DETAILED PROJECT REPORT
ON
DIVIDED BLAST CUPOLA FURNACE
(BATALA, JALANDHAR, LUDHIANA FOUNDRY CLUSTER)











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Bureau of Energy Efficiency (BEE)

Prepared By

CII
Confederation of Indian Industry

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DIVIDED BLAST CUPOLA FURNACE

BATALA, JALANDHAR, LUDHIANA FOUNDRY CLUSTER

BEE, 2011

Detailed Project Report on Divided Blast Cupola Furnace

Foundry SME Cluster, Batala, Jalandhar , Ludhiana (Punjab) (India)

New Delhi: Bureau of Energy Efficiency

Detail Project Report No.: **BJL/FUR/DBC/01**

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We take this opportunity to express our appreciation for the excellent support provided by Foundry 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).

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CII – AVANTHA Centre for Competitiveness for SMEs

Confederation of Indian Industry

Chandigarh

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List of Abbreviations

BEE	Bureau of Energy Efficiency
SME	Small and Medium Enterprises
DPR	Detailed Project Report
GHG	Green House Gases
PF	Power Factor
EEF	Energy Efficient Motor
CDM	Clean Development Mechanism
DSCR	Debt Service Coverage Ratio
NPV	Net Present Value
IRR	Internal Rate of Return
ROI	Return on Investment
MT	Metric Tonne
SIDBI	Small Industries Development Bank of India

EXECUTIVE SUMMARY

Confederation of Indian Industry is executing BEE-SME program in Batala, Jalandhar and Ludhiana Foundry Cluster, supported by Bureau of Energy Efficiency (BEE) with an overall objective of improving the energy efficiency in cluster units.

Batala, Jalandhar and Ludhiana Foundry cluster, is one of the largest Foundry 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 Foundry clusters in India. The main energy forms used in the cluster units are grid electricity & fuel.

Most of the Industrial installations in the country have large electrical loads which are severely inductive in nature, such as motors, large machines etc which results in a high power consumption. Also many foundry units use conventional cupola furnace. Installation of a divided blast cupola furnace in place of conventional cupola furnace leads to less pollution and also saves coal.

Implementation of Divided Blast Cupola Furnace will reduce the running cost of the furnace. It helps in reducing the money spent on buying coal used as a fuel in a cupola furnace. Project implementation will lead to reduction in fuel bill by `3.90 Lakhs per year.

This DPR highlights the details of the study conducted for the Divided Blast Cupola furnace, possible Energy saving and its monetary benefit, availability of the technologies/design, local service providers, technical features & proposed equipment specifications, various barriers in implementation, environmental aspects, estimated GHG reductions, capital cost, financial analysis, sensitivity analysis in 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)	6.64
2	Monetary benefit	`(in lakh)	3.95
3	Debit equity ratio	Ratio	3:1
4	Simple payback period	years	1.68
5	NPV	(in lakh)	7.92

S. No.	Particular	Unit	Value
6	IRR	%age	41.75
7	ROI	%age	27.01
8	DSCR	Ratio	2.45
9	Process down time	weeks	3
10	CO_2 reduction	Tonne/year	25

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 energy performance in 29 selected SMEs clusters. Batala, Jalandhar and Ludhiana Foundry Cluster is one of them. The BEE's SME Programme intends to enhance 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:

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 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, 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 of energy efficiency projects in the clusters.

Activity 3: ***Implementation of Energy Efficiency Measures***

To implement the technology up gradation projects in 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 the Cluster

Indian foundry industry is very energy intensive. The energy input to the furnaces and the cost of energy play an important role in determining the cost of production of castings. Major energy consumption in medium and large scale foundry industry is the electrical energy for induction and Arc furnaces. Furnace oil is used in rotary furnaces. In Small foundry industry, coal is used for metal melting in Cupola furnaces. The energy costs contribute about 25 - 30% of the manufacturing cost in Indian foundry industry.

There are approximately 450 units, engaged in Foundry Cluster (automobile parts, agricultural implements, machine tools, diesel engine components, manhole covers, sewing machine stands, pump-sets, decorative gates and valves) production. The major locations wherein the units are spread are G.T. Road, Industrial area, Focal Point in Batala. In Jalandhar Dada Colony Industrial Area, Focal point, Focal Point Extn, Udyog Nagar, I.D.C, Kapurthala Road & Preet Nagar. In Ludhiana Focal Point Phase 5 to 8, Janta Nagar, Bhagwan Chowk Area & Industrial area – A/B. .

Availability of Electricity in Batala – across Dhir Road, GT Road is an issue; power is available from the grid for maximum 12/14 hours a day. There are some units in Jalandhar and Ludhiana having induction furnace in the range of 500 kg to 1 ton capacity whereas other units which are using local scrap as well as have high melting temperatures are having cupola and rotary furnace and has a capacity of minimum 5 ton per day.

The foundry produces a wide variety of castings such as manhole covers, pipe and pipe fittings, sanitary items, tube well body, metric weights, automobile components, railway parts, electric motor, fan body etc. 90% of the castings produced are from the SSI sector.

1.1.1. Energy Usage Pattern

Major energy sources being used in foundry cluster are electricity and fuels such as Coal, Furnace Oil, and Diesel. Electrical energy is being used in melting of iron in induction furnaces, operation of electrical utilities and thermal energy is being used in cupola furnaces operation.

1.1.2. Classification of Units

Broadly units are classified with respect to production capacity;

- Large Scale Units

- Medium Scale Units
- Small Scale Units

1.1.3. Production Wise Unit Breakup

Foundry cluster at Batala, Jalandhar and Ludhiana can be broken into three categories viz. small, medium and large size unit. Table 1.2 shows that production wise breakup of Foundry cluster.

