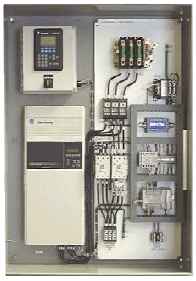
DETAILED PROJECT REPORT
ON
BRIQUETTE FIRED HOT AIR GENERATOR
(MORBI CERAMIC CLUSTER)









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BRIQUETTE FIRED HOT AIR GENERATOR

MORBI CERAMIC CLUSTER

BEE, 2010
Detailed Project Report on Briquette Fired Hot Air Generator
Ceramic SME Cluster, Morbi, Gujarat (India)
New Delhi: Bureau of Energy Efficiency;
Detail Project Report No.: **MRV/CRM/HAG/05**

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Acknowledgement

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

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

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List of Abbreviation

BEE	Bureau of Energy Efficiency
EE	Energy Efficient
SME	Small and Medium Enterprises
DPR	Detailed Project Report
GHG	Green House Gases
CDM	Clean Development Mechanism
DSCR	Debt Service Coverage Ratio
NPV	Net Present Value
IRR	Internal Rate of Return
ROI	Return on Investment
SCM	Standard Cubic Meter
MWh	Mega Watt hour
SIDBI	Small Industrial Development Bank of India
HAG	Hot Air Generator

EXECUTIVE SUMMARY

SEE-Tech Solution Pvt. Ltd. is executing BEE-SME program in Morbi Ceramic Cluster, supported by Bureau of Energy Efficiency (BEE) with an overall objective of improving the energy efficiency in cluster units.

Morbi cluster is one of the largest ceramic 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 ceramic clusters in India. The main energy forms used in the cluster units are grid electricity, Natural gas, charcoal, lignite and small quantity of diesel oil.

In spray dryer, moisture is removed from the material by flue gas which is generated by the combustion of Natural gas. After tiles formation in press, tiles are then sent in dryer for removal of the remaining moisture where Natural gas is used as a fuel. After drying, tiles are then sent for final firing in a kiln where the tiles are fired upto a temperature of about 1200 ^{o}C. This temperature is maintained in the kiln by firing of Natural gas. Use of preheated air in spray dryer and dryer results in reduction in Natural gas consumption just like the case of kiln. Hot air upto a temperature of 300 ^{o}C is generated by briquette fire hot air generator.

Total investment required and financial indicators calculated such as debt equity ratio, monetary saving, IRR, NPV, DSCR and ROI etc for proposed technology is furnished in Table below:

S.No	*Particular*	*Unit*	*Value*
1	Project cost	₹(in lakh)	53.01
2	Natural gas saving	SCM/year	671700
3	Briquette consumption	Kg/year	1847400
3	Monetary benefit	₹(in lakh)	36.10
4	Debit equity ratio	ratio	3:1
5	Simple payback period	years	1.47
6	NPV	₹(in lakh)	46.08
7	IRR	%age	57.79
8	ROI	%age	32.64
9	DSCR	ratio	3.28
10	Process down time	days	5

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

ABOUT BEE'S SME PROGRAM

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

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

Energy use and technology audit

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

Capacity building of stake holders in cluster on energy efficiency

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

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.

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

Morbi SME Cluster is one of the largest ceramic clusters in India and mainly famous for manufacturing of ceramic tiles. Over 70% of total ceramic tiles product comes from Morbi cluster. This cluster is spread over a stretch of about 10km on the Morbi–Dhuva Highway.

There are approximately 479 ceramic units in this cluster which are engaged in manufacturing of wall tiles, vitrified tiles, floor tiles, sanitary wares, roofing tiles and others product. There are around 50 more ceramic units coming up in Morbi cluster.

Primary raw materials required for manufacturing of tiles are various types of clay, quartz, calcite/wool astonite, frits & Glazes. Most of the raw materials are easily available in Gujarat and in the neighboring state of Rajasthan. Some of the units use raw material produced at another plant. The main reason for growth of ceramic cluster in Morbi is easy availability of raw material viz; clay suitable for ceramic tiles.

