DETAILED PROJECT REPORT
ON
VARIABLE FREQUENCY DRIVES
FOR FD & ID FAN
(SOLAPUR TEXTILE CLUSTER)











Bureau of Energy Efficiency

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VARIABLE FREQUENCY DRIVE FOR FD & ID FANS

SOLAPUR TEXTILE CLUSTER

BEE, 2010
Detailed Project Report on Variable Frequency Drives for FD & ID Fans
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Acknowledgement

We sincerely appreciate the efforts of industry, energy auditors, equipment manufacturers, technology providers, consultants and other experts in the area of energy conservation for joining hands with Bureau of Energy Efficiency (BEE), Ministry of Power, and Government of India for preparing the Detailed Project Report (DPR) under BEE SME Program in SMEs clusters. We appreciate the support of suppliers/vendors for providing the adoptable energy efficient equipments/technical details to the SMEs.

We have received very encouraging feedback for the BEE SME Program in various SME Clusters. Therefore, it was decided to bring out the DPR for the benefits of SMEs. We sincerely thank the officials of BEE, Executing Agencies and ISTSL for all the support and cooperation extended for preparation of the DPR. We gracefully acknowledge the diligent efforts and commitments of all those who have contributed in preparation of the DPR.

Contents

List of Annexure

List of Tables

List of Figures

List of Abbreviations

kWh	kilo Watt Hour
SME	Small and Medium Enterprises
GHG	Green House Gas
BEE	Bureau of Energy Efficiency
DPR	Detailed Project Report
O&M	Operational & Maintenance
NPV	Net Present Values
ROI	Return on Investment
IRR	Internal Rate of Return
DSCR	Debt Service Coverage Ratio
PBT	Profit Before Tax
PAT	Profit After Tax
SIDBI	Small Industries Development of India
VFD	Variable Frequency Drives
ID	Induced Draft
FD	Force Draft

EXECUTIVE SUMMARY

Zenith Energy Services Pvt. Ltd is executing BEE-SME program in Solapur textile cluster, supported by Bureau of Energy Efficiency (BEE) with an overall objective of improving the energy efficiency in cluster units.

Solapur textile cluster is one of the largest textile clusters in India; accordingly this cluster was chosen for energy efficiency improvements by implementing energy efficient measures/technologies, so as to facilitate maximum replication in other textile clusters in India.

The main energy forms used in the cluster units are electricity and fuel such as wood and other biomass product. Cluster units have boilers and thermic fluid heaters for hot water generation and are equipped with either forced draft system or induced draft system for supply of combustion and removal of hot flue gases. Fans are driven by electrical motors and the flow & pressure are controlled by mechanical dampers. A variable frequency drive will control the flow of the fan by speed variation and thus reduces power consumption.

Project implementation i.e. installation of VFD will lead to reduction in electricity consumption by 8250 kWh per year however; this intervention will not have any effect on the existing consumption pattern of fuel.

Total investment, debt equity ratio for financing the project, monetary savings, Internal rate of return (IRR), Net present value (NPV),Debt service coverage ratio (DSCR), Return on investment (ROI) etc. for implementing energy efficient economizer is furnished in Table below:

S.No	*Particular*	*Unit*	*Value*
1	Project cost	₹(in lakh)	032
2	Electricity saving	kWh / year	8250
3	Monetary benefit	₹(in lakh)	0.20
4	Debit equity ratio	ratio	3:1
5	Simple payback period	years	1.9
6	NPV	₹(in lakh)	0.06
7	IRR	%age	20.59
8	ROI	%age	48.14
9	DSCR	ratio	1.56
10	Process down time	day	1

The projected profitability and cash flow statements indicate that the project implementation will be financially viable and technically feasible.

ABOUT BEE'S SME PROGRAM

Bureau of Energy Efficiency (BEE) is implementing a BEE-SME Programme to improve the energy performance in 25 selected SMEs clusters. Solapur Textile Cluster is one of them. The BEE's SME Programme intends to enhance the energy efficiency awareness by funding / subsidizing need based studies in SME clusters and giving energy conservation recommendations. For addressing the specific problems of these SMEs and enhancing energy efficiency in the clusters, BEE will be focusing on energy efficiency, energy conservation and technology up-gradation through studies and pilot projects in these SMEs clusters.

Major activities in the BEE -SME program are furnished below:

Energy use and technology audit

The energy use technology studies would provide information on technology status, best operating practices, gaps in skills and knowledge on energy conservation opportunities, energy saving potential and new energy efficient technologies, etc for each of the sub sector in SMEs.

Capacity building of stake holders in cluster on energy efficiency

In most of the cases SME entrepreneurs are dependent on the locally available technologies, service providers for various reasons. To address this issue BEE has also undertaken capacity building of local service providers and entrepreneurs/ Managers of SMEs on energy efficiency improvement in their units as well as clusters. The local service providers will be trained in order to be able to provide the local services in setting up energy efficiency projects in the clusters

Implementation of energy efficiency measures

To implement the technology up-gradation projects in clusters, BEE have proposed to prepare the technology based detailed project reports (DPRs) for a minimum of five technologies in three capacities for each technology.

Facilitation of innovative financing mechanisms for implementation of energy efficiency projects

The objective of this activity is to facilitate the uptake of energy efficiency measures through innovative financing mechanisms without creating market distortion

1 INTRODUCTION

1.1 About the solapur textile cluster

The products manufactured in Solapur Textile Cluster are cotton terry towels and bed sheets. The towels and bed sheets are renowned in the country and have good market in India. The main raw material for the units is cotton yarn, which is procured from local spinning mills and agents. The cost of energy (electrical and thermal energy) as percentage of manufacturing cost varies between 8 and 10%.

Majority of the cluster units are of integrated type, where the raw material yarn is processed in-house to the final product. The energy cost is second to the raw materials cost. Majority of the units in the cluster are dependent on local/ run of the mill technologies of low end and with little investment initiatives and technology up-gradation.

The main energy forms used in the cluster units are grid electricity, wood, and small quantity of coal. The electricity is used for power looms, doubling machines, winding machines, hydro extractors, warping machines and lighting. Wood is used as fuel for boilers, thermic fluid heaters, and chulhas for hot water generation. The details of annual energy consumption of a typical unit having a production capacity of 3,75,000 kg of final product of the cluster are furnished in the Table 1.1 below:

Table 1.1 Details of annual energy consumption of a typical unit

Parameter	*Unit*	*Value*
Electricity consumption	kWh	4,52,900
Wood consumption	tonne	240
Production	kg	3,75,000

1.1.1 Production process

The main operational process for production of towels and bed sheets in cluster units are:

Doubling

In the Doubling process, thin single yarn is converted to double yarn for strengthening the yarn by using doubling machine.

Yarn dyeing

Initially, the yarn is soaked in soap water for 24 hours to remove the dirt and other foreign materials and after soaking, the yarn is taken for bleaching. Bleaching is carried out by

soaking the yarn in tanks mixed with bleaching agents and after completion of the process; the yarn is washed with normal water.

The hang dyeing machine tanks are filled with required quantity of normal water and required chemicals and dyeing agents are added. The temperature of the water is raised by oil circulation or direct steam injection. Fire wood is used as fuel. The required colors are added to the yarn and the dyeing process takes about 90 to 120 minutes per batch. After dyeing, the yarn is washed with normal water, and the yarn is taken for soaping for colour fixation in hot water for about 20 minutes in hang dyeing machines. The water is drained to the waste drainage lines. The wet yarn is taken to hydro extractors for removing the water in the yarn and taken for drying in the natural sunlight.

Winding

The yarn after drying is taken for winding in which the yarn is wounded to bobbins and cones. The winded yarn is taken for further process.

Warping

In warping, the winded yarn is wound to beams according to designed pattern (customized designs). Then the beams are taken for Weaving.

Weaving

The beams, which are wound with yarn are taken and placed in power looms where the designed pattern is already set. In power looms, the yarn is converted to final product (Towel or bed sheets) by weaving. The product obtained from weaving is taken for stitching and packing. The general process flow diagram of a typical unit for production of towels and bed sheets is furnished in Figure 1.1.

