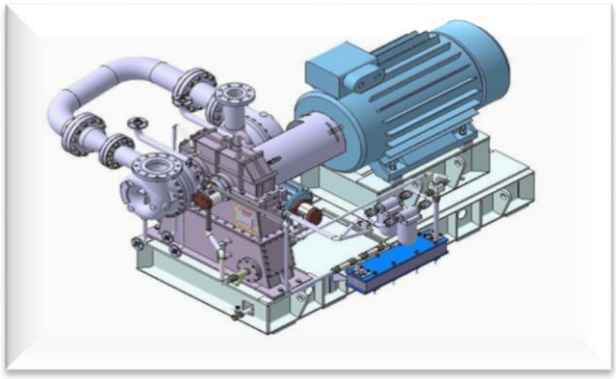
August 2018

DETAILED PROJECT REPORT ON MICRO TURBINE

M/s Amul Fed Dairy, Gandhi Nagar – Gujarat
Dairy Cluster



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

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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
GCMMF	Gujarat Cooperative Milk Marketing Federation
GEF	Global Environmental Facility
IRR	Internal Rate of Return
kJ	Kilo Joule
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
WACC	Weighted Average Cost of Capital

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 Gujarat 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	Amul Fed Dairy , Gandhinagar
Name(s) of the Plant Head	Mr. R S Sodhi, Managing Director
Contact person	Mr. Prashant Seth
Constitution	Cooperative Society
MSME Classification	Large Scale
Address:	Plot No 35, Gandhinagar- Ahmedabad Road ,Bhat , Gujarat
Industry-sector	Dairy

1.2 Proposed EE Measure

After the discussion with the plant team, it has been decided to install micro turbine in the steam line by removing the PRV to generate electricity. 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 Micro turbine	5,18,400	44.58	40.95	53.69	16	425.09

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	**53.69**
ii	Means of Finance	Self / Bank Finance	**Self**
Iii	IRR	%	**100.81**
Iv	NPV at 70 % Debt	Rs. Lakh	**182.94**

2. INTRODUCTION ABOUT AFDG

2.1 Unit Profile

Amul is the apex organisation of the Dairy Cooperatives of Gujarat which aims to provide remunerative returns to the farmers and also serve the interest of consumers by providing quality products which are good value for money. AFDG was established with the objective of receiving of "Surplus Milk" from the Member Unions Cooperative Dairies of Gujarat State and convert it to milk products and also to supply milk round the year to meet liquid milk market demand of Ahmedabad and Saurashtra.

Table 4: Unit Profile

Particulars	Details
Name of Plant	Amul Fed Dairy , Gandhinagar
Name(s) of the Plant Head	Mr R S Sodhi, Managing Director
Contact person	Mr Prashant Seth
Contact Mail Id	prashant.sheth@amul.coop
Contact No	07574802084
Constitution	Cooperative Society
MSME Classification	SME
No. of years in operation	72
No of operating hrs/day	24
No of operating days/year	360
Address:	Plot No 35, Gandhinagar- Ahmedabad Road ,Bhat , Gujarat
Industry-sector	Dairy
Type of Products manufactured	Milk ,Ghee, Dahi, Butter milk, Powder

2.2 Production Details

The various products manufactured in AFDG dairy are liquid milk, butter milk, flavoured milk, lassi, ghee and ice cream. The graph below shows the milk processed during last one year

