

Detailed Project Report On Energy Efficient shell baking furnace

Mallika Alloys Pvt. Ltd.
Indore (MP)

Prepared for
Bureau of Energy Efficiency
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List of abbreviations

BEE	:	Bureau of Energy Efficiency
CI	:	Cast Iron
CO ₂	:	Carbon Dioxide
D/E	:	Debt /Equity
DPR	:	Detailed Project Report
DSCR	:	Debt Service Coverage Ratio
EE	:	Energy Efficient
GEF	:	Global Environmental Facility
GHG	:	Green House Gas
IGBT	:	Insulated-gate Bipolar Transistor
IGDPR	:	Investment Grade Detailed Project Report
IRR	:	Internal Rate of Return
kW	:	Kilo Watt
kWh	:	Kilo Watt Hour
LSPs	:	Local Service Providers
MSME	:	Micro, Small and Medium Enterprises
MT	:	Metric Tonne
NPV	:	Net Present Value
O&M	:	Operation and Maintenance
RE	:	Renewable Energy
ROI	:	Return On Investment
SME	:	Small and Medium Enterprises
SPP	:	Simple Payback Period
TERI	:	The Energy and Resources Institute
Toe	:	Tonnes of oil equivalent
UNIDO	:	United Nations Industrial Development Organization

Executive summary

The overall aim of the GEF-UNIDO-BEE project 'Promoting Energy Efficiency (EE) and Renewable Energy (RE) in selected MSME clusters in India' is to develop and promote a market environment for introducing energy efficiency and enhancing the use of renewable energy technologies in process applications in selected energy-intensive MSME clusters in India. This would help in improving the productivity and competitiveness of the MSME units, as well as in reducing the overall carbon emissions and improving the local environment.

Under the GEF-UNIDO-BEE Project, TERI has been entrusted to undertake Capacity building of Local Service Providers (LSPs) to BEE. The Scope of Work under the project

- Organizing 4 one-day training/capacity building workshops for LSPs in each cluster.
- Development of 10 bankable DPRs for each cluster, based on mapping technology needs with capacities of local technology suppliers/service providers, and also replication potential and applications to banks in each cluster.

Brief introduction of the MSME unit

Name of the unit	M/s Mallika Alloys Pvt. Ltd.
Constitution	Private Limited
MSME Classification	Small
No. of years in operation	9
Address: Registered Office:	Plot Number 564-565 571-573 Sector-3 Pithampur, Dhar-454775, Madhya Pradesh, India
Industry-sector	Foundry (Steel)
Products manufactured	Manufacturer of Valves
Name(s) of the promoters/ directors	Mr. Manish Neema

A detailed assessment study was undertaken in the identified area with the use of the sophisticated handheld instruments. Energy consumption pattern and production data were collected to estimate the specific energy consumption of the unit. The unit level baseline of the unit was also estimated using the historical data. The plant is consuming about 801480 kWh of electricity per year. The annual consumption of the LDO is 72,000 litres. The total energy consumption of the unit during last 12 months is estimated to be 140 toe which is equivalent to 83.4 lakh rupees. The total CO₂ emission during this period is estimated to be 847 tonnes. Electricity and LDO were considered for CO₂ emission estimation.

The unit manufactures the Steel castings for valves. The total annual liquid metal production of the unit during 2017-18 is estimated to be 624 tonnes and total annual good castings production is around 250 tonnes. The major source of energy is LDO used in Shell baking furnace for shell heating and electricity is consumed in the induction melting a furnace, motors and lighting.

Accepted/ recommended technology implementation

The recommended technology considered after discussion with the plant personnel for implementation in the unit is given below.

Energy conservation measures	Annual energy savings	Investment ¹	Savings	Simple Payback	Emission reduction (tonnes CO ₂)
	LDO (liters)	(Rs Lakh)	(Rs. lakh/year)	(Year)	
Replacement of existing shell baking furnace with energy efficient shell baking furnace	28,059	15.0	10.7	1.4	77

Other benefits

- The proposed project is not expected to bring in any change in process step or operating practices therefore no change expected in the product quality.
- Implementation of the selected technology in the unit may result in reduction in CO₂ emissions.

Cost of project & means of finance

S. No.	Particulars	Unit	100% equity	D/E- 70:30	D/E- 50:50
1	Cost of Project	Rs. In Lakh	15.00	15.55	15.39
2	D/E Ratio	-	-	7:3	1:1
3	Project IRR	%	46.71	40.63	42.33
4	NPV	Rs. In Lakh	14.71	12.10	12.84
5	DSCR	-	-	3.18	4.42

¹ Investment including (i) Furnace cost – 12.75 Rs. lakh, and (ii) Applicable taxes and other misc. cost – Rs. 2.30 lakh

1.0 Details of the unit

1.1 Particulars of unit

Table 1.1: Particulars of the unit

1	Name of the unit	M/s Mallika Alloys Private Limited	
2	Constitution	Private Limited	
3	Date of incorporation / commencement of business	2009	
4	Name of the Contact Person	Mr. Manish Neema	
7	Mobile / Ph. No	+91-	
8	Email	-	
9	Address: Registered Office	Plot Number 564-565 571-573 Sector-3 Pithampur, Dhar- 454775, Madhya Pradesh, India	Owned
10	Factory	Plot Number 564-565 571-573 Sector-3 Pithampur, Dhar- 454775, Madhya Pradesh, India	Owned
11	Industry / Sector	MSME/Manufacturing	
12	Products Manufactured	Manufacturer of valves	
13	No of hours of operation/shift	12	
14	No of shifts/ day	01	
15	No of days/year	300	
16	Installed Capacity	600 MT per year	
17	Whether the unit is exporting its products (Yes/ No)	No	
18	Quality Certification, if any	ISO 9001:2008	

2.0 Energy profile

2.1 Process flow diagram

The major steps of process are mould sand preparation, charge preparation followed by melting, pouring, knockout and finishing. The steps are explained below.

2.1.1 Wax mould preparation

The major equipment installed is press for wax moulding. Wax mould are prepared using a hot wax which comes in the press and then moulded into the required shape. These press machines are hydraulic based.

2.1.2 Assembly of wax pattern and coating

Wax patterns are coated using coating sand which is Zircon made. This coating takes a shape of wax pattern and has a capability to withstand the liquid melt. Secondary coating of sand is also given to mould.

2.1.3 Drying and dewaxing

Drying of the coated mould is done using fans in a separate room. These mould are dried and then sent for dewaxing in an Auto-clavor machine, which is electric based heating of water to make the steam and then that steam is used to indirectly melt the wax inside mould.

2.1.4 Shell baking and melting

Shells after dewaxing are kept in a shell baking furnace and heated at 950 degrees and then taken out for pouring. Melting of charge is done with help of induction furnace. Induction furnace runs on medium frequency three phase electrical supply. Once melt attained required temperature and metallurgy, the liquid melt is poured into the earlier prepared sand moulds using ladles.