Table 1.1 Production Wise Unit Breakups

S. No.	Type of Unit	Production Capacity
1	Large scale unit	More than 1500 MT
2	Medium scale unit	250 to 1500 MT
3	Small scale unit	Less than 250 MT

1.1.4. Products Manufactured

Foundry SME cluster at Batala, Jalandhar and Ludhiana produces a wide variety of castings such as manhole covers, pipe and pipe fittings, sanitary items, tube well body, metric weights, automobile components, railway parts, electric motor, fan body etc.

1.2. Process Flow diagram of a Foundry Cluster

The manufacturing process is described as below;

Melting Section:

The raw material is melted in melting furnace. The melting furnace can be an induction furnace or rotary or arc furnace or cupola furnace. Molten metal from the melting furnace is tapped in Ladles and then transferred to the holding furnaces. Typically the holding furnaces are induction furnaces. The holding furnace is used to maintain the required molten metal temperature and also acts as a buffer for storing molten metal for casting process. The molten metal is tapped from the holding furnace whenever it is required for casting process.

Sand Plant:

Green sand preparation is done in the sand plant. Return sand from the molding section is also utilized again after the reclamation process. Sand Muller’s are used for green sand preparation. In the sand millers, green sand, additives and water are mixed in appropriate proportion. Then the prepared sand is stored in bunkers for making moulds.

Pattern Making:

Patterns are the exact facsimile of the final product produces. Generally these master patterns are made of Aluminum or wood. Using the patterns the sand moulds are prepared.

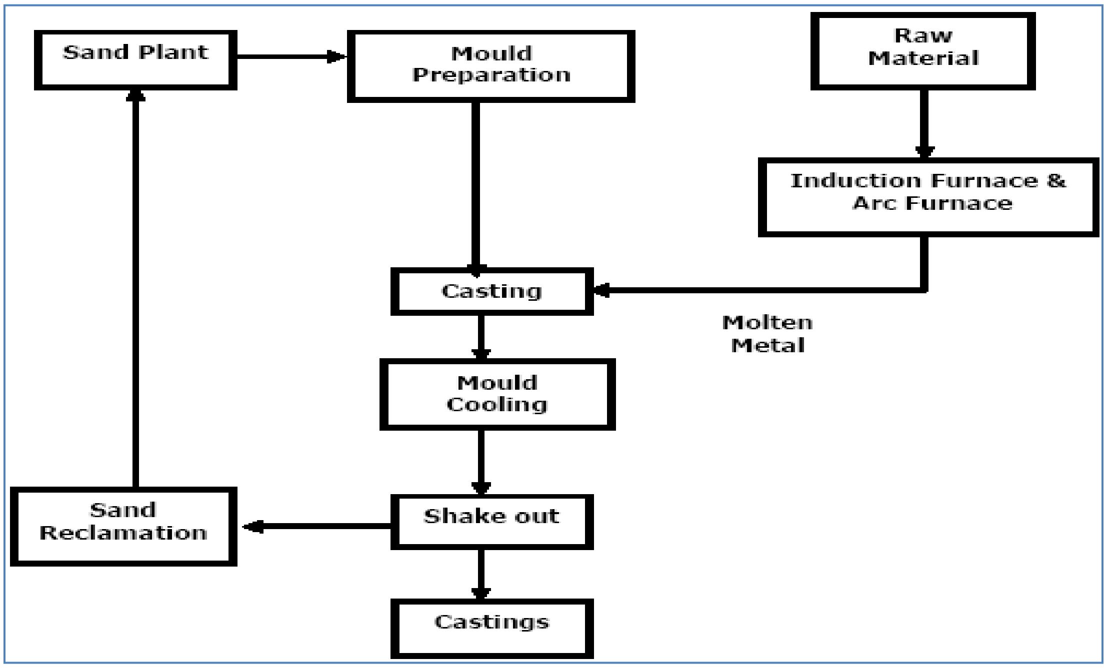

Figure 1.1 Process flow diagram of Typical foundry Units

Mould Preparation:

In small-scale industries still the moulds are handmade. Modern plants are utilizing pneumatic or hydraulically operated automatic molding machines for preparing the moulds. After the molding process if required the cores are placed at the appropriate position in the moulds. Then the moulds are kept ready for pouring the molten metal.

Casting:

The molten metal tapped from the holding furnace is poured into the moulds. The molten metal is allowed to cool in the moulds for the required period of time and the castings are produced. The moulds are then broken in the shake out for removing the sand and the used sand is sent back to the sand plant for reclamation and reuse. The castings produced are sent to fettling section for further operations such as shot blasting, heat treatment etc. depending upon the customer requirements.

1.3. Energy performance in existing situation

Major energy sources being used in foundry cluster are electricity and fuels such as Coal, Furnace Oil, and Diesel. Electrical energy is being used in melting of iron in induction furnaces, operation of electrical utilities and thermal energy is being used in cupola furnaces operation.

1.3.1. Average Production

The Average Production of the Foundry Units in above mentioned category during Year 2009-10 are as follows;