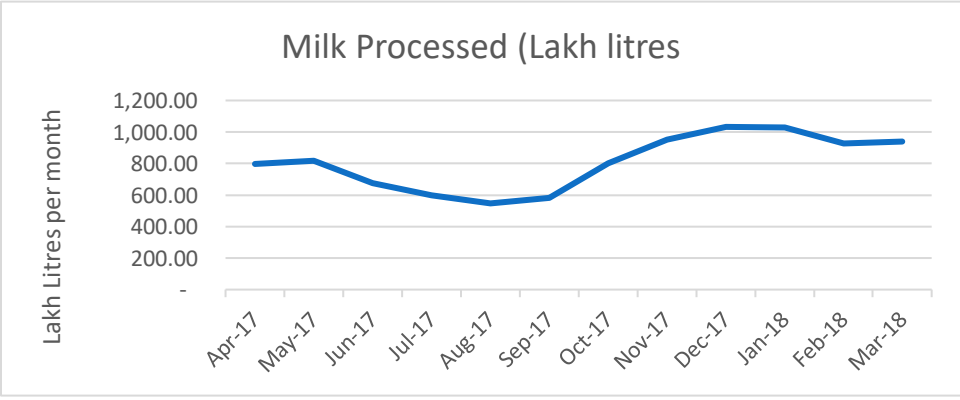

Figure 1: Milk Processed

2.3 Typical Dairy Process Flow Diagram

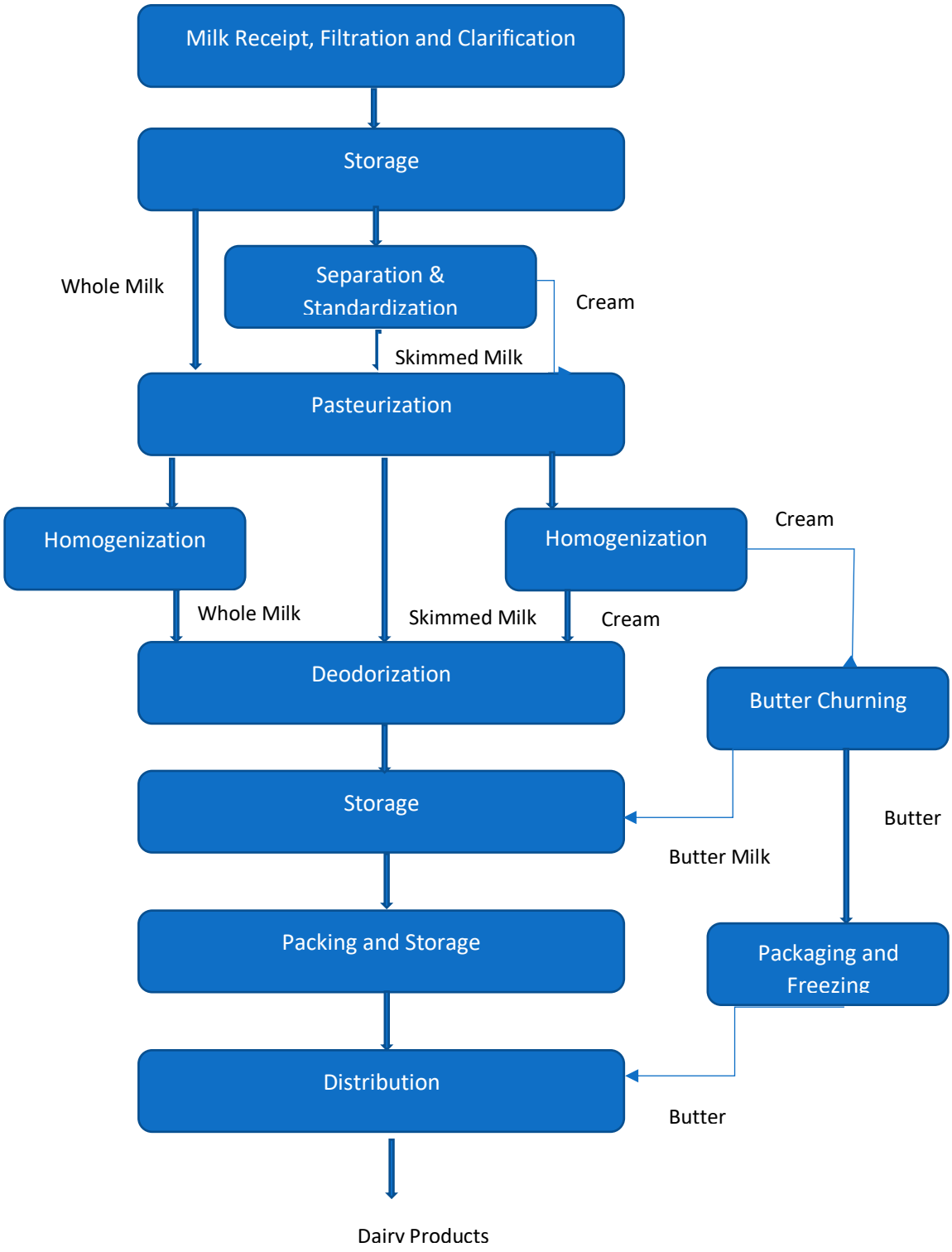

Figure 2: Typical process flow of Milk manufacturing

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.

Table 5: Production Capacity

Sl No	Product	UOM	Quantity
1	Milk Processing	Lakh Litres per Day	32
2	Milk Packaging in Poly Pouches	Lakh Litres per Day	12
3	Ghee Manufacturing and Packaging	MT/day	60
4	Milk Powder Manufacture and Packaging	MT/day	160
5	Ice Cream Manufacture and Packaging	KL/day	150
6	UHT Processing and Aspecting Packaging in Tetra Pack	KL/day	600
7	Frozen Pizza Manufacturing and Packaging	Pieces/day	15000
8	Cultured Milk Product	Tons/day	4

9	UHT Processing and Aseptic Packaging in Pet Bottle	KL/day	100
10	Butter Plant	Tons/day	40

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/m^3)
1	Electricity	Rs./kWh	7.90	
2	Natural Gas	Rs/SCM	27	8750
3	Bio gas			5000

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 – NG (SCM)	Bio Gas from ETP (SCM)
Apr-17	54,19,313	9,96,870	1,25,200
May-17	58,06,800	10,33,427	1,33,200
Jun-17	49,87,540	7,38,025	1,27,700
Jul-17	41,65,900	6,76,852	1,17,960
Aug-17	42,33,800	5,47,415	1,26,000
Sep-17	42,58,080	6,20,058	1,21,500
Oct-17	49,06,300	10,05,865	1,30,000
Nov-17	49,75,852	13,03,072	1,32,680
Dec-17	49,07,600	14,46,200	1,13,750
Jan-18	52,30,000	14,92,005	1,09,200
Feb-18	50,98,700	13,24,665	1,25,200
Mar-18	58,35,200	14,03,537	1,27,000
Total	**5,98,25,085**	**1,25,87,990**	**14,89,390**