2.1.5 Knockout and finishing

Mould is left to cool for certain time, then it follows to a vibrator with grated surface, it knocks-out the sand and the casting is send for finishing, which involves shot blasting and machining job.

The process flow diagram for major product and steel grade casting produced in the foundry is given in figure 2.1.5.

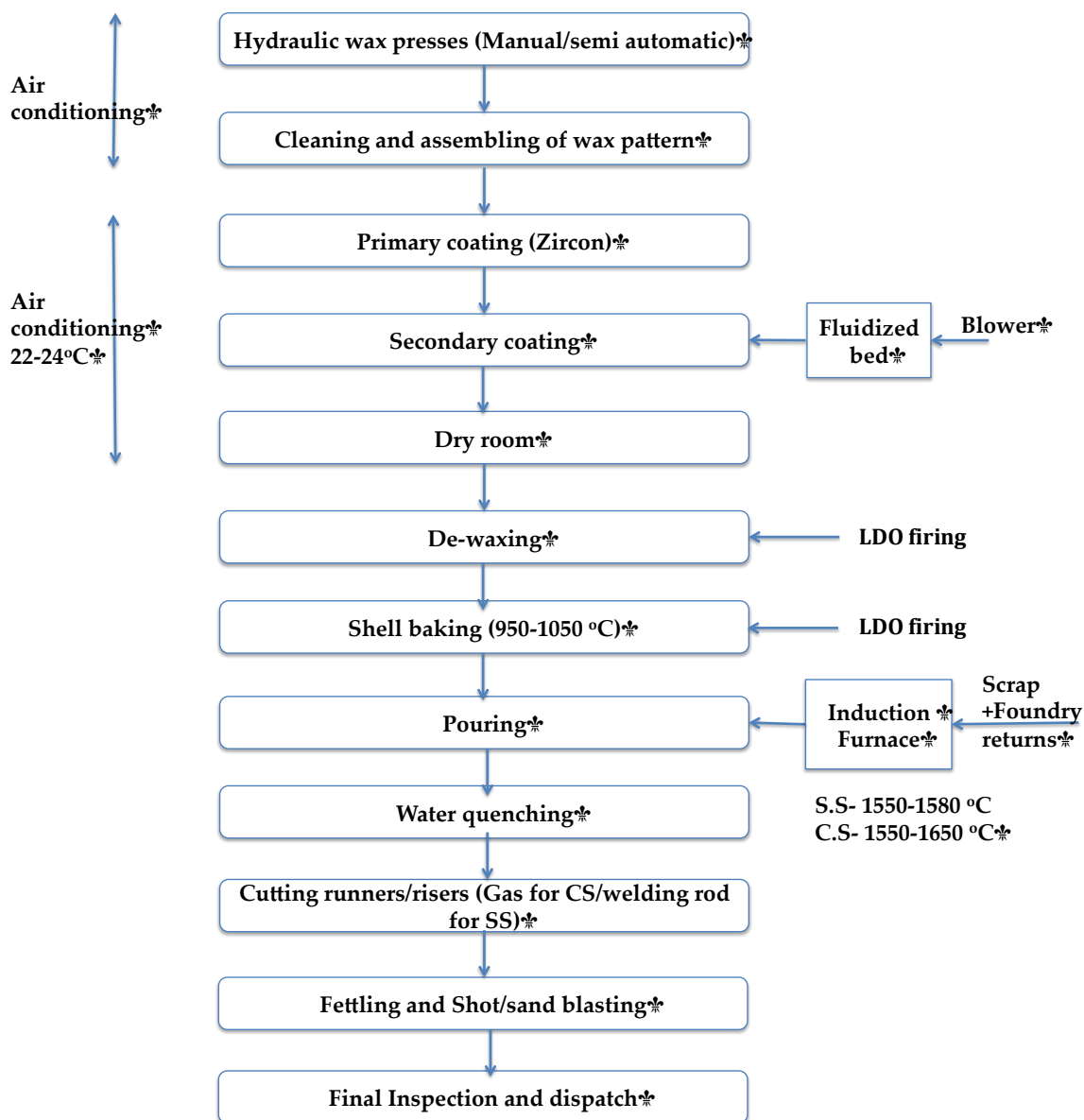


Figure 2.1.5 Process flow chart

2.2 Details of technology identified

The details of the existing technology installed in the unit are given in table 2.2.

Table 2.2: Details of existing technology

Parameters/Equipment ID	Unit	Value
Equipment (Brief Description)		Shell baking
Type		Box
Make/year		9
Fuel	-	LDO
Purpose/ application		Shell baking
Design Capacity	Kg	600
Burners	nos.	2.0
Blower	kW	3.7

2.3 Energy used and brief description of their usage pattern

The unit uses grid power supplied by Madhya Pradesh Paschim Kshetra Vidyut Vitaran Company Limited. Table 2.3 provides the details of energy uses.

Table 2.3: Energy used and description of use

S No	Energy source	Description of use
1	Electricity	Motive power for different drives in different process sections and utilities
2	LDO	Shell baking furnace

2.4 Energy sources, availability & tariff details

The power supply to the facility is from Madhya Pradesh Paschim Kshetra Vidyut Vitaran Company Limited grid @ 11 kV, with 285 kVA sanctioned contract demand. Different energy sources, availability of listed energy types and their respective tariffs are given in table 2.4.

Table 2.4: Energy sources, availability and tariffs

Particular	For supply at 11 kV
Demand charges	Rs. 330/kVA/month
Energy charges	Rs. 6.0/ kWh
LDO	Rs. 38 per liter

2.5 Analysis of electricity consumption

Table 2.5: Electricity consumption profile

Month	Electricity consumption, kWh/month	Contract demand, kVA	Actual Demand, kVA	Energy Charges, Rs.	Demand Charges, Rs.	PF	PF Rebate, Rs.	Monthly Bill amount, Rs.
Dec-17	67,390	285	274	335,150	145,220	0.99	-23,788	473,502
Jan-18	77,380	285	274	384,400	145,220	0.99	-26,692	512,111
Feb-18	69,420	285	271	344,550	143,630	0.99	-23,925	469,384
Mar-18	52,970	285	273	263,350	144,690	0.99	-18,287	401,758
Average	66,790	285	273	331,863	144,690	1	-23,173	464,189
Yearly	801,480			3,982,350	1,736,280		-278,076	5,570,265

Figure 2.5 presents contract demand, recorded maximum demand and the energy consumption of the unit.

