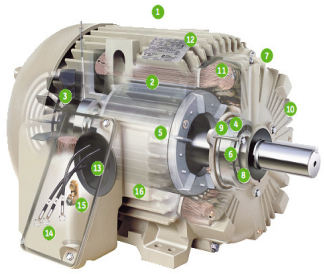
DETAILED PROJECT REPORT
ON
ENERGY EFFICIENT MOTOR (22 kW EEF 1)
HOWRAH CLUSTER











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Bureau of Energy Efficiency

Prepared By

Reviewed By

ISTSL

ENERGY EFFICIENT MOTORS OF 22 kW RATING

HOWRAH GALVANIZING
AND WIRE DRAWING CLUSTER

BEE, 2010
Detailed Project Report on Energy Efficient Motors (22 kW)
Galvanizing and Wire Drawing SME Cluster,
Howrah, West Bengal (India)
New Delhi: Bureau of Energy Efficiency;
Detail Project Report No.: ***HWR/WDG/EFF/08***

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Indian Institute of Social Welfare and Business Management(IISWBM) is also thankful to District Industry Center(DIC), Howrah chamber of Commerce & Industry(HCCI), Bengal National Chamber of commerce & Industry(BNCCI), Federation of Small & Medium Industry(FOSMI) and West Bengal Renewable Energy Development Agency(WBREDA) for their valuable inputs, co-operation, support and identification of the units for energy use and technology audit studies and facilitating the implementation of BEE SME program in Howrah Galvanizing and Wire Drawing Cluster.

We take this opportunity to express our appreciation for the excellent support provided by Galvanizing and Wire Drawing Unit Owners, Local Service Providers, and Equipment Suppliers for their active involvement and their valuable inputs in making the program successful and in completion of the Detailed Project Report (DPR).

IISWBM is also thankful to all the SME owners, plant in charges and all workers of the SME units for their support during the energy use and technology audit studies and in implementation of the project objectives.

Indian Institute of Social Welfare and Business Management Kolkata

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List of Abbreviation

BEE	Bureau of Energy Efficiency
CDM	Clean Development Mechanism
DPR	Detailed Project Report
DSCR	Debt Service Coverage Ratio
GHG	Green House Gases
GWh	Giga Watt Hours
IRR	Internal Rate of Return
MT	Million Ton
MW	Mega Watt
NA, NAp	Not Available, Not Applicable
NPV	Net Present Value
ROI	Return on Investment
SHC Coal	Semi Hard Coke Coal
SIDBI	Small Industrial Development Bank of India
MoMSME	Ministry of Micro Small and Medium Enterprises

EXECUTIVE SUMMARY

Indian Institute of School Welfare and Business management (IISWBM), Kolkata is executing BEE-SME program in the Galvanizing and Wire Drawing Cluster of Howrah, supported by Bureau of Energy Efficiency (BEE) with an overall objective of improving the energy efficiency in cluster units.

One of the identified sectors was Galvanizing and Wire-drawing cluster in Howrah district of West Bengal. There are about 100 SMEs in Galvanizing and Wire-drawing sector of Howrah Cluster comprising about 50% galvanizing units and 50% wire drawing units. These units are constantly under the threat of closure due to poor energy efficiency along with pollution issues and variability in demand. Improvement in energy efficiency would largely ensure sustainable growth of the sector, which needs a mechanism to identify technology and techniques for improving energy efficiency in these highly unorganized and so far uncared industrial units.

Motors are an integral part of any unit in this cluster. However, those motors are typically of the conventional type with low maximum efficiency. Use of energy efficient motors which have higher efficiency than existing motor and help in saving a lot of money for the units. The replicability potential of the energy efficient motors is as high as 90 in the Howrah cluster. It may also be noted that the replicability also applies to motors in the same unit.

Installation of proposed equipment i.e. installation of new energy efficient motor having 22 kW capacity to replace existing motor having low efficiency as well as higher capacity than the required would save about 7522kWh electricity per year.

This DPR highlights the details of the study conducted for assessing the potential for installation new energy efficient motor, possible reduction in energy/production cost and its monetary benefit, availability of the technologies/design, local service providers, technical features and proposed equipment specifications, various barriers in implementation, environmental aspects, estimated GHG reductions, capital cost, financial analysis, sensitivity analysis for different scenarios and schedule of Project Implementation.

This bankable DPR also found eligible for subsidy scheme of MoMSME for “Technology and Quality Upgradation Support to Micro, Small and Medium Enterprises” under “National Manufacturing and Competitiveness Programme”. The key indicators of the DPR including the Project cost, debt equity ratio, monetary benefit and other necessary parameters are given in table:

S.No	Particular	Unit	Value
1	Project cost	₹ in lakh	0.54
2	Electricity saving	kWh/year	7522
3	Monetary benefit	Rs. in lakh	0.49
4	Debit equity ratio	Ratio	3:1
5	Simple payback period	Year	1.10
6	NPV	₹ in lakh	1.29
7	IRR	%age	71.23
8	ROI	%age	28.22
9	DSCR	Ratio	3.84
10	Process down time	Days	7

The projected profitability and cash flow statements indicate that the project implementation i.e. installation of energy efficient motors will be financially viable and technically feasible solution for galvanizing and wire drawing cluster.

ABOUT BEE'S SME PROGRAM

The Bureau of Energy Efficiency (BEE) is implementing a BEE-SME Programme to improve the energy performance in 25 selected SMEs clusters. Howrah Galvanizing and Wire Drawing Cluster is one of them. The SME Programme of BEE intends to enhance the awareness about energy efficiency in each cluster by funding/ subsidizing need based studies 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*:**

Activity 1: 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 the SMEs.

Activity 2: Capacity building of stake holders in cluster on energy efficiency

In most of the cases SME entrepreneurs are dependent on the locally available technologies, and service providers for various reasons. To address this issue BEE has also undertaken capacity building of local service providers and entrepreneurs / managers of the 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 of energy efficiency projects in the clusters

Activity 3: Implementation of energy efficiency measures

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

Activity 4: 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 Brief Introduction about cluster

The Galvanizing and Wire-drawing cluster in Howrah district of West Bengal is a very large cluster. There are about 100 SMEs in the Howrah Cluster and comprising of about 50% galvanizing units and 50% wire drawing units. The units are constantly under threat of closure due to poor energy efficiency along with pollution issues and variability in demand. Improvement in energy efficiency would largely ensure sustainable growth of the sector. It needs a mechanism to identify technology and techniques for improving energy efficiency in these highly unorganized and so far uncared industrial units.

The major raw materials for the Galvanizing industry are zinc, ammonium chloride, hydrochloric acid, and di-chromate powder. On the other hand, the raw materials used in Wire-drawing units are MS / Copper / Aluminium Wires of gauges varying from 14 to 4 gauge i.e. 1.6 to 5.1 mm dia., while Uni-Lab powder (of Predington company based in Bombay or Grommet–44 is used for lubrication).

The main form of energy used by the cluster units are grid electricity, Furnace Oil, SHC coal, LPG and Diesel oil. Major consumptions of energy are in the form of Furnace Oil and Diesel. Details of total energy consumption at Howrah cluster are furnished in Table 1.1a and 1.1b:

Table 1.1a Details of annual energy consumption in the wire drawing units

S. No	Type of Fuel	Unit	Value	% contribution
1	Electricity	GWh/year	2.24	76
2	Wood	Ton/year	300	5
3	LPG	Ton/year	70.5	19

Table 1.1b Details of annual energy consumption in the galvanizing units

S. No	Type of Fuel	Unit	Value	% contribution
1	Electricity	MWh/year	867.3	13
2	Diesel	kl/year	19.2	2
3	Furnace Oil	kl/year	731.7	62.5
4	SHC coal	Ton/year	1161	18.5
5	Wood	Ton/year	600	4

Classification of Units

The Galvanizing and Wire Drawing units can be broadly classified on the basis of the following criteria:

1) Product wise
2) Production capacity wise

Products Manufactured

The galvanizing units can be classified on the basis of products into five basis groups. Those are:

a) Units producing transmission tower structures
b) Units producing fastener items
c) Units producing angles and channels
d) Units working on scrap iron
e) Units producing wires