The major form of energy used in the plant is electricity which is from UGVCL grid. For thermal plant is using NG as the major fuel and also Bio gas from ETP. The percentage share of fuel cost is shown below:

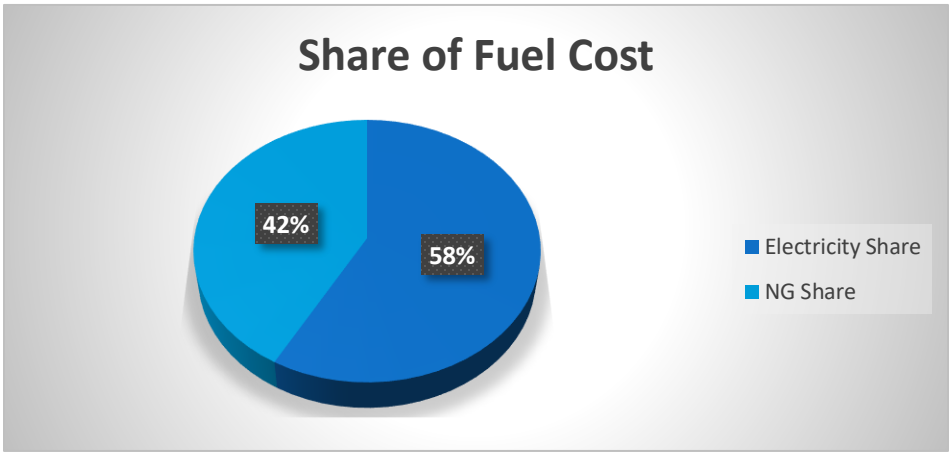

Figure 3: Share of fuel cost

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 3.93 Crore/month whereas the average thermal energy cost is Rs 2.83 Crore/month.

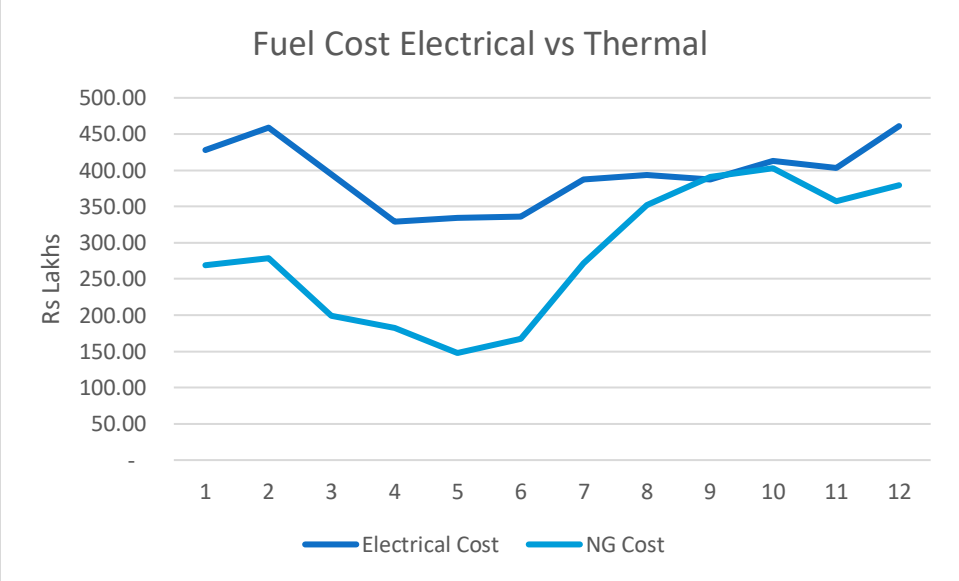

Figure 4: Fuel Cost Electrical vs Thermal

3. PROPOSED EE MEASURE – MICROTURBINE IN STEAM LINE

3.1 Present System

Amul Dairy have installed boilers to generate steam for their various process applications which include pasteurization, CIP, powdering plant etc. All the heating process in dairy is through indirect heating. The boilers are connected to a common steam header and steam is redistributed to various processes through steam lines with the use of PRV based on application. The table below shows the details of boiler installed in the plant.

Table 8: Boiler Details

Boiler	Fuel Type	Design Capacity (TPH)	Make of the company	Operating (TPH)	Design pressure (bar)
Boiler 1	NG/BioGas/FO	15 TPH	Thermax	12 TPH	24
Boiler 2	NG/BioGas/FO	10 TPH	Viessman	8 TPH	22
Boiler 3	NG/FO	10 TPH	Viessman	8 TPH	17.5
Boiler 4	NG/FO	12 TPH	Forbes Marshal	10 TPH	17.5

The plant has installed 4 boilers in which one is standby and 3 are running. 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. Another major application of steam in the plant is powdering plant where steam is supplied by a 15 TPH boiler with a design pressure of 24 bar. This boiler is supplying 6 TPH steam to powdering plant at a pressure of 8 bar after PRV. The steam at 8 bar is used to heat milk in evaporator column. In evaporator columns milk is heated with steam under vacuum to remove water content in milk to make powder.