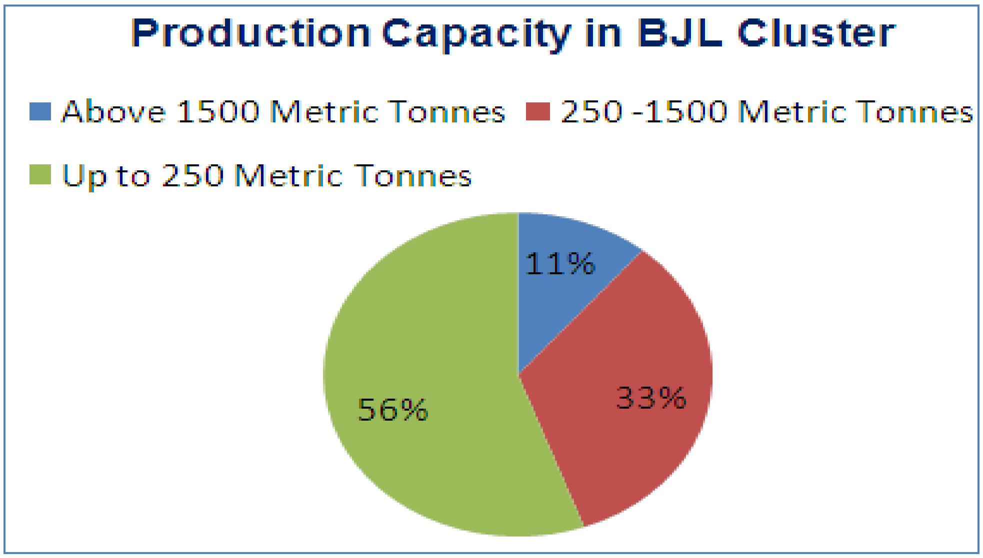

Figure 1.2 Production Capacity BJL Foundry cluster

Table 1.2 Annual Production Capacities

S. No.	Production Capacities	% of Units
1	Above 1500 Metric Tonne	11
2	250 to 1500 Metric Tonne	33
3	Below 250 Metric Tonne	56

1.3.2. Energy Consumption

Energy consumption (electrical) in a typical Foundry plant for different types of products is given in Table 1.3 below:

Table 1.3 Annual Energy Consumption (Electricity)

Electricity Consumption Pattern	Unit Consumed in kWh	Total Unit Consumption kWh
Blower Motor for Cupola	962100	26.92 Lakhs
Rotary Motor for Rotary Furnace	330000	
Melting material in Induction Furnace	1400000	

Table 1.4 Annual Energy Consumption (Coal & Furnace Oil)

Thermal Energy Consumption Pattern	Consumption per Year
Coal for Cupola	5000 Metric Tonnes
Furnace Oil for Rotary Furnace	17.8 Lakhs Litter

1.3.3. Specific Energy Consumption

Specific energy consumption of Foundry units depends upon the production capacity & their corresponding power consumption. Specific energy consumption also depends on type of furnace. A brief summary of specific energy consumption depending upon type of furnace is shown in below table;

Table 1.5 Specific Energy Consumption

S. No	Types of Furnace	Types of Fuel	Specific Fuel Consumption / One kg Molten Material	Cost of Fuel in `
1	Cupola	Coal	0.2 kg	3.0
2	Rotary Furnace	Furnace Oil	0.15 Lt	4.20
3	Arc / Induction Furnace	Electricity	0.72 kWh	3.6

**Assuming Coal rate `15.0 /kg*

**Assuming F.O rate `28.0 /Lt.*

**Assuming electricity rate `5.0/kWh*

1.4. Proposed Technology/Equipment

1.4.1. Description about the existing technology

During energy audit in the foundry units at Batala, Jalandhar and Ludhiana region, it was found that maximum units are using Blast Copula for melting. Usually the units in the cluster process one batch per day in 8 to 10 hours shift and 250 days across the year. The installed furnace is utilized for melting the material (Cast Iron) of about an average of 2.14 tonne per batch at temperature of 1300 to 1500^{o}C in about 5 to 7 hours per batch. Cupola is the most common type of melting furnace used for the production of grey iron castings in all foundries. Some of the contributing factors that were identified for this poor energy performance are listed below.

- Incorrect blast rate
- Lower blast air pressure
- Incorrect distribution of air between the top and lower tuyeres
- Turbulent (non-linear) entry of air into the cupola
- Incorrect sizing of cupola parameters such as tuyere area, well depth, and stack height among others

- Poor operating and maintenance practices
- Poor control of feed materials (shape, size, weight, sequence)

1.5. Establishing the Baseline for the Proposed Technology

Presently all the Foundry units in Batala, Jalandhar and Ludhiana are operating with conventional cupola furnace. The existing energy consumption profile of the Cupola furnace is tabulated below:

Table 1.6 Baseline Consumption

S. No.	Parameters	Units	Existing System
1.	Raw Material	Tonne / batch	2.14
2.	Coal Consumption	Kg/batch	500
3.	Raw Material rejection	Kg/batch	140
4.	Cost per batch	`/ batch	7500
5.	Output per batch	Tonne / batch	2.0
6.	***Annual Production***	***Tonne/ year***	***500***
7.	***Annual Production Cost***	***`(in lakh)/ year***	***18.75***

1.6. Barriers in adoption of proposed technology

1.6.1. Technological Barrier

- Lack of awareness and information of the loss in terms of coal consumption of conventional cupola and a divided blast cupola furnace
- Due to lack of technical knowledge and expertise, conventional cupola furnaces are used in the Foundry units.
- In this cluster, like many others, there is lack of leadership to take up the energy efficiency projects in the plant.

1.6.2. Financial Barrier

Availing finance is not the major issue. Among the SMEs, the larger units, if convinced they are capable of either financing it themselves or get the finance from their banks. The smaller units will require competitive loan and other support to raise the loan. However as most of them have been able to expand their setup and grow, there is readiness to spend for energy efficiency technologies which have good returns. Energy Efficiency Financing Schemes such as SIDBI's, if focused on the cluster, will play a catalytic role in implementation of identified energy conservation projects & technologies.

1.6.3. Skilled Manpower

In Foundry cluster at Batala, Jalandhar and Ludhiana, the availability of skilled manpower is one of the limitations; this issue gets further aggravated due to more number of Foundry units as compared to the availability of skilled manpower. For major equipments of Foundry units like Cupola furnace for maintenance or the repair works of these equipments take care by the equipment suppliers itself.

