August 2018

DETAILED PROJECT REPORT ON VFD FOR AMMONIA COMPRESSOR

M/s Gangtok Dairy Plant – Sikkim Dairy Cluster

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

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Prepared by

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List of Abbreviations

BEE	Bureau of Energy Efficiency
CS	Capital Structure
°C	°Celsius
CO_2	Carbon dioxide
DPR	Detailed Project Report
EE	Energy Efficiency
FI	Financial Institution
GEF	Global Environmental Facility
HSD	High Speed Diesel
IBT	Ice Bank Tank
IRR	Internal Rate of Return
kW	Kilo Watt
LSP	Local Service Provider
MSME	Micro and Medium Scale Industries
NPV	Net Present Value
OEM	Original Equipment Manufacturer
RE	Renewable Energy
SBI	State Bank of India
SIDBI	Small Industrial Development Bank of India
TOE	Tonnes of Oil Equivalent
UNIDO	United Nations Industrial Development Organisation
VFD	Variable Frequency Drive
WACC	Weighted Average Cost of Capital
VFD	Variable Frequency Drives

ACKNOWLEDGEMENT

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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 Project 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.

Key activities involved in the project are shown below

- **LSP MAPPING:** Detailed Mapping of LSPs in the cluster.
- **TECHNOLOGY FEASIBILITY STUDIES:** Preparation of 10 bankable DPRs.
- **TRAINING MATERIALS:** Development of 5 customized training material based on mapping
- **TRAINING PROGRAM:** Conduct 4 training programs in the cluster for the capacity building of local service providers.
- **LSP's AS LOCAL DISTRIBUTORS:** Mapping of LSPs and OEMs so that LSPs can be local dealers for major OEMs.

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

1.2 Proposed EE Measure

After the discussion with the plant team, it has been decided to install VFD for chiller compressor. The details of the proposed EE measure is given in below table:

Table 2: Proposed EE Measure

Sl No	EE Measure	Annual Energy Savings		Monetary Savings (Rs. Lakhs)	Investment (Rs. Lakhs)	Payback (Months)	Annual TCO_2 reduction
		kWh	TOE				
1	Installation of VFD – Chiller Compressor	30,960	2.66	1.24	3.00	29	25.39

1.3 Means of Finance

The details of means of finance for the proposed EE measure is as under:

Table 3; Project Finance

Sl. No.	Particulars	Unit	Value
i	Total Investment (Incl of Tax)	Rs. Lakh	**3.00**
ii	Means of Finance	Self / Bank Finance	**Self**
Iii	IRR	%	**60.05**
Iv	NPV at 70 % Debt	Rs. Lakh	**4.90**

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 4: 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:-

