the evaporator achieve the desired temperature, with proper feedback the speed of the compressor can be reduced and hence power savings can be achieved.

Savings

The expected electricity savings by installation of VFD for chiller compressor is 30,960 units annually. The annual monetary saving for this project is ***Rs 1.24 Lakhs with an investment of Rs 3.00 lakhs and payback for the project is 2.4 years.***

Detailed savings calculations is given in below table:

Table 23: Savings Calculation for VFD for chiller compressor

Parameters	UOM	
Size of compressor	kW	55.875

	TR	50
Power Consumption of Compressor	kW	43
Power Savings	%	20
Power Consumption after installing VFD	kW	34
Power Savings	kW	8.60
Hours of operation	hours per day	10
Days of operation	days per year	360
Annual Energy Savings	kWh	30960
Electricity Cost	Rs/kWh	4
Savings per year	Rs Lakhs	1.24
Investment	Rs Lakhs	3.00
Pay Back	Years	2.4
NPV AT 70% Debt	**Rs Lakhs**	4.91
IRR (%)	**%**	60.11
TOE Savings	**TOE**	2.66
TCO_2	**TCO_2**	25.4

Energy Saving Proposal 5 – Installation of Heat Pump for preheating boiler feed water

Present System

Gangtok Dairy Plant has installed two HSD boilers for the process application like pasteurization, curd making, CIP, crate washing etc. One boiler is running and one is standby. All the heating process in dairy is through indirect heating.

The table below shows the details of boiler installed in the plant.

Table 24: Boiler Details

Boiler	Fuel Type	Design Capacity (TPH)	Make of the company	Operating Pressure (bar)	Operating Condition	Operating hrs
Boiler 1	HSD Fired	0.6	Ross Boiler	5	Standby	-
Boiler 2	HSD Fired	0.7	Energy Solutions	6	Running	6

Table 25: Efficiency calculation of 0.7 TPH boiler

Boiler Efficiency Calculation for 0.7 TPH Boiler		
Feed Water Temperature	22	°C
Calorific value of fuel	10800	kCal/kg
Density of HSD	0.84	kg/l
Feed Water Flow	472	lph
Feed Water Flow	472	kg/hr
HSD Flow	35.28	kg/hr
Enthalpy of steam at 6.5 kg/cm²	660	kCal/kg
Feed Water Enthalpy at 22 deg C	22	kCal/kg
Boiler Efficiency	79	%

Currently the feed water for the boiler is taken from a 1500 litre tank using a 3 Hp feed water pump. During the study it was observed that the feed water temperature is 22°C and feed water required for the boiler is 472 litres per hour. Since the feed water is going at ambient condition to the boiler more fuel is to be burned inside the boiler to generate steam at higher temperature. Also lower temperature of feed water can result in the formation of dissolved oxygen which can lead to corrosion.

Figure 20: 700 kG Boiler

Recommendation

It is recommended to install a 28 kW electrical heat pump for boiler feed water heating from 22°C to 80°C. An EHP system works on the principle of the 'heat pump'. This is the cyclic process in which heat is taken up from an area of cold temperature and discarded into an area of high temperature.

A heat pump cannot operate by itself; it requires an external energy source. In an electric heat pump (EHP) system, electrical energy is used to drive the heat pump.