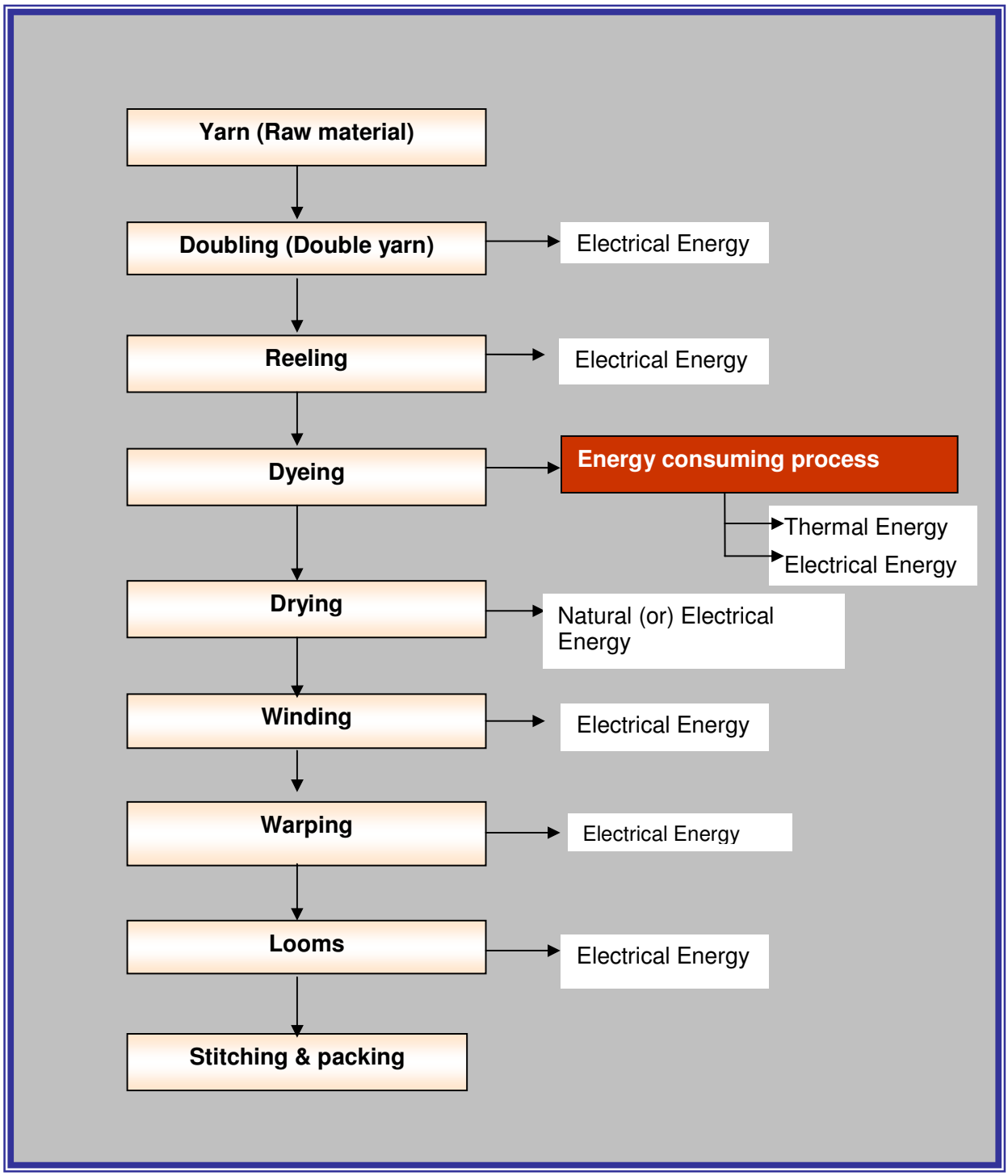


Figure 1.1 Process flow chart of typical textile unit

The production process as depicted above is similar for all textile units in Solapur textile cluster. However, depending on type of product and product quality, the above stated process flow varies as per the requirement of the industry.

1.2 Energy performance in solapur textile cluster

Majority of the industries located in solapur are engaged in manufacturing of towels and bed sheets. The main energy sources for Solapur cluster units are electricity and fuels such as Wood & briquettes. The wood and GN husk briquettes are used as fuel for boilers, thermic fluid heaters and chulhas for hot water generation and electricity is used for operation of prime movers of doubling machine motors, ID & FD fans, pumps, hank dyeing machine drives, power loom drives, winding machine motors, etc. Majority of the units in the Solapur textile cluster are using wood for thermal energy generation due to easy availability and economical point of view.

Energy cost is around 8 to 10 percent of manufacturing cost in typical manufacturing unit, out of which the cost of electrical energy works out to 58 percent of the total energy cost and remaining accounts for thermal energy.

In a typical textile manufacturing unit annual consumption of electrical energy and wood is 4,52,000 kWh and 240 tonnes respectively for average production capacity of 2,88,000 kg of final product.

1.2.1 Specific energy consumption of final product

Specific electrical and thermal energy consumption in textile unit depends upon the final product manufactured in that unit. The electrical and thermal energy consumption of typical textile unit is 1.37 kWh per kg of final product and 0.49 kg of wood per kg of final product respectively (includes all colours dyeing in cold water, medium temperature water and high temperature water)

1.3 Proposed equipment to be upgrade

1.3.1 Description of existing equipment

During energy audit studies in various textile industries in Solapur textile cluster, it was observed that about 30 boilers & 10 thermic fluid heaters in the cluster having ID & FD fans of various capacities for removals of hot flue gas and supply of combustion air respectively. These ID & FD fans are manually controlled by using mechanical damper according to the load on boiler and thermic fluid heater.

From energy use and technology gap studies in various textile industries in Solapur textile cluster, the following were identified

- Energy efficiency improvement opportunities
- Environment and safety improvement of workers
- Operational & maintenance practices in conventional thermic fluid heater and boiler

1.3.2 Role in process

For production of towels and bed sheets of different colours, the dyeing of cotton yarn is vital and dying process requires hot water. Thermic fluid heater and boiler are used for hot water generation having FD & ID fans for supply of combustion air to boilers and thermic fluid heaters and removal of hot flue gas from the boilers and thermic fluid heaters.

1.4 Baseline for existing equipment

Energy consumption in FD & ID fans would depend on following:

- Load on boiler or thermic fluid heater
- Percentage opening of mechanical damper
- Operational & maintenance practices

1.4.1 Design and operating parameter

Present electricity consumption in ID fan which is installed at boiler in a typical unit is 13,800 kWh at 40 to 50% damper openings.

1.4.2 Electricity consumption

Electricity consumption for ID fans of capacity 3 hp for two typical units in the cluster is separately furnished in Table 1.2 below:

Table 1.2 Electricity consumption in ID fan

S.No.	*Name of unit*	*Unit*	*Value*	*%age damper opening*
1	A Tex	kWh	2.2	40 - 50
2	Banda Textile	kWh	9.16	30- 40

1.5 Barriers for adoption of proposed equipment

The technology and innovations in SMEs are generally different from that of large firms. Technology in the SME sector has an increasingly complex or combinative character, most of the SMEs units in Solapur cluster are labour intensive and utilize local resources. The SME entrepreneurs are generally not willing to invest in state-or-art technology. Major barriers in the up-gradation of technology in the cluster are non availability of technology; distrust on technology supplier, lack of awareness about energy efficiency among small and medium enterprises, prevents them from adoption of energy efficient technologies. Further, non availability of skilled manpower and exorbitant cost of new technologies also works as the barrier. Details of the other barriers in the implementation of energy efficient technologies / equipments in the Solapur textile cluster are presented in below sections

1.5.1 Technological Barriers

The major technical barriers that prevented the implementation of energy efficient hot water generator are

- Lack of awareness and information about the VFD and its benefit
- Absence of local VFD supplier
- Dependence on local equipment suppliers, whom doesn't have technical knowledge about VFD and its proper installation
- The main focus of SME owners is on uninterrupted production of the plant by necessary repair work at low costs, than on investing on new technologies.
- There is a strong feeling in the owners, that energy efficiency initiatives are a risky proposition as it may lead to interruption in business and production loss due to process down time as most of the owners are ignorant about the losses in the plant due to poor energy efficiency.
- The majority of the textile unit owners/entrepreneurs do not have in-depth technical expertise, knowledge or training about energy efficiency, and are dependent on local technology suppliers or service companies, whom they normally rely for established and commonly used technology. The lack of technical know-how makes it difficult for the textile unit owners to identify the most effective technical measures.