2. PROPOSED TECHNOLOGY

2.1. Detailed Description of Technology

2.1.1. Description of Technology

Divided blast cupola (DBC) or twin blast cupola is a proven technology for improving the energy performance at a modest investment. As, is evident from its name, a DBC supplies blast air to the cupola furnace at two levels through a double row of tuyeres.

Poorly designed cupolas lead to high consumption of coke, thus increasing input costs of melting. Most Indian foundries use conventional cupolas - cupolas having a single row of tuyeres. Further, several designs versions of cupola, which split or divide the blast air to the furnace are also in use. Dividing the blast air has benefits in terms of energy savings. However, to realize the full benefits of energy efficiency, optimal design of the divided blast system is crucial.

In order to popularize the correct design of DBC among Indian foundries, TERI has set-up a demonstration Divided Blast Cupola (DBC), at a foundry unit in Howrah, in the year 1988. The Indian Foundry Association nominated the demonstration unit. The design of the DBC was provided by BCIRA foundry experts. The DBC is equipped with skip-bucket charger and a high-efficiency pollution control system. The coke consumption in the DBC was reduced by 35% in comparison to the sub-optimal designed DBC being operated by the foundry unit earlier. Subsequently, TERI has been providing design of DBC and commissioning assistance to several foundry units in different foundry clusters in India.

Features of the DBC Technology:

Divided blast cupola (DBC) is a well-proven technology for improving the energy performance at a modest investment. As is evident from its name, a DBC supplied blast air to the cupola furnace at two levels metal tapping temperature.

Initially Blast Furnace operation, Warm /Hot Blast Cupola and Oxygen Enriched Cupola were developed which were not much successful, particularly in small and medium size units. In Divided Blast Cupola, air is supplied through two sets of blast pipe, tuyeres and wind box. The pressure and volume of each air supply can be separately controlled.

The advantages of a DBC, compared to a conventional cupola, are as follows.

- A higher metal tapping temperature and higher carbon pick-up are obtained for a given charge- coke consumption.
- Charge-coke consumption is reduced as high as 30% and the melting rate is increased, while maintaining the same metal tapping temperature.

Following advantages can be achieved with DBC;

- Optimum well capacity
- Higher stack height
- Mechanical charging system
- Stringent material specifications
- Optimum blower specifications (quantity and pressure)
- Optimum ratio of the air delivered to the top and bottom tuyeres
- Minimum pressure drop and turbulence of the combustion air Separate wind-belts for top and bottom tuyeres
- Correct tuyere area, number of tuyeres, and distance between the two rows of tuyeres

Advantages of DBC

Divided blast cupola (DBC) is a well-proven technology for improving the energy performance at a modest investment. As is evident from its name, DBC supplies blast air to the cupola furnace at two levels through a double row of tuyeres. The blast air is almost equally divided between the top and bottom row of tuyeres, and the spacing between the tuyeres is about one meter apart, irrespective of the diameter of the cupola. Some comparative advantages of a DBC, as found in studies conducted by BCIRA, are given below:

- A higher metal tapping temperature (approximately 45-50^{0}C more) and higher carbon pick-up (approximately 0.06%) are obtained for a given charge-coke consumption
- Charge-coke consumption is reduced by 20-32% and the melting rate is increased by 11-23%, while maintaining the same metal tapping temperature.

However, in the initial survey conducted at Agra and Howrah foundry clusters, it was found that conventional cupolas are commonly used by Indian foundry units and DBCs, where ever adopted, are of sub-optimal designs. Hence the intervention aims to demonstrate and disseminate the benefits of a well -designed DBC among Indian foundries.

2.1.2. Technology Specification

For implementation of the proposed project, conventional cupola furnace should be replaced with divided blast cupola furnace. The DBC was developed & designed by

TERI (The Energy & Resource Institute). And the successful implementation of DBC has been done by TERI at many places like Rajkot, Kolkata etc. Fabrication design drawings of the DBC are provided by TERI & its authorized vendors.

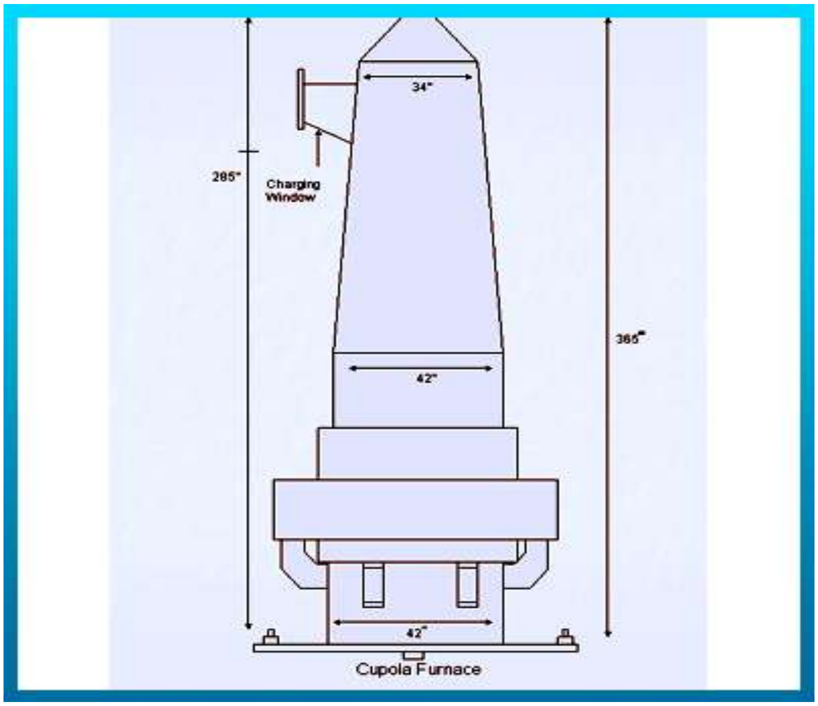

Figure 2.1 (A): Divided Blast Cupola (Sketch)

Figure 2.1 (B): Divided Blast Cupola

Table 2.1 Technical specifications

Parameters	*Value*
Internal diameter (Inches)	21"
Melting Capacity (Tonne/ Hour)	2.5
Mode of Tapping	Continuous manual
Raw material charging	by elevator (with Charging Bucket)
Coke to metal ratio	1:13.88
Average temp. (at Spout)	1375 to 1450 ^{0}C
Average temp. (ladle)	1325 to 1400 ^{0}C

2.1.3. Suitability or Integration with Existing Process and Reasons for Selection

This is the simplest and widely accepted measure for energy cost reduction in all the industries. It does not affect the process but improves the process efficiency since these furnaces save fuel consumption.