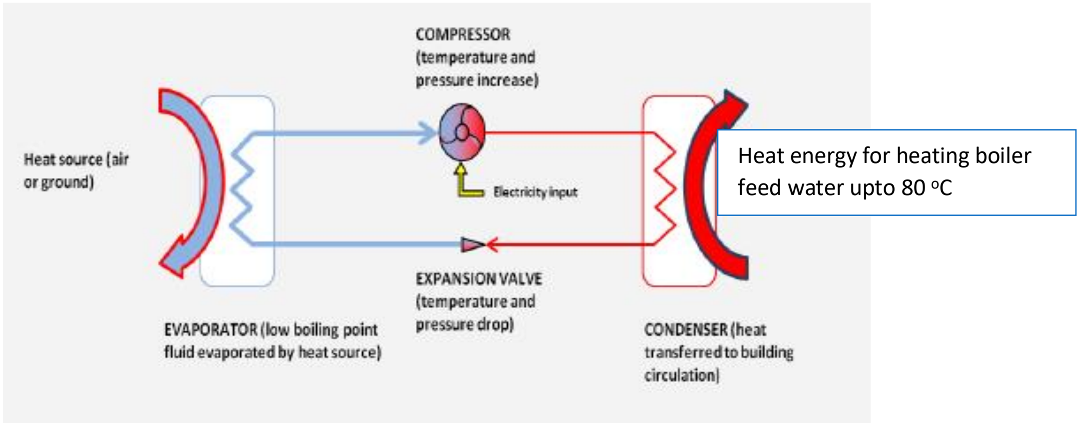


Figure 21 : Heat Pump working

The heat pump is similar to a chiller unit where the utilization point is from condenser part for heating application. It has four basic components compressor, condenser, expansion valve and an evaporator. When electrical energy is given to unit, compressor compresses the R134a refrigerant to high temperature high pressure vapor. From compressor the vapor goes to the condenser which is basically a heat exchanger where on one side boiler feed water is circulated and other side refrigerant flows. The heat from the refrigerant is dissipated to the boiler feed water which in coming at 22°C. The heat is used to heat the boiler feed water to 80°C[3] and fed to the boiler. The refrigerant is then expanded using an expansion valve to low temperature low pressure vapor and given to the evaporator. In the evaporator using small fans installed on the top of heat pump the ambient air is used to evaporate the refrigerant due to it low boiling point. The low temperature low pressure vapor is sucked in by the compressor and cycle is repeated. The COP of heat pump is 2.5 i.e. if 1 kW of energy can generate 2.5 kW of heat energy.

The heat pump is supplied on a rental model for initial period of one year at an amount of Rs 25,000 + 18% GST per month. The rental model will be automatically renewed every year.

Savings

The expected savings by installation of electrical heat pump is 8247 litres of HSD annually. The annual monetary saving for this project is ***Rs 4.43 Lakhs with an investment of Rs 3.54 lakhs and payback for the project is 0.8 years.***

Detailed savings calculations is given in below table

Table 26: Savings Calculation for heat pump

Parameters	UOM	
Feed Water Temperature	°C	22
GCV of fuel	kCal/kg	10800
Boiler Efficiency	%	79

Feed Water Requirement	kg/hr	472
Feed Water Requirement for 6 hour boiler operation	kg/day	2832
Max temperature delivered by heat pump	°C	80
Heat Energy required to raise temp to 80 °C	kCal/day	164256
Pipe line losses	%	10
Heat Energy required to raise temp to 80 °C after losses	kWh/day	212.22
Operating hrs of heat pump	hrs/day	8
Electrical heat energy of pump	kW	26.53
COP of Heat Pump		2.5
Fuel required for equivalent energy of 108000 kCal/day	litre/day	22.91
Auxiliary Power Consumption of Heat Pump	kW	10
Energy Consumption of heat pump	kWh/day	76.4
Operating days	days	360
Fuel Cost	Rs/litre	67
Electricity Cost	Rs/kWh	4
Annual Fuel Savings	Rs Lakhs	5.53
Electricity cost for running heat pump	Rs Lakhs	1.10
Net Annual Savings	Rs Lakhs	4.43
Size of Heat Pump available for producing 17.44 kW Electrical Heat Energy	kW	28
Investment for 28 kW Heat Pump	Rs Lakhs	3.54
Pay Back	Years	0.8
NPV AT 70% Debt	**Rs Lakhs**	20.83
IRR (%)	**%**	153.31
TOE Savings	**TOE**	7.48
TCO_2	**TCO_2**	22.10

Energy Saving Proposal 6 – Installation of temperature interlock control for EVAPCO fans

Present System

The plant has installed an evaporative condenser to condense the high temperature refrigerant coming from compressor. During the audit only one condenser was running and other was stopped due to maintenance related problem. The condenser is having two pumps in which one is standby and other one is running, also two fans are running continuously without any temperature interlock.