1.5.2 Financial Barrier

Implementation of the proposed project activity requires investment of ` 0.30 lakh per unit. Such investment is not commonly seen in the cluster units for energy efficiency improvment.

Further, from the business perspective of SMEs, it is more viable, assured, and convenient to invest on project expansion for improving the production capacity or quality, rather than make piecemeal investment in retrofit and replace options for energy savings. In view of this and given the limited financial strength of the textile mills, it is evident that the owners would not like to take the risk and invest in energy efficiency measures.

However, the financial attractiveness of the project activity may motivate the owners to move forward in taking up initiatives in energy conservation and efficiency.

1.5.3 Skilled manpower

The non-availability of skilled manpower having awareness about energy efficiency and related issues in the cluster is one of the major barriers. Though, the skilled manpower is available in the cluster, they are not aware of energy conservation/efficiency and its importance. Their prime responsibility of worker is to maintain machines and ensure uninterrupted production by minimizing down time as per the targets set by the management.

Specialized training with the local service providers for better operation and maintenance of the equipments, importance of energy use and conservation will create awareness among workforce thereby enhancing their skill set about efficient use of energy and its conservation.

1.5.4 Other barrier (If any)

Absence of clean environment around the thermic fluid heater, as VFD require clean environment for uninterrupted operation.

2 PROPOSED ENERGY EFFICIENT EQUIPMENT

2.1 Detail description of technology

2.1.1 Description of equipment

In Indian industries more than 50% of the total electrical energy consumption is used by rotating equipment. Out of which 65% of this is consumed by centrifugal or flow related applications such as fans, blowers, compressors, and pumps. By using Variable Frequency Drive (VFD) technology the advantage gained in both productivity improvements and reduction in energy consumption has been widely documented in the past few years. For example, by lowering fan or pump speed by 15% to 20%, shaft power can be reduced by as much as 20-30%. The main purpose of variable speed drives is to reduce energy costs and prolong the life of equipment by adjusting motor speed to meet load requirements

Variable Frequency Drive

A variable frequency drive is an electronic controller that adjusts the speed of an electric motor by regulating the power being delivered. Variable-frequency drives provide continuous control, matching motor speed to the specific demands of the work being performed. Variable-frequency drives are an excellent choice for adjustable-speed drive users because they allow operators to fine-tune processes while reducing costs for energy and equipment maintenance.

Figure 2.1 Variable frequency drive

Working Principle

Single-speed drives start motors abruptly, subjecting the motor to high torque and current surges up to 10 times the full-load current. Variable frequency drives offer a soft start, gradually ramping up a motor to operating speed. VFD minimizes the mechanical and electrical stress on the motors and can reduce maintenance and repair costs and extend the motor life.

Energy savings from variable-frequency drives can be significant. For example with centrifugal fan even a small reduction in motor speed can reduce fans energy use by as much as 50%. For example a 25 hp motor running 23 hours per day (2 hours at 100% speed; 8 hours at 75%: 8 hours at 67%; and 5 hours at 50%) a variable frequency drives can reduce energy use by 45%. Because benefits vary depending on operating speed of the system hence it is important to calculate benefits for each application before specifying a variable frequency drive.

In Solapur Textile Cluster units, the flow of the fans is controlled by mechanical dampers. If the flow can be controlled by reducing the speed of the fan's motor according to the requirement this would offer a more efficient means of achieving flow control of air. In fact the saving is greater than that might initially be expected by mechanical damper. As the speed of the fan is reduced, the flow will reduce partially, while the power required by the fan reduces with the cube of the speed.

The mechanical damper for control of the flow may reduce the load on the motor/fan/pump motor, but the constriction itself is an energy loss, which is obviously an inefficient technique. If the flow or speed can be controlled by reducing the speed of motor, this would offer a more efficient means of achieving flow control.

Considering the above facts and for reducing electricity consumption in the present boilers and thermic fluid heaters, it is suggested to install VFD for ID fans.

2.1.2 Availability of equipment

The VFD suppliers are available in Pune, which is 200 km from Solapur city and M/s Tangent Technologies is also planning to appoint a dealer at Solapur.

2.1.3 Service/equipment providers

The service providers are available in Pune. Details of service providers are given in Annexure 6.

2.1.4 Technology/equipment specification

Variable frequency drive of VSC plus series suitable for 1 no. 415V, 50 Hz, 3 phase 2.2 kW/ 3 HP AC Motor

Power Rating: 2.2 kW / 3 HP

- Protection class of VFD:IP20
- Sensor less vector control
- Overload duty:150% for 2 minutes
- 50 ^{o}C Ambient

2.1.5 Justification of technology selected and suitability

As discussed above, controlling the flow of fans and pumps by mechanical damper is inefficient and consumes more power. If the flow is controlled by reducing the speed of the fan's motor this would offer a more efficient means of achieving flow control. In fact the saving is greater than that might initially be expected from mechanical damper. As the speed of the fan is reduced, the flow will reduce partially, while the power required by the fan reduces with the cube of the speed. Proposed technology is completely suitable with existing system for control of air flow.

2.1.6 Superiority over existing system

The installation of VFD for fans has the following advantages:

- Reduction in breakdowns and smooth start
- Reduction in breakages and motor burning
- Improved life of the motor and increased production
- Reduction in production cost and maintenance cost due to frequent failures of belts, bearings, yarn breakages
- Improved power factor (0.98 across speed range)
- Maximize power distribution system
- Reduced inrush current
- Minimize peak demand charges
- Eliminates mechanical shock and stress on power train (couplings, belts, drive shafts, gear boxes, etc.)

- Reduce Utility operating costs
- Allows Load Shedding
- May qualify for utility rebates due increase in power factor
- Controlled acceleration and deceleration
- Eliminates Motor Voltage Imbalance

2.1.7 Terms and conditions in sales & service of VFD

Terms of payment

50% advance with purchase order, and remaining 50% along with taxes and duties against Performa invoice before dispatch.

Excise duty, sales tax & other levies

The quoted prices are exclusive of all taxes, duties, levies such as excise duty, central/local sales tax, octroi, etc. as are applicable at the time of dispatch or imposed by any statutory authorities subsequently or paid by us, shall be paid by you extra at actual. However CVD is charged at 8% plus 4% on the unit price plus 3% education cess and VAT is charged at 5%.

Warranty

The supplier shall repair or replace at free of cost, on ex – works basis the whole or any portion of material which under normal and proper use and maintenance proves defective in material and/or workmanship within 12 months from the date of commissioning or 18 months from the date of shipment of equipment whichever is earlier, provided prompt notice is given of such defects.

The terms and conditions of sale of hot water generator of the Ross Boilers is furnished below

2.1.8 Process down time during Implementation

No process down time is envisaged as installation of VFD is additional and will take 2 to 3 hours for installation.

2.2 Life cycle assesment and risk analysis

Life cycle of VFD is considered as 15 years. Actual capacity and suitable location are two improtant point must be considerd before instalation of VFD.

2.3 Suitable unit for implementation of proposed technology

The proposed VFD is suitable for installing for 7.5 kW motor and is standard as per the capacity of the motor.

3 ECONOMIC BENEFITS OF PROPOSED EUIPMENT

3.1 Technical benefits

3.1.1 Fuel saving

No fuel saving is possible by the implementation of the project activity.

3.1.2 Electricity saving

The present utilization capacity of the ID fan flow is only 50% of the rated flow of the fan and the flow is controlled by mechanical dampers. The flow can also be controlled by monitoring the motor RPM also. It is well known fact that, a 10% reduction in RPM of the motor will reduce the motor power consumption by 25%. For assessing the savings, under worst scenario, a 10% flow reduction is considered for avoiding the other consequences like overheating of furnace walls, etc.. Hence, 25% power savings is assumed by installing a VFD for ID/FD fans. Present electricity consumption in ID fan at Banda Textile is about 33000 kWh per year hence by the installation of VFD on ID fan it will save about 8250 kWh electricity annually.