Advantages:-

- Optimum well capacity
- High efficiency
- Higher stack height
- Less losses
- Mechanical charging system
- Wide range with good efficiency
- Stringent material specifications
- Optimum blower specifications (quantity and pressure)
- Optimum ratio of the air delivered to the top and bottom tuyeres
- Minimum pressure drop and turbulence of the combustion air
  Separate wind-belts for top and bottom tuyeres
- Correct tuyere area, number of tuyeres, and distance between the two rows of tuyeres

2.1.4. Availability of Technology

Now days when energy cost is high, it is poor practice to use a conventional cupola furnace. As far as technology is concerned Divided Blast Cupola Furnace are available in local/ national market. It is well proven technology which is adopted in many of the other similar and dissimilar units. Local vendors can arrange Divided Blast Cupola Furnace at order. Local service providers are also available at Batala, Jalandhar and Ludhiana. More details of service provider are given in annexure 6.

2.1.5. Source of Technology

The DBC was developed & designed by TERI (The Energy & Resource Institute). And the successful implementation of DBC has been done by TERI at many places like Rajkot, Kolkata etc. Fabrication design drawings of the DBC are provided by TERI & its authorized vendors.

2.1.6. Terms and Conditions after Sale

Warranty period of one year will be provided from the date of invoice against any manufacturing defects. Details are provided in Annexure 7.

2.1.7. Process down Time during Implementation

Technology provider will bring the complete setup for the proposed project from their site and make all the arrangements for implementation at the client's site. And the process will be effected for a period of 2 to 3 weeks, when all the required is at the client's site.

2.2. Life Cycle Assessment

Life of the proposed divided blast cupola furnace will be around 10 to 15 years which depends on the operating conditions and maintenance at client's side.

2.3. Suitable Unit for Implementation of the Identified Technology

For estimation of the saving potential on implementation of this project, here the Foundry units engaged in making castings, having conventional cupola furnace can be considered.

3. ECONOMIC BENEFITS FROM PROPOSED TECHNOLOGY

3.1. Technical Benefits

3.1.1. Electricity savings per year

Project of Installation of Divided Blast Cupola Furnace in place of conventional Cupola Furnace will not result in savings of electricity consumption but will lead to reduction in the fuel consumption. Total coal saving would be 25 tonne per year.

3.1.2. Improvement in product quality

This project is not contributing to any improvement in product quality.

3.1.3. Improvement in production

This project is not contributing for increasing in production in Foundry units. But it reduces the fuel consumption by 25 tonne of coal per year for producing the same casting.

3.1.4. Reduction in raw material consumption

Raw material consumption will reduce by 10 tonne per year after the implementation of the proposed project.

3.1.5. Reduction in other losses

This project does not contribute to any reduction in any loss.

3.2. Monetary Benefits

Annual monetary savings with installation of Divided Blast Cupola Furnace will be `3.95 Lakhs per year with reduction in coal consumption by 25 tonne per year.

Table 3.1 Monetary savings

S. No.	Parameters	Units	Existing System	Proposed System
1.	Raw Material	Tonne / batch	2.14	2.10
2.	Coal Consumption (` 15/Kg)	Kg/batch	500	400
3.	Raw Material rejection	Kg/batch	140	100
4.	Energy Cost Savings on rejected Raw Material (@ `2/kg)	`/ Batch	--	80
5.	*Cost per batch*	*`/ batch*	*7500*	*5920*
6.	*Total batch per year*	*Batch/year*	*250*	*250*
7.	Annual Production Cost	`(in lakh)/ year	18.75	14.80
8.	Annual Production	Tonne/ year	500	
9	Monetary savings	`(in lakh)/ year	3.95	

3.3. Social Benefits

3.3.1. Improvement in Working Environment in the Plant

The proposed system will burn the fuel efficiently, so less fuel would be required every batch thus working environment in the plant will be cleaner when compared to the existing system.

3.3.2. Improvement in Skill Set of Workers

The technical skills of workers will definitely improve. Training on the regular maintenance will help in improving the technical understanding of the workers.

3.4. Environmental Benefits

The major GHG reduction would be in CO_2 reduction. Emission reductions are estimated around 25 tons of CO_2 per annum.

(Tonnes of CO_2/yr = 2.1 x Tons of fuel savings/yr – source: www.epa.gov)

4. INSTALLATION OF THE PROPOSED TECHNOLOGY

4.1. Cost of Technology Implementation

The cost of technology quoted by the vendor is ` 6.10 lakh.

Table 4.1 Details of Proposed Technology Installation Cost

S. No.	Particular	Cost ` in Lakhs
1	Equipment cost	6.10
2	Taxes @ 5.5%	0.34
3	Other cost	0.10
4	Misc	0.10
5	Total Cost	6.64

4.1.1. Technology Cost

Cost of the project is about `6.64 Lakhs which includes the purchase of Divided Blast Cupola Furnace.