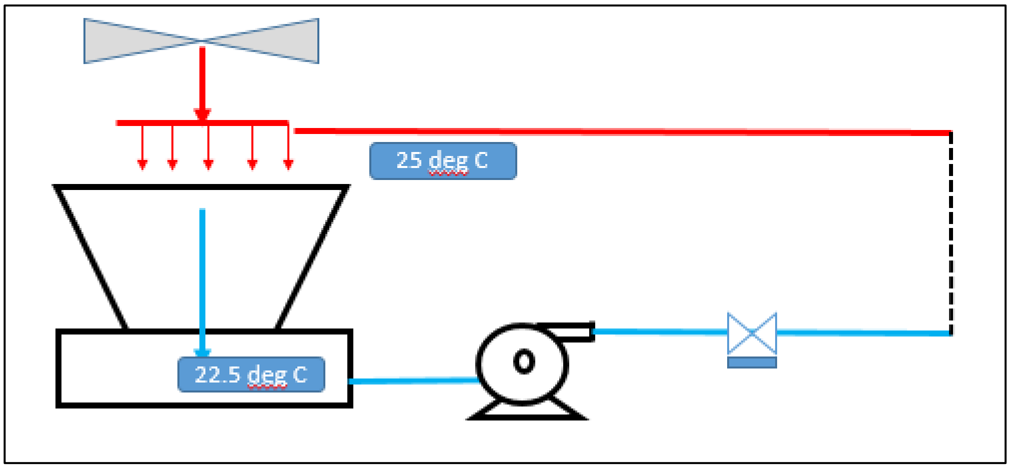


Figure 22: Evaporative Condenser

Cooling water fans are operated manually. Based on manual discussions and on seasonal variations, the fan to be run is set. Also it was observed that there was no control on the fan speed.

The temperature difference between the inlet and outlet of the condenser was measured to be 25^{0}C and 22.5^{0}C respectively. The outlet temperatures of the evapco were very close to WBT.

Recommendation

It is recommended to install a temperature interlock controller for the condenser fans. The TIC should be interlocked with cooling water sump temperature (WBT +3°C). After interlocking the condenser fans operation will be based on cold well temperature. The fans will operate in such a way that if the cold well temperature falls below 22°C, CT fan will automatically switch off. Savings can be achieved in favourable condition.

Savings

The expected savings by installation of TIC for condenser fans is 2126 units annually. The annual monetary saving for this project is ***Rs 0.09 Lakhs with an investment of Rs 0.10 Lakhs and payback for the project is 1.1 years.***

Table 27: Saving calculation for TIC

Parameters	UOM	
Fan Power	kW	4.43
Power Consumption after installing TIC	kW	2.215
Power Savings	kW	2.215
Hours of operation	hours per day	8
Days of operation	days per year	120
Annual Energy Savings	kWh	2126.4
Electricity Cost	Rs/kWh	4
Savings per year	Rs Lakhs	0.09
Investment	Rs Lakhs	0.10
Pay Back	Years	1.1
NPV AT 70% Debt	**Rs Lakhs**	0.41
IRR (%)	**%**	115.85
TOE Savings	**TOE**	0.18
TCO_2	**TCO_2**	1.70

Energy Saving Proposal 7 – Installation of 30 kWp Solar Roof Top

Present System

Gangtok Dairy Plant is purchasing electricity from grid for the operation of various equipment's in the plant. The contract demand of the plant is 200 kVA with electricity price of Rs 4/kWh with an average load of 100kW to 130kW.

Observation

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


Figure 23: Rooftop area for solar

Table 28: Site Specifications

Parameters	
Effective Rooftop available ,sq ft	3000
Location	Latitude: - 27° 20' 20.17" N, Longitude: - 88° 36' 23.41" E
Altitude above sea level, m	1484
Annual in plane irradiation	1533 kWh/m2

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 0.45 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 45,990 units of electricity annually. The annual monetary saving for this project is ***Rs 1.84 Lakhs with an investment of Rs 17.32 lakhs and payback for the project is 9.4 years.***

Detailed savings calculations is given in below table

Table 29: Savings calculation for solar roof top

Parameters	UOM	
Proposed Roof top Solar installation	kW	30
Area Available at Roof	Sq.ft	3000
Annual units generation per kW of Solar PV	kWh per kW/year	1533
Total Energy Generation Per Annum	kWh/year	45,990
Electricity Cost	Rs/kWh	4
Cost Savings	Rs Lakhs	1.8
Investment	Rs Lakhs	17.3
Payback period	Years	9.4
NPV AT 70% Debt	**Rs Lakhs**	1.20
IRR (%)	**%**	13.40
TOE Savings	**TOE**	3.96
TCO_2	**TCO_2**	37.70

Energy Saving Proposal 8 – Replacement of existing compressor with Screw Compressor

Present System

Gangtok Dairy Plant has installed reciprocating compressor of rated capacity 35 CFM to cater the compressed air requirement of the plant.