Table 3.1 Energy and cost benefit of VFD

Parameter	*Unit*	*Value*
Present electricity consumption in ID fan	kWh/annum	33000
Operational hours	hours/day	12
Operational days per annum	days/annum	300
Electricity consumption after installation of VFD fan on ID fan	kWh/annum	24750
Cost of electricity	₹/kWh	2.42
Cost savings after implementation	₹ in lakh	0.20

From the above table it is evident that project implementation i.e. installation of VFD for ID/FD fan is financially viable and technically feasible. Detailed cash flow evaluation and financial parameters are discussed in detail in the next chapter.

3.1.3 Improvement in product quality

Product quality achieved would be same as the present quality. It does not have any impact in improving the quality of the product.

3.1.4 Increase in production

The proposed equipment does not contribute to any increase in production.

3.1.5 Reduction in raw material consumption

Raw material consumption is same even after the implementation of proposed technology.

3.2 Monetary benefits

The monetary benefit due to installation of VFD for ID fan motor is estimated as ₹ 0.20 lakh per annum due to reduction in electricity consumption.

3.3 Social benefits

3.2.1 Improvement in working environment

As installation of VFD eliminates Mechanical shock and stress on couplings, belts, drive shafts, gear boxes, etc., this may lessen the breakdowns and working environment may improved**.**

3.2.2 Improvement in skill set of workers

The technology selected for the implementation is new and energy efficient. The technology implemented will create awareness among the workforce about energy saving.

3.2.3 Impact on wages/emoluments

No impact on wages or emolument of workers.

3.4 Envirinmental benefit

3.4.1 Reduction in effluent generation

The effluent generation due to implementation of the project activity is insignificant.

3.4.2 Reduction in GHG emission such as CO_2, NOx, etc

The major GHG emission reduction source is CO_2 and the technology will reduce electricity consumption. The total emission reductions are estimated as 7 tonne of CO_2 per annum due to implementation of the project activity.

3.3.3 Reduction in other emissions like Sox

No significant impact on SO_x emissions.

4 INSTALLATION OF PROPOSED EQUIPMENT

4.1 Cost of equipment implementation

4.1.1 Cost of equipment

The total cost for installation of VFD is estimated at Rs.0.30 lakhs, which includes VFD, Panel, switches and cabling.

4.1.2 Other costs

The total cost of implementation of the Variable frequency drive is estimated at ₹ 0.32 lakh. The above cost includes cost of equipment/machinery, cost of fabrication (and/or) commissioning charges and the details are furnished in Table 4.1 below:

Table 4.1 Details of Project Cost

S.No	Particular	Cost (` in lakh)
1	Equipment and machinery	0.30
2	Erection & Commissioning	0.01
3	Interest during implementation	0.01
4	Total	0.32

4.2 Arrangement of funds

4.2.1 Entrepreneur's contribution

The total cost of the proposed technology is estimated at ₹ 0.32 lakh. The entrepreneur's contribution is 25% of total project cost, which is ₹ 0.08 lakh.

4.2.2 Loan amount

The term loan is 75% of the total project, which is ₹ 0.24 lakh.

As the overall energy efficiency in the project is more than 15% it qualifies for subsidy of 25% of the project cost as per the NMCP scheme of Ministry of MSME, GoI. 25 % of the project cost in this case works out to ₹0.08 lakh. As the subsidy is normally available after implementation of the project the same has not been taken in the project cost and means of finance. On receipt of subsidy from Ministry of MSME, GoI through the nodal agency the amount of subsidy is generally set off [reduced] from the loan outstanding by the lending bank. Availability of this subsidy will make the project economically more attractive

4.2.3 Terms & conditions of loan

The interest rate is considered at 10.00% which is SIDBI'S Lending rate for energy efficiency projects. The loan tenure is assumed 2 years and the moratorium period is 3 months.

4.3 Financial indicators

4.3.1 Cash flow analysis

Considering the above mentioned assumptions, the net cash accruals starting with ₹ 0.07 lakh in the first year operation and gradually increases to ₹ 0.16 lakh at the end of third year.

4.3.2 Simple payback period

The total project cost of the proposed technology is ₹ 0.32 lakh and monetary savings due to reduction in electricity consumption is ₹ 0.20 lakh and the simple payback period works out to be 1.60 years (21 months).

4.3.3 Net Present Value (NPV)

The Net present value of the investment at 10.00% works out to be `0.06 lakh.

4.3.4 Internal rate of return (IRR)

The after tax Internal Rate of Return of the project works out to be 20.59% thus the project is financially viable.

4.3.5 Return on investment (ROI)

The average return on investment of the project activity works out at 48.14% for an investment of ₹ 0.32 lakh.

Table 4.2 Financial indicator of project

S. No	Particulars	Unit	Value
1	Simple Pay Back period	months	21
2	IRR	%age	20.59
3	NPV	lakh	0.06
4	ROI	%age	48.14
5	DSCR	ratio	1.56

4.4 Sensitivity analysis

A sensitivity analysis has been carried out to ascertain how the project financials would behave in different situations like there is an increase in electricity savings or decrease in electricity savings. For the purpose of sensitive analysis, two scenarios are considered are.

- Increase in electricity savings by 5%
- Decrease in electricity savings by 5%

In each scenario, other inputs are assumed as constant. The financial indicators in each of the above situation are indicated along with standard indicators.

Details of sensitivity analysis for different scenario are furnished in Table 4.3 below:

Table 4.3 Sensitivity analysis in different scenario

Particulars	*DSCR*	*IRR*	*ROI*	*NPV*
Normal	1.56	20.59%	48.14%	0.06
5% increase in electricity savings	1.65	24.25%	48.72%	0.07
5% decrease in electricity savings	1.48	16.88%	47.49%	0.04

As could be seen from the above table, though the project is highly sensitive to electricity savings, DSCR works out to be 2.27times in worst scenario, which indicates the strength of the project.

4.5 Procurement and Implementation schedule

The project is expected to be completed in 1 week from the date of financial closure. The detailed schedule of project implementation is furnished in Annexure 6.