4.1.2. Other Cost

Other costs required will be `0.10 Lakh which includes commissioning, manpower cost, transportation etc and other miscellaneous costs will be `0.10 Lakh as the contingency amount.

4.2. Arrangements of Funds

4.2.1. Entrepreneur's Contribution

Entrepreneur will contribute 25% of the total project cost which is `1.66 Lakhs.

4.2.2. Loan Amount

Remaining 75% cost of the proposed project will be borrowed from bank, which is Rs. 4.98 Lakhs.

4.2.3. Terms & Conditions of Loan

The interest rate is considered at 10% which is normal rate of interest for energy efficiency projects. 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 cost of equipment considered is inclusive of hot water storage tanks also.

- The Operation and Maintenance cost is estimated at 4 % of 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.

Based on the above assumptions, profitability and cash flow statements have been prepared and calculated in Annexure-3.

4.3.2. Simple Payback Period

The total project cost of the proposed technology is 6.64 Lakhs and monetary savings due to reduction in electricity consumption is 3.95 Lakhs hence, the simple payback period works out to be 1.68 years.

4.3.3. Net Present Value (NPV)

The Net present value of the investment at 10% works out to be 7.92 Lakhs.

4.3.4. Internal Rate of Return (IRR)

The after tax Internal Rate of Return of the project works out to be 41.75%. 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 27.01%.

Table 4.2 Financial Indicators of Proposed Technology

S No	Particular	Unit	Value
1	Simple Payback	Year	1.68
2	NPV	` In Lakh	7.92
3	IRR	%age	41.75
4	ROI	%age	27.01
5	DSCR	Ratio	2.45

4.4. Sensitivity analysis in realistic, pessimistic and optimistic scenarios

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 rupees savings or decrease in rupees savings. For the purpose of sensitive analysis, two following scenarios have been considered.

- **Optimistic scenario (Increase in monetary savings by 5%)**
- **Pessimistic scenario (Decrease in monetary 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.

Table 4.3 Sensitivity Analysis in Different Scenarios

Scenario	Monetary Benefit(`Lakh/year)	IRR (%)	NPV(in Lakh)	ROI (%)	DSCR
Pessimistic	3.75	38.93	7.16	26.81	2.32
Base	3.95	41.75	7.92	27.01	2.45
Optimistic	4.15	44.56	8.68	27.18	2.58

4.5. Procurement and Implementation Schedule

Procurement and implementation schedule required for implementation of this technology is about 8 weeks and 2 to 3 weeks required as a process break down. Details of procurement and implementation schedules are shown in Table 4.4 below

Table 4.4 Procurement and Implementation Schedule

S. No.	Activities	Weeks						
		1	2	3	...	6	7	8
1	Planning and material order							
2	Procurement							
3	Dismantling of conventional Cupola Furnace							
4	Commissioning							

ANNEXURES

Annexure 1: Energy audit data used for baseline establishment

S. No.	Parameters	Units	Existing System
1.	Raw Material	Tonne / batch	2.14
2.	Coal Consumption	Kg/batch	500
3.	Raw Material rejection	Kg/batch	140
4.	Cost per batch	`/ batch	7500
5.	Output per batch	Tonne / batch	2.0
6.	***Annual Production***	***Tonne/ year***	***500***
7.	***Annual Production Cost***	***`(in lakh)/ year***	***18.75***

Annexure 2: Detailed Technology Assessment Report

S. No.	Parameters	Units	Existing System	Proposed System
1.	Raw Material	Tonne / batch	2.14	2.10
2.	Coal Consumption (` 15/Kg)	Kg/batch	500	400
3.	Raw Material rejection	Kg/batch	140	100
4.	Energy Cost Savings on rejected Raw Material (@ `2/kg)	`/ Batch	--	80
5.	***Cost per batch***	***`/ batch***	***7500***	***5920***
6.	***Total batch per year***	***Batch/year***	***250***	***250***
7.	Annual Production Cost	`(in lakh)/ year	18.75	14.80
8.	**Annual Production**	**Tonne/ year**	**500**	
9.	**Monetary savings**	**`(in lakh)/ year**	**3.95**	

Annexure 3: Detailed Financial Calculations

Name of the Technology	Divided Blast Ventilator		
Rated Capacity	2 TPB		
Details	**Unit**	**Value**	**Basis**
Installed Capacity	TPB	2	
No. of Operating Days	Days	250	
No. of Shifts/ Hours	No. / Hours	1 / 8	
Proposed Investment			
Plant & Machinery	` (in lakh)	6.44	
Civil Work	` (in lakh)	0.00	
Erection & Commissioning	` (in lakh)	0.10	
Misc. Cost	` (in lakh)	0.10	
Total Investment	` (in lakh)	6.64	
Financing pattern			
Own Funds (Equity)	` (in lakh)	1.66	Feasibility Study
Loan Funds (Term Loan)	` (in lakh)	4.98	Feasibility Study
Loan Tenure	Years	5.00	Assumed
Moratorium Period	Months	6.00	Assumed
Repayment Period	Months	66.00	Assumed
Interest Rate	%age	10.00%	
Estimation of Costs			
O & M Costs	% on Plant & Equip	4.00	Feasibility Study
Annual Escalation	%age	5.00	Feasibility Study
Estimation of Revenue			
Coal Savings	Tonne/Year	25	
Cost of Coal	`/Tonne	15000	
Energy Cost Savings on Rejected Raw Material	`/Batch	80	
No. of batches	Batches/ year	250	
St. line Depn.	%age	5.28	Indian Companies Act
IT Depreciation	%age	80.00	Income Tax Rules
Income Tax	%age	33.99	Income Tax