The main form of energy used by the cluster units are grid electricity, Natural gas, charcoal, lignite, and diesel oil. Major consumptions of energy are in the form of Natural gas and lignite. Details of total energy consumption at Morbi ceramic cluster are furnished in Table 1.1 below:

Table 1.1 Details of annual energy consumption

S. No	*Type of Fuel*	*Unit*	*Value*	*% contribution*
1	Electricity	GWh/year	1,200	8.23
2	Natural gas	SCM/year	660,000,000	46.32
3	Charcoal	tonne/year	165,000	8.55
4	Lignite	tonne/year	1,320,000	36.84
5	Diesel	litre/year	800,000	0.06

Classification of Units

The ceramic units can be broadly categorized into four types based on product manufactured

- Floor tiles unit
- Sanitary ware unit
- Vitrified tiles unit
- Wall tiles unit

Further the ceramic cluster is classified into three type based on capacity of unit viz small scale, medium scale and large scale unit.

Products Manufactured

There are many types of ceramic product manufactured from four different types of units. Details of product manufactured and number of units engaged in manufacturing of such products are given in Table 1.2 below:

Table 1.2 Details of types of product manufactured

S. No	Type of Product	No. of unit	%age share
1	Wall Tiles	178	37
2	Vitrified Tiles	36	8
3	Floor Tiles	52	11
4	Sanitary Wares	43	9
5	Spray dryer Mud manufacturing	40	8
6	Roofing Tiles (seasonal operation)	120	25
7	Third firing manufacturing (Producing pictures on tiles)	10	2
8	Total	479	

Capacity wise production

Capacity wise production breakup is furnished in Table 1.3 below:

Table 1.3 Production wise unit breakups

Type of product	No. of Units.				Production (m^2/day or MT[a]/day)			
Scale of Unit	Small	Medium	Large	Total	Small	Medium	Large	Total
Wall Tiles	43	100	35	178	2,500	3,500	7,500	13,500
Floor Tiles	8	38	6	52	3,000	4,000	7,000	14,000
Vitrified Tiles	NA	22	4	26[b]	NA	5,760	11,520	17,280
Sanitary Wares	10	24	9	43	4	8	14	26

[a]- In case of sanitary wares, production is measured in MT.
[b]- During audit no SSI vitrified tiles units were covered, therefore production data are not available for these units.

Energy usages pattern

Average monthly electricity consumption in ceramic unit ranges from 1 lakh to 2 lakh kWh depending on the size of the unit. In thermal energy, solid fuel such as lignite, charcoal, Indonesian coal, briquette, etc are used in spray dryer and Natural gas is used in kiln in all almost all units. Solid fuel consumption in spray dryer ranges from 80 to 160 kg per MT and Natural gas consumption in kiln varies from 1.01 to 1.4 SCM per m^2 of tiles produced.

General production process for ceramic cluster

The units of Morbi ceramic cluster are involved in the manufacturing of 4 different types of products such as floor tiles, wall tiles, vitrified tiles and sanitary wares. Production process for manufacture of wall, floor and vitrified tiles is nearly the same except some differences in process parameters while the manufacturing process of sanitary wares inter alia involves manual moulding whereas in case of tiles, press is used to form the biscuits. General production processes for manufacturing of ceramic products is are following:

Wet Grinding

The raw material such as clay, feldspar, quartz, calcite etc. are mixed with water in a proper proportion and grind in a ball mill to make homogeneous mixture. Ball Mill is a batch type of process. After completion of one batch of ball mill, slurry is sent to the underground tanks containing the agitator motor in each tank to maintain the uniformity of mixture. Mainly blungers are used for mixing and grinding in case of wall and floor tiles, while ball mills are used for grinding in case of vitrified tiles.

Spray Drying

After preparation of slurry of required density it is stored in the underground tanks in which it is agitated to maintain uniformity of slurry. The slurry is then pumped through a hydraulic pump into the spray dryer where it is sprayed through nozzles. The material is dried in spray dryer to remove the moisture added during the grinding process in a ball mill. The moisture in the raw material is brought down to about 5–6 % from 35-40%. The product from spray dryer is stored in silos. Hot flue gases at a temperature of about 550 – 600 °C is used as the heating source which is generated by combustion of lignite, Indonesian coal, saw dust, briquette, Natural gas etc.

Pressing/Moulding

The product from spray dryer is then sent to the press section which is pneumatically operated where the required sizes of biscuit tiles are formed. In case of sanitary ware manual moulding is carried out by hand held hose.

Drying

After pressing/moulding products containing about 5–6% moisture is dried to about 2–3% moisture in a dryer. In some units, hot air from kiln cooling zone exhaust is used in dryers and additional fuel firing is provided if required whereas in case of wall and floor tiles, fuel firing is done continuously.