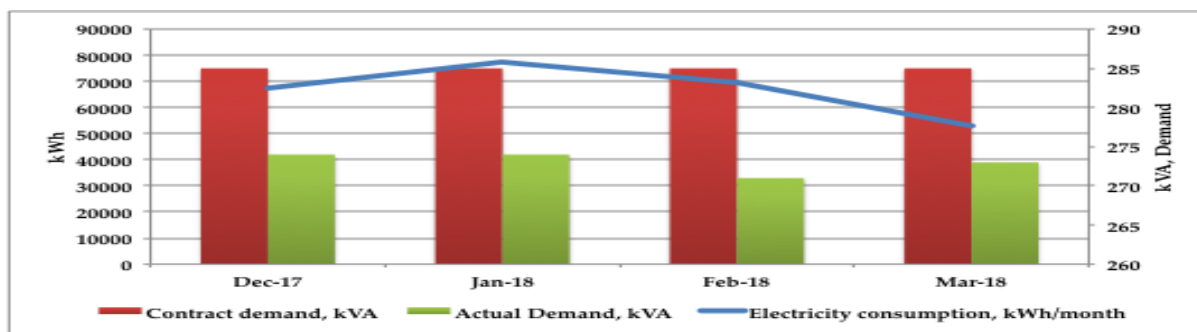


Figure 2.5: Demand pattern and energy consumption profile

2.6 Analysis of other energy forms/ fuels

The analysis of the other fuels/forms of energy used in the unit is given in table 2.6.

Table 2.6: Analysis of other energy/ fuel consumption

Parameters	LDO (Litre)
Consumption unit/year	69,240
Calorific value per unit	9,202
Equivalent toe per year	63.7
Price (Rs per unit)	35
Total price per year	24,23,400

The share of various energy forms used in the unit is given in figure 2.6.

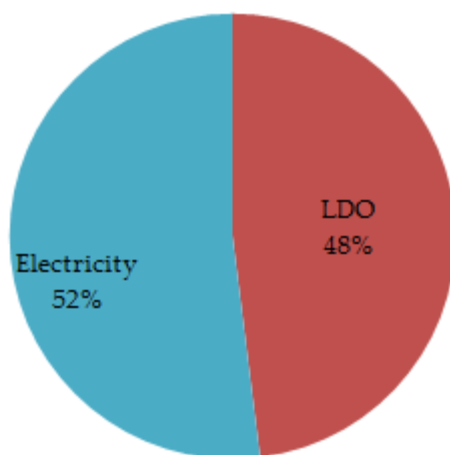


Figure 2.6: Percentage share of various fuel types in the unit

The plant is consuming about 801,480 kWh of electricity per year. The annual consumption of the LDO is 72,000 litres. The total energy consumption of the unit during last 12 months is estimated to be 140 toe which is equivalent to 83.4 lakh rupees. The total CO₂ emission during this period is estimated to be 847 tonnes. Electricity and LDO were considered for CO₂ emission estimation.

3.0 Proposed technology for energy efficiency

Based on the measurements, observations/ findings during detailed assessment study conducted in the unit, the following technology has been identified for energy efficiency improvement. The detail is given below.

3.1 Replacement of existing shell baking furnace with energy efficient shell baking furnace

3.1.1 Background

The Plant manufactures of stone crusher machine parts and has installed an induction furnace of rated capacity of 250 kW with two crucibles of capacity of 300 kg each for melting (one standby). Along with that one box type LDO fired shell baking furnace is operated for heating shells at 950 degrees for liquid metal pouring operation. The operational parameters of the shell baking furnace including the LDO consumption and material charged were measured during the detailed assessment study and analysis of the past one-year data.

3.1.2 Observations and analysis

The operation parameters of the existing shell baking furnace installed in the plant is shown in table 3.1.2a.

Table 3.1.2a: General operational parameters

Observation and Measurements	Unit	Furnace
Fuel Type	-	LDO
Calorific Value	kCal/ltr	9202
Mode of operation	-	Batch
Days per year	-	300
Feed temperature	°C	40
Operating Temperature	°C	100
Flue gases temperature	°C	804
Excess air level	%	45
Dry bulb temperature	°C	33.0
Type of insulation	-	Ceramic
Skin temperature	°C	102
External Surface area	m ²	18

The refractory lining of shell baking furnace has deteriorated showing an average surface temperature of 102 °C, while the temperature of door was 130 °C. The higher surface temperature of the furnace would lead to higher heat losses. The total surface heat loss in this furnace was estimated to be 17,236 kcal/hr.

Table 3.1.2b: Heat loss calculations

Parameters	Avg. temp (°C)	Film coeff (kCal/m ² -hr)	Area (m ²)	Δ T (°C)	Heat loss (kCal/hr)
Back side	80	12.87	3.40	40.0	1,751
Longi. Sides (burner side) ¹	75	12.49	3.57	35.0	1,561

Parameters	Avg. temp	Film coeff	Area	ΔT	Heat loss
	(°C)	(kCal/m ² -hr)	(m ²)	(°C)	(kCal/hr)
Top side	130	15.91	4.20	90.0	6,016
door side	150	16.97	3.40	110.0	6,348
Longi. Sides (burner side)2	75	12.49	3.57	35.0	1,561
Total surface heat loss in kCal/hr					17,236

Flue gas analysis was done in order to check the combustion of the LDO in the furnace. It was observed that Carbon monoxide formation in excess quantity was occurring due to wrong air to fuel ration. Carbon monoxide 4,800 ppm was measured which is very high and signifies significant heat loss. The heat loss analysis due to formation of carbon monoxide is shown in table

Table 3.1.2c: Heat loss due to CO formation

Parameters	Unit	Value
Excess Air %	%	45
LDO supplied	litres/hr	23.1
CO in flue gas	Ppm	4,800
Heat loss due to CO formation	kCal/kg	2,200

The furnace has two local burners which run on ON/OFF mode. Due to local design, attached blowers of the burners keep running while LDO is cut off which in turn reduces the inside temperature of the furnace by supplying air. This condition increases burner ON time increasing the LDO consumption. Presently temperature of air at the inlet of burner is around 40 °C, which is very low. The flue gas temperature is more than 650 °C resulting in substantial heat losses and reduced efficiency of the furnace. The amount of heat exhausted in to the flue gases has been shown in table 3.1.2d.

Table 3.1.2d: Heat loss in stack

Parameters	Unit	Value
Avg. LDO consumption kg per day	litres/day	230.8
Excess air supplied,	%	45%
Total air supplied to furnace	kg/hour	319.4
Specific heat of air (@ 650°C)	kCal/kg°C	0.27
Blower inlet air temperature	°C	40
Flue gas temperature	°C	804
Quantity of heat input to furnace	kCal/hour	2,27,538
Quantity of heat in flue gas	kCal/hour	66,322

3.1.3 Recommendation

The unit may adopt the new shell-baking furnace, which will have a new draft design along with high velocity burners. Present furnace has a direct draft design, which is inefficient and unit is losing significant energy. High velocity burners are recommended in the new furnace which will be used with PLC control and recuperator. Recuperator will do waste heat recovery from the exhaust gasses of the furnace and will use to preheat the blower air for burners.

3.2 Cost benefit analysis

The estimated annual energy savings by replacement of existing shell baking furnace with new shell baking furnace 28,059 litres of LDO equivalents to a monetary saving of Rs 9.95 lakh. The investment requirement is Rs 15.05 lakh with a simple payback period of 1.5 years. The detailed calculations of the recommended energy conservation measures for IGDP are provided in table 3.2.