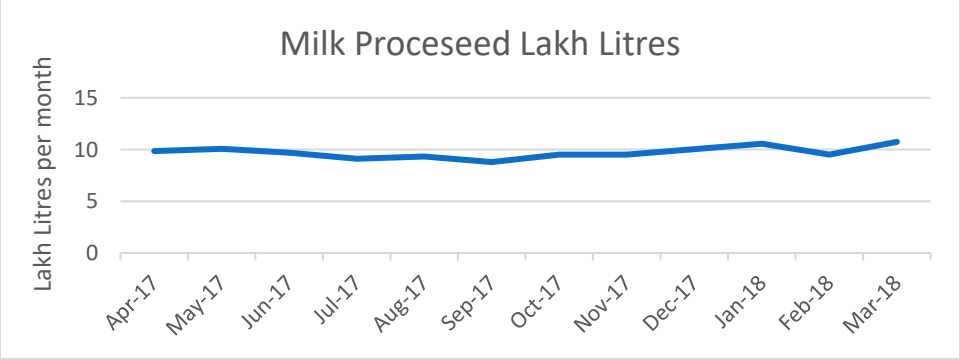

Figure 1: Milk Processed

2.3 Typical Dairy Process Flow Diagram

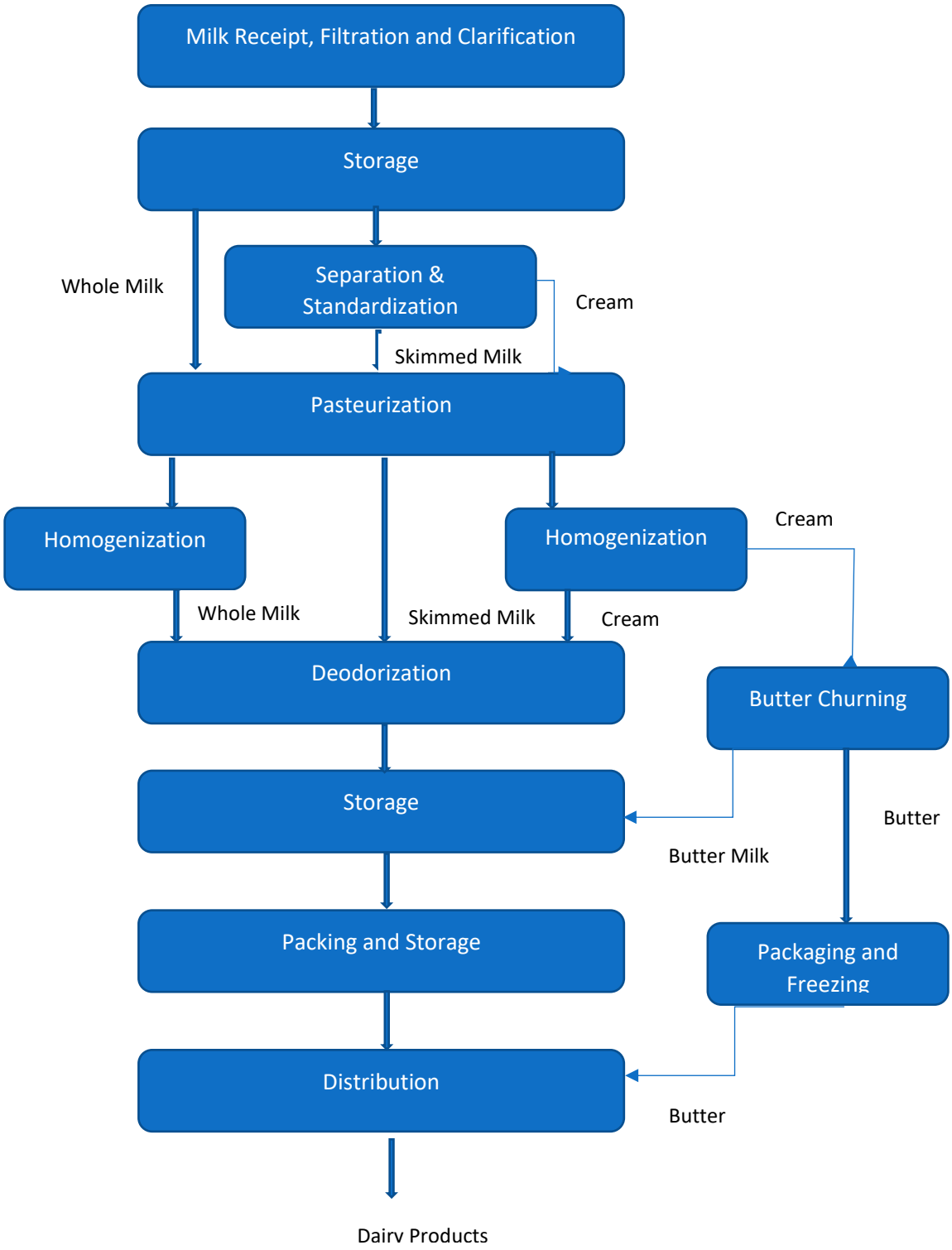

Figure 2: Typical process flow of Milk manufacturing

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 5: 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

2.3 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 6: 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

Table 7: 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**

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. The percentage share of fuel cost is shown below:-