Over a period of time the reciprocating compressor operating efficiency comes down and the quantity of free air delivered reduces due to reasons such as poor maintenance, wear and tear etc.

If the operating efficiency of the compressor is low the specific power consumption (kW/cfm) increases and hence the cost of compressed air goes up. The quantity of free air delivered, operating efficiency and the specific power consumption of the compressor can be determined by carrying out a performance test. If the specific power consumption increases by 25 - 30 % as compared to a new efficient compressor, it makes economic sense to replace the compressor with new efficient.

Compressor free air delivery test (FAD) was conducted for the reciprocating compressor to evaluate the volumetric efficiency and specific power consumption.

The parameters of the FAD test conducted is shown below:

Table 30: Performance of compressor

Parameters	UOM	
Rated capacity of compressor	CFM	35
Rated power of compressor	kW	7.5
Free air delivery of compressor(FAD)	CFM	16
Operating power consumption of compressor	kW	6
Specific power consumption of compressor	kW/CFM	0.375
Volumetric Efficiency of compressor	%	45

It can be seen clearly from the above parameters that the volumetric efficiency of the compressor is on lower side and have high operating specific energy consumption (SEC) figure 0.37kW/CFM. Typically for reciprocating compressor the specific power consumption should be 0.13 kW/CFM at an operating pressure of 6.5 kg/cm^2

Recommendation

It is recommended to replace the existing 35 CFM/7.5 kW reciprocating compressor with a new screw compressor and the keep the old one as standby.

- Rated Power: 5.5 kW
- Rated Capacity: 25 CFM
- Overall specific power consumption: 0.17kW/CFM @7 Kg/cm^2

Savings

The expected electricity savings by replacement of the old compressor with new screw one is 4,900 units annually. The annual monetary saving for this project is ***Rs 0.20 Lakhs with an investment of Rs 1.00 lakh and payback for the project is 5 years.***

Detailed savings calculations is given in below table:

Table 31: Savings Calculation for air compressor

Parameters	UOM	
Power consumption of the existing compressor	kW	6
Rated capacity of the new compressor	CFM	25
Specific power consumption of the new compressor@ 6 kg/cm^2	kW/CFM	0.13
Anticipated power consumption of new compressor	kW	3.25
Power Savings	kW	2.75
Hours of operation	hours per day	5
Days of operation	days per year	360
Annual Energy Savings	kWh	4900
Electricity Cost	Rs/kWh	4
Savings per year	Rs Lakhs	0.20
Investment	Rs Lakhs	1.00
Pay Back	Years	5
NPV AT 70% Debt	**Rs Lakhs**	0.56
IRR (%)	**%**	30.67
TOE Savings	**TOE**	0.42
TCO_2	**TCO_2**	4.00

5. MANAGEMENT ASPECTS AND CONCLUSIONS

THE OBJECTIVES OF GANGTOK DAIRY MAIN PLANT SHOULD BE

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

5.1 Approach to an Energy Conservation Idea

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

5.2 Specific Recommendations

Gangtok Dairy Main Plant 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. Gangtok 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 Gangtok Dairy Main Plant should be to implement the identified proposals and get the savings.

We would recommend Gangtok Dairy Main Plant 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, Gangtok Dairy Main Plant should carry out the following motivational aspects to sustain energy conservation activities.

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

5.6 Conclusions

- Gangtok Dairy Main Plant and CII – Godrej GBC teams have jointly identified **08** energy saving proposals worth an annual saving potential of **Rs. 14.74 Lakhs**. The investment required for implementation of energy saving proposals is **Rs. 39.63 Lakhs**. The total investment will have a simple payback period of **2.7 years.**

Table 32: Summary of savings

Details	No. of Proposals	Annual savings
Total Annual savings	08	14.74
Investment Required (Rs. Lakhs)	08	39.63
Pay Back	Years	2.7

Table 33: Summary of fuel savings

Details	UOM	Annual savings
Total Electricity Savings	kWh	88296
Total Fuel Savings (HSD)	Litres	18360
Annual TOE Savings	TOE	24.24
Annual TCO_2	TCO_2	121.60