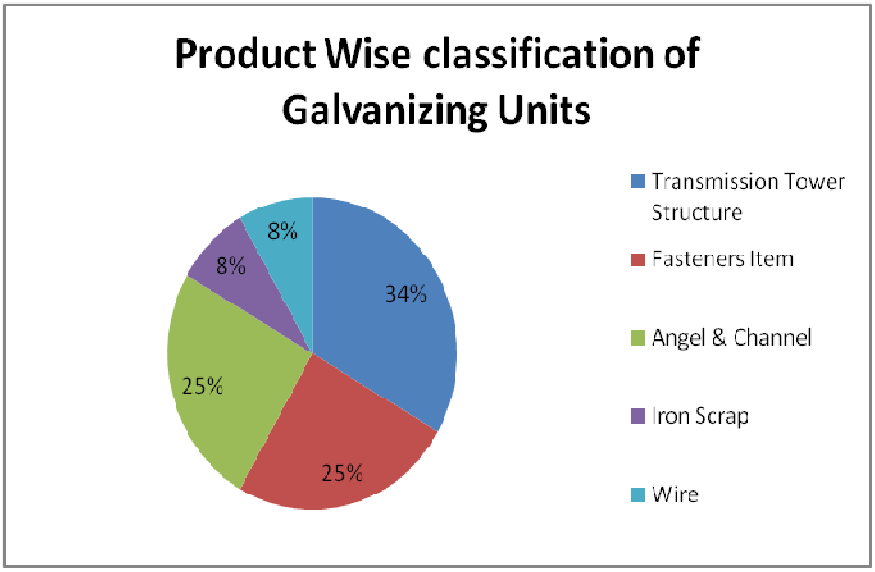


Figure 1.1: Product Wise Classification of Galvanizing Units

Similarly, the wire drawing units are mainly classified into the following categories on the basis of products manufactured as units, which produce:

a) MS wire

b) Copper Wire

c) High carbon wire

d) Aluminium wire

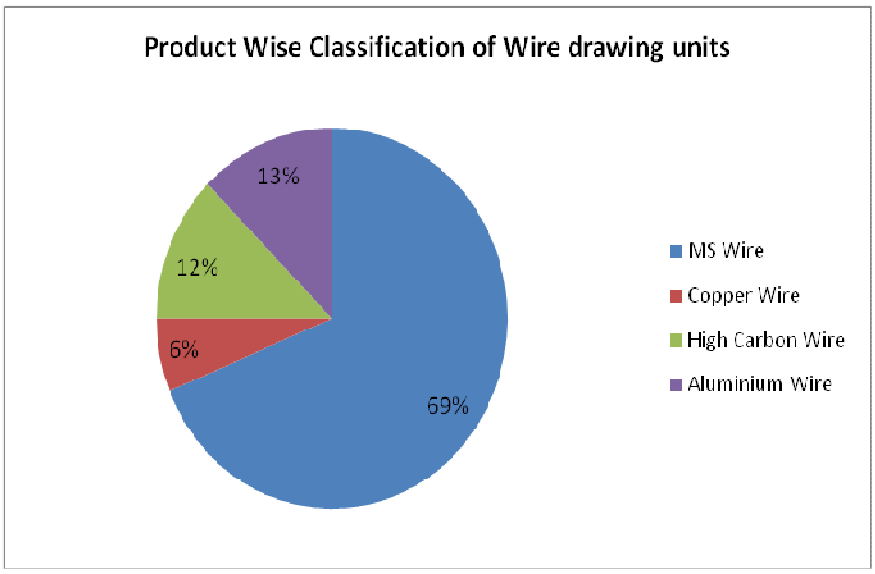


Figure 1.2: Product Wise Classification of Wire-drawing Units

Capacity wise production

In both Wiredrawing and Galvanizing units in Howrah, the production capacity has been found to vary more than 10 folds. In the units, where detailed audit has been performed, there are Wire-drawing units producing as low as 241 Ton/year to as high as 3500 Ton/year. Similarly, the production from Galvanizing units, where audit was performed, has been found to be within the range of 890 to 7500 Ton per annum. Both the Galvanizing and the Wire Drawing units have been classified on the basis of production into three categories, namely 1-500 TPA (calling micro scale), 500-1000 TPA (small scale) and above 1000 TPA (medium scale) capacities.

The distribution of units of Galvanizing and Wire Drawing industries have been depicted in figures 1.3 and 1.4 below:

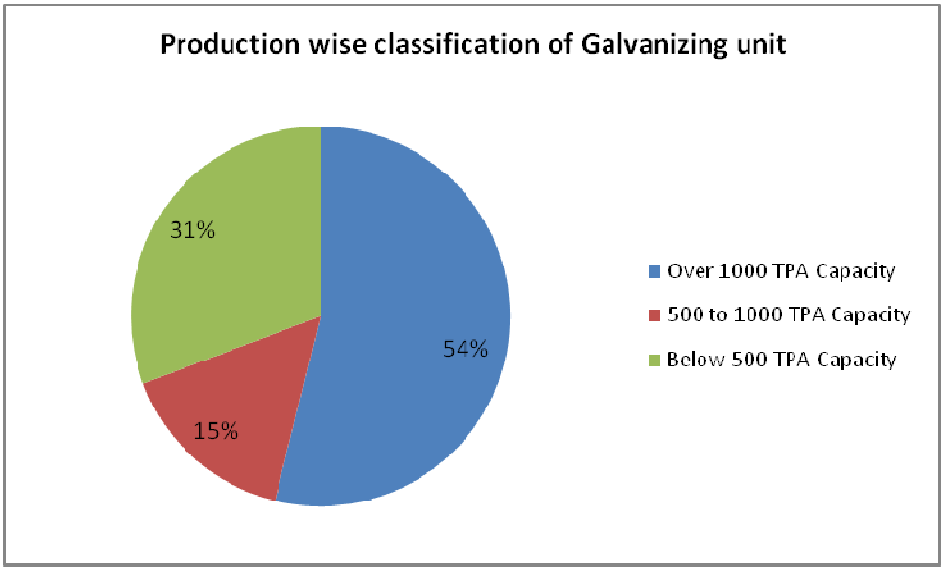


Figure 1.3: Production Wise Classification of Galvanizing Units

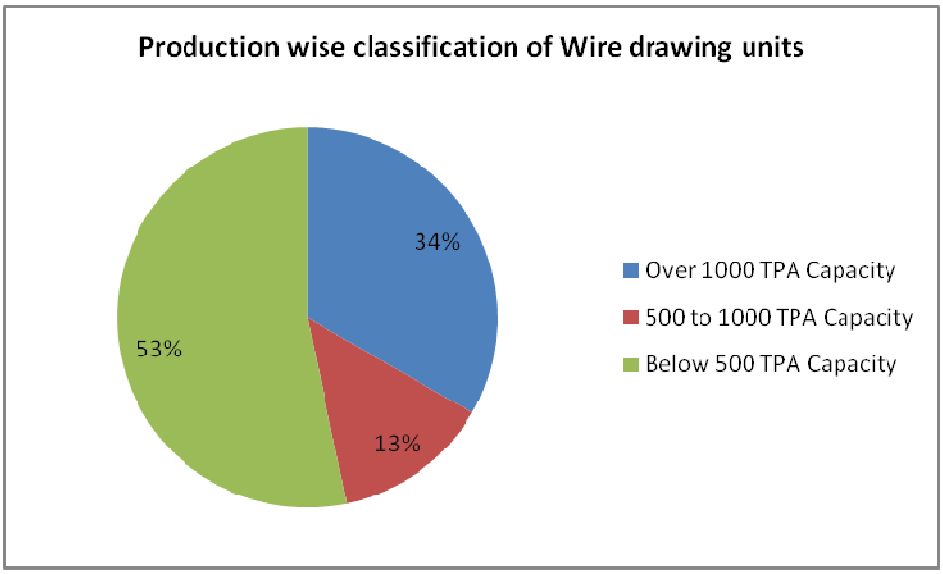


Figure 1.4: Production Wise Classification of Wire-drawing Units

Energy usages pattern

Average yearly electricity consumption in Wire Drawing unit ranges from 82 thousands to 7 lakh kWh depending on the size of the unit. In thermal energy, solid fuel such as wood and gaseous fuel like LPG are used in annealing furnaces in some of the units. The LPG consumption in a typical unit is about 135000 kg/year. The wood consumption in a typical unit is about 300 Ton/year.

Average yearly electricity consumption in a galvanizing unit ranges from 60 thousands to 3 lakh kWh depending on the size of the unit and type of operations performed. In thermal energy, furnace oil is primarily used in the galvanizing furnaces since it is reasonably cheap. The use of FO ranges from 0.5 to 4.5 lakh liters/year. The use of diesel oil ranges from 1.3 to 19.2 kilolitre/year and is used in either drying the job or pre-heating flux solution. SHC coal is also used for the purpose of drying the job and ranges from 1.5 to 8 lakh kg/year. Wood is used in some larger units which have facilities for running processes other than galvanizing. It can typically use 6 lakh kg/year of wood.

General production process for the wire drawing units

The wire about to be drawn is first put into an annealing furnace. The annealed wire is then put into drums for coiling wires. Thereafter, the wire is put through dies of various sizes interspersed by sets of coiler drums.