Table 3.2: Cost benefit analysis for heat loss saving

Parameters/Equipment ID	Unit	Existing	Proposed
Type		Box	Box
Waste heat recovery	-	No	Yes
Purpose/ application		Shell baking	
Design Capacity	kg	600	
Burners	nos.	2.0	
Blower	kW	3.7	
Annual fuel consumption	Lit/year	72,000	45,811
Total surface heat loss	Million kCal/Yr	72.4	15.8
Heat loss due to CO formation	Million kCal/Yr	136.2	-
Flue gas losses	Million kCal/Yr	238.8	173.4
Total heat loss	Million kCal/Yr	447.4	189.2
Reduction in heat loss	Million kCal/Yr	-	258.2
Annual reduction in fuel consumption	Lit/year	-	28,059
Annual monetary benefits	Rs./Yr	-	10,66,246
Investment toward installation of new shell baling furnace	Rs	-	1,275,000
Applicable taxes and duties	Rs	-	229,500
Total investment	Rs	-	1,504,500
Simple payback period	Rs	-	1.4

3.3 Pre-training requirements

The training would be required on best charging practices and best melting operations. Also best practices to be adopted for operation like - initial charging, pouring, superheating, holding for chemical analysis or de-slagging.

3.4 Process down time for implementation

The estimated process down time required for implementation of recommended measure is estimated to be 3 days after commissioning and testing of the new furnace.

3.5 Environmental benefits

3.5.1 CO₂ reduction²

Implementation of the selected energy conservation measures in the unit may result in reduction in CO₂ emissions due to reduction in overall energy consumption. The estimated reduction in GHG emission by implementation of the recommended energy conservation measures is 77 tonne of CO₂ per year.

3.5.2 Reduction in other pollution parameters (gas, liquid and solid)

There is not significant impact on the reduction in other pollution parameters including gas, liquid and solid.

² Source for emission factor: 2006 IPCC Guidelines for National Greenhouse Gas Inventories
Electricity: CO₂ Baseline Database for the Indian Power Sector, user guide version 12.0, May 2017 (CEA)

4.0 Project financials

4.1 Cost of project and means of finance

4.1.1 Particulars of machinery proposed for the project

The particulars of machinery proposed for the project is given in table 4.1.1.

Table 4.1.1: Particulars of machinery proposed for the project

S. No.	Name of machinery (Model/ specification)	Name of manufacturer, contact person	Advantage
1	Box type Shell baking furnace with Recuperator and high velocity burners	Enerex Solutions Private Limited 401, AMBIT, 1, Krishna Park Society, Pushkar Dham Road, Rajkot - 360005. Gujarat (INDIA) Email: enerexsolutions@gmail.com www.enerex.in	<ul style="list-style-type: none"> MS Structure Design, Manufacture, Supply, Testing, Installation and Commissioning, and Performance Demonstration of Shell Baking Furnace of inside size 1800mm. 1800mm. 1000mm (lhb) with complete Brick Lining and Glass Wool Lining with chimney of diameter 300mm and length 6M as per standard specification. Wesman Gas Burner Gas Burner with Gas Line Accessories and Air Line Accessories with Temperature controller for switching Burner and Blower ON/OFF as per standard specification. Recuperator Design, Manufacture, Supply, Testing, Installation and Commissioning Support, and Performance Demonstration of Recuperator as per requirement identified at shell baking furnace.

4.1.2 Means of finance

The means of finance for the project is shown in table 4.1.2.

Table 4.1.2: Means of finance

S. No.	Details	100% equity	D/E- 70:30	D/E- 50:50
1	Additional (Share) Capital	15.0	4.5	7.5
2	Internal Accruals	-	-	-
3	Interest free unsecured loans	-	-	-
4	Term loan proposed (Banks/FIs)	-	10.5	7.5
5	Others	-	-	-
	Total	15.0	15.0	15.0

4.2 Financial statement (project)

4.2.1 Assumptions

The assumptions made are provided in table 4.2.1.

Table 4.2.1: Assumptions made

Details	Unit	100% equity	D/E- 70:30	D/E- 50:50
General about unit				
No of working days	Days		300	
No of shifts per day	Shifts		1	
Annual operating hours	hours/year		3,600	
Installed production capacity	tonnes/year		600	
Production in last financial years	tonnes/year		324	
Capacity utilization factor	%		54	
Proposed investment (Project)				
Total cost of the project	Rs. (in Lakh)	15.00	15.00	15.00
Investment without interest defer credit (IDC)	Rs. (in Lakh)	15.00	15.00	15.00
Implementation time	months	6.00	6.00	6.00
Interest during the implementation phase	Rs. in lakhs	-	0.55	0.39
Total investment	Rs. in lakhs	15.00	15.55	15.39
Financing pattern				
Own funds	Rs. in lakhs	15.00	5.05	7.89
Loan funds (term loan)	Rs. in lakhs	-	10.50	7.50
Loan tenure	Years	-	5.0	5.0
Moratorium period (No EMI (interest and principal amount))	Months	-	6.0	6.0
Total repayment period	Months	-	66.0	66.0
Interest rate	%	-	10.5	10.5
Estimation of costs				
Operation & maintenance costs	%		5.0	
Annual escalation rate of O&M	%		5.0	
Estimation of revenue				
Reduction in energy cost	Rs. (in lakh)/year		10.70	
Total saving	(Rs Lakh/year)		10.70	
Straight line depreciation	%		16.21	
IT depreciation	%		80.00	
Income tax	%		33.99	
Period of cash flow analysis	Years		5.0	

4.2.2 Payback

The simple payback period on the investments made are shown in table 4.2.2.

Table 4.2.2: Payback

Details	100% equity	D/E- 70:30	D/E-50:50
Total project cost (Rs. In lakh)	15.00	15.55	15.39
Cash flow as annual saving (Rs. In lakh/year)	10.70	10.70	10.70
O&M Expenses for first year (Rs. In lakh/year)	0.75	0.78	0.77
Net Cash flow (Rs. In lakh/year)	9.95	9.92	9.93
SPP (months)	18.09	18.81	18.60
Considered (month)	18.10	18.80	18.60

4.2.3 NPV and IRR

The NPV and IRR calculations are shown in table 4.2.3.