Annexure 1 Establishment of baseline

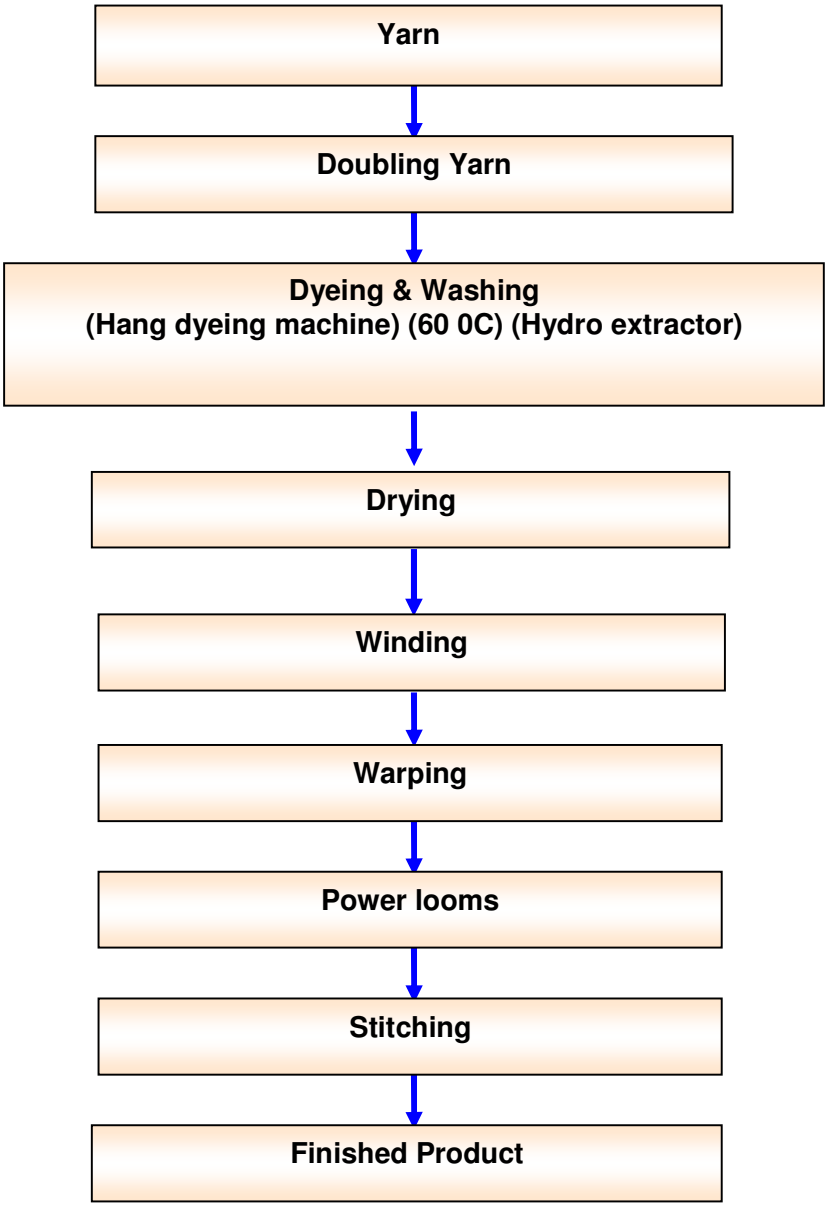
Banda Textile

Details	Unit	Value
No of operating hours	hr	12
No of operating days	days	300
Power consumption in ID fan	kWh	9.16
Damper opening	%age	30-40
Power consumption	kWh/day	110
Power consumption	kWh/year	33000

A Tex Industry

Details	Unit	Value
No of operating hours	hr	12
No of operating days	days	300
Power consumption in ID fan	kWh	2.2
Damper opening	%age	40-50
Power consumption	kWh/day	26.4
Power consumption	kWh/year	7920