In the plant even though steam pressure required is lesser at user ends, the generation pressure is on higher side. Since steam is generated at higher pressure in boiler compared to user end pressure requirement, pressure is reduced through Pressure Reducing Valves (PRV) as per each user requirement. In PRV, pressure of the steam is reduced to a pre-set limit so as the steam comes out at a lower pressure and will get utilized in the user end process applications. During the process of steam pressure reduction, there is a loss of steam pressure energy in PRV without any use. The table below shows the steam parameters before and after the PRV which is going to powdering plant:

Table 9: Steam Parameters

Inlet Conditions	UOM	
Inlet Steam Pressure (At the Turbine Main Inlet Control Valve)	Kg/cm^2	21

Inlet Steam Temperature (At the Turbine Main Inlet Control Valve)	°C	217 (sat)
Inlet Steam Flow (At the Turbine Main Inlet Control Valve)	TPH	6
Outlet Conditions	**UOM**	
Exit Steam Pressure (At the Turbine Exhaust Flange)	Kg/cm^2	9
Exit Steam Temperature (At the Turbine Exhaust Flange)	°C	180 (sat)
Exit Steam Flow (At the Turbine Exhaust Flange)	TPH	6

In order to utilize steam pressure energy instead of getting wasted in PRV, it is recommended to install back pressure turbine at LP steam header. Passing steam through the turbine instead of PRV will generate electricity and also give the required steam pressure at output as per requirement.

3.2 Recommendation

It is recommended to install a 90 kW generating potential micro turbine in the HP line supplying steam to powdering plant. By replacing the existing PRV with microturbine nearly 90 kW power can be generated which can be used in non-critical loads like ETP's, admin building, lighting loads etc.

The existing PRV line can be kept in standby and can be used in situations of sudden load fluctuations or additional steam requirements.

Micro turbine offer a number of potential advantages compared to other technologies for small-scale power generation. These advantages include a small number of moving parts, compact size, light-weight, greater efficiency, lower emissions, lower electricity costs, and opportunities to avoid pressure loss in steam systems. They have the potential to be located on sites with space limitations for the production of power.