Table 4.2.3a: NPV and IRR (100% equity)

Particulars / years	0	1	2	3	4	5
	(Rs. in lakhs)					
Profit after tax	-	7.52	5.62	4.25	4.09	4.04
Depreciation	-	2.43	2.43	2.43	2.43	2.43
Cash outflow	15.00	-	-	-	-	-
Net cash flow	-15.00	9.95	8.06	6.68	6.52	6.47
Discount rate % @ WACC	9.25	9.25	9.25	9.25	9.25	9.25
Discount factor	1.00	0.92	0.84	0.77	0.70	0.64
Present value	-15.00	9.11	6.75	5.12	4.58	4.16
Net present value		14.71				
Simple IRR considering regular cash flow		46.71%				

Table 4.2.3b: NPV and IRR (D/E- 70:30)

Particulars / years	0	1	2	3	4	5
	(Rs. in lakhs)					
Profit after tax	-	6.87	5.27	3.66	3.64	3.74
Depreciation	-	2.52	2.52	2.52	2.52	2.52
Cash outflow	15.55	-	-	-	-	-
Net cash flow	-15.55	9.39	7.79	6.18	6.16	6.26
Discount rate % @ WACC	10.09	10.09	10.09	10.09	10.09	10.09
Discount factor	1.00	0.91	0.83	0.75	0.68	0.62
Present value	-15.55	8.53	6.43	4.63	4.19	3.87
Net present value		12.10				
Simple IRR considering regular cash flow		40.63%				

Table 4.2.3c: NPV and IRR (D/E- 50:50)

Particulars / years	0	1	2	3	4	5
	(Rs. in lakhs)					
Profit after tax	-	7.05	5.37	3.83	3.77	3.83
Depreciation	-	2.50	2.50	2.50	2.50	2.50
Cash outflow	15.39	-	-	-	-	-
Net cash flow	-15.39	9.55	7.87	6.32	6.26	6.32
Discount rate % @ WACC	9.86	9.86	9.86	9.86	9.86	9.86
Discount factor	1.00	0.91	0.83	0.75	0.69	0.62
Present value	-15.39	8.69	6.52	4.77	4.30	3.95
Net present value		12.84				
Simple IRR considering regular cash flow		42.33%				

4.3 Marketing & selling arrangement

The marketing and selling arrangements of the unit are given in table 4.3.

Table 4.3: Marketing & selling arrangements

Items	Remarks
Main Markets (locations)	Pan India
Locational advantages	-
Indicate competitors	Other furnace manufacturing units
Any USP or specific market strength	-
Whether product has multiple applications	NA
Distribution channels (e.g. direct sales, retail network, distribution network)	Direct sales
Marketing team details, if any.	NA

4.4 Risk analysis and mitigation

The risk analysis and mitigation for the proposed options are given in table 4.4.

Table 4.4: Risk analysis and mitigation

Type of risk	Description	Mitigation
Technology	The equipment/technology provided by the supplier may not be of high quality, which may result in underperformance.	The equipment/technology should be procured from standard/reputed vendors only.
Market /Product	Demand of the product manufactured by the unit may change resulting in lower capacity utilization.	Regular vigilance/tab on the market scenario by the SME will help in better understanding of new substitute product. The unit may modify the product line based on the emerging market trend.
Policy/Regulatory	Changes in government regulation/policy related to pollution and taxes & duties can affect the viability of the unit.	Local industrial association may play a role in discussing these issues with the relevant governmental bodies on a regular basis, so that any concerns of the unit are brought to their notice.

4.5 Sensitivity analysis

A sensitivity analysis has been carried out to ascertain how the project financials would behave in different scenarios are given in table 4.5.

Table 4.5: Sensitivity analysis

S. No.	Scenario	D/E ratio	Payback period (months)	NPV (Rs lakh)	IRR (%)	DSCR	ROI (%)
1	10% increase in	100% equity	16.30	17.47	53.14	-	24.88

DPR – Energy Efficient shell baking furnace (Mallika Alloys Pvt. Ltd.)

S. No.	Scenario	D/E ratio	Payback period (months)	NPV (Rs lakh)	IRR (%)	DSCR	ROI (%)
	estimated savings	70:30	17.00	14.80	46.92	3.47	34.28
		50:50	16.80	15.55	48.65	4.82	30.74
2	10% reduction in estimated savings	100% equity	20.30	11.96	40.18	-	21.36
		70:30	21.10	9.40	34.23	2.89	30.80
	10% rise in interest rates	50:50	20.80	10.12	35.89	4.01	27.08
		70:30	18.90	11.44	40.02	3.12	32.52
3	10% rise in interest rates	50:50	18.70	12.35	41.89	4.32	28.94
		70:30	18.70	12.78	41.24	3.25	32.93
4	10% reduction in interest rates	70:30	18.70	12.78	41.24	3.25	32.93
		50:50	18.60	13.33	42.77	4.52	29.22

5.0 Conclusions & recommendations

The IGDPR prepared for the replacement of existing shell baking furnace by new EE shell baking furnace based on the performance assessment study conducted at unit and the acceptance of the unit management. The brief of selected energy conservation measure is given below.

5.1 List of energy conservation measures

The brief summary of the energy conservation measures are given in table 5.1.

Table 5.1: Summary of the energy conservation measures

Energy conservation measures	Annual energy savings	Investment ³	Savings	Simple Payback	Emission reduction (tonnes CO ₂)
	LDO (liters)	(Rs Lakh)	(Rs. lakh/year)	(Year)	
Replacement of existing shell baking furnace with energy efficient shell baking furnace	28,059	15.0	10.7	1.4	77

The measure has an estimated investment of 15.0 lakh rupees and can yield a savings of 10.7 lakh rupees per year. The total annual reduction in emission by implementation of recommended measure is estimated to be 77 tonnes of CO₂. The financial indicators provided above in the table shows the project is financially viable and technically feasible.

5.2 Summary of the project

The summary of the project is given in table 5.2.

Table 5.2: Summary of the project

S. No.	Particulars	Unit	100% equity	D/E- 7:3	D/E- 1:1
1	Cost of Project	Rs Lakh	15.05	15.05	15.05
2	Energy Saving Potential	Rs Lakh	9.95	9.95	9.95
3	D/E ratio	-	-	7:3	1:1
4	Project IRR	%	41.97	37.33	37.65
5	NPV	Rs Lakh	12.75	10.47	10.89

5.3 Recommendations

The financial indicators provided above show the project is financially viable and technically feasible. It is recommended that the implementation of the identified the energy conservation measures may be undertaken by the unit.

³ Investment including the (i) Furnace and recuperator and burner cost – 12.75 Rs. lakh, and (iii) Installation, Taxes and other misc. cost – Rs. 2.30 lakh

6.0 Financing schemes for EE investments for MSME sector

Government of India has many schemes to provide concessional finance for EE technologies among MSMEs. Some major government schemes are summarised in table 6.1.