Annexure 2 Process flow diagram

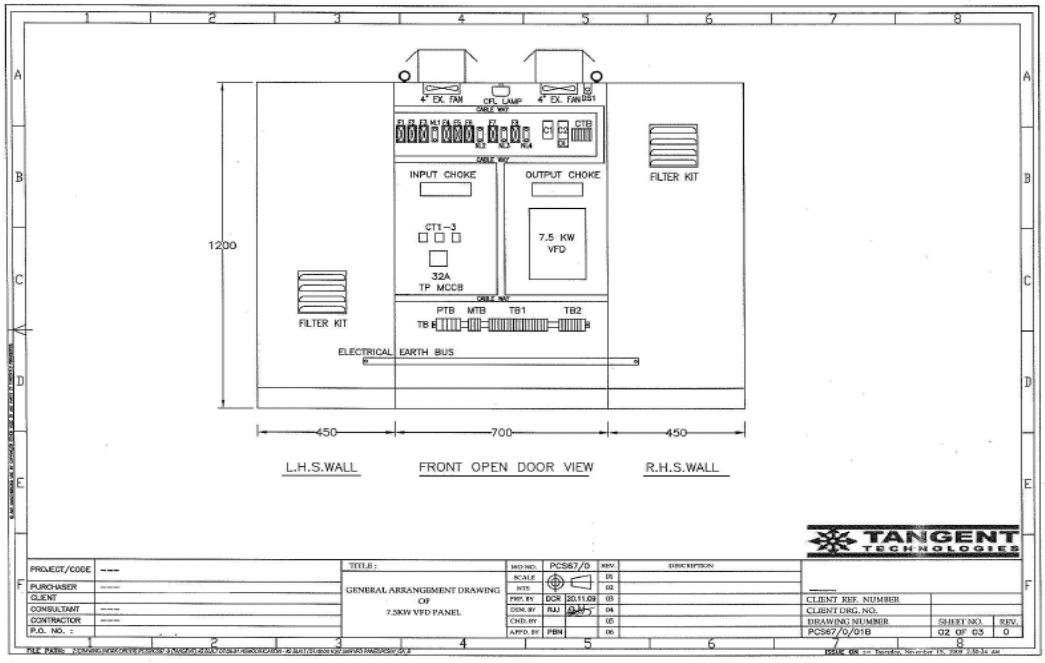


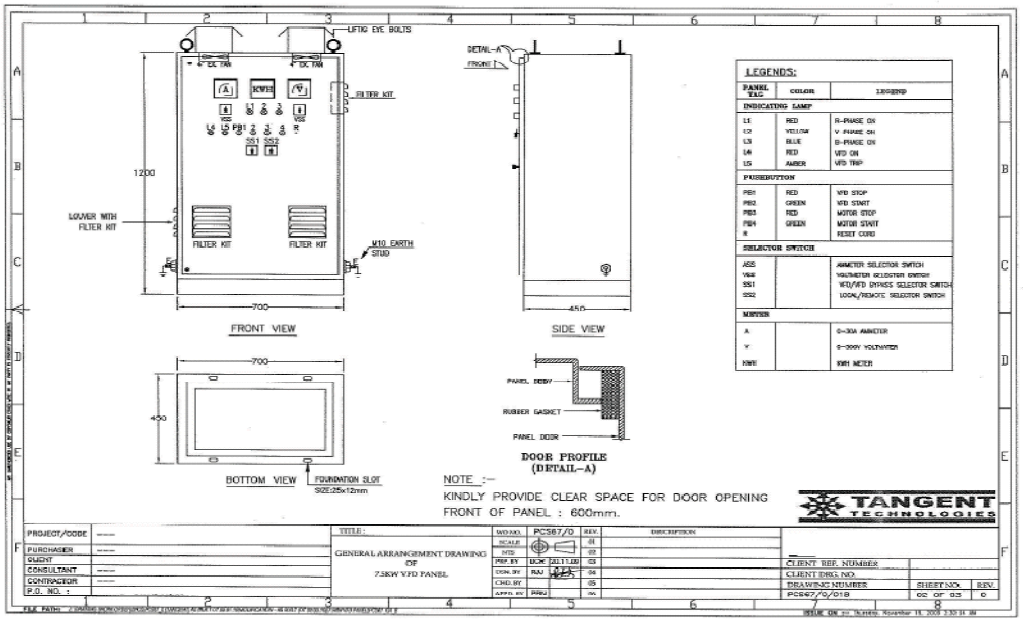
Annexure 3 Technology assessment report

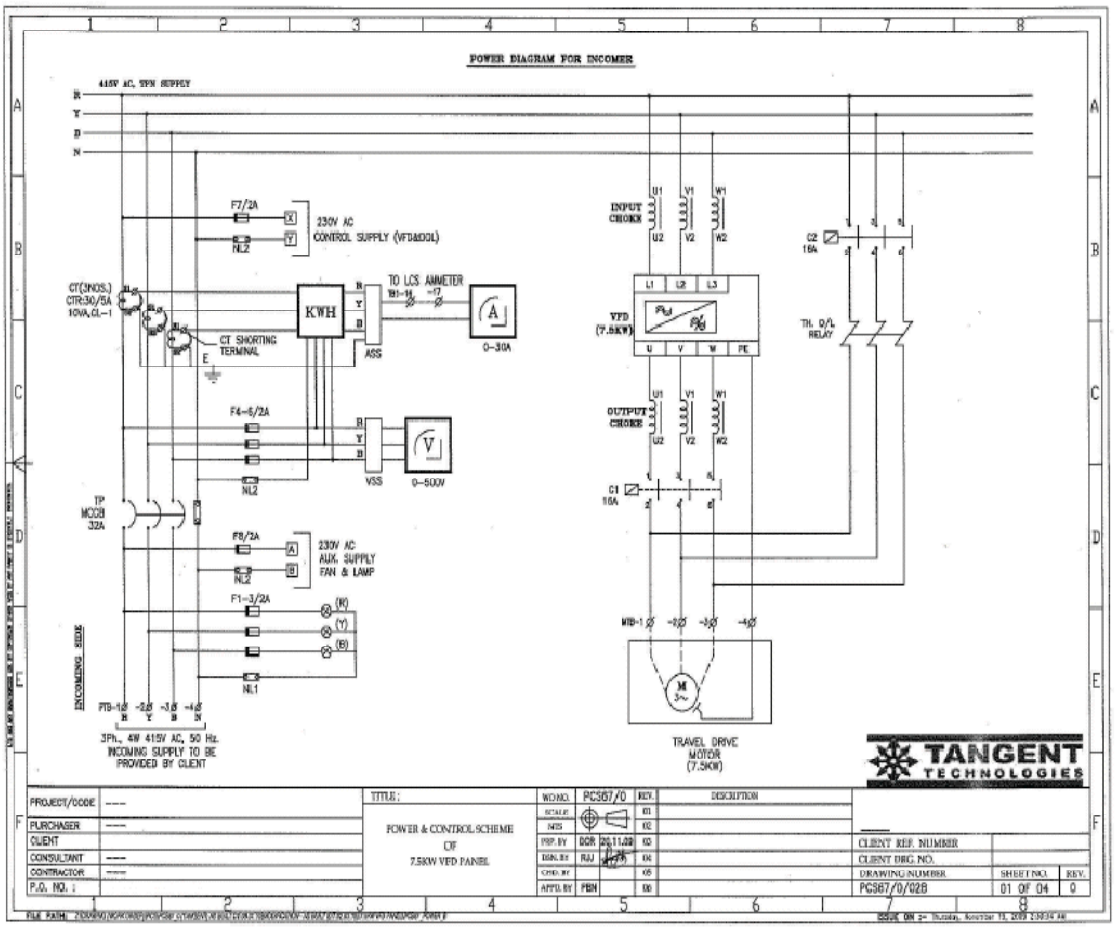
Controlling the flow of fans and pumps by mechanical is inefficient and consumes more power. If the flow is controlled by reducing the speed of the fan motor this would offer a more efficient means of achieving flow control. In fact the saving is greater than that might initially be expected. As the speed of the fan is reduced, the flow will reduce partially, while the power required by the fan reduces with the cube of the speed. In all the cluster units having thermic fluid heaters and boilers, the flow of the fans is controlled by mechanical dampers. Hence, for reducing power consumption of the fans, VFD is suggested for ID and FD fans.

Annexure 4 Electrical drawings for proposed equipment

Major civil works is not required for the technology hence no drawings are furnished






POWER DIAGRAM FOR INCOMER
415V AC, 3PH SUPPLY
F7/2A
230V AC
CONTROL SUPPLY (VFD&BOIL)
NL2
CT(3NOS.)
CTR:30/5A
10VA,CL-1
KWH
TO LCS AMMETER
CT SHORTING
TERMINAL
ASS
0-30A
F4-6/2A
VSS
0-500V
TP
MCCB
32A
F8/2A
230V AC
AUX. SUPPLY
FAN & LAMP
F1-3/2A
NL1
INCOMING SIDE
3Ph., 4W 415V AC, 50 Hz.
INCOMING SUPPLY TO BE
PROVIDED BY CLIENT
INPUT
CHOKE
VFD
(7.5KW)
OUTPUT
CHOKE
C2
16A
C1
16A
TH. O/L
RELAY
TRAVEL DRIVE
MOTOR
(7.5KW)
TANGENT
TECHNOLOGIES
PROJECT/CODE
PURCHASER
CLIENT
CONSULTANT
CONTRACTOR
P.O. NO. :
TITLE :
POWER & CONTROL SCHEME
OF
7.5KW VFD PANEL
WONO.
PCS67/0
DESCRIPTION
CLIENT REF. NUMBER
CLIENT DRG. NO.
DRAWING NUMBER
PCS67/0/02B
SHEET NO.
01 OF 04
REV.
0

Annexure 5 Detailed financial analysis of Hot Water Generator

Assumptions

Name of the Technology	**Variable frequency drive**		
Rated Capacity			
Detail	**Unit**	**Value**	
Installed Capacity	kWh/Hr		Feasibility Study
No of working days	Days	240	Feasibility Study
No of Shifts per day	Shifts	1	Feasibility Study
Capacity Utilization Factor	%		Feasibility Study
Proposed Investment			
Plant & Machinery	₹ (in lakh)	0.30	Feasibility Study
Erection & Commissioning (2%)	% on Plant & Equip	0.01	Feasibility Study
Investment without IDC	₹ (in lakh)	0.31	Feasibility Study
Interest During Implementation	₹ (in lakh)	0.01	Feasibility Study
Total Investment	₹ (in lakh)	0.32	Feasibility Study
Financing pattern			
Own Funds (Internal Accruals)	₹ (in lakh)	0.08	Feasibility Study
Loan Funds (Term Loan)	₹ (in lakh)	0.24	Feasibility Study
Loan Tenure	Years	2	Assumed
Moratorium Period	Months	3	Assumed
Repayment Period [excluding moratorium]	Months	24	Assumed
Interest Rate	%	10	SIDBI's rate of interest for energy efficiency project
Estimation of Costs			
O & M Costs	% Plant & Equip	4.00	Feasibility Study
Annual Escalation	%	5.00	Feasibility Study
Estimation of Revenue			
Electricity savings	kWh/year	8250	-
Cost	₹/kWh	2.42	-
St. line Depn.	%	5.28	Indian Companies Act

Estimation of Interest on Term Loan

(₹ in lakh)

Years	*Opening Balance*	*Repayment*	*Closing Balance*	*Interest*
1	0.24	0.09	0.15	0.02
2	0.15	0.12	0.03	0.01
3	0.03	0.03	0.00	0.00
		0.24		

WDV Depreciation:

Particulars / years	1	2	3
Plant and Machinery			
Cost	0.31	-	-
Depreciation	0.31	-	-
WDV	-	-	-

Projected Profitability

Particulars / Years	1	2	3
Revenue through Savings			
Fuel savings	0.20	0.20	0.20
Total Revenue (A)	0.20	0.20	0.20
Expenses			
O & M Expenses	0.01	0.01	0.01
Total Expenses (B)	0.01	0.01	0.01
PBDIT (A)-(B)	0.19	0.19	0.19
Interest	0.02	0.01	0.00
PBDT	0.16	0.17	0.18
Depreciation	0.02	0.02	0.02
PBT	0.15	0.16	0.17
Income tax	-	0.06	0.06
Profit after tax (PAT)	0.15	0.10	0.10

Computation of Tax ***(₹ in lakh)***

Particulars / Years	1	2	3
Profit before tax	0.15	0.16	0.17
Add: Book depreciation	0.02	0.02	0.02
Less: WDV depreciation	0.31	-	-
Taxable profit	(0.15)	0.17	0.18
Income Tax	-	0.06	0.06

Projected Balance Sheet ***(₹ in lakh)***

Particulars / Years	1	2	3
Liabilities			
Share Capital (D)	0.08	0.08	0.08
Reserves & Surplus (E)	0.15	0.24	0.35
Term Loans (F)	0.15	0.03	0.00
Total Liabilities D)+(E)+(F)	0.37	0.35	0.42

Assets

Gross Fixed Assets	0.31	0.31	0.31
Less: Accm. Depreciation	0.02	0.03	0.05
Net Fixed Assets	0.30	0.28	0.26
Cash & Bank Balance	0.07	0.07	0.16

Total Assets	0.37	0.35	0.42
Net Worth	0.23	0.32	0.43
Debt Equity Ratio	0.64	0.08	-0.01

Projected Cash Flow: ***(₹ in lakh)***

Particulars / Years	*0*	*1*	*2*	*3*
Sources				
Share Capital	0.08	-	-	-
Term Loan	0.24			
Profit After tax		0.15	0.10	0.10
Depreciation		0.02	0.02	0.02
Total Sources	0.31	0.16	0.11	0.12
Application				
Capital Expenditure	0.31			
Repayment of Loan	-	0.09	0.12	0.03
Total Application	0.31	0.09	0.12	0.03
Net Surplus	-	0.07	(0.01)	0.09
Add: Opening Balance	-	-	0.07	0.07
Closing Balance	-	0.07	0.07	0.16

Internal Rate of Return ***(₹ in lakh)***

Particulars / months	*0*	*1*	*2*	*3*
Profit after Tax		0.15	0.10	0.10
Depreciation		0.02	0.02	0.02
Interest on Term Loan		0.02	0.01	0.00
Salvage/Realizable value				
Cash outflow	(0.31)	-	-	-
Net Cash flow	(0.31)	0.19	0.13	0.12
IRR	20.59%			