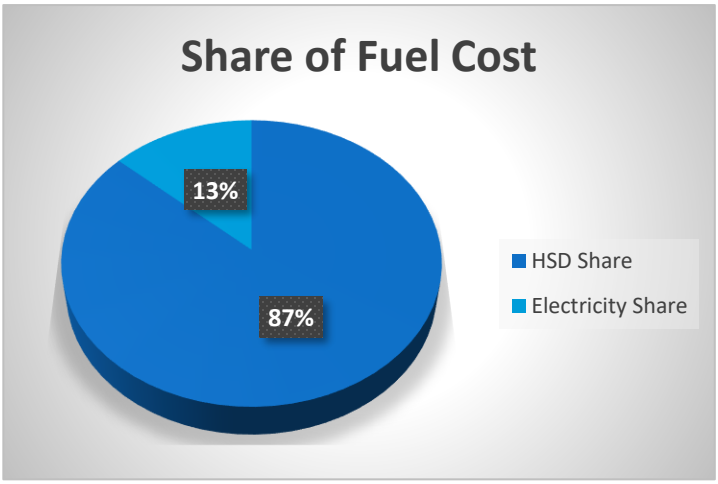

Figure 3: Share of fuel cost

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.

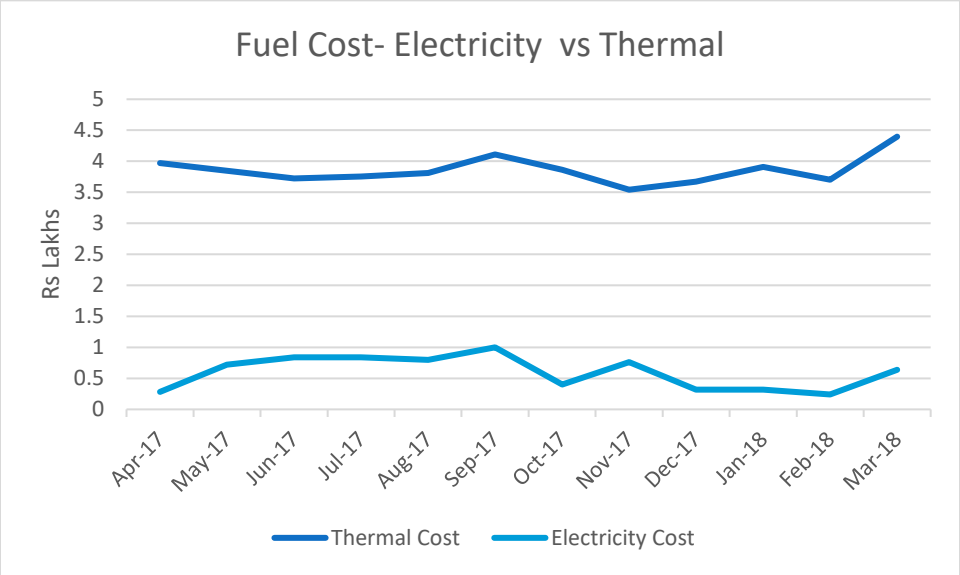

Figure 4: Fuel Cost Electrical vs Thermal

3. PROPOSED EE MEASURE – VFD FOR CHILLER COMPRESSOR

3.1 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 5: Chiller Compressor

Table 8: 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	°C	105
Evaporator Temperature	°C	-2
Condensing Temperature	°C	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 $0^{o}C$) and also for the Fan Coil units to maintain the temperature at cold storage. During the morning time when all the processes (mainly pasteurization and pre chilling of raw milk) are in operation the compressor is 80% to 100% loaded and consumes more power. 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.

3.2 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.

3.3 Supplier Details

Table 9: Supplier Detail

Equipment Detail	VFD for refrigeration compressor
Supplier Name[3]	Frick India Ltd
Address	Frick India Ltd. 5/2 Russel Street, Kolkata – 700 071
Contact Person	Mr. Rajender Singh
Mail Id	cal@frick.co.in
Phone No	+91 9331059109

3.4 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 29 months.***

Detailed savings calculations is given in below table:

Table 10: Savings Calculation

Parameters	UOM	
Size of compressor	kW	55.875
	TR	50
Power Consumption of Compressor	kW	43
Power Savings	%	20[4]
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	Months	29

[3] Quotation of only one supplier who is the OEM of the refrigeration section
[4] Guaranteed savings by supplier