Table 6.1: Major government schemes

Name of the scheme	Brief Description and key benefits
ZED assessment and certification	<p>Assessment process, fee and subsidy are as follows: Online (e-Platform) self-assessment: Nil fee Desk Top assessment : Rs 10,000 per SME Complete assessment : Rs 80,000 ZED rating per SME; Rs 40,000 for additional ZED defence rating; Rs 40,000 for re-rating The rating costs will include cost of Rs 10,000/- as certification cost by QCI. Subsidy for Micro, Small and Medium Enterprises are 80%, 60% and 50% respectively.</p>
Credit Linked Capital Subsidy Scheme (CLCSS) (2000-ongoing)	<p>15% capital subsidy of cost of eligible plant and machinery / equipment for adoption of proven technologies for approved products / sub-sectors for MSE units subject to ceiling of INR 15 lakhs</p>
Credit Guarantee Fund Scheme for Micro and small Enterprises (in partnership with SIDBI) (2000-ongoing)	<p>This scheme was launched by MoMSME and SIDBI to alleviate the problem of collateral security and enable micro and small scale units to easily adopt new technologies. Under the scheme, collateral free loans up to Rs 1 crore can be provided to micro and small scale units. Additionally, in the event of a failure of the SME unit which availed collateral free credit facilities to discharge its liabilities to the lender, the Guarantee Trust would guarantee the loss incurred by the lender up to 75 / 80/ 85 per cent of the credit facility.</p>
Technology and Quality Up gradation Support to MSMEs (TEQUP) (2010-ongoing)	<p>The benefits available to SMEs under TEQUP include –technical assistance for energy audits, preparation of DPRs and significant capital subsidy on technologies yielding an energy savings of over 15%. The scheme offers a subsidy of 25% of the project cost, subject to a maximum of Rs. 10 lakhs. TEQUP, a scheme under NMCP, focuses on the two important issues in enhancing competitiveness of the SME sector, through EE and Product Quality Certification.</p>
Technology Upgradation Fund Scheme (TUFS) (1999-ongoing)	<p>Interest subsidy and /or capital subsidy for Textile and Jute Industry only.</p> <ol style="list-style-type: none"> To facilitate Technology Up gradation of Small Scale (SSE) units in the textile and jute industries. Key features being: <ul style="list-style-type: none"> Promoter’s margin -15%; Subsidy - 15% available on investment in TUF compatible machinery subject to ceiling of Rs 45 lakh; Loan amount - 70% of the cost of the machinery by way of Term Loan

Name of the scheme	Brief Description and key benefits
	<ul style="list-style-type: none"> • Interest rate: Reimbursement of 5% on the interest charged by the lending agency on a project of technology upgradation in conformity with the Scheme • Cover under Credit Guarantee Fund Scheme for Micro and Small Enterprises (CGMSE) available <p>2. To enable technology upgradation in micro and small power looms to improve their productivity, quality of products and/ or environmental conditions</p> <ul style="list-style-type: none"> • 20% margin subsidy on investment in TUF compatible specified machinery subject to a ceiling of Rs 60 lakhs or Rs 1crore (whichever is applicable) on subsidy amount to each unit – released directly to the machinery manufacturer.
Tax incentives	<ul style="list-style-type: none"> • Accelerated depreciation is provided to the customers / users of the energy saving or renewable energy devises under the direct tax laws. • Under indirect taxes, specific concessional rates of duty are only available to CFLs and not to all energy efficient products • A further waiver of import tariffs and taxes for EE technology imports are dealt on a case to case basis, meaning higher costs for those imported technologies that are not available in the domestic markets at present.

Two financing schemes have been created by Bureau of Energy Efficiency (BEE) under The National Mission for Enhanced Energy Efficiency (NMEEE) for financing of energy efficiency projects - Venture Capital for Energy Efficiency (VCFEE) and Partial Risk Guarantee Fund for Energy Efficiency (PRGFEE). These funds seek to provide appropriate fiscal instruments to supplement the efforts of the government for creation of energy efficiency market. Highlights of these two schemes are provided in the table 6.2.

Table 6.2: BEE’s VCFEE and PRGFEE scheme

Venture Capital for Energy Efficiency (VCFEE)	<ul style="list-style-type: none"> • This fund is to provide equity capital for energy efficiency projects in Government buildings and Municipalities in the first phase. • A single investment by the fund shall not exceed Rs 2 crore • Fund shall provide last mile equity support to specific energy efficiency projects, limited to a maximum of 15% of total equity required, through Special Purpose Vehicle (SPV) or Rs 2 crore, whichever is less
Partial Risk Guarantee Fund for Energy Efficiency (PRGFEE)	<ul style="list-style-type: none"> • A PRGF is a risk sharing mechanism lowering the risk to the lender by substituting part of the risk of the borrower by granting guarantees ensuring repayment of part of the loan upon a default event. • Guarantees a maximum 50% of the loan (only principal). In case of default, the fund will: <ul style="list-style-type: none"> ○ Cover the first loss subject to maximum of 10% of the total guaranteed amount ○ Cover the remaining default (outstanding principal) amount on

Venture Capital for Energy Efficiency (VCFEE)	<ul style="list-style-type: none"> This fund is to provide equity capital for energy efficiency projects in Government buildings and Municipalities in the first phase. A single investment by the fund shall not exceed Rs 2 crore Fund shall provide last mile equity support to specific energy efficiency projects, limited to a maximum of 15% of total equity required, through Special Purpose Vehicle (SPV) or Rs 2 crore, whichever is less
	<p style="text-align: center;">partial basis upto the maximum guaranteed amount</p> <ul style="list-style-type: none"> PFI shall take guarantee from the PRGFEE before disbursement of loan to the borrower. The Guarantee will not exceed Rs 300 lakh per project or 50% of loan amount, whichever is less. Maximum tenure of the guarantee will be 5 years from the date of issue of the guarantee

Indian Renewable Energy Development Agency (IREDA), a non-banking financial institution established by the government also extends financial assistance for setting up projects relating to new and renewable sources of energy and energy efficiency/conservation. The detailed financing guidelines for energy efficiency projects are provided in table 6.3.

Table 6.3: IREDA's financing guidelines

Eligible companies who can apply	Private Sector Companies/ firms, Central Public Sector Undertaking (CPSU), State Utilities/ Discoms/ Transcos/ Gencos/ Corporations, Joint Sector Companies which are not loss making.
Minimum loan amount	<ul style="list-style-type: none"> Rs. 50 lakh
Type of projects considered for term loans	<ul style="list-style-type: none"> Replacement / retrofit of selected equipment with energy efficient equipment Modification of entire manufacturing processing Recovery of waste heat for power generation
Incentive available	<ul style="list-style-type: none"> Rebate in central excise duty Rebate in interest rate on term loan Rebate in prompt payment of loan instalment
Interest rate	<ul style="list-style-type: none"> 10.60% to 11.90% depending upon the grading of the applicant with prompt payment rebate of 15 bps if payment is made on / before due dates Interest rates are floating and would be reset on commissioning of the project or two years from the date of first disbursement. Thereafter, the rates will be reset after every two years. Rebate of 0.5% in interest rates are available for projects set up in North Eastern States, Sikkim, J&K, Islands, Estuaries. Rebates of 0.5% in interest rates are also available for projects being set up by SC/ST, Women, Ex Servicemen and Handicapped categories involving project cost of upto Rs. 75.00 lakh.
Loan	Upto 70% of the total project cost. Promoter's contribution should be Minimum 30% of the total project cost
Maximum debt	3:1

equity ratio	The project cash flow should have a minimum average Debt Service Coverage Ratio of 1.3
Maximum repayment period	12 years with moratorium of maximum 12 months
Procurement procedures	The borrower is required to follow the established market practices for procurement and shall demonstrate that the quality goods and services are being purchased at reasonable and competitive prices. Wherever the loan is sanctioned against international lines of credit such as the World Bank, Asian Development Bank, kfW, etc., the relevant procedures will have to be followed and requisite documents will have to be submitted by the borrower

Small Industries Development Bank of India (SIDBI) has several schemes and focused lines of credit for providing financial assistance for energy efficiency and cleaner production projects for SMEs. Highlights of some of the major financial assistance schemes/projects managed by SIDBI are given in table 6.4.