Performance curves

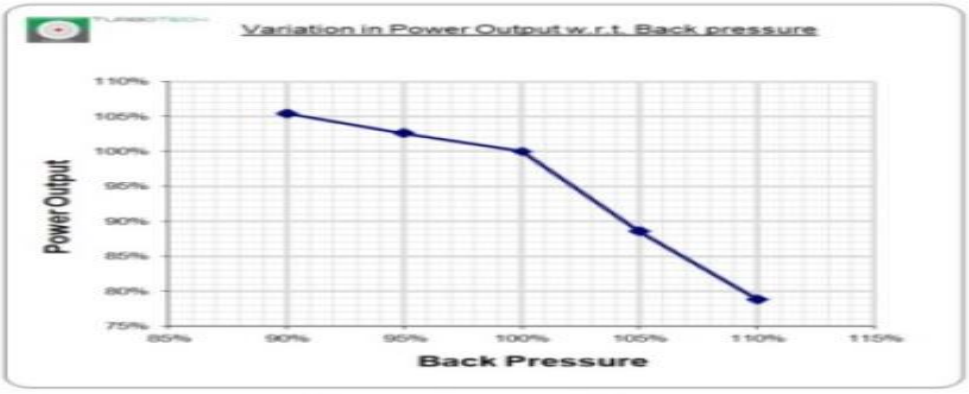

Figure 5: Power Output vs Back Pressure

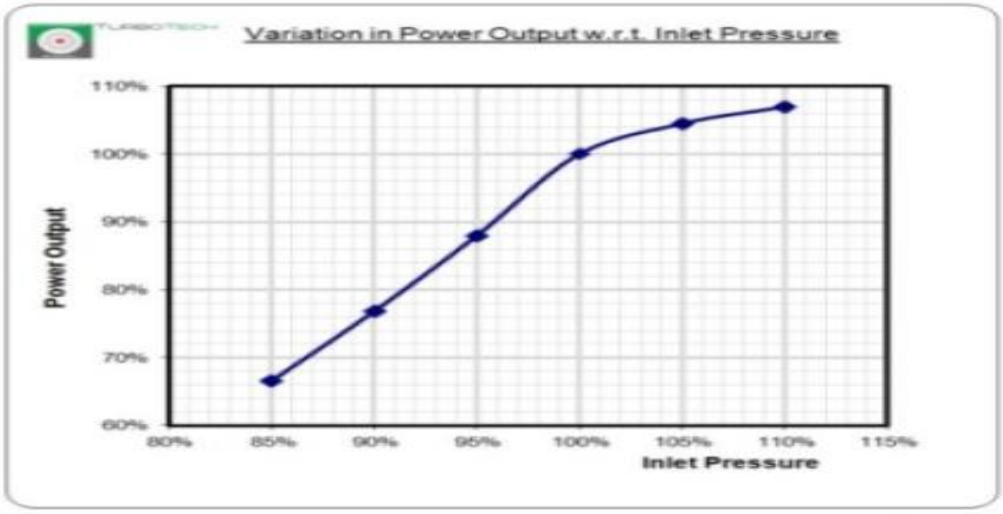

Figure 7: Power O/P vs Inlet Pressure

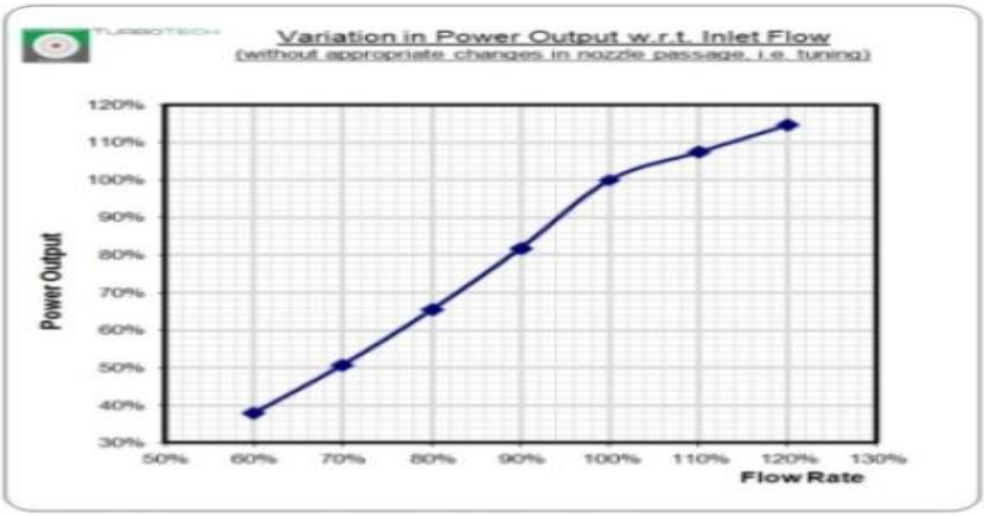

Figure 6: Power output vs Inlet Flow

Auxillary Power

AC Supply : Single and Three Phase @ 50 Hz

Sl No	Utility	Start up and Shut Down	Continuous Demand
1	Auxillary Oil Pump	1.5 Hp	Not Required
2	Auxillary Power	0.5 Hp	0.5 Hp
Total Power		2 Hp	0.5 Hp

3.3 Supplier Details

Table 10: Supplier Detail

Equipment Detail	Micro turbine
Supplier Name[1]	TurboTech Precision Engineering Private Limited
Address	TurboTech Precision Engineering Private Limited Survey No. 8/2, Honnasandra Village Kasaba Hobli, Nelamangala Taluk, Bengaluru Rural District - 562123
Contact Person	Mr. Saurabh Tripathi
Mail Id	saurabh@turbotechindia.com
Phone No	+91 96060 85791

3.4 Savings

The expected electricity savings by installation of micro turbine is 5,18,400 kWh annually. The annual monetary saving for this project is ***Rs 40.95 Lakhs with an investment of Rs 53.69 lakhs and payback for the project is 16 months.***

Detailed savings calculations is given in below table:

Table 11: Savings Calculation

Parameters	UOM	Value
Inlet Pressure	kg/cm2(g)	21.00
Back Pressure	kg/cm2(g)	9.00
Saturated Steam Temp. at Inlet	°C	217
Steam Flow Rate	x 1,000 kg/h	6.00
Steam Condition at Inlet	Dry-Saturated	100%
Enthalpy at Inlet	kJ / kg	2
Isentropic Enthalpy Drop	kJ / kg	207
Actual enthalpy Drop	kJ / kg	66
Generator Efficiency		95%
Temperature at Exit	°C	143
Enthalpy at Exit	kJ / kg	(64)
Electrical Power Output:	kW	90
Boiler Operation Hours	hrs/day	16
Auxiliary Power	kW	0.37
Electricity Cost	Rs/kWh	7.90
Operating Days	Days	360
Annual Electricity Savings	kWh	5,18,400
Annual Cost Savings	Rs. Lakhs	40.95
Investment	Rs. Lakhs	53.69
Pay back	Months	16

[1] Technology is unique and is supplied by Turbotech Ltd

4. FINANCIAL ANALYSIS

4.1 Project Cost

Table 12: Project Cost

Parameter	Amount in Rs Lakhs
Design, Engineering, Manufacture and Supply of Back Pressure Steam Turbine Generator (STG) System along with allied supplies rated at 90 kW	45.50
GST @18%	8.19
Total Project Cost	**53.69**

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 : 40 %
- 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 13: 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	53.69							
Energy Savings		40.95	41.77	42.61	43.46	44.33	45.22	46.12
O&M Cost		-2.68	-2.68	-2.68	-2.68	-2.68	-2.68	-2.68
Depreciation		21.5	12.9	7.73	4.6	2.8	1.7	1.0
Net Cash Flow	-53.69	59.75	51.97	47.65	45.41	44.43	44.20	44.44

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

Table 14: 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 15: 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)	-53.69	54.1	42.7	35.4	30.6	27.1	24.4	22.3	182.9
NPV at CS 2 (50:50)	-53.69	53.5	41.7	34.2	29.2	25.6	22.8	20.5	173.6
NPV at CS 3 (100% Equity)	-53.69	52.0	39.3	31.3	26.0	22.1	19.1	16.7	152.8