4. FINANCIAL ANALYSIS

4.1 Project Cost

Table 11: Project Cost

Parameter	Amount in Rs Lakhs
VFD Cost	2.55
GST Charges @ 18%	0.45
Total Project Cost	**3.00**

4.2 Assumptions for Financial Analysis

- Interest rate taken as 12 %
- Yearly increase in electricity cost by 2% for cash flow analysis
- Life cycle of the project is taken as 7 years
- Three different Capital Structure considered
    - CS1 – 70:30 Debt Equity Ratio
    - CS2 – 50:50 Debt Equity Ratio
    - CS3 – 100 % Equity
- Return on equity is taken as 15 %
- Depreciation
- Operation and Maintenance Cost taken as 5% of Initial investment
- For calculating weighted average cost of capital, tax rate is assumed as 30 %

4.3 Cash Flow Analysis

Table 12: Cash flow of the project

Cash flow for the project		1	2	3	4	5	6	7
	Year 0	Year 1	Year 2	Year 3	Year 4	Year 5	Year 6	Year 7
Required Investment	3.00							
Energy Savings		1.24	1.26	1.29	1.31	1.34	1.37	1.39
O&M Cost		-0.15	-0.15	-0.15	-0.15	-0.15	-0.15	-0.15
Depreciation		1.2	0.7	0.43	0.3	0.2	0.1	0.1
Net Cash Flow	-3.00	2.29	1.83	1.57	1.42	1.35	1.31	1.30

The table below shows the various capital structure assumed for the project finance

Table 13: Capital Structure

Capital Structure			
Particulars	CS 1	CS 2	CS 3
Debt	70	50	0
Cost of Debt	0.12	0.12	0.12
Equity	30	50	100
Cost of Equity	0.15	0.15	0.15
WACC	10.38	11.7	15

Table 14: NPV Calculation

NPV Calculation	Year 0	Year 1	Year 2	Year 3	Year 4	Year 5	Year 6	Year 7	NPV
NPV at CS 1 (70:30)	-3.00	2.1	1.5	1.2	1.0	0.8	0.7	0.7	4.9
NPV at CS 2 (50:50)	-3.00	2.0	1.5	1.1	0.9	0.8	0.7	0.6	4.6
NPV at CS 3 (100% Equity)	-3.00	2.0	1.4	1.0	0.8	0.7	0.6	0.5	3.9

4.3 Sensitivity Analysis

A sensitivity analysis has been carried out to ascertain how the project financials would behave In different situations such as

- Change in energy savings
- Change in operating hours
- Change in interest rate

A good sensitivity analysis will help to estimate the behavioral nature thereby helping to understand the financial viability over a long period of time.

Table 15: Sensitivity analysis: based on energy savings

Based on Savings	at 100% Savings	at 75% Savings	at 50% Savings
NPV at CS 1 (D70:E30)	4.9	3.3	1.8
NPV at CS2 (D50:E50)	4.6	2.8	1.4
NPV at CS3 (D0:E100)	3.9	2.6	1.2
IRR	60%	47%	32%

Table 16: Sensitivity analysis: change in operating hrs

Based on Operating Hours	at 100% operating hours	at 90% Operating hours	at 80% Operating hours
NPV at CS 1 (D70:E30)	4.9	4.3	3.6
NPV at CS2 (D50:E50)	4.6	4.0	3.4
NPV at CS3 (D0:E100)	3.9	3.4	2.9
IRR	60%	55%	49%

Table 17: Sensitivity analysis: change in interest rate

Based on Interest Rate	at 9.5% interest rate	at 10.05% interest rate	at 11% interest rate	at 12% Interest Rate	at 12.5% Interest Rate	at 13% Interest Rate
NPV (70:30)	5.2	5.1	5.0	4.90	4.85	4.79

5. ENERGY EFFICIENCY FINANCING IN MSMEs

Financing plays a key role in facilitating procurement and implementation of energy efficient technologies and products in any industry. Government has given EE financing in MSMEs top priority since the sector contributes significantly towards India's economic growth. However, existing financing options are not sufficient to meet the financing requirement in the sector due to the large size of the sector. MSMEs using various financing schemes for technological up-gradation are still very less, as most of them use their own capital fund rather than making use of external financing models. Although financing models were very successful in some clusters, the scale-up of such activities is rather slow. This slow pace in implementation of energy efficiency financing in MSMEs is due to the various sector specific challenges in the sector.