Table 6.4: Major EE financing schemes/initiatives of SIDBI

End to End Energy Efficiency (4E) Program	<p>Support for technical /advisory services such as:</p> <ul style="list-style-type: none"> • Detailed Energy Audit • Support for implementation • Measurement & Verification <p>Financing terms:</p> <ul style="list-style-type: none"> • Terms loans upto 90% • Interest rate upto 3% below normal lending rate.
TIFAC-SIDBI Revolving Fund for Technology Innovation (Srijan Scheme)	<p>To support SMEs for up-scaling and commercialization of innovative technology based project at flexible terms and interest rate.</p> <p>Preference accorded to sustainable technologies / products. Soft term loan with an interest of not more than 5%.</p>
Partial Risk Sharing Facility for Energy Efficiency (PRSF) Project (supported by World Bank)	<p>Sectors covered:</p> <ul style="list-style-type: none"> • Large industries (excluding thermal power plants) • SMEs • Municipalities (including street lighting) • Buildings <p>Coverage:</p> <ul style="list-style-type: none"> • The minimum loan amount Rs 10 lakh and maximum loan amount of Rs 15 crore per project. • The extent of guarantee is 75% of the loan amount
JICA-SIDBI Financing Scheme	<ul style="list-style-type: none"> • The loan is used to provide SMEs with funds necessary to invest in energy-saving equipment (and some medical equipment) in the form of two-step loans through SIDBI or three-step loans through intermediary financial institutions.

	<ul style="list-style-type: none"> • Project uses an Energy Saving Equipment List approach • Equipment/machinery with energy saving potential less than 10% is not eligible. • Interest rate: As per credit rating and 1% below the normal lending rate • Separate technical assistance component which is used for wetting of loan applications, holding seminars to raise awareness of energy saving among SMEs and to improve the ability of financial institutions to screen loan applications for energy-saving efforts
KfW-SIDBI Financing Scheme	<p>Coverage</p> <ul style="list-style-type: none"> a) SMEs for energy efficiency projects b) SMEs and clusters for cleaner production and emission reduction measures, waste management and Common Effluent Treatment Plant (CETP) facilities <p>Interest rate</p> <p>As per credit rating and 1% below the normal lending rate</p> <p>Eligible criteria</p> <p>3 t CO₂ emission reduction per year per lakh invested</p> <p>List of eligible equipment/technology and potential suppliers developed for guidance</p>

State Bank of India (SBI) has been provided a green line of credit by Japan Bank for International Cooperation (JBIC) for financing of energy efficiency investments. Highlights of the line of credit are given in table 6.5.

Table 6.5: JBIC-SBI Green Line

<p><u>Key Features</u></p> <ul style="list-style-type: none"> • Amount : USD 90 million • Repayment Schedule: First repayment on May 30, 2017 and final repayment date May 30, 2025 (equal instalment) <p><u>Eligibility Criteria</u></p> <ul style="list-style-type: none"> • Projects contributing to preservation of global environment, i.e. significant reduction of GHG emissions • Acceptance of JBIC-MRV (“J-MRV”) by the project proponent in terms of the numerical effect of the environment preservation. To ensure effective GHG reduction emissions in Green financed projects, JBIC reviews such effects through simple and practical Measurement Reporting Verification (MRV) process both in (a) prior estimation and (b) ex-post monitoring. • Procurement in line with the “Guidelines for Procurement under Untied Loans by Japan Bank for International Cooperation”
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Canara bank has a dedicated scheme for financing EE investment among SME sector as mentioned in table 6.6.

Table 6.6: Canara bank scheme of EE SME loans

Purpose	For acquiring/adopting energy conservation/savings equipment/measures by SMEs
Eligibility	Units under Small and Medium Enterprises Cost of energy for the unit should constitute not less than 20% of the total cost of production Unit should possess energy audit report issued by an approved energy Consultant/Auditor. Borrowal a/cs-ASCC code S1 or S2 during previous review. Current account holders having dealings exclusively with us satisfactorily for a period of last one year
Maximum loan	Maximum Rs 100 lakhs in the form of term loan
Security	Prime: Assets created out of loan Collateral: Upto Rs.5 lakhs – NIL Above Rs.5 lakhs, as determined by the bank
Repayment	Maximum 5-7 years including moratorium of 6 months
Guarantee cover	Cover available under CGMSE of CGTMSE available for eligible loans
Margin	10% of the project cost
Rate of interest	1% less than the applicable rate
Upfront fee	1% of the loan
Insurance cover	Assets acquired and charged as security to Bank to be insured
Special offer, if any	Grants : Bank provides 25% of the cost of Energy Audit / Consultancy charges with a maximum of Rs 25000/- to the first 100 units on a first come first served basis which is in addition to the grant of Rs 25000/- being provided by IREDA(First 100 units)

Among the private sector banks in India, Yes Bank is also active in financing of renewable energy and energy efficiency projects. The bank has an MOU with SIDBI for providing funding for EE through PRSF.

Most commercial banks charge interest rate between from 11% to 13% from MSMEs depending upon general criteria such as credit ratings, references, past lending record, balance sheet for last 3 years and so on. Interest rebate is offered for a few customers whose collateral value is around 125% of the loan amount. Further 0.5% concession in interest rate was offered to women entrepreneurs.

Annexures

Annexure 1: Budgetary offers / quotations

Quotation 1: Enerex Solutions

(Quotation mentions NG but cost of LDO fired furnace is same. As per supplier)



Enerex Solutions

Enerex Solutions Private Limited
401, AMBIT, 1, Krishna Park Society,
Pushkar Dham Road,
Rajkot – 360005. Gujarat (INDIA)
Email: enerexsolutions@gmail.com
www.enerex.in

Ref. No.: ESPL/MS/QT/18 -19/10

Date: 08/06/2018

Your Ref. No.– Telephonic

To,
TERI,
Delhi.

Kind Attention: - Mr. Vivek Sharma

Sub: - Supply of Shell Baking Furnace with Recuperator

Dear Sir,

Greeting from Enerex Solutions Private Ltd.!

Kindly find the quotation as per your requirement.