These drums are driven by electric motors that are of induction type. The chemical used for lubricating the wire through the die is mainly wire-drawing powder (as it is commonly termed in the wire-drawing industry). The finished products of MS Wires are stacked on a steeper from where finished goods are dispatched to the end customers, after dipping in to a rust-preventive oil solution, which protects the final product from corrosion for up to one-and-half month. The finished wire products are mainly supplied to downstream industries such as galvanizers, electrical manufactures and the local market.

General production process flow diagram for drawing wires is shown in Figure 1.5 below:

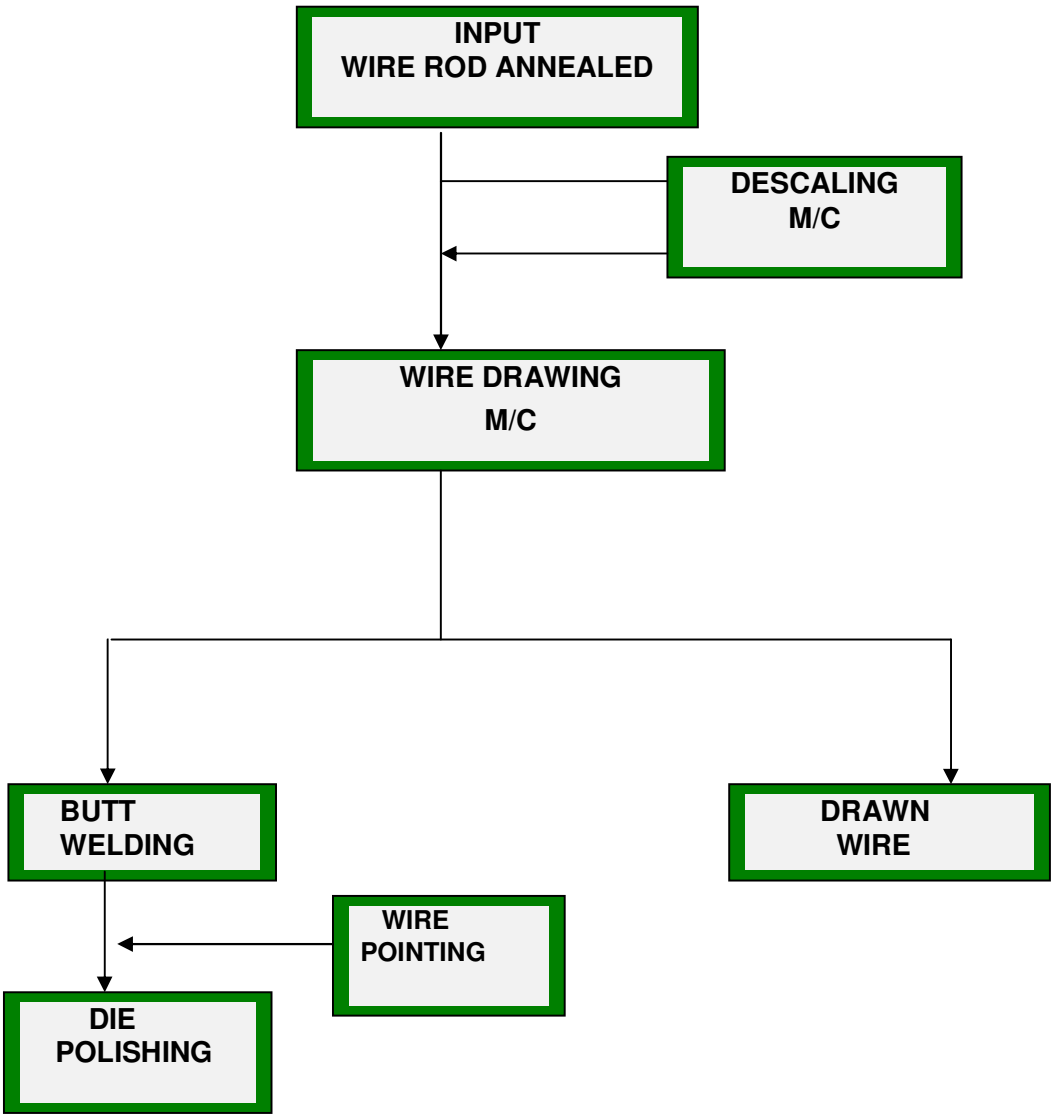


Figure 1.5 Process flow diagrams for a typical wire drawing unit

General production process for the galvanizing units

In a typical galvanizing unit, the production process involves seven stages as is shown in the schematic diagram in Figure 1.6. First the job or the raw material, which is to be galvanized is dipped in dilute acid solution and termed acid pickling. Then after the acid pickling process, the job is rinsed in plain water to remove any acid layer present on the job surface. Thereafter, the job is moved onto a SHC coal based drying bed for preheating and drying purpose. This helps produce a uniform layer of zinc on the job surface when the job is dipped in the zinc bath. Then after the drying process is over, the job is dipped into the zinc bath for galvanizing where a layer of molten zinc is deposited uniformly over the job surface.

When the job is taken out of the zinc bath, ammonium chloride powder (the fluxing agent) is sprayed over the job to remove the impurities and other dust particles remaining over the surface. Then the job is dipped in plain cold water for cooling. This process is termed as water quenching. After completion of the water-quenching process, the job is dipped into dichromate solution to give a glazing effect to the job galvanized. The description of the above galvanizing process is depicted in the following figure 1.6 process flow diagram.

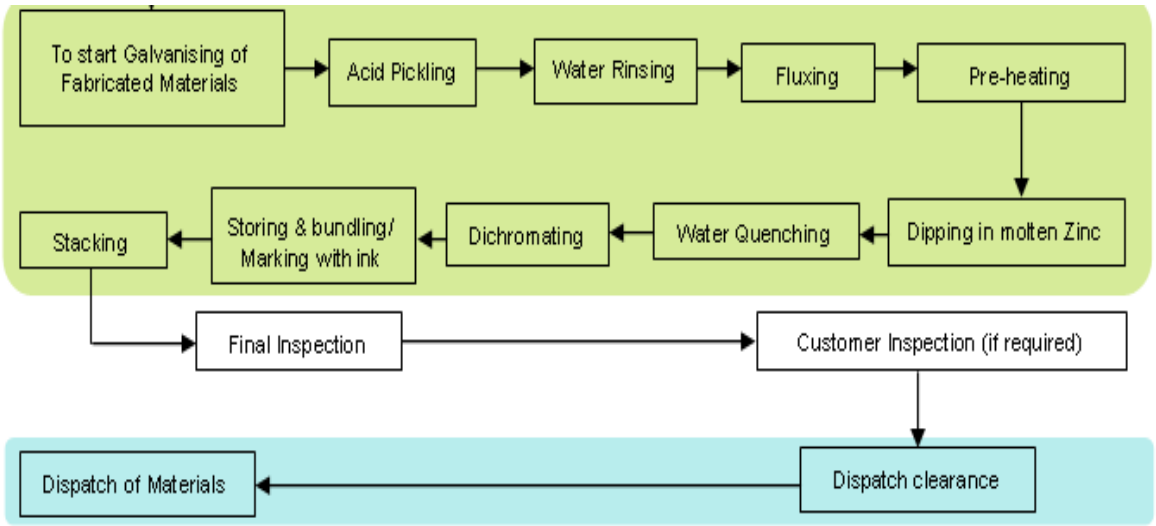


Figure 1.6: Process Flow diagram for a typical galvanizing unit

1.2 Energy performance in existing system

1.2.1 Fuel consumption

Average fuel and electricity consumption in typical wire drawing units is given in Table 1.2 and that of galvanizing units is given in Table 1.3. A small unit is defined to be a unit with production between 500 and 1000 TPA and medium to be greater than 1000 TPA. The micro units are defined to have capacity less than 500 TPA.

Only the larger wire drawing industries have furnaces and perform annealing. Among the wire drawing units audited, only one, which was also larger used wood for annealing. Further, most of the wire drawing units produces MS wires.

Table 1.2 Average fuel and electricity consumption in typical wire drawing units

Scale of Unit	*Micro*	*Small*	*Medium*		
Energy	*Electricity (kWh/ yr)*	*Electricity (kWh/ yr)*	*Electricity (kWh/ yr)*	*LPG (Ton/yr)*	*Wood (Ton/yr)*
MS wire	101486	209216	266889	NA	300
Copper wire	NA	NA	295310	70.5	NA
High carbon wire	NA	NA	1088751	NA	NA
Aluminium wire	NA	NA	266889	NA	NA

Table 1.3 Average fuel and electricity consumption in typical galvanizing units

Scale of Unit	*Small*			*Medium*				
Energy	*Electricity*	*Furnace Oil*	*Diesel Oil*	*Electricity*	*Furnace Oil*	*Diesel Oil*	*SHC coal*	*Wood*
	(kWh/ yr)	*(l/yr)*	*(l/yr)*	*(kWh/ yr)*	*(l/yr)*	*(l/yr)*	*(kg/yr)*	*(kg/yr)*
Transmission Tower Structure	NA	NA	NA	59346	85195	NA	NA	NA
Fasteners Item	107670	132000	19200	109883	112500	NA	21000	NA
Angle & Channel	NA	NA	NA	35491	165000	NA	150000	NA
Wire	NA	NA	NA	302013	165000	7040	NA	600000

1.2.2 Average annual production

Annual production in terms of TPA is taken in case of wire drawing units. The micro units are defined to have production less than 500 TPA, small to be between 500 and 1000 TPA and medium to have production higher than 1000 TPA.