Table 34: Summary of Energy Saving Proposals

Sl. No.	Energy Saving Proposals	Annual savings (lakhs)	Investment (lakhs)	Payback, Years	Electricity Savings (kWh)	Fuel Savings (HSD)	TOE savings	TCO2 savings
1	Installation of condensate recovery system	2.89	6.55	2.3		4320	3.92	11.6
2	Replacement of existing chilled water pump with energy efficient pump	0.18	0.98	5.4	4320		0.37	3.5
3	Waste heat recovery from chiller compressor	3.88	7.14	1.8		5793	5.26	15.5
4	Installation of VFD for chiller compressor	1.24	3	2.4	30960		2.66	25.4
5	Installation of Heat Pump for preheating boiler feed water	4.43	3.54	0.8		8247	7.48	22.1
6	Installation of temperature interlock control for EVAPCO fans	0.085	0.1	1.1	2126		0.18	1.7
7	Installation of 30 kWp Solar Roof Top	1.84	17.32	9.4	45990		3.96	37.7
8	Replacement of existing compressor with Screw Compressor	0.2	1	5	4900		0.42	4.0
	Total	**14.745**	**39.63**	**2.7**	**88296**	**18360**	**24.2**	**121.6**

5.7 Gangtok Dairy, Main Plant should

- Assign specific responsibility for implementation of proposals

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

6. ANNEXURE

6.1 Common Monitorable Parameters in Dairy

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

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

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

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

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

6.2 Supplier Details

Sl.No	Equipment	Supplier Name	Contact Person	Contact Number	Mail Address
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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
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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
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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
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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
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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
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71	**Insulation**	Permacel	Mr.Venkatesh Kulkarni	9892513453	vkulkarni@prs-permacel.com
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74	**Insulation**	Rockwool India Pvt Ltd	Mr Kevin Pereira		kpereira@rockwoolindia.com
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83	**LED**	E view Global PVt Ltd	Mr Rajiv Gupta	9757158328	rajiv@eviewglobal.com
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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
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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
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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 Kuvalekar Datta	9823199619	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@katipumps.com
128	**Vaccum Pumps**	Atlas Copco	Mr Vigneswaran	8975090551	n.vigneswaran@in.atlascopco.com
129	**VAM**	Transparent Energy Systems Pvt. Ltd	Mr Ajit Apte	020 24211347	ajit.apte@tespl.com
130	**VFD**	Yaskawa	Mr Sree Kumar	9573770123	sreekumar_n@yaskawa.in
131	**VFD**	Danfoss	Mr Nagahari Krishna	9500065867	Nagahari@danfoss.com
132	**VFD**	Siemens	Mr Shanti Swaroop	9000988322	santhiswaroop.m@siemens.com
133	**VFD**	Schneider Electric India Pvt. Ltd.	Mr Amresh Deshpande	0124 - 3940400	Amresh.Deshpande@schneider-electric.com
134	**VFD**	Rockwell Automation India Pvt. Ltd. (Allen-Bradley India Ltd.)	Ms Ruchi Mathur	9711991447	rmathur@ra.rockwell.com
135	**VFD**	ABB Ltd	Mr Madhav Vemuri		madhav.vemuri@in.abb.com
136	**Bio Gas**	FOV Bio Gas	Mr Joseph	9940159968	joseph@nordcleantech.com
137	**Boiler**	Energy Solutions	Mr Arnab	9831005354	Arnab231@gmail.com
138	**Refrigeration Compressor**	Frick India	Mr Rajendar Singh	9331059109	cal@frick.co.in
139	**Heat Pump**	Aspiration Energy	Mr. Sudharshan	98406 19252	sudharsan.r@aspirationenergy.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**	**Rem arks**
1	Installation of condensate recovery system	2.89	6.55	27			
2	Replacement of existing chilled water pump with energy efficient pump	0.18	0.98	65			
3	Waste heat recovery from chiller compressor	3.88	7.14	22			
4	Installation of VFD for chiller compressor	1.24	3	29			
5	Installation of Heat Pump for preheating boiler feed water	4.43	3.54	10			
6	Installation of temperature interlock control for EVAPCO fans	0.085	0.1	14			
7	Installation of 30 kWp Solar Roof Top	1.84	17.32	113			
8	Replacement of existing compressor with Screw Compressor	0.2	1	60			
	Total	**14.745**	**39.63**	**32**			

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