Sr. No.	Description	Rate MRP	or Qty	Total (Rupees)
1	MS Structure Design, Manufacture, Supply, Testing, Installation and Commissioning, and Performance Demonstration of Shell Baking Furnace of inside size 1800mm × 1800mm × 1000mm (lbh) with complete Brick Lining and Glass Wool Lining with chimney of diameter 300mm and length 6M as per standard specification. Wesman Gas Burner Gas Burner with Gas Line Accessories and Air Line Accessories with Temperature controller for switching Burner and Blower ON/OFF as per standard specification. Recuperator Design, Manufacture, Supply, Testing, Installation and Commissioning Support, and Performance Demonstration of Recuperator as per requirement identified at shell baking furnace.	12,75,000.00	1 No.	12,75,000.00

Trust that, the above is in line with your requirements and for any further clarification or support, you are gratefully welcome to make a call to our Mr. V. B. Doshi (Cell No. 98980 07457) and Mr. C. J. Chothani (Cell No. 94291 69498).

Thanking you and assuring you of our best attention and services at all times.

Yours truly,

--s/d--

K. R. Siddhapura

Director,

Enerex Solutions Private Limited,

Rajkot.

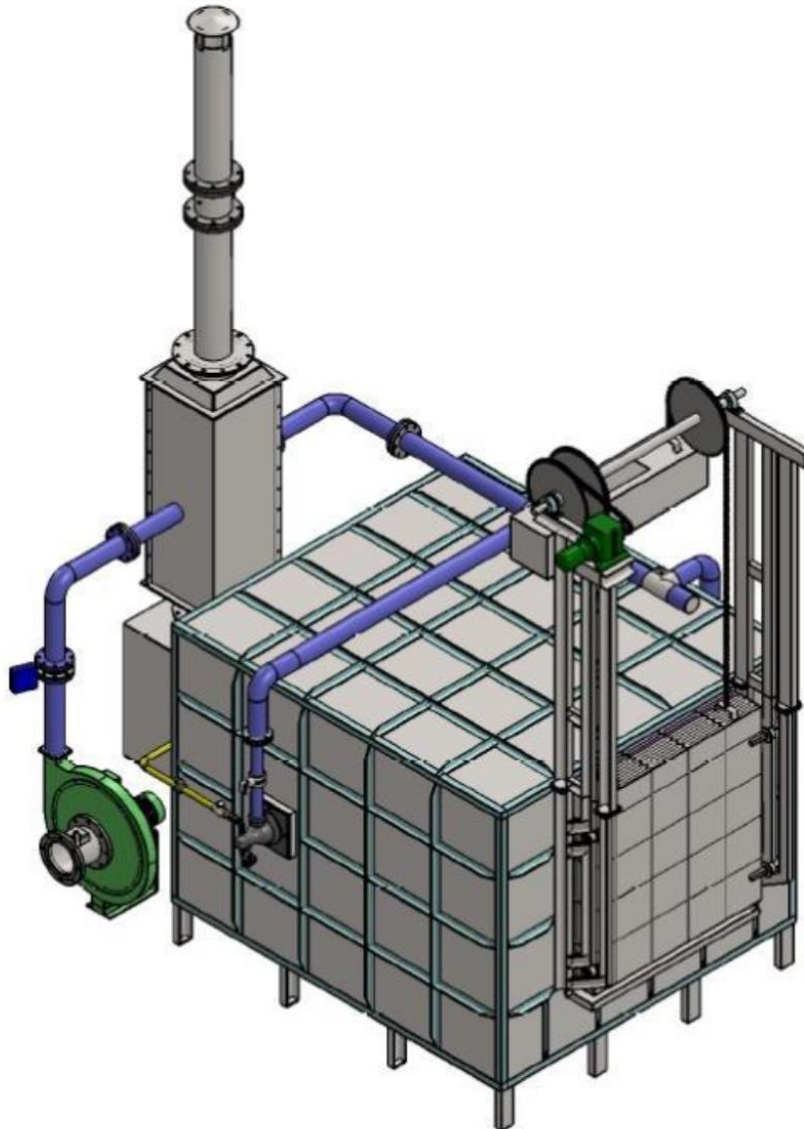
Terms and Conditions:

1	FOR	Nagpur
2	GST	As applicable
3	P & F	Our quoted EX WORKS price is exclusive of Forwarding charges. The packing and loading will be free of charge.
4	Gas Piping	Gas piping up to furnace end with 1000mmWC pressure line. Primary PRV and valve in your scope.
5	Unloading	It is excluded from our scope of supply. The same has to be arranged by you.
6	Erection	Electrification, cabling, lighting, piping, etc., required for any equipment at the site will be done by you. Our scope for erection and commissioning involves attaching all assemblies (if any), starting of the equipment and giving one trial run of the equipment (if required raw materials are available on site). For this 2000/- per person per day will be charged extra. All lodging, boarding and travel expenses for our commissioning team will be to your account.
7	Civil Work	In your Scope like foundation, tank etc.
8	Supervision and Erection	We shall provide service of Commissioning / Erection Engineer if required for one man day.
9	Payment Terms	60% Advance and 40% Against Performa
10	Validity	30 Days
11	Delivery	Within 5 – 6 weeks
12	Warranty	1 Year
13	GSTIN	24AAECE9892P1ZR

Annexure: I (Bill of Material for item No. 1)

Sr. No.	Description	Quantity
1	Fabricated Structure for furnace	1 Lot
2	Motorised door lifting mechanism	1 No.
3	Recuperator	1 No.
4	Refractory and clay (AL-70, IS 8, HFK)	1 Lot
5	Refractory ceramic fibre with anchors	1 Lot
6	High grade burners	2 Nos.
7	Ball valve	2 Nos.
8	Air/Gas ratio regulator	2 Nos.
9	Pressure gauge	6 Nos.
10	Auto reset gas solenoid valve	2 Nos.
11	Limiting Orifice	2 Nos.
12	Burner sequence and temperature controller	2 Nos.
13	Auto ignition system	2 Nos.
14	Control panel	1 No.
15	Thermocouple	2 Nos.
16	Air blower including motor	1 No.
17	Motorised butterfly valve with linkage mechanism	1 No.
18	Butterfly valve	2 Nos.
19	Chimney (6M)	1 No.
20	Heat insulating paint	1 Lot

Annexure: II (Layout of Shell Backing Furnace)



Annexure 2: Instruments used

Instruments	Model/ Make	Application	Accuracy
Flue gas analyser	Testo: 330-2LL	Flue gas O ₂ , CO, CO ₂ & Temperature	±0.1vol%, 1ppm, 1ppm, 0.1°C
Thermal imager	875-2/Testo	Surface Temperature & Image	± 2%
Digital Temperature indicator	Comark: N1001, Testo: 925	Temperature	± 1%
Infrared thermometer	Testo: 845, Comark: KM848	Surface Temperature	±0.75% of mv
Anemometer	Testo: 425, Airflow: TA45	Air Velocity	±(0.03 m/s +5% of mv)