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 16: Sensitivity analysis: based on energy savings

Based on Savings	at 100% Savings	at 75% Savings	at 50% Savings
NPV at CS 1 (D70:E30)	182.9	131.1	79.2
NPV at CS2 (D50:E50)	173.6	114.9	68.1
NPV at CS3 (D0:E100)	152.8	108.0	63.3
IRR	101%	79%	56%

Table 17: 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)	182.9	162.2	141.4
NPV at CS2 (D50:E50)	173.6	153.7	133.9
NPV at CS3 (D0:E100)	152.8	134.9	117.0
IRR	101%	92%	84%

Table 18: 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)	192.2	188.4	186.6	182.94	181.16	179.40

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

5.2 FI Schemes in Gujarat

Table 19: FI schemes in Gujarat

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	Mr Chandan SIDBI, Bhavan, Ist Floor, P.B.No. 10, Navjivan P.O., Ahmedabad Ph No : : 8769436639 Mail Id: ahmedabad@sidbi.co.in
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	Mr Chandan SIDBI, Bhavan, Ist Floor, P.B.No. 10, Navjivan P.O., Ahmedabad. Ph No : 8769436639 Mail Id: ahmedabad@sidbi.co.in
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	Mr Chandan SIDBI, Bhavan, Ist Floor, P.B.No. 10, Navjivan P.O., Ahmedabad. Ph No : 0562-2521023 Mail Id: ahmedabad@sidbi.co.in

4	Bank of Baroda's Scheme for Financing Energy Efficiency Projects	All these these Schemes from various banks (SBI, Bank of Baroda, 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 SME Loan Factory 2nd Floor Baroda Towers, Ellisbridge, Ahmedabad Ph No : 9979867501 Mail Id : cpc.sme.ahmedabad@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	Swaraj Arcade, Kumudvadi Opp.Lal Tanki, Chitra Road,Bhavnagar-364002 Ph No : 0751-2233141/ 2431541 Email Id : cb4831@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 SMECC Ground Floor, Zodiac Avenue, Opp Commisionar Bunglow, Navrangpura, Ahmedabad, Gujarat Ph No : 022 22029456 Email Id : sbi.60438@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	IREDA Camp Office 603, Atlanta Towers Near Panchvati Circle, Gulabi Tekra Ahmedabad Ph No : 9811889805 Email Id : ashokyadav@ireda.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 SMECC Ground Floor, Zodiac Avenue, Opp Commisionar Bunglow, Navrangpura, Ahmedabad, Gujarat Ph No : 022 22029456 Email Id : sbi.60438@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 proposed EE measure of installing micro turbine in steam line would result in annual electricity savings of 5,18,400 kWh which is equivalent to 44.58 TOE per annum. The proposed EE measure will result in decrease of CO_2 emissions by 425.09 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 upskilling 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 Gujarat Dairy cluster as each dairy units can replicate the new technology and promote the concept of energy efficiency in entire Gujarat 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 Gujarat 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 Micro turbine has been prepared after the OEM came to the dairy and done a detailed feasibility study. The implementation of this measure will significantly will result in an annual electricity savings of 5,18,400 units with 425.09 TCO_2 reduction. The following table gives the overall summary of the savings achieved:

Table 20: 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 Micro turbine in steam line	5,18,400	44.58	40.95	53.69	16	425.09

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 micro turbine in the HP steam line.

Table 21: Financial Analysis

Sl. No.	Particulars	Unit	Value
i	Total Investment (Incl of Tax)	Rs. Lakh	**53.69**
ii	Means of Finance	Self / Bank Finance	**Self**
Iii	IRR	%	**100.81**
Iv	NPV at 70 % Debt	Rs. Lakh	**182.94**

7.1 Replication Potential

Micro turbine has a good replication potential in all the dairy plants having powdering plant. For the implementation of this project plant need to do a steam mapping to identify the pressure and temperature requirement of each users. This would help in segregating the HP and LP steam users thereby feasibility of installation of micro turbine in steam lines. The implementation of this project will inspire other 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 Gujarat 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

TURBOTECH
ENERGY

ECT™

PROPOSAL FOR 90 kW BACK PRESSURE STEAM TURBINE,

MOTHER DAIRY,
AHMEDABAD, GUJARAT

TurboTech Turbine at Waste Incineration Plant in Korea

Empowering Industry with Green Power

COMMERCIAL TERMS & CONDITIONS

PRICE:

1. CONSIDERATION TOWARDS SUPPLY OF EQUIPMENT

1.1 PRICE

No.	Description	Unit Price (INR)	Units	Amount* (INR)
1	Design, Engineering, Manufacture and Supply of TurboTech make ECT™ Back Pressure Steam Turbine Generator (STG) System along with allied supplies rated at 90 kW as per Scope of Supply defined under Section 1.0	₹ 45,50,000/-	1 set	₹ 45,50,000/-

90 kW ECT™ STG Set: INDIAN RUPEES: Forty Five Lakh Twenty Two Thousand ONLY (Contract Value)

2.1 MODE OF PAYMENT

*The prices quoted are Ex-TurboTech works, Nelamangala, Bengaluru, INDIA. This Price does not include any and all prevailing taxes and Duties as per the Laws Governed in the Country of Origin - INDIA and Country of Destination. These Taxes and Duties as applicable at the time of dispatch and generation of Invoice will be to the account of Customer. The packing, forwarding, freight and insurance charges will be account to the customer. The price for supervision of erection & commissioning charges is quoted separately.