Some of the key barriers to finance EE projects in the sector are:-

- Lack of available capital for investment as EE interventions being small may not get financed through FIs as they do not qualify as term loans
- Lack of clarity on financing schemes- repayment mechanism and complex procedural requirements
- Lack of availability of financing model that cater to the particular requirement of the MSME
- Lack of awareness among MSMEs with respect to benefits of implementing EE technologies
- FIs consider MSMEs as a high risk category due to low credit flow to this sector. This is due to several factors such as poor book-keeping practices, weak balance sheets, poor credit history and smaller sizes of MSME loans.
- Collateral based lending, advocated by FIs, restricts MSMEs from availing loans
- No formal M&V procedure available to estimate the savings achieved by implementing EE measure
- Risks associated with repayment of loans which include technical, commercial and performance risks

5.1 FI Schemes in Sikkim

Table 18: FI schemes in Sikkim

Sl.No	Name of Scheme	Purpose	Financial Details	Contact Address
1	SIDBI Make in India Soft Loan Fund for Micro, Small & Medium Enterprises (SMILE)	• The focus of the scheme is on technology upgradation which helps in reducing the impacts from process and operations as the reduction in resource consumption and productivity improvements are major outcome of technology upgradation • The program aims to bridge the gap by providing financial support to the companies.	• Rate of interest is according to credit rating • Interest rates for soft loans are from (8.90 % to 8.95 % pa) and term loans are in the range of (9.45% to 9.60% pa) • Min loan amount: Rs 25 Lakhs • Term Loan: 75% of the project cost as debt	Small Industries Development Bank of India (SIDBI) Branch Manager, Deorali School Road, Gangtok
2	4E scheme (End to End Energy Efficiency Financing scheme)	• The 4E scheme promoted by SIDBI aims to assist the industries in implementation of energy efficiency and renewable energy projects. • The scheme addresses all aspects of energy efficiency in a company from assessment and identification of energy efficiency interventions to facilitating implementation by providing technical and financial support	• Interest rate - 2.5% below market interest rate • Min loan amount: Rs 10 Lakhs • Max loan amount: Rs 150 Lakhs • 90% of the project cost as debt	Small Industries Development Bank of India (SIDBI) Branch Manager, Deorali School Road, Gangtok
3	Partial Risk Sharing Facility for Energy Efficiency project (PRSF)	• The partial risk sharing facility aims at transforming the energy efficiency market in India and promotion of Energy Service Contracting Model for the Energy Efficiency. • The scheme address barrier related to the financing aspects for energy efficiency	• Term Loan: 12%-15% • Min loan amount: Rs 10 Lakhs • Max loan amount: Rs 15 Cr • Total Project funding of – USD 43 million • Risk Sharing facility component of USD 37 million to be managed by SIDBI • Technical assistance component of USD 6 billion to be managed by SIDBI and EESL	Small Industries Development Bank of India (SIDBI) Branch Manager, Deorali School Road, Gangtok