Table 1.4 Typical average annual production in wire drawing units

S. No.	Type of Industry	Production (in TPA)		
		Micro scale	Small scale	Medium scale
1	MS wire	100	600	2000
2	Copper wire	NA	NA	1000
3	High carbon wire	NA	NA	1000
4	Aluminium wire	100	NA	700

Table 1.5 Typical average annual production in galvanizing units

S. No.	Type of Industry	Production (in TPA)		
		Micro scale	Small scale	Medium scale
1	Transmission Tower Structure	NA	NA	1969
2	Fasteners Item	200	890	4320
3	Angel & Channel	150	NA	3750
4	Wire	NA	NA	3650

1.2.3 Specific energy consumption

Specific energy consumption both electrical and thermal energy per Ton of production for galvanizing and wire drawing units are furnished in Table 1.6 below:

Table 1.6: Specific Energy Consumption in Galvanizing and Wire-drawing Units

Process		Unit	Specific Energy Consumption		
			Min	Max	Average
Galvanizing	Electrical	kWh/Ton	5.12	120	46.15
	Thermal	kCal/Ton	200370	579600	385978
Wire Drawing	Electrical	kWh/Ton	30	868	308
	Thermal	kCal/Ton	135	511	323

1.3 Existing technology/equipment

1.3.1 Description of existing technology

Motors are the driving force for all wire-drawing machines, as shown in Figure 1.5. Standard motors have lower efficiency than energy efficient motor of EFF1 class as per IS-12615 and also given in Annexure – 10. Further, it has been observed that, almost all the units are using standard motors and re-wind them from the local service providers who are not considering the efficiency issue, but only the operation of the motor even with higher consumption of electricity for the same output. Every such rewinding can lead to reduction of efficiency by 2 to 5% depending on the size of the motor and in case of 22 kW motor, it could be as high as 4.5%, as shown in Annexure – 2 and Annexure – 10. In a wire drawing plant, the electricity cost is about 5% of total cost and the rest of it is the cost of raw material (wires) that would be drawn. However, in a typical unit, the electricity cost is about . 4-35 lakh.

Motors are used in a variety of applications in the wire drawing industry, of which the primary one is to turn the spindles where wires of various sizes are coiled up. The spindles maintain the tension to pull the wire through the dies. The typical motors used at present in the galvanizing and wire drawing units are normal motors. Their ratings vary from 0.55 kW to 112 kW. Existing Motors specifications for the cluster are shown in Table 1.7 below:

Table 1.7 Typical specifications of present motors

S. No.	Parameters	Detail
1	Manufacturer	SIMENS, KIRLOSKAR and also many from local fabricators
2	Capacity	0.55 kW to 112 kW
3	Efficiency	64% to 92.5%
4	Operation	Continuous

S. No.	Parameters	Detail
5	Motor type	Induction motor
6	Voltage ratings	415 V +/- 10 V, 3 Phase, 50 Hz +/- 5%.
7	Ambient temperature max	50 Deg C
8	Number of poles	4
9	Speed	1440 rpm

In some areas of Howrah, such as, Jangalpur, electricity is supplied by the West Bengal State Electricity Distribution Company Limited (WBSEDCL) at the following tariff rates:

Energy charges

Table 1.8 Electricity charges for WBSEDCL

S. No.	*Unit consumed, kWh*	*Energy Charges, ₹ /kWh*
1	Upto 500	4.63
2	Next 1500	5.81
3	Above 2000	6.07

Contract demand charges is ₹ 15/kVA. Thus the energy charge for a typical unit with contract demand of 49 kVA and average monthly energy consumption of 9157 kWh is Rs. 6.50 / kWh.

In some areas of Howrah, such as, Liluah, electricity is supplied by CESC at the following tariff rates:

Table 1.9 Electricity charges for CESC

S. No.	*Unit consumed, kWh*	*Energy Charges, ₹ /kWh*
1	For first 500	4.43
2	For next 1500	4.87
3	For next 1500	5.20
4	For above 3500	5.49

Contract demand charges is Rs. 15/kVA. Thus the energy charge for a typical unit with contract demand of 71.8 kVA and average monthly energy consumption of 8972 kWh is Rs. 5.40 / kWh.

1.3.2 Role in process

The motors turn the spindles to pull the wires through the dies. Hence, these are the heart of the drawing process. However, ones used in the units are of the conventional type and at present provide upto 92.5% maximum efficiency.

1.4 Baseline establishment for existing technology

1.4.1 Design and operating parameters

The typical motors used at present in the galvanizing and wire drawing units are normal motors. Their ratings vary from 0.55 kW to 112 kW. The subject of the present DPR is however is for 22 kW energy efficient (EEF1) motors.

Considering a 37.5 kW standard motor to be replaced by 22 kW energy efficient (EEF1) motor for present analysis, here are the specifications for it.

Table 1.10 Present motor specifications

S. No.	*Parameter*	*Detail*
1	Manufacturer	SIMENS
2	Capacity	37.5 kW
3	Efficiency	78.95%
4	Operation	Continuous
5	Motor type	Induction motor
6	Voltage rating	415 V +/- 10 V, 3 Phase, 50 Hz +/- 5%.
7	Ambient temperature max	50 Deg C
8	Number of poles	4
9	Speed	1440 rpm

Maximum efficiency of the 37.5 kW standard motor is 87.5% (IS 12615). The reduction is due to poor loading and poor quality rewinding as given in Annexure-10.

Electricity consumption in the motors depend on the following parameters

a) Condition of the motor including bearings

b) Number of times it has been rewound

c) Quality of the components present.

Electricity requirement in the wire-drawing plant depends on the production. Detail of electricity consumption in a typical unit is given in Table 1.11 below:

Table 1.11 Electricity consumption at a typical wire drawing unit

S. No.	Energy Type	Unit	Value
1	Electricity	kWh/year	266889

1.4.2 Operating efficiency analysis

The Annexure-1 shows a typical set of ordinary motors present in a typical wire drawing unit and their respective efficiencies.

1.5 Barriers in adoption of proposed equipment

1.5.1 Technological barrier

In Howrah cluster, the technical understanding of the wire drawing process has been excellent with several committed technical personnel having detailed know-how of the processes involved. Some of them are also visiting countries like China and European ones to find the best possible technological solutions to meet the challenges in their units. Indeed, there is committed effort on the part of the management in such units to grasp alterations, which may give them benefits, however, with the caveat that the advantages be proven without any doubt.

People are generally reluctant to invest in an experimental scheme particularly if the sufficient savings are not guaranteed. Hence, finding the first person, who is willing to implement a change is still a challenge. While carrying out the audits and presenting the Energy audit reports to the units, in the discussion with the plant owners & other personnel, many of them agreed with many of the identified energy saving measures and technologies but they demanded demonstration of the energy saving technologies in any plant and thereafter they have readiness to follow.

1.5.2 Financial barrier

Discussions of financial issues with the units concluded that they are not scared of investments. The larger units are confident of financing their own alterations while the smaller units are certain to find good schemes from the banks to fund their respective efficiency

measures. However, the good part of the discussions was that more and more units are taking energy conservation measures seriously and willing to go to the distance. A mention must be made of SIDBI, whose schemes have attracted attention and can play a catalytic role in the implementation of the measures.

1.5.3 Skilled manpower

Technical personnel employed in the units are generally skilled works but not engineers. Thus, the production process remains traditional. This is one of the main hindrances in adopting newer technology. Specialized training among the workforce and local experts can circumvent the problem significantly. Effective dissemination can enhance replication potential in the various units. The gains obtained by one plant can inspire other units to follow suit.

2. PROPOSED EQUIPMENT FOR ENERGY EFFICENCY IMPROVEMENT

2.1 Description of proposed equipment

2.1.1 Detailed of proposed equipment

Energy-efficient motors (EEM) are the ones in which design improvements are incorporated specifically to increase operating efficiency over motors of standard design. Design improvements focus on reducing intrinsic motor losses. Improvements include the use of lower-loss silicon steel, a longer core (to increase active material), thicker wires (to reduce resistance), thinner laminations, smaller air gap between stator and rotor, copper instead of aluminum bars in the rotor, superior bearings and a smaller fan, etc.