Estimation of Interest on Term Loan **` (in lakh)**

Years	Opening Balance	Repayment	Closing Balance	Interest
1	4.98	0.25	4.73	0.58
2	4.73	0.75	3.98	0.44
3	3.98	1.00	2.99	0.35
4	2.99	1.24	1.74	0.24
5	1.74	1.24	0.50	0.12
6	0.50	0.50	0.00	0.01
		4.98		

WDV Depreciation **`(in lakh)**

Particulars / years	1	2
Plant and Machinery		
Cost	6.64	1.33
Depreciation	5.31	1.06
WDV	1.33	0.27

Projected Profitability ` (in lakh)

Particulars / Years	1	2	3	4	5	6	7	8
Electricity savings	3.95	3.95	3.95	3.95	3.95	3.95	3.95	3.95
Total Revenue (A)	3.95	3.95	3.95	3.95	3.95	3.95	3.95	3.95
Expenses								
O & M Expenses	0.27	0.28	0.29	0.31	0.32	0.34	0.36	0.37
Total Expenses (B)	0.27	0.28	0.29	0.31	0.32	0.34	0.36	0.37
PBDIT (A)-(B)	3.68	3.67	3.66	3.64	3.63	3.61	3.59	3.58
Interest	0.58	0.44	0.35	0.24	0.12	0.01	0.00	0.00
PBDT	3.11	3.23	3.30	3.40	3.51	3.60	3.59	3.58
Depreciation	0.35	0.35	0.35	0.35	0.35	0.35	0.35	0.35
PBT	2.76	2.88	2.95	3.05	3.16	3.25	3.24	3.23
Income tax	0.00	0.74	1.12	1.16	1.19	1.22	1.22	1.22
Profit after tax (PAT)	2.76	2.14	1.83	1.89	1.97	2.02	2.02	2.01

Computation of Tax ` (in lakh)

Particulars / Years	1	2	3	4	5	6	7	8
Profit before tax	2.76	2.88	2.95	3.05	3.16	3.25	3.24	3.23
Add: Book depreciation	0.35	0.35	0.35	0.35	0.35	0.35	0.35	0.35
Less: WDV depreciation	5.31	1.06	-	-	-	-	-	-
Taxable profit	(2.20)	2.17	3.30	3.40	3.51	3.60	3.59	3.58
Income Tax	-	0.74	1.12	1.16	1.19	1.22	1.22	1.22

Projected Balance Sheet ` (in lakh)

Particulars / Years	1	2	3	4	5	6	7	8
Share Capital (D)	1.66	1.66	1.66	1.66	1.66	1.66	1.66	1.66
Reserves & Surplus (E)	2.76	4.90	6.73	8.63	10.59	12.62	14.64	16.65
Term Loans (F)	4.73	3.98	2.99	1.74	0.50	0.00	0.00	0.00
Total Liabilities (D)+(E)+(F)	9.14	10.54	11.38	12.03	12.75	14.28	16.30	18.31
Assets	**1**	**2**	**3**	**4**	**5**	**6**	**7**	**8**
Gross Fixed Assets	6.64	6.64	6.64	6.64	6.64	6.64	6.64	6.64
Less Accumulated Depreciation	0.35	0.70	1.05	1.40	1.75	2.10	2.45	2.80
Net Fixed Assets	6.29	5.93	5.58	5.23	4.88	4.53	4.18	3.83
Cash & Bank Balance	2.86	4.61	5.79	6.79	7.87	9.74	12.12	14.48
TOTAL ASSETS	9.14	10.54	11.38	12.03	12.75	14.28	16.30	18.31
Net Worth	4.42	6.56	8.39	10.29	12.25	14.28	16.30	18.31
Debt Equity Ratio	2.85	2.40	1.80	1.05	0.30	0.00	0.00	0.00

Projected Cash Flow ` (in lakh)

Particulars / Years	0	1	2	3	4	5	6	7	8
Sources									
Share Capital	1.66	-	-	-	-	-	-	-	-
Term Loan	4.98								
Profit After tax		2.76	2.14	1.83	1.89	1.97	2.02	2.02	2.01
Depreciation		0.35	0.35	0.35	0.35	0.35	0.35	0.35	0.35
Total Sources	6.64	3.11	2.49	2.18	2.24	2.32	2.37	2.37	2.36
Application									
Capital Expenditure	6.64								
Repayment Of Loan	-	0.25	0.75	1.00	1.24	1.24	0.50	0.00	0.00
Total Application	6.64	0.25	0.75	1.00	1.24	1.24	0.50	0.00	0.00
Net Surplus	-	2.86	1.75	1.19	1.00	1.07	1.88	2.37	2.36

Particulars / Years	0	1	2	3	4	5	6	7	8
Add: Opening Balance	-	-	2.86	4.61	5.79	6.79	7.87	9.74	12.12
Closing Balance	-	2.86	4.61	5.79	6.79	7.87	9.74	12.12	14.48

IRR **` (in lakh)**

Particulars / months	0	1	2	3	4	5	6	7	8
Profit after Tax		2.76	2.14	1.83	1.89	1.97	2.02	2.02	2.01
Depreciation		0.35	0.35	0.35	0.35	0.35	0.35	0.35	0.35
Interest on Term Loan		0.58	0.44	0.35	0.24	0.12	0.01	-	-
Cash outflow	(6.64)	-	-	-	-	-	-	-	-
Net Cash flow	(6.64)	3.68	2.93	2.53	2.49	2.43	2.39	2.37	2.36
IRR	41.75 %								
NPV	7.92								