4	Bank of Baroda's Scheme for Financing Energy Efficiency Projects	All these Schemes from various banks (SBI, Bank of Baroda, and Canara Bank) have their focus towards technology upgradation. Technology upgradation can lead to improvement in energy, productivity, and lower emission from the MSME company. As technology upgradation could be capital intensive most of the schemes from banking institutions aim at bridging the gaps for access to finance for MSME sector	• Loans of up to 75% of the total project cost, subject to maximum of Rs. 1 crore, will be provided. (Minimum amount of loan Rs. 5 Lakhs • Collateral will be required for all loans. An interest rate of bank base rate + 4% will be applicable, to be paid back over a period of 5 years.	Bank of Baroda MG Marg Gangtok, Sikkim Ph No : 03592 203216 Mail Id : gangto@bankofbaroda.com
5	Canara Bank's Loan scheme for Energy Savings for SMEs		• The scheme covers up to 90% of project costs of up to INR 1 million (EUR 13,000). • Max. loan: INR 10 million (EUR 130,000) • Security: collateral free up to INR 5 million (EUR 65,000), beyond INR 5 million collateral required as determined by the bank • Margin: 10% of project costs	Punam Chand Building, M G Marg Gangtok, Sikkim Email Id : cb2337@canarabank.com
6	SBI's Project Uptake for Energy Efficiency		• SBI identifies industrial clusters with potential for quick technology upgradation and a supporting environment. Based on studies in interested units, technology upgradation is undertaken if the same in viable. • With a ceiling of INR 1 lakh, an amount equal to that invested by the unit is provided under this loan. There is a start-up period of 3 years, with a repayment period of 5-7 years, at zero interest.	SBI National Highway 31 A Gangtok, Sikkim Ph No : (3592) 206091 Email Id : sbi.00232@sbi.co.in
7	Solar Roof Top Financing Scheme IREDA	The loan scheme is applicable to grid interactive, rooftop solar PV plants for industries, institutions and commercial establishments. Financing can be accessed for single or aggregated investments.	• Interest rate: 9.9% - 10.75% • Max. repayment time: 9 years • Minimum promoter's contribution: 30% • The applicant's minimum capacity needs to be 1MW	Sikkim Renewable Energy Development Agency, Government of Sikkim D.P.H. Road (Near Janta Bhawan) , Gangtok Ph No : 03592- 22659 Email Id : slg sreda@sancharnet.in

8	SBI - World Bank: Grid Connected Rooftop Solar PV Program	Loans for financing grid connected rooftop solar photovoltaic (GS- RSPV)	• Loan amount is 75% of the project cost • Fixed Asset coverage ratio: >1.25 • Moratorium period: upto 12 months from date of commencement of commercial operations • Guarantee: in case of sole proprietorship/partnership firm/personal guarantee of partners	SBI National Highway 31 A Gangtok, Sikkim Ph No : (3592) 206091 Email Id : sbi.00232@sbi.co.in sbi.co.in

6. ENVIRONMENTAL AND SOCIAL BENEFIT

6.1 Environmental Benefit

A resource-efficient business demonstrates a responsibility towards the environment. Energy and the environment are so closely linked, that, in addition to saving energy and reducing utility expenses, there are additional and often unreported benefits from conserving energy, saving natural resources being an important benefit.

Energy efficiency plays a major role, even where company output is increased, energy efficiency improvements can contribute significantly in most cases to reducing the negative impact of energy consumption per unit of output. Any increase in pollutant emissions will thus be minimized. Significant environmental benefits gained by adopting energy efficient technologies and processes may include lowering the demand for natural resources, reducing the emission of air pollutants, improving water quality, reducing the accumulation of solid waste and also reducing climate change impacts. Improving energy conservation at the facility can improve the facility's overall efficiency, which leads to a cleaner environment.

Reduction in Pollution Parameters

The expected electricity savings by installation of VFD for chiller compressor is 31,960 units annually which is equivalent to 2.66 TOE per annum. The proposed EE measure will result in decrease of CO_2 emissions by 25.39 TCO_2 annually, thus resulting in reduced GHG effect.

6.2 Social Benefit

Work Environment

The Factories Act, 1948 covers various aspects relating to working environment maintenance and improvement. The good maintenance practices, technology up gradation, efficient use of energy and resource conservation not only contribute to energy and pollutant reduction but also contributes in ensuring safe and clean working environment to the employees of the organization. Many units have also been doing review of safety process and have provided access to safe working environment to the workers. Basic facilities such as first aid kit, PPE gears and many others have been made available

Skill Improvement

Implementing energy efficiency measures requires mix of people and skills. It involves up skilling workers at all levels from the shop floor to the board room to understand how companies manage their energy use—and to identify, evaluate and implement opportunities to improve energy performance. As the project involved identifying energy saving projects, implementing and verifying the savings, the unit have understood how to estimate energy savings with respect to energy saving proposals and also energy wastage have been identified. The activity has been successful in bringing the awareness among workers on energy wastage reduction, technology up gradation possible, etc.