Energy-efficient motors now available in India operate with efficiencies that are typically 3 to 4 percentage points higher than standard motors. In keeping with the stipulation of the BIS, energy-efficient motors are designed to operate without loss in efficiency at loads between 75 % and 100 % of rated capacity. This may result in major benefits in varying load applications. The power factor is about the same or may be higher than for standard motors. Furthermore, energy-efficient motors have lower operating temperatures and noise levels, greater ability to accelerate higher-inertia loads, and are less affected by supply voltage fluctuations.

2.1.2 Equipment/ technology specification

The energy efficient motors that need to be used depend upon necessity. Some are of 2 kW rating and some as high as 90 kW. Detailed technical specifications of energy efficient motors are furnished in Table 2.1 below:

Table 2.1 Technical specification of a typical Energy Efficient Motor

S. No.	*Parameter*	*Detail*
1	Manufacturer	KIRLOSKAR
2	Model	SC180L
3	Operation	Continuous
4	Capacity	22 kW
5	Efficiency	92.6 %
6	Motor type	Induction motor
7	Voltage rating	415 V +/- 10 V, 3 Phase, 50 Hz +/- 5%.
8	Ambient temperature max	50 Deg C

S. No.	Parameter	Detail
9	Max altitude	1000 m above MSL
10	Number of poles	4
11	Speed	1440 rpm

2.1.3 Integration with existing equipment

The motors used in the units are at present the conventional ones with present maximum efficiency of about 87.5% (IS 12615). Further, the loading of those motors are also low in general. For that low loading and poor quality rewinding the efficiency become 78.95%. Hence, those have to be downsized to reduce the energy bill in any case. While doing that, buying and installing energy efficient motors would certainly help by making a maximum efficiency of 92.6% available.

The following are the reasons for selection of this technology:

- Maximum efficiency goes up to 92.6%
- It will reduce the total operating energy cost of the plant.
- It reduces the GHG emissions
- This project is also applicable for getting the carbon credit benefits.

2.1.4 Superiority over existing system

Use of this technology reduces the amount of electricity consumed by the unit.

2.1.5 Source of equipment

There are many vendors for such technology. It has successfully been adopted and implemented throughout the country and benefits reaped have been established beyond doubt. There are no concerns of scarcity of such devices and the prices are reasonable as well.

2.1.6 Availability of technology/equipment

Suppliers of this technology are available at local level as well as at international level very easily. Many of the suppliers took initiative in reaching out to the industry representatives and informing them about the utility of such devices.

2.1.7 Service providers

Details of technology service providers are shown in Annexure-7.

2.1.8 Terms and conditions in sales of equipment

50% of the charges would have to be paid upfront and the rest along with the taxes would have to be paid while sending the Performa invoice prior to dispatch. Further, the warranty period extends upto 12 months from the point of delivery for any inherent manufacturing defect or faulty workmanship.

2.1.9 Process down time

The down time might hardly be 6-7 days for the installation of the motors.

2.2 Life cycle assessment and risks analysis

Life of the equipment is about 15 years. Risk involves in the installation of proposed project are mainly in getting the size of the motor right. If the load is calculated wrongly and the motor is oversized, the efficiency would still remain poor. On the other hand, if the rating of the installed motor is too low, it can simply burn out.

2.3 Suitable unit for Implementation of proposed technology

Suitable unit for implementation of this technology are vitrified unit having the production capacity of about 2700 Ton/yr and having total electrical consumption of about 266889 kWh per year.

3. ECONOMIC BENEFITS FROM PROPOSED TECHNOLOGY

3.1 Technical benefit

3.1.1 Fuel saving

Since the primary source of energy in a motor is electricity, the suggested technology does not contribute to fuel savings.

3.1.2 Electricity saving

After implementation of project, the unit would consume about 7522 kWh/yr of less electricity. As the cost of electricity rises, the monetary savings would only rise.

3.1.3 Improvement in product quality

The quality of the product would still remain the same. It shall have no impact on the way wires are drawn but merely make the process more efficient.

3.1.4 Increase in production

The production will remain the same as in present.

3.1.5 Reduction in raw material

Raw material consumption would also remain same even after the implementation of the proposed technology.

3.1.6 Reduction in other losses

Since in the primary mode, the unused energy is dissipated via heat, which can wear out, say, the bearing of the motor more quickly, while motors that are more efficient would increase the longevity of the device. Further, right sized and more efficient motors would require less cooling and thereby reduces the dependence on the cooling apparatus like fans and chilled fluids. Thus, it has more indirect benefits.

3.2 Monetary benefits

The monetary benefits of the unit are mainly due to reduction in the electricity consumption by 7522 kWh/yr. This amounts to monetary savings of ₹ 48,892 per year. A detailed estimate of the saving has been provided in the table 3.1 below:

Table 3.1 Energy and monetary benefit

S.No	Parameter	Unit	Value
1	Present electricity consumption in unit for existing motor	kWh/year	50381
2	Cost of electricity consumption	₹ /year	6.50
3	Savings in electricity by using energy efficient motors	kWh/year r	7522
4	Monetary savings due to electricity savings	₹ /year	48892
5	Total monetary benefit	₹ /year	48892

Further details of total monetary benefit are given in Annexure-3.

3.3 Social benefits

3.3.1 Improvement in working environment

Reduction in electricity consumption would probably not change the working environment apart from making the management happier.

3.3.2 Improvement in workers skill

The workers would probably not find too much of a difference in the day to day operation of the device. Hence, their skills are probably going to be unaffected.

3.4 Environmental benefits

3.4.1 Reduction in effluent generation

There is no significant impact in effluent generation due to implementation of the project.

3.4.2 Reduction in GHG emission

The measure helps in reducing CO_2 emission since it demands less electricity off the grid. An estimate suggests that a saving of 7522 kWh/year of electricity reduces 6.3 ton of CO_2 equivalent per year.

3.4.3 Reduction in other emissions like SO_X

Significant amount of SO_X will be reduced amounting to 19 kg/yr due to reduction in energy consumption, as 0.002541 kg of SO_X would be reduced for a reduction of 1 kWh of electricity.

4 INSTALLATION OF PROPOSED EQUIPMENT

4.1 Cost of project

4.1.1 Equipment cost

Cost of an energy efficient motor of 22 kW rating is ₹ 38000 as per the quotation provided in by the vendor in Annexure 8.

4.1.2 Erection, commissioning and other misc. cost

The tax and installation costs could amount to a further ₹ 15574. Detail of project cost is given in the Table 4.1 below:

Table 4.1 Details of proposed technology project cost

S.No	Particular	Unit	Value
1	Cost of system	₹	38000
2	Taxes & Installation cost	₹	15574
3	Total cost	₹ (in lakh)	0.54

4.2 Arrangements of funds

4.2.1 Entrepreneur's contribution

Total entrepreneur's contribution for replacing normal motors in the unit with energy efficient motors is about ₹ 0.13 lakh.

4.2.2 Loan amount

There are loans available for buying such equipments from SIDBI and from the MSME of the Government of India, which have 25% subsidy in some schemes. Total loan about will be ₹ 0.40 lakh.

4.2.4 Terms & conditions of loan

The interest rate is considered at 10%, which is SIDBI's rate of interest for energy efficient projects (Interest rate chart of SIDBI is shown in annexure 9). The loan tenure is 5 years excluding initial moratorium period is 6 months from the date of first disbursement of loan.

4.3 Financial indicators

4.3.1 Cash flow analysis

Profitability and cash flow statements have been worked out for a period of 8 years. The financials have been worked out on the basis of certain reasonable assumptions, which are outlined below.

The project is expected to achieve monetary savings.

- The Operation and Maintenance cost is estimated at 4% of the cost of total project with 5% increase in every year as escalations.
- Interest on term loan is estimated at 10%.
- Depreciation is provided as per the rates provided in the companies act.

Considering the above mentioned assumptions, the net cash accruals starting with ₹ 0.39 in the first year operation and gradually increases to ₹ 2.13 at the end of eighth year.

4.3.2 Simple payback period

The total cost of implementing the proposed technology is ₹ 0.54 lakh and monetary savings is ₹ 0.49. Hence, the simple payback period works out to be 1.10 years.

4.3.3 Net Present Value (NPV)

The Net present value of the investment works out to be ₹ 1.29 lakh.

4.3.4 Internal Rate of Return (IRR)

The IRR for the project is 71.23 %.

4.3.5 Return on Investment (ROI)

The average return on investment of the project activity works out at 28.22 %.