Break Even Point **` (in lakh)**

Particulars / Years	1	2	3	4	5	6	7	8
Variable Expenses								
O & M Expenses (75%)	0.20	0.21	0.22	0.23	0.24	0.25	0.27	0.28
Sub Total(G)	0.20	0.21	0.22	0.23	0.24	0.25	0.27	0.28
Fixed Expenses								
O & M Expenses (25%)	0.07	0.07	0.07	0.08	0.08	0.08	0.09	0.09
Interest on Term Loan	0.58	0.44	0.35	0.24	0.12	0.01	0.00	0.00
Depreciation (H)	0.35	0.35	0.35	0.35	0.35	0.35	0.35	0.35
Sub Total (I)	0.99	0.86	0.78	0.67	0.55	0.45	0.44	0.44
Sales (J)	3.95	3.95	3.95	3.95	3.95	3.95	3.95	3.95
Contribution (K)	3.75	3.74	3.73	3.72	3.71	3.70	3.68	3.67
Break Even Point (L= G/I)%	26.49%	22.96%	20.81%	17.99%	14.80%	12.17%	11.93%	12.09%
Cash Break Even {(I)-(H)}%	17.15%	13.59%	11.42%	8.57%	5.35%	2.69%	2.41%	2.54%
Break Even Sales (J)*(L)	1.05	0.91	0.82	0.71	0.58	0.48	0.47	0.48

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

Particulars / Years	1	2	3	4	5	6	7	8	Total
Net Profit Before Taxes	2.76	2.88	2.95	3.05	3.16	3.25	3.24	3.23	24.52
Net Worth	4.42	6.56	8.39	10.29	12.25	14.28	16.30	18.31	90.79
									27.01%

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

Particulars / Years	1	2	3	4	5	6	7	8	Total
Cash Inflow									
Profit after Tax	2.76	2.14	1.83	1.89	1.97	2.02	2.02	2.01	12.62
Depreciation	0.35	0.35	0.35	0.35	0.35	0.35	0.35	0.35	2.10
Interest on Term Loan	0.58	0.44	0.35	0.24	0.12	0.01	0.00	0.00	1.74
Total (M)	3.68	2.93	2.53	2.49	2.43	2.39	2.37	2.36	16.46

DEBT

Interest on Term Loan	0.58	0.44	0.35	0.24	0.12	0.01	0.00	0.00	1.74
Repayment of Term Loan	0.25	0.75	1.00	1.24	1.24	0.50	0.00	0.00	4.98
Total (N)	0.83	1.19	1.35	1.49	1.36	0.51	0.00	0.00	6.72
DSCR (M/N)	4.46	2.47	1.88	1.67	1.79	4.66	0.00	0.00	2.45
Average DSCR	2.45								

Annexure 4: Procurement and implementation schedule

S. No.	Activities	Weeks						
		1	2	3	…	6	7	8
1	Planning and material order							
2	Procurement							
3	Dismantling of conventional Cupola Furnace							
4	Commissioning							

Annexure 5: **Break-up of Process down Time**

S No	Activities	Weeks		
		6/8	7/8	8/8
1	Dismantling of conventional Cupola Furnace			
2	Installing Divided Blast Cupola Furnace			
3	Testing & Trial			

Annexure 6: Details of technology service providers

S. No.	Source of product	Details of Local vendor / service provider
1.	Sohanpal Mechanical Works	Mr. Rakesh Verma Near Petrol Pump, Amloh Road, Mandi Gobindgarh Mob – 9417335423
2.	Punjab State Council for Science & Technology	MGSIPA Complex, Adjacent Sacred Heart School, Sec-26, Chandigarh Phone: 0172-2795001/2792325/2792787 E-mail – ranjit-185@yahoo.com Mob – 09855243089
3.	B A Industries	Mr. Tawinder Singh G.T.Batala-143505(Pb) Tel : 01871-242502 Mob: 98151-62502

Annexure 7: Quotations or Techno-commercial bids for new technology /equipment

TIN No. : 03971122062

SOHANPAL MECHANICAL WORKS

Air Pollution Control Device for All type of Industries (Govt. Approved)

Mfrs. of : Chimney, Oil Store Tanks, Air Pollution Control Device for all kinds of Industries

NEAR PETROL PUMP, AMLOH ROAD, MANDI GOBINDGARH-147 301 (PB.)

Phone : 01765-256623, 94173-35423, 94175-17523

Visit us : www.sohanpalmechanical.com

Ref | *SMW/QT/137*

Dated | *29-July-2011*

Quotation

Kind Attention: Mr. Gagandeep Mohey ji

Subject: - Cupola Furnace, Conveyer (Lift), Wet air pollution control device & FD Fan

Sir,

With reference to your telefonic talk and discusion held in connection with your requirement cupola furnace, conveyer (lift), wet air pollution control device & FD Fan. We are pleased to quote our minimum possible rates for the above-mentioned of cupola furnace, conveyer, A.P.C.D & FD Fan. Our lowest rates are given below: -

1. ***Price of cupola furnace with base plate*** *(Cupola Furnace plate thickness 6mm & base plate thickness 28 or 30mm)*	***Rs. 2, 80, 000/-***
2. ***Price of wet air pollution control device***	***Rs. 1, 55, 000/-***
3. ***Price of conveyer (lift)***	***Rs. 1, 45, 000/-***
4. ***Price of FD Fan include pulley***	***Rs. 30, 000/-***

Our Terms & Conditions

1. *30 % advqnce & balance payment at the time of delivery*
2. *All material will be painted*
3. *Erection charges extra*
4. *CST 2% against 'C form' otherwise 5.5% will be charged extra*
5. *Delivery will be ex-our works*
6. *Delivery within 5 to 6 weeks*

Thanking you,

For Sohanpal Mechanical Works

Auth. Signatory

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

Confederation of Indian Industry
CII – AVANTHA Centre for Competitiveness
Block No.3, Dakshin Marg
Sector 31-A, Chandigarh - 160030
Tel: 0172-5080784 (D) / 2666517-19
Fax: 0172-2606259 / 2614974
E-mail: harinder.singh@cii.in
Website: www.ciicfc.org

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