NPV	0.06

Break Even Point ***(₹ in lakh)***

Particulars / Years	*1*	*2*	*3*
Variable Expenses			
Oper. & Maintenance Exp (75%)	0.01	0.01	0.01
Sub Total ***(G)***	0.01	0.01	0.01
Fixed Expenses			
Oper.& Maintenance Exp (25%)	0.00	0.00	0.00
Interest on Term Loan	0.02	0.01	0.00
Depreciation *(H)*	0.02	0.02	0.02
Sub Total (I)	0.04	0.03	0.02

Sales (J)	0.20	0.20	0.20
Contribution (K)	0.19	0.19	0.19
Break Even Point (L= G/I)	22.72%	18.12%	11.91%
Cash Break Even {(I)-(H)}	14.01%	9.39%	3.16%
Break Even Sales (J)*(L)	0.05	0.04	0.02

Return on Investment ***(₹ in lakh)***

Particulars / Years	*1*	*2*	*3*	*Total*
Net Profit Before Taxes	0.15	0.16	0.17	0.47
Net Worth	0.23	0.32	0.43	0.97
				48.14%

Debt Service Coverage Ratio ***(₹ in lakh)***

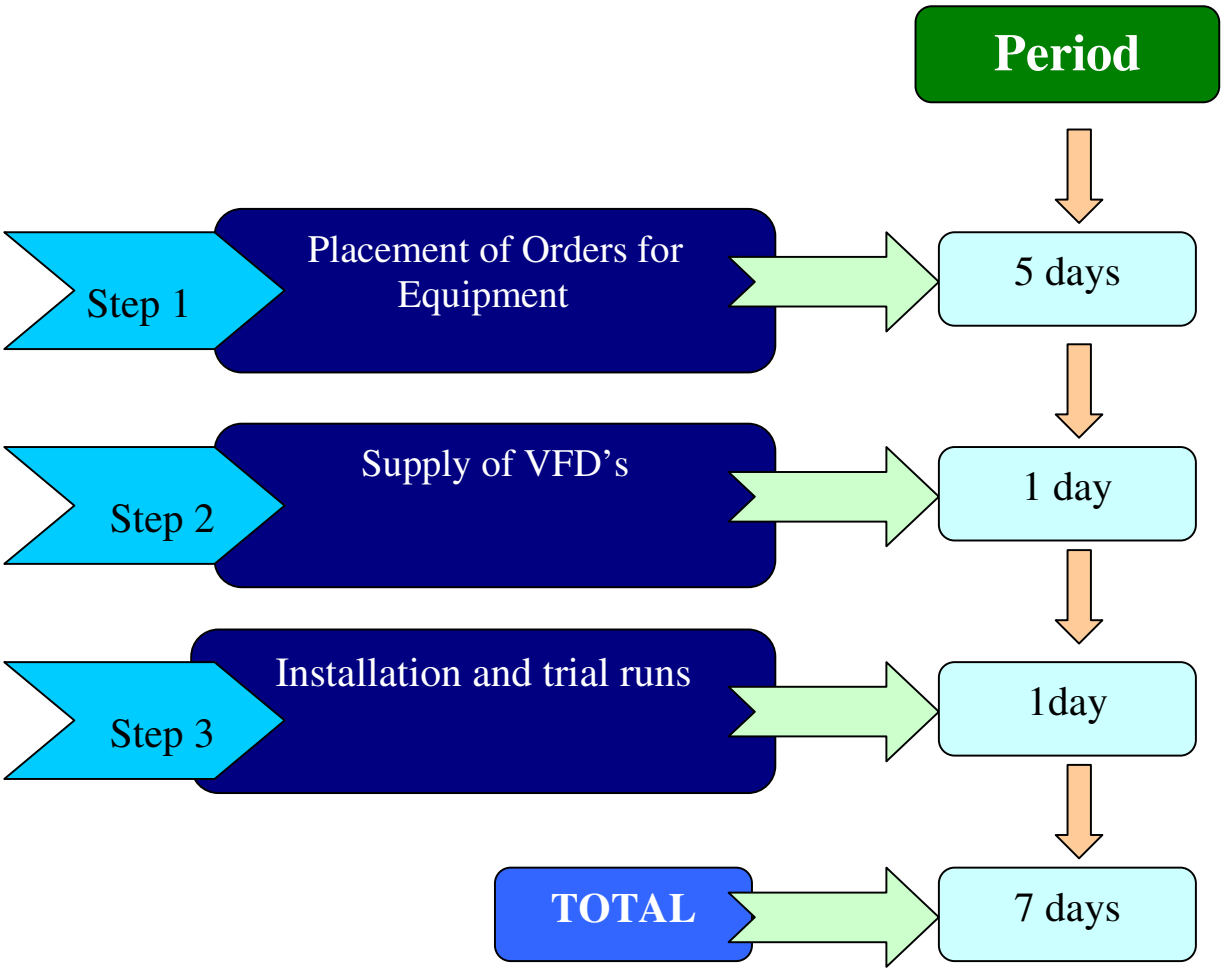
Particulars / Years	*1*	*2*	*3*	*Total*
CASH INFLOW				
Profit after Tax	0.15	0.10	0.10	0.35
Depreciation	0.02	0.02	0.02	0.05
Interest on Term Loan	0.02	0.01	0.00	0.04
Total (M)	0.19	0.13	0.12	0.44

DEBT

Interest on Term Loan	0.02	0.01	0.00	0.04
Repayment of Term Loan	0.09	0.12	0.03	0.24
Total (N)	0.11	0.13	0.03	0.28
Average DSCR (M/N)	1.56			

Annexure 6 Details of procurement and implementation plan

Project Implementation Schedule



Annexure 7 Details of equipment and service provider

Equipment details	*Service/technology provider*
Variable Frequency Drive (VFD)	**TANGENT TECHNOLOGIES** 105, 131 Ambica Complex, Gorwa Refinery Road, Vadodara India- 390016 E-mail: info@tangent.in Mobile:+91 9825500449 Telefax:+91 265 2291264 Website: www.tangent.in

Annexure 8 Quotations of proposed equipment

TANGENT TECHNOLOGIES

Scope Of Supply and Price Schedule

Sl.	Description	Qty	Unit Price (Ex Works Vadodara)
01	Emotron/Tangent make Variable Frequency Drive of VSCplus series suitable for 1 NO. 415V, 50Hz 3 phase **0.75KW/ 1HP AC Motor** **Power Rating: 0.75kw / 1HP** • Protection Class of VFD: IP20 • Sensorless Vector Control • Overload duty: 150% for 2 minutes • 50degC Ambient	01	**Rs. 11,200/-**
02	Emotron/Tangent make Variable Frequency Drive of VSCplus series suitable for 1 NO. 415V, 50Hz 3 phase **1.5KW/ 2HP AC Motor** **Power Rating: 1.5kw / 2HP** • Protection Class of VFD: IP20 • Sensorless Vector Control • Overload duty: 150% for 2 minutes • 50degC Ambient	01	**Rs. 13,200/-**
03	Emotron/Tangent make Variable Frequency Drive of VSCplus series suitable for 1 NO. 415V, 50Hz 3 phase **2.2KW/ 3HP AC Motor** **Power Rating: 2.2kw / 3HP** • Protection Class of VFD: IP20 • Sensorless Vector Control • Overload duty: 150% for 2 minutes • 50degC Ambient	01	**Rs. 15,600/-**
04	Emotron/Tangent make Variable Frequency Drive of VSCplus series suitable for 1 NO. 415V, 50Hz 3 phase	01	**Rs. 18,600/-**

	3.7KW/ 5HP AC Motor **Power Rating: 0.75kw / 1HP** • Protection Class of VFD: IP20 • Sensorless Vector Control • Overload duty: 150% for 2 minutes • 50degC Ambient		
05	Emotron/Tangent make Variable Frequency Drive of VSCplus series suitable for 1 NO. 415V, 50Hz 3 phase **5.5KW/ 7.5HP AC Motor** **Power Rating: 5.5kw / 7.5HP** • Protection Class of VFD: IP20 • Sensorless Vector Control • Overload duty: 150% for 2 minutes • 50degC Ambient	01	**Rs. 23,700/-**
06	Emotron/Tangent make Variable Frequency Drive of VSCplus series suitable for 1 NO. 415V, 50Hz 3 phase **7.5KW/ 10HP AC Motor** **Power Rating: 7.5kw / 10HP** • Protection Class of VFD: IP20 • Sensorless Vector Control • Overload duty: 150% for 2 minutes • 50degC Ambient	01	**Rs. 27,500/-**

Exclusions :

- Mounting frames if any for motor and VFD.
- Power, control, screened cables and all cable accessories.
- Erection of the equipment.
- Motors and Tachogenerators.
- Alignment of the motor with the load.
- The field cable Lugs / Glands are excluded from our scope.