Purchase order to be placed on TurboTech factory address (Nelamangala, Karnataka).

8.2 Technical Details

TURBOTECH ENERGY

SECTION 1

SCOPE OF SUPPLY

A. STEAM TURBINE, GEAR BOX AND ACCESSORIES

1. Steam Turbine:

- Steam Turbine Module
  - Type – Back Pressure Turbine
  - Casing
  - Nozzle
  - Rotor
- Governor Valve (Throttle Valve – Pneumatically Operated)
- Skid Module together with Stool for Generator
- Anti-Vibration Mounts (AVM) Pads (1 Set)

2. Gearbox:

- Reduction Gear (Gear Box with Integral Oil Tank)
  - Single Helical Gear Box
  - Parallel Axis
  - Single Reduction

3. Coupling:

- Coupling between Turbine and Generator with coupling guard (Flexible Type)

4. Lubrication Oil System:

- Shaft driven Main Oil Pump (MOP)
- Motor driven Auxiliary Oil Pump (AOP)
- Oil Pressure Regulating Valve
- Lubricating Oil Strainer and Filter
- Lubricating Oil Cooler (Heat Exchanger)
- Non Return Valve for Oil Line
- All Internal Piping required for lubrication and sealing

NOTE: The appropriate size and rating will be selected during detailed engineering

TURBOTECH ENERGY

B. INDUCTION GENERATOR (IG) WITH PROTECTION PANEL & ELECTRICALS

- 1 no. of suitable rating, 415 V, 3 phase, 50 Hz

NOTE: The appropriate size and rating will be selected during detailed engineering

C. INSTRUMENTS AND GOVERNING CONTROL:

- Turbine Control Panel (PLC Panel)
- Redundant Speed Sensing System
- HMI and Accessories
- Turbine Protection and Safety System include
  - Over Speed Trip System
  - Low Lube Oil Pressure and Warning System
  - High Exhaust Steam Pressure Trip and Warning System
  - Emergency Push Button Trip System (Manual at Turbine Control Panel)
  - High Reduction Gear Bearing Temperature Warning System
  - High Turbine Bearing Temperature Warning System
- RTD for Bearing Temperature Detection
- Speed Indicator
- Vibration Monitoring Probe

NOTE: The appropriate size and rating will be selected during detailed engineering

TURBOTECH ENERGY

SECTION 3

TECHNICAL DATA SHEET

3.1 MECHANICAL

Sr. No.	Item	Description
1.	**STEAM TURBINE**	
1.1	Steam Turbine quantity	1 No.
1.2	Type	Single stage, Back Pressure type
1.3	Turbine construction	Integrally geared, radial split with built-up rotor
1.4	Casing	Radially split type (cast/fabricated steel)
1.5	Rotor	Single solid hardened forging, Integral bladed type (hardened stainless steel)
1.6	Blade	bladed disk/blisk (Precipitated hardened steel)
1.7	Nozzle	Aerodynamic bladed (AISI 304)
1.8	Shaft Seals	Labyrinth and carbon seal ring
1.9	Speed	12000 rpm
1.10	Mounting	Unitary skid with vibration isolators (Anti-vibrational mounts/AVMs)
1.11	No. of vibrational isolators (AVMs)	6 (approx.)
1.12	Turbine Governing	Pneumatically controlled
1.13	Turbine output	90 kWe
2.	**GEARBOX (Integral to Turbine)**	
2.1	**Design**	
2.1.1	Type	Parallel axis, Single helical, single reduction
2.1.2	Output speed	1500 rpm (8:1 gear ratio)
2.1.3	Gearing standard	AGMA-6011

2.1.4	Service factor	1.7
2.1.5	Gearbox rating	250 kW
2.2	**Bearings**	
2.2.1	Type (Journal Bearings)	Cylindrical
2.2.2	Material	White metal with steel Babbit
2.2.3	Type (Thrust Bearings)	Cylindrical
2.2.4	Material	White metal with steel Babbit
3.	**OIL SYSTEM**	
3.1	**Lube Oil**	
3.1.1	Type	Skid based forced lubrication system
3.1.2	Construction	Fabricated type
3.1.3	Oil grade	ISO VG-46 (Servo/Shell/Equivalent)
3.1.4	Oil filter	Duplex replaceable filter cartridge
3.1.5	Lube Oil Pressure	2.5 kg/cm^2(g)
3.1.6	Oil reservoir capacity (top up)	80 Litres
3.1.7	Oil quantity for intial fill	100 Litres
3.1.8	Oil quantity for flushing	30 Litres
3.1.9	Oil reservoir material	Carbon steel
3.1.10	Oil piping material from pumps to filters	Stainless steel
3.1.11	Oil piping material from filters to bearings	Stainless steel
3.2	**Oil Cooler**	
3.2.1	Type	Plate Heat
3.2.2	Oil inlet temperature	70°C
3.2.3	Oil outlet temperature	45°C
3.2.4	Cooling water inlet temperature	32°C