Each new technology implemented in a dairy plant will create an impact on the entire Sikkim Dairy cluster as each dairy units can replicate the new technology and promote the concept of energy efficiency in entire Sikkim Dairy Cluster and thus reduce the overall energy consumption of the cluster as a whole.

Technical skills of persons will be definitely improved. As the training provided by the OEMS' on latest technology will create awareness among the employees on new trends happening in market. The training also helps in improving the operational and maintenance skills of manpower required for efficient operation of the equipment.

7. CONCLUSION

Energy efficiency is an instrument to address the issue of energy crisis and also be employed as a cost effective means to attain sustainability and business. Cost of energy is considered as a vital component for industries and warrant judicious use of energy. Amid spiraling power cost energy efficiency assumes at most importance for the sector to remain competitive.

The GEF, UNIDO and BEE project through its various engagements is able to demonstrate energy efficiency potential in Sikkim Dairy cluster. The project is able to promote the concept of energy efficiency and renewable energy in dairy cluster through various capacity building programs for local service providers, technology feasibility studies in dairy units, training programs on EE/RE technologies and also helped in penetrating new /latest technologies into the cluster.

The DPR for installation of VFD for chiller compressor has been prepared after the discussion with the OEM who installed refrigeration section in the plant. The expected electricity savings by installation of VFD for chiller compressor is 31,960 units annually which is equivalent 25.39 TCO_2 per annum. The following table gives the overall summary of the savings achieved:-

Table 19: Proposed EE Measure

Sl No	EE Measure	Annual Energy Savings		Monetary Savings (Rs. Lakhs)	Investment (Rs. Lakhs)	Payback (Months)	AnnualTCO_2 reduction
		kWh	TOE				
1	VFD for Chiller Compressor	30,960	2.66	1.24	3.00	29	25.39

The summary of financial analysis given in the below table clearly indicates that implementation of this project is economically and financially viable with an attractive payback period. So it is recommended to install VFD for chiller compressor to reduce the compressor speed during part load condition.

Table 20: Financial Analysis

Sl. No.	Particulars	Unit	Value
i	Total Investment (Incl of Tax)	Rs. Lakh	**3.00**
ii	Means of Finance	Self / Bank Finance	**Self**
Iii	IRR	%	**60.05**
Iv	NPV at 70 % Debt	Rs. Lakh	**4.90**

7.1 Replication Potential

VFD for chiller compressor has a good potential in Sikkim Dairy Cluster. The system can be easily replicated in the Jorethang dairy plant. Also in the implementation of this project will inspire other units in Sikkim mainly pharma units to take up similar energy efficiency initiatives which eventually will lower the bottom line and increase the top line therefore the margin increases. Secondly, the very clear specifications on vendor and the cost base is already available which makes it easy for other units in the Sikkim Dairy cluster to access the technology and gives them a very good idea about the cost and benefits associated with the projects. Overall, the holistic approach adopted by the project will be extremely useful in achieving the goal of improving EE in the cluster.

8. ANNEXURE

8.1 Financial Quotation

Vishnu Prabhakaran

From: frick <cal@frick.co.in>
Sent: 24 July 2018 14:43
To: Vishnu Prabhakaran
Cc: amikanrubai@yahoo.co.in
Subject: VFD for Compressor Motor for refrigeration Plant at Gangtok Dairy & Jorethang Dairy

Attention : Mr. P. Vishnu, Associate Counsellor

Sub : VFD for Compressor Motor for refrigeration Plant at Gangtok Dairy & Jorethang Dairy.

With reference to the above, the approximate estimated cost of VFD for the following Motors is as per the following :-

1) VFD with Controller for 75 HP Motor - Rs. 3,00,000/- each.

2) VFD with Controller for 40 HP Motor - Rs. 2,70,000/- each.

3) VFD with Controller for 20 HP Motor - Rs. 1,80,000/- each.

Regards

RAJINDER SINGH
DY. GENERAL MANAGER
(EASTERN REGION)
FRICK INDIA LIMITED
(CIN - L74899HR1962PLC002618)
5/2 RUSSEL STREET,
KOLKATA 700 071

Mobile : 9331059109