Details of financial indicator are shown in table 4.2 below:

Table 4.2 Financial indicators of proposed technology/equipment

S.No	Particulars	Unit	Value
1	Simple Pay Back period	Months	13
2	IRR	%age	71.23
3	NPV	₹ (lakh)	1.29
4	ROI	%age	28.22
5	DSCR	Ratio	3.84

4.4 Sensitivity analysis

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

- Optimistic scenario (Increase in fuel savings by 5%)
- Pessimistic scenario (Decrease in fuel savings by 5%)

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

Details of sensitivity analysis at different scenarios are shown in Table 4.3 below:

Table 4.3 Sensitivity analysis at different scenarios

Particulars	*IRR(% age)*	*NPV(Rs. in lakh)*	*ROI(%age)*	*DSCR*
Normal	71.23	1.29	28.22	3.84
5% increase in fuel savings	75.44	1.38	28.32	4.04
5% decrease in fuel savings	67.20	1.20	28.10	3.64

4.5 Procurement and implementation schedule

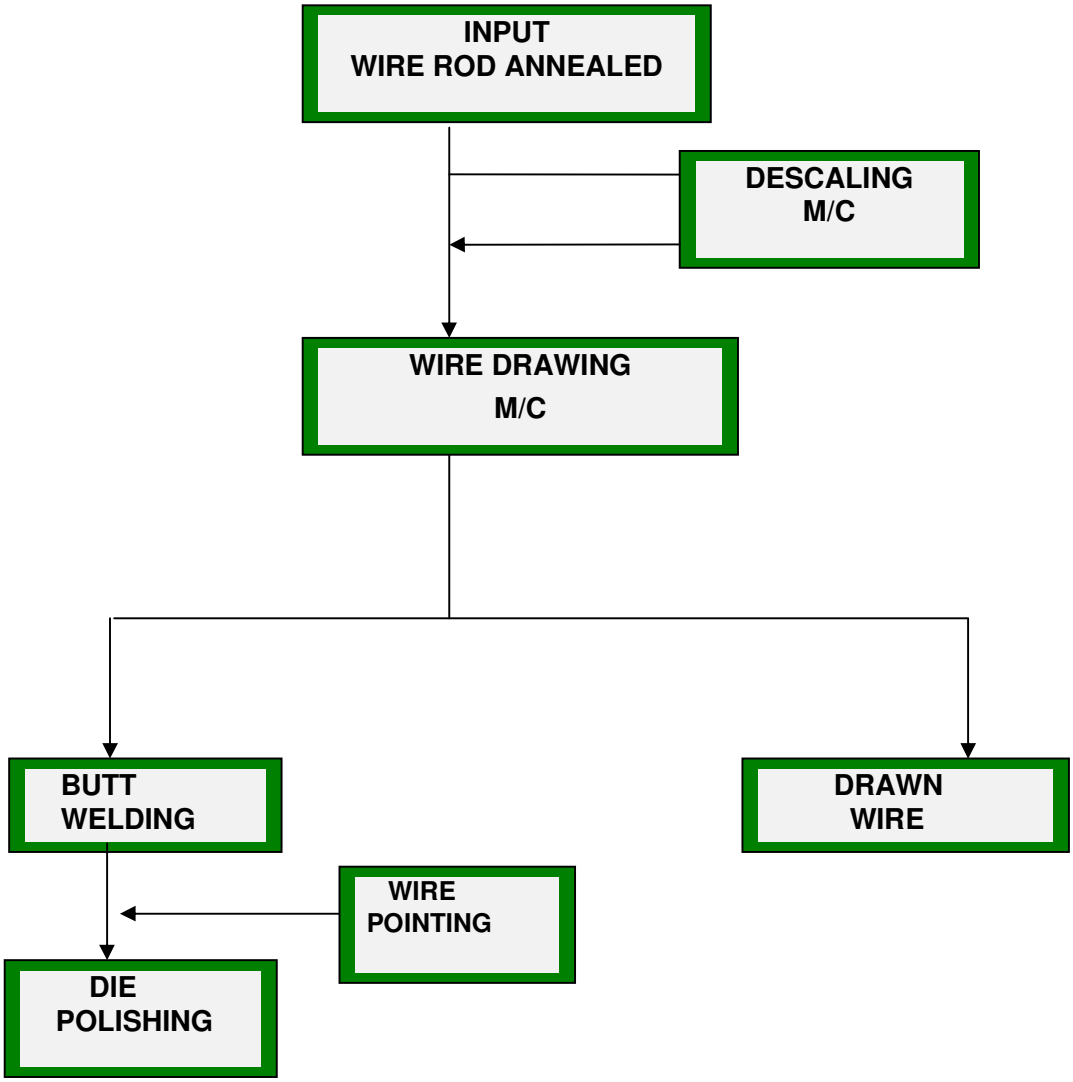
Procurement and implementation schedule for proposed project are about four months and complete details are shown in Annexure 6.

ANNEXURE

Annexure -1: Energy audit data used for baseline establishment

S.No.	Particulars	Unit	Value	Unit	Value
1	Motor name	**Block machine 1**		**Block machine 2**	
2	Rated capacity	Hp	50	Hp	50
3	Rated capacity	kW	37.5	kW	37.5
4	Measured current	Amp	42	Amp	25
5	Measured voltage	Volt	422	Volt	424
6	Measured power factor	-	0.74	-	0.80
7	Measured power	kW	22.71	kW	14.68
8	Percentage loading	%age	60	%age	39
9	Operating hour	Hr	12	Hr	12
10	Operating days	Days	286	Days	286
11	Estimated electricity consumption	kWh/year	77940	kWh/year	50381

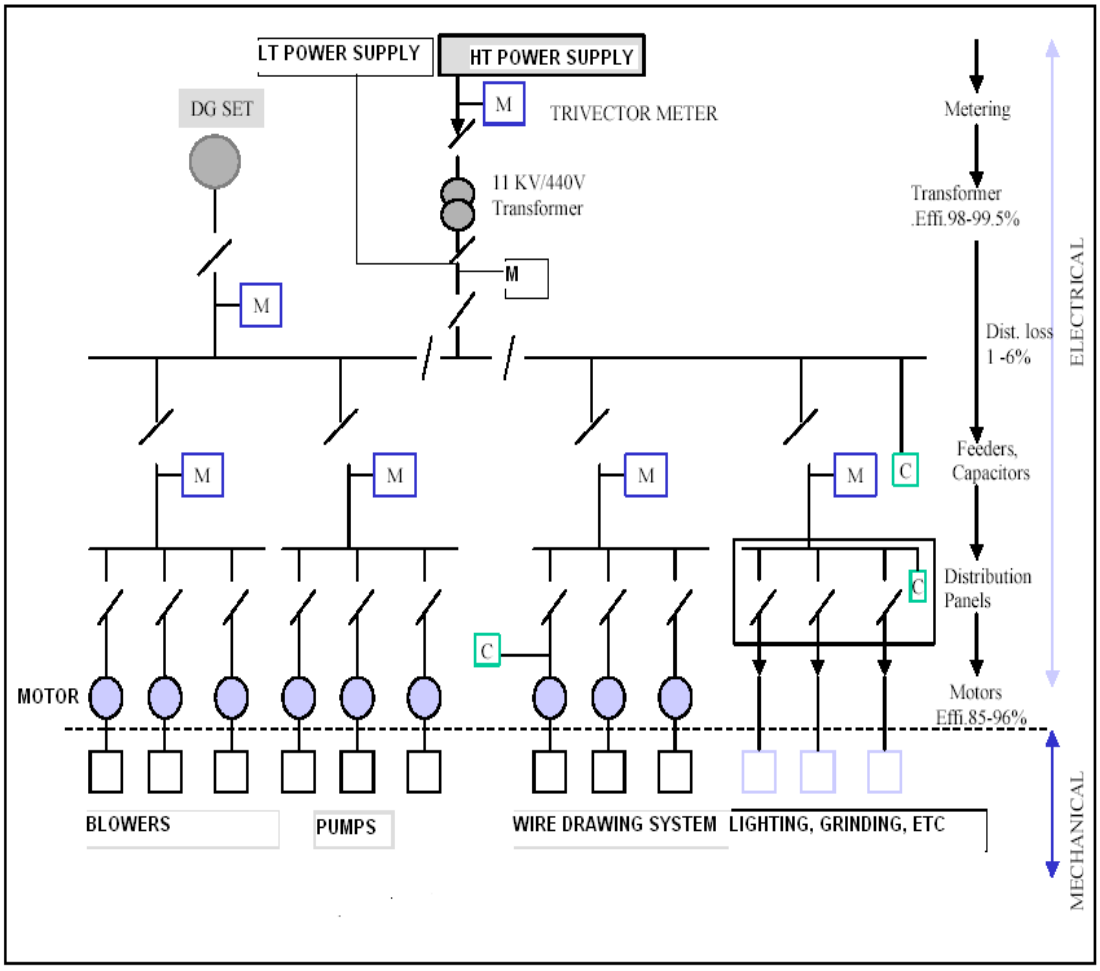
Annexure -2: Process flow diagram after project implementation