3.2.5	Cooling water outlet temperature	40°C
3.2.6	Cooling water pressure	2.0 kg/cm²(g)
3.2.7	Cooling water quantity	40 litres per minute (lpm)
3.2.8	Oil flow capacity	36 litres per minute (lpm)
3.3	**Main Oil Pump (MOP)**	
3.3.1	Type	Gear (positive displacement), Gear box shaft driven
3.3.2	Operating speed	1500 rpm
3.3.3	Capacity	36 litres per minute (lpm)
3.4	**Auxiliary Oil Pump (AOP)**	
3.4.1	Type	Gear (positive displacement), AC motor driven
3.4.2	Operating speed	1500 rpm
3.4.3	Capacity	36 litres per minute (lpm)
3.5	**Bearings**	
3.5.1	Type (Journal Bearings)	Offset
3.5.2	Material	White metal with steel Babbit
3.5.3	Type (Thrust Bearings)	Tilting pad
3.5.4	Material	White metal with steel Babbit
4.	**COUPLING**	
4.1	Type	High speed, Flexible type

NOTE: The appropriate size and rating will be selected during detailed engineering

TURBOTECH ENERGY

3.2 ELECTRICAL

Sr. No.	Item	Description
1.	**GENERATOR**	
1.1	Turbine rating	90 kW
1.2	Generator rating	110 kW
1.3	Rated speed	1500 rpm
1.4	Rated voltage	415 V ± 10%
1.5	Rated frequency	50 Hz ± 5%
1.6	No. of poles	4 pole
1.7	No. of phases	3 phase
1.8	Rated power factor	0.8 (lag)
1.9	Ambient temperature	45°C
1.10	Cooling method & Enclosure	TEFC
1.13	Insulation	As per Class F
1.14	Temperature rise	As per Class B limits
1.15	Duty	Continuous
1.17	Noise level	85 dB(A) @ 1 meter
2.	**CONTROL CUM GOVERNING PANEL**	
2.1	**Relays**	
2.1.1	Earth Fault (1 no.)	
2.1.2	Over Current (1 no.)	
2.1.3	Under / over voltage (1 no.)	
2.1.4	Auxiliary relays (1 set)	
2.1.5	Earth Leakage relay (1 no.)	
2.1.6	Reverse Power Relay (1 no.)	
2.2	**Other**	

2.2.1	Multi data meter/multi-function meter
2.2.2	Frequency Transducers

NOTE: The appropriate size and rating will be selected during detailed engineering

3.3 INSTRUMENTS & CONTROLS

Sr. No.	Description	Quantity
1	Inlet steam Pressure Transmitter	1 No.
2	Inlet steam Temperature element	1 No.
3	Exit steam Pressure Transmitter	1 No.
4	Exit steam Temperature element	1 No.
5	Pressure Indicator/Gauge	3 nos.
6	Temperature Indicator/Gauge	3 nos.
7	Lube Oil Pressure Gauge	1 No.
8	Oil level indicator	1 No.
9	Temperature Scanner	1 No.
10	Bearing Temperature element	1 No. per bearing
11	Speed Indicator	1 No.
12	DOL starter for AOP motor	1 No.
13	Indicating Lamps	1 set
14	Push Buttons	1 set
15	Control Auxiliary Relays	1 set
16	Selector Switch	1 set

NOTE: The appropriate size and rating will be selected during detailed engineering

TURBOTECH ENERGY

SECTION 4

UTILITY REQUIREMENT

a. Air:

Type	: Dried and Filtered
Quantity	: 30 Nm^3/hr
Pressure	: 6 $kg/cm^2(g)$
Filtration Level	: 10 Microns
Dew-Point	: -40°C
Oil Contamination	: Not permitted

b. Cooling Water:

Type : Filtered fresh water

Description	Requirement	
	Start-up	Continuous
Cooling water @ 2 bar(g), 32°C (Re-circulating) for lube oil cooler	40 lpm	40 lpm

c. Lube Oil:

Type : Straight mineral oil lubricant with detergent additives for turbine lubrication service

d. Auxiliary Power:

AC supply - Single phase and 3 Phase, 50 Hz

Sr. No.	Utility	Start Up & Shut Down	Continuous Demand
1	Auxiliary Oil Pump (AOP)	1.5 HP	Not required
2	Auxiliary Power	0.5 HP	0.5 HP
Total Auxiliary Power		2.0 HP	0.5 HP

Note: All utility figures mentioned above are indicative only. The actual requirement shall be furnished during detailed engineering.

TURBOTECH ENERGY

SECTION 5

BATTERY LIMITS

This order is complete within the following limits beyond which purchaser shall arrange any and all equipment:

Mechanical:

a) **For Steam** : At Turbine Inlet and Exhaust Flange

b) **For Cooling Water** : At the Oil cooler (Heat Exchanger) water Inlet and Exit Flange

c) **Instrument Air** : At Each Control Valve & Turbine Sealing System

d) Tube drains with drain plugs terminated at the base plate

Electrical:

a) **Main Power** : At TurboTech Generator Terminals

b) **LT Power** : Incoming Terminals of All Motors