General Terms and Conditions

Our Offer is subject to the following terms and conditions of the contract.

PRICES
Unless otherwise mentioned clearly in our offer, the quoted prices are FIRM, and on Ex-works, Vadodara or our sub-suppliers Ex-works basis.

Prices exclude packing & forwarding charges, **freight & insurance.**

Packing & forwarding will be charged @0.5%

If there is any delay in giving despatch clearance, we will be entitled for increase in the price due to

- storage of equipment @ 0.5 % of contract value per month and

Interest charges @ 2.0 % of contract value per month or part thereof.

FREIGHT
The quoted prices are exclusive of freight charges and the equipment is therefore normally despatched on freight '**TO PAY** ' basis through rail /road transport.

TERMS OF PAYMENT
50% Advance with purchase order, and remaining 50% along with taxes and duties against Proforma Invoice before dispatch

Failure to make payment shall attract a levy of interest @ 18% per annum on the amount unpaid and any other incidental costs including demurrage, without prejudice to any action taken by us to safeguard our interest and the purchaser indemnifies the seller against any such delays or any losses or cost incurred therefrom.

EXCISE DUTY, SALES TAX & OTHER LEVIES
The quoted prices are exclusive of all taxes, duties, levies such as excise duty, central/local sales tax, octroi, etc. as are applicable at the time of despatch or imposed by any statutory authorities subsequently or paid by us, shall be paid by you extra at actuals.
However CVD is charged at 8% + 4% on the unit price plus 3% Education cess. And VAT is charged at 5%.

Necessary declaration forms, if applicable, shall be furnished by you.

DELIVERY TIME
We expect the equipment to be ready for delivery within **Ex Works** from the date of receipt of your advance payment & drawing approval.

The above delivery period is given in all good faith and is subject to our / our sub-suppliers usual force majeure conditions.

DESPATCH INFORMATION

The purchaser shall give clear despatch information indicating the destination, CST/LST registration no., Road permit wherever applicable in the order itself.

WARRANTY

We shall repair or replace at our option, free of cost, on ex - works basis the whole or any portion of material which under normal and proper use and maintenance proves defective in material and/or workmanship within 12 months from the date of commissioning or 18 months from the date of shipment of equipment whichever is earlier, provided prompt notice is given of such defects. Such replacements shall be effected within a reasonable time actually required to do so. Our liability arising out of supplying the material or its use, whether on warranties or otherwise shall not in any case extend the warranty period and exceed the cost of correcting the defects or replacement of the defective material and upon expiration of the period mentioned above, all such liability shall terminate. Our liability does not extend to consequential damages, either direct or indirect or expenses for repairs or replacements or otherwise paid or incurred without our authority. We accept no liability for defects or depreciation caused by damage in transit, lightning, dampness, neglect, misuse / negligent actions or omissions of the purchaser, inadequate storage, other abnormal conditions due directly or indirectly to circumstances beyond our control.

In case of goods not of our manufacture, our liability will be limited to the benefits we may receive under the manufacturers Warranty Clause. This warranty excludes consumables like fuses (semiconductor or HRC or glass), fragile equipments like indicating lamps, indicating meters etc.

The warranty contained herein shall be voidable at our discretion, in the event of breach of the contractual terms and conditions by the purchaser, including non-payment of consideration or servicing by a person or agency not authorised by us.

EQUIPMENT PERFORMANCE

The equipment offered shall perform satisfactorily within the guaranteed environmental/power supply conditions as mentioned in the offer. The equipment may malfunction due to the site conditions beyond the specified limits and we shall not be liable for any damage caused by the same.

For safe and optimum use of the equipment supplied, the purchaser shall strictly follow the instructions given in the operations and maintenance manual. We shall not be responsible for damages, injuries or losses suffered or caused due to, directly or indirectly, non-compliance with the operation and maintenance manual and other related instructions.

SUSPENSION

In the event of work suspension, as a compensation, we will be reimbursed the following costs, to the extent that such costs directly result from such suspension :

- A standby charge to be paid to us during the period of suspension, which shall be actual costs for holding /storing the equipment made ready as per the contract delivery time. (E.g. Interest costs, storage costs, etc.).
- Necessary costs associated with de mobilisation and mobilisation of our equipment.
- We shall also be compensated for escalation in the prices of the equipment under supply package, the value of which shall be mutually discussed and agreed upon.

CANCELLATION

Any order placed pursuant hereto, forming a LOI/purchase order/award of contract may be cancelled and terminated by the purchaser only upon notifying in writing and upon mutual consent and on payment of the cancellation charges as detailed below.

	Contractual Delivery	
	3 – 5 months	6 – 8 month
Within 30 days of release of LOI/PO/contract signing	10 %	10 %
Within 31 days – 60 days	30 %	
More than 61 days	100 %	
Within 31 days – 90 days	--	30 %
> 90days but < 120 days	--	50 %
More than 121 days	--	100 %

FORCE MAJEURE

If at any time during the continuance of this contract, the performance, in whole or in part, of any obligation under this contract shall be prevented or delayed at our/ our sub-suppliers works by reasons by any war (whether declared or otherwise), hostility, acts of the public enemy, civil commotion, sabotage, fires, floods, explosives, earthquake, epidemics, quarantine restrictions, strikes, labour disputes, lockouts, compliance with regulations, orders or instructions of any central, state or municipal government or agencies thereof, inability to obtain material or sufficient electricity for full manufacturing operations, any acts of God, then provided notice of the happening of any such eventuality is given by us to the purchaser within a reasonable period of time from the date of eventuality, the suitable extension of delivery time shall be granted by the purchaser.

CONFIDENTIAL INFORMATION

All information submitted along with this offer shall be held by the purchaser in confidence. Purchaser shall not disclose to third parties nor reuse any information in connection or association with equipment other than that delivered by us hereunder without the written consent of us.

All the information's in respect of software, programmes, know-how, techniques and other forms of proprietary information that will be supplied as a part of the contract through any acceptable media, whether documented or not, shall remain the sole and exclusive property of us or the respective owner of such intellectual property. The purchaser has the right to use this information but is forbidden to make any unauthorised copies, by any means, or in any manner violate, breach or infringe any and all of the said intellectual property rights.

ARBITRATION

In case of any breach of contract / disputes / differences arising under or in connection with this agreement, which can not be settled by friendly negotiation and agreement amongst the parties, this offer is subjected to the standard arbitration clause in accordance with the provisions of the arbitration and conciliation act 1996. The venue of arbitration proceedings shall be Vadodara, India. The cost of the arbitration shall be equally shared by the parties.

Bureau of Energy Efficiency (BEE)
(Ministry of Power, Government of India)
4th Floor, Sewa Bhawan, R. K. Puram, New Delhi – 110066
Ph.: +91 – 11 – 26179699 (5 Lines), Fax: +91 – 11 – 26178352
Websites: www.bee-india.nic.in, www.energymanagertraining.com

Zenith Energy Services Pvt. Ltd
10-5-6/B, My Home Plaza, Masab
Tank HYDERABAD, AP 500 028
Phone: 040 23376630, 31,
Fax No.040 23322517
Website: www.zenithenergy.com

India SME Technology Services Ltd
DFC Building, Plot No.37-38,
D-Block, Pankha Road,
Institutional Area, Janakpuri, New Delhi-110058
Tel: +91-11-28525534, Fax: +91-11-28525535
Website: www.techsmall.com