Annexure -3: Detailed technology assessment report

Sl No	Particular	Unit	Motor Name
			Block Machine 2
1	Rated power	HP	50
2	Rated power	kW	37.5
3	Actual power	kW	14.68
4	Loading	%age	39
5	Present Efficiency	%age	78.95
6	Expected efficiency of EEM	%age	92.6
7	Hours per year	hr/yr	2860
8	Suggested power required	kW	12.05
9	Recommended size of EE Motor	kW	22
10	Reduction in power	kW	2.63
11	Cost of electricity	₹/kWh	6.5
12	Power savings	kWh/yr	7522
13	Savings	₹/Yr	48892
14	Investment	₹	53574
15	Estimated Life	yrs	15
16	Payback Period	yrs	1.10

Annexure -4 Drawings for proposed electrical & civil works



Annexure -5: Detailed financial analysis

Assumption

Name of the Technology	***Energy Efficient Motor (EFF 1)***		
Rated Capacity	***22 kW***		
Details	***Unit***	***Value***	***Basis***
Installed Capacity	kW	22	Feasibility Study
Life	yr	15	Assumed
No of working days	Days	230	Feasibility Study
No of Shifts per day	Shifts	1	Feasibility Study
Proposed Investment			
Investment for 15 kW Energy Efficient Motors (EFF 1)	₹in Lakh	0.38	
Other Cost	₹in Lakh	0.16	
Total investment	₹ in Lakh	0.54	
Financing pattern			
Own Funds (Equity)	₹	0.13	
Loan Funds (Term Loan)	₹	0.40	
Loan Tenure	yr	5	Assumed
Moratorium Period	Months	6	Assumed
Repayment Period	Months	66	Assumed
Interest Rate	%/yr	10	SIDBI Lending rate
Estimation of Costs			
O & M Costs (% on Plant & Equip)	%	4	Feasibility Study
Annual Escalation	%	5	Feasibility Study
Estimation of Revenue			
Saving in Electricity	kWh/yr	7522	
Cost of Electricity	₹/ kWh	6.50	
St. line Depn.	% age	5.28	Indian Companies Act
Depriciation	% age	80	Income tax rule
Income Tax	% age	33.99	Income Tax rule

Estimation of Interest on Term Loan

Years	***Opening Balance***	***Repayment***	***Closing Balance***	***Interest***
1	0.40	0.03	0.37	0.05
2	0.37	0.06	0.31	0.03
3	0.31	0.08	0.23	0.03
4	0.23	0.09	0.15	0.02
5	0.15	0.10	0.05	0.01
6	0.05	0.04	0.01	0.00
		0.40		

WDV Depreciation

Particulars / years	*1*	*2*
Plant and Machinery		
Cost	0.54	0.11
Depreciation	0.43	0.09
WDV	0.11	0.02

Projected Profitability **₹ in Lakh**

Particulars / Years	*1*	*2*	*3*	*4*	*5*	*6*	*7*	*8*
Revenue through Savings								
Fuel savings	0.49	0.49	0.49	0.49	0.49	0.49	0.49	0.49
Total Revenue (A)	0.49	0.49	0.49	0.49	0.49	0.49	0.49	0.49
Expenses								
O & M Expenses	0.02	0.02	0.02	0.02	0.03	0.03	0.03	0.03
Total Expenses (B)	0.02	0.02	0.02	0.02	0.03	0.03	0.03	0.03
PBDIT (A)-(B)	0.47	0.47	0.46	0.46	0.46	0.46	0.46	0.46
Interest	0.05	0.03	0.03	0.02	0.01	0.00	-	-
PBDT	0.42	0.43	0.44	0.44	0.45	0.46	0.46	0.46
Depreciation	0.03	0.03	0.03	0.03	0.03	0.03	0.03	0.03
PBT	0.39	0.40	0.41	0.42	0.42	0.43	0.43	0.43
Income tax	-	0.12	0.15	0.15	0.15	0.16	0.16	0.16
Profit after tax (PAT)	0.39	0.29	0.26	0.26	0.27	0.27	0.28	0.27

Computation of Tax ***₹ in Lakh***

Particulars / Years	*1*	*2*	*3*	*4*	*5*	*6*	*7*	*8*
Profit before tax	0.39	0.40	0.41	0.42	0.42	0.43	0.43	0.43
Add: Book depreciation	0.03	0.03	0.03	0.03	0.03	0.03	0.03	0.03
Less: WDV depreciation	0.43	0.09	-	-	-	-	-	-
Taxable profit	(0.01)	0.35	0.44	0.44	0.45	0.46	0.46	0.46
Income Tax	-	0.12	0.15	0.15	0.15	0.16	0.16	0.16

Projected Balance Sheet

Particulars / Years	*1*	*2*	*3*	*4*	*5*	*6*	*7*	*8*
Liabilities								
Share Capital (D)	0.13	0.13	0.13	0.13	0.13	0.13	0.13	0.13
Reserves & Surplus (E)	0.39	0.68	0.94	1.20	1.47	1.75	2.02	2.30
Term Loans (F)	0.37	0.31	0.23	0.15	0.05	0.01	0.01	0.01
Total Liabilities D)+(E)+(F)	0.90	1.12	1.30	1.48	1.65	1.89	2.16	2.44
Assets								
Gross Fixed Assets	0.54	0.54	0.54	0.54	0.54	0.54	0.54	0.54
Less: Accm. Depreciation	0.03	0.06	0.08	0.11	0.14	0.17	0.20	0.23
Net Fixed Assets	0.51	0.48	0.45	0.42	0.39	0.37	0.34	0.31
Cash & Bank Balance	0.39	0.64	0.85	1.06	1.26	1.52	1.82	2.13
TOTAL ASSETS	0.90	1.12	1.30	1.48	1.65	1.89	2.16	2.44
Net Worth	0.53	0.81	1.07	1.34	1.61	1.88	2.16	2.43
Debt equity ratio	2.78	2.33	1.73	1.10	0.35	0.05	0.05	0.05

Projected Cash Flow:

Particulars / Years	***0***	***1***	***2***	***3***	***4***	***5***	***6***	***7***	***8***
Sources									
Share Capital	0.13	-	-	-	-	-	-	-	-
Term Loan	0.40								
Profit After tax		0.39	0.29	0.26	0.26	0.27	0.27	0.28	0.27
Depreciation		0.03	0.03	0.03	0.03	0.03	0.03	0.03	0.03
Total Sources	0.54	0.42	0.31	0.29	0.29	0.30	0.30	0.30	0.30
Application									
Capital Expenditure	0.54								
Repayment of Loan	-	0.03	0.06	0.08	0.09	0.10	0.04	-	-
Total Application	0.54	0.03	0.06	0.08	0.09	0.10	0.04	-	-
Net Surplus	-	0.39	0.25	0.21	0.21	0.20	0.26	0.30	0.30
Add: Opening Balance	-	-	0.39	0.64	0.85	1.06	1.26	1.52	1.82
Closing Balance	-	0.39	0.64	0.85	1.06	1.26	1.52	1.82	2.13

Calculation of Internal Rate of Return

Particulars / Years	***0***	***1***	***2***	***3***	***4***	***5***	***6***	***7***	***8***
Profit after Tax		0.39	0.29	0.26	0.26	0.27	0.27	0.28	0.27
Depreciation		0.03	0.03	0.03	0.03	0.03	0.03	0.03	0.03
Interest on Term Loan		0.05	0.03	0.03	0.02	0.01	0.00	-	-
Cash outflow	(0.54)	-	-	-	-	-	-	-	-
Net Cash flow	(0.54)	0.47	0.35	0.32	0.31	0.31	0.30	0.30	0.30
IRR (%/yr)	71.23 %								
NPV	1.29								

Break Even Point

Particulars / Years	***1***	***2***	***3***	***4***	***5***	***6***	***7***	***8***
Variable Expenses								
Oper. & Maintenance Exp (75%)	0.02	0.02	0.02	0.02	0.02	0.02	0.02	0.02
Sub Total (G)	0.02	0.02	0.02	0.02	0.02	0.02	0.02	0.02
Fixed Expenses								
Oper. & Maintenance Exp (25%)	0.01	0.01	0.01	0.01	0.01	0.01	0.01	0.01
Interest on Term Loan	0.05	0.03	0.03	0.02	0.01	0.00	0.00	0.00
Depreciation (H)	0.03	0.03	0.03	0.03	0.03	0.03	0.03	0.03
Sub Total (I)	0.08	0.07	0.06	0.05	0.05	0.04	0.04	0.04
Sales (J)	0.49	0.49	0.49	0.49	0.49	0.49	0.49	0.49
Contribution (K)	0.47	0.47	0.47	0.47	0.47	0.47	0.47	0.47
Break Even Point (L= I/K)	16.92%	14.48%	13.24%	11.59%	9.72%	7.86%	7.59%	7.68%
Cash Break Even [{(I)-(H)}/K]	10.94%	8.49%	7.24%	5.58%	3.69%	1.82%	1.54%	1.62%
Break Even Sales (J)*(L)	0.08	0.07	0.06	0.06	0.05	0.04	0.04	0.04

Return on Investment

Particulars / Years	*1*	*2*	*3*	*4*	*5*	*6*	*7*	*8*	*Total*
Net Profit Before Taxes	0.39	0.40	0.41	0.42	0.42	0.43	0.43	0.43	3.33
Net Worth	0.53	0.81	1.07	1.34	1.61	1.88	2.16	2.43	11.83
									28.22%

Debt Service Coverage Ratio

Particulars / Years	*1*	*2*	*3*	*4*	*5*	*6*	*7*	*8*	*Total*
Cash Inflow									
Profit after Tax	0.39	0.29	0.26	0.26	0.27	0.27	0.28	0.27	1.75
Depreciation	0.03	0.03	0.03	0.03	0.03	0.03	0.03	0.03	0.17
Interest on term loan	0.05	0.03	0.03	0.02	0.01	0.00	0.00	0.00	0.14
TOTAL (M)	0.47	0.35	0.32	0.31	0.31	0.30	0.30	0.30	2.06
Debt									
Interest on Term Loan	0.05	0.03	0.03	0.02	0.01	0.00	0.00	0.00	0.14
Repayment of Term Loan	0.03	0.06	0.08	0.09	0.10	0.04	0.00	0.00	0.40
TOTAL (N)	0.08	0.09	0.11	0.11	0.11	0.04	0.00	0.00	0.54
	6.11	3.69	2.92	2.98	2.78	7.31	0.00	0.00	3.83
Average DSCR (M/N)	3.84								

Annexure:-6 Procurement and implementation schedule

S. No.	Activities	Months			
		1	2	3	4
1	Delivery after placing order				
2	Erection & commissioning of EEM motors				
3	Cabling & elec-trical panel fitting				
4	Testing and trial				
5	On site operator training				

Break up of shutdown period of plant required for replacement of the motor.

S.No	Activity	Day
1	Installation of the device	7

Annexure -7: Details of technology service providers

S.No.	*Name of Service Provider*	*Address*	*Contact Person and No.*
1	Technosoft Consultancy Services	217, S. N Road, Dum dum, Kolkata- 55	Mr. Raju Saha 9230056795 contact.tcskolkata@gmail.com
2	Surendra & Company	11 Pullok Street, Kolkata -700 007	Mr. Surendra Mohta scoinfo@rediffmail.com Ph: (033) 22351769 Fax: 91-033-22355824
3	Siemens	Siemens Ltd 43, Shantipalli Rash Behari Connector E M By Pass, Kolkata -700042	Ms. Ipsita Ghosh Telephone- +91 33 2444 9228 Email : ipsita.ghosh@siemens.com

Annexure -8: Quotations or Techno-commercial bids for new technology/equipment

Technosoft Consultancy & Services

217,Shyamnagar Road, Dum Dum, Kolkata -700 055
Phone : 033-645 29366 (Office)
+91 9230056795 (Mobile)
+91 9830056795 (Works)
email : contact@tcskolkata.com /URL: www.tcskolkata.com

ePower-Process-Pollution Control Systems&Solutions

QUOTATION

IISWBM Management House College Square West Kolkata - 700073	OUR REF.:TCS/IISWBM/E1/ACM/10-11/12Q124 DATE : 09.12.10 YOUR REF.: <soumenachar143@gmail.com> DATE : 07.12.10

Kind Attn. Mr. S. Achar.
Sub: Your requirement Energy efficient AC MOTOR.
With reference to your enquiry we are pleased to quote hereunder our most competitive offer for your kind consideration & looking forward to your valuable order.

S/N	PARTICULARS	QTY.	Price in Each(Rs.)
1.1	**Kirloskar Electric make , EFF 1 , 4pole,** 3PH, 415V AC, +/- 10%, 50HZ +/- 5% , TEFC Squirrel Cage Induction Motor, STANDARD -IS 325 , IP -55 , HORIZONTAL FOOT MOUNTING B3, INSL.CLAS-F with temp. rise limited to Class B , AMBNT.-50DEG.C. of following ratings :-		
	7.5 kW in frame - PM132M	01	**13,500.00**
	9.3 kW in frame - PM160M	01	**21,000.00**
	11 kW in frame - PM160M	01	**21,500.00**
	15 kW in frame - PM160L	01	**26,000.00**
	18.5 kW in frame - SC180M	01	**36,000.00**
	22 kW in frame - SC180L	01	**38,000.00**
	30 kW in frame - SC200L	01	**51,000.00**
	37 kW in frame - SC225S	01	**65,000.00**
	45 kW in frame - SC225M	01	**80,000.00**
	55 kW in frame - SC250M	01	**1,10,000.00**
	75 kW in frame - SC280S	01	**1,35,000.00**
	90 kW in frame - SC280M	01	**1,55,000.00**

2. Material will be dispatched from KEC Mysore on E1 transaction to Consignee Address.
3. Taxes & duties: As applicable during the time of dispatch.
4. Freight & insurance charges : Extra at actual and to be borne by you.
5. Packing & Forwarding charge : @ 2 % on Basic Order Value **(Discounted)**
6. Dispatch : 12-16 from the date of receipt of P.O.
7. Payment Terms : 50% along with P.O. and balance with taxes against Proforma Invoice prior to dispatch.
8. Warranty : As per (product / component used in systems)manufacturer 12 months for any inherent manufacturing defect or faulty workmanship.
9. Validity : 7 days from the above date, after which it is subject to our confirmation in writing
10. Errors : All clerical and typographical errors/omissions are subject to corrections.

NOTE : i)Delivery : If there be any delay for reasons beyond our control to be accepted.
ii) Octroi / Town Duty / Entry Tax : If applicable will be charged extra at actual. Any service charges incurred on account of the same will also be to buyer's account.

Assuring you of our best attention at all times & if you need any Technical / Commercial clarification please feel free to contact us.

OUR VAT NO. :19675353028 OUR CST NO. : 19675353222 OUR PAN NO. : AWLPS1095C	FOR Technosoft Consultancy & Services Authorized Signatory

Associates of Industrial Electrical, Electronics & Automation group of
KIRLOSKAR ELECTRIC CO. LTD.

Annexure -9: SIDBI financing scheme for energy saving projects in MSME sector

S. No.	Parameter	Norms
1	Minimum Assistance	Rs.10 lakh
2	Minimum promoters contribution	25% for existing units 33% for new units
3	Debt Equity Ratio	Maximum 2.5 :1
4	Interest Rate	The project expenditure eligible for coverage under the Line will carry rate of interest of 11% p.a. payable monthly
5	Upfront fee	Non refundable upfront fee of 1% of sanctioned loan plus applicable service tax.
6	Security	First charge over assets acquired under the scheme; first/second charge over existing assets and collateral security as may be deemed necessary.
7	Asset coverage	Minimum Asset Coverage should be 1.4:1 for new units and 1.3:1 for existing units.
8	Repayment period	Need based. Normally, the repayment period does not extend beyond 7 years. However, longer repayment period of more than 7 years can be considered under the Line if considered necessary.

Source: http://www.sidbi.in/energysaving.asp

Annexure -10: Efficiency of electric motors

Motor Capacity	Standard motor (IS 8789)				Energy efficient motor (IS 12615)	
	Motor load *				EFF1	EFF2
kW	100%	75%	50%	25%	Motor load 100% to 60%	
0.37	64	64	64		73	
0.55	69	69	69		78	
1.1	73	73	73		83.8	76.2
1.5	76	76	76		85	78.2
2.2	79	79	79		86.4	81
3.7	83	83	83		88.3	84
5.5	84	84	84		89.2	85.7
7.5	85	85	85		90.1	87
11	84.5	84.5	84.5		91	88.4
15	85	85	85	74.28	91.8	89.4
18.5	86	86	86			
22	86.5	86.5	86.5		92.6	90.5
30	87.5	87.5	87.5	77.14	93.2	91.4
37	87.5	87.5	87.5	78.95	93.6	92
45	89	89	89		93.9	
55	89.5	89.5	89.5			
75	90	90	90			
90	91	91	91		95	
112.5	92.5	92.5	92.5	84.28		

The Impact of Rewinding on Motor Efficiency**

kW	HP	Impact on efficiency (%)
7.46	10	-6.0
14.92	20	-5.2
29.84	40	-4.4
37.3	50	-3.7
74.6	100	-2.1
89.52	120	-2.0
111.9	150	-1.8

** Source: The Impact of Rewinding on motor efficiency, by Jim Custodio, Page 38 as accessed in www.pump-zone.com

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