Glazing

After drying, biscuit tiles are send for glazing on a glaze line. Glaze is prepared in ball mills. Glazing is required for designing on tiles. In case of sanitary ware the dried wares are glazed in several spray glazing booths, where compressed air is used.

Firing and Baking

After glazing product are then sent for final firing in kiln where temperature of 1100-1150 ^{o}C is maintained in the kiln. Natural gas is used for combustion in kiln. In some units hot air from gasifier is utilized for combustion.

Sizing

Tiles coming out of kiln are sent for sizing and calibration in case of wall and floor tiles. The tiles are cut in proper sizes so that all tiles have similar dimensions. After sizing the finished product is ready for dispatch.

Polishing

Polishing is required for vitrified tiles. It utilizes 40-45% of total electricity consumption of plant. After kiln the vitrified tiles are passed through polishing line. Polishing line consist of sizing, calibration and polishing machines.

General production process flow diagram for manufacturing of ceramic product is shown in Figure 1.1.

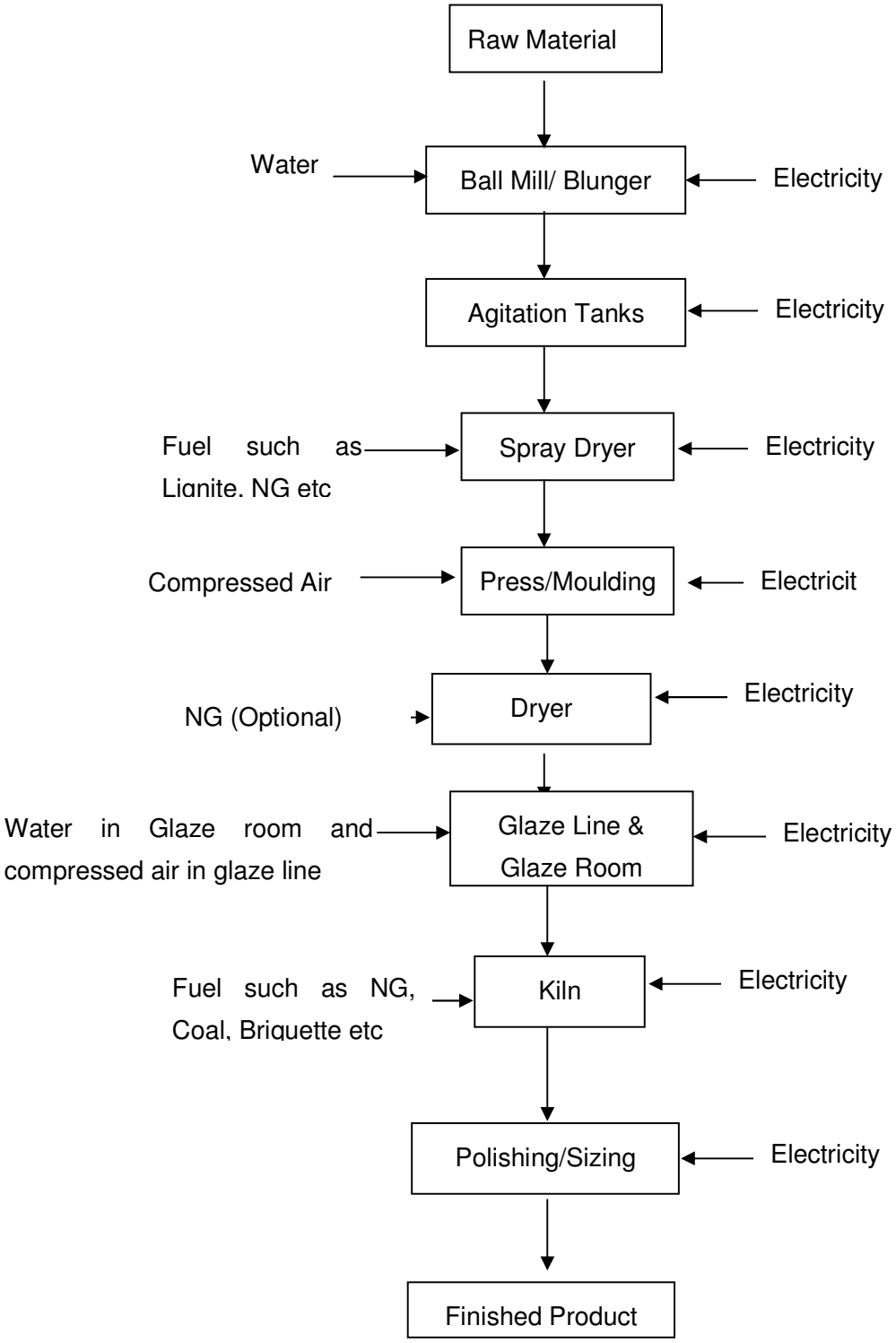

Figure 1.1Process flow diagram

1.2 Energy performance in existing system

1.2.1 Fuel consumption

Average fuel and electricity consumption in a typical ceramic unit is given in Table 1.4 below:

Table 1.4 Average fuel and electricity consumption

Energy	*Electricity (MWh per year)*			*Natural gas (SCM per year)*			*Solid Fuel [lignite] (Tonne per year)*		
Scale of Unit	*Small*	*Medium*	*Large*	*Small*	*Medium*	*Large*	*Small*	*Medium*	*Large*
Wall Tiles	900	1500	2400	750,000	1,050,000	2,250,000	2,400	2,880	3,600
Floor Tiles	900	1500	2400	900,000	1,200,000	2,100,000	3,600	4,200	4,800
Vitrified Tiles	NA	6000	12000	NA	2,700,000	6,000,000	NA	6,000	9,000
Sanitary Wares	2400	450	900	120,000	240,000	420,000	NA	NA	NA

1.2.2 Average annual production

Annual production in terms of m^2/year is taken in case of tiles and in terms of MT/year in case of sanitary wares is given in the following Table 1.5 below:

Table 1.5 Average annual production

S. No.	*Type of Industry*	*Production (m^2/year) or MT/year*		
		Small scale	*Medium scale*	*Large scale*
1	Vitrified Tiles	750,000	1,050,000	2,250,000
2	Wall Tiles	900,000	1,200,000	2,100,000
3	Floor Tiles	NA	1,728,000	3,456,000
4	Sanitary Wares	1200	2400	4200

1.2.3 Specific energy consumption

Specific energy consumption both electrical and thermal energy per m^2 or MT of production for different type of ceramic products are furnished in Table 1.6 below:

Table 1.6 Specific energy consumption

S. No.	*Type of Industry*	*kWh/m² or kWh/piece[c]*	*SCM/m² or SCM/ piece[c]*
1	Vitrified Tiles	3.71 - 5.01	1.51 - 3.11
2	Wall Tiles	0.61 - 2.47	0.68 - 1.65
3	Floor Tiles	1.51 - 1.92	1.28 - 1.8
4	Sanitary Wares	0.78 - 1.73	1.10 - 1.49

Equipment wise specific energy consumption

The specific energy consumption of the equipments used in the ceramic industry is given in Table 1.7 below wherever possible.

Table 1.7 Equipment wise specific energy consumption

S.No	Equipment	Electrical energy		Thermal energy	
		Unit	Vale	Unit	value
1	Ball Mill/Blunger	kWh/MT	4 -12		-
2	Agitation process	kWh/m³/hr	0.2 - 0.8		-
3	Spray Dryer	-	-	kg/MT	80 - 160
4	Press	kWh/m²	0.22- 0.4		-
5	Dryer	kWh/m²	0.011	SCM/m²	0 - 0.63
6	Glaze line + Glaze ball mill	kWh/MT	2 - 9		-
7	Kiln	kWh/m²	0.36 - 1.26	SCM/m²	1.01 -1.4
8	Polishing line/sizing	kWh/m²	1.74 - 2.35		-

[c] *In sanitary ware production is measured in term of pieces only.*

1.3 Existing technology/equipment

1.3.1 Description of existing technology

In ceramic industry, spray dryer, dryer and kiln are the thermal fuel consumption equipments. In spray dryer, moisture is removed from the material by flue gas which is generated by the combustion of Natural gas. After tiles formation in press, tiles are then sent in dryer for removal of the remaining moisture where also Natural gas is used as a fuel. After drying, tiles are then sent for final firing in a kiln where the tiles are fired upto a temperature of about 1200 oC. This temperature is maintained in the kiln by firing of Natural gas. In kiln in few places, hot air from the final cooling zone of kiln is used as a combustion air. Ceramic unit owners have seen the savings achieved by this project. But in case of spray dryer and dryer, combustion air at room temperature is utilized. Use of preheated air in spray dryer and dryer also results in reduction in Natural gas consumption just like the case of kiln.

1.3.2 Role in process

Spray dryer is used for removal of moisture content of about 33 % from the grinded material upto 5 % moisture content in final product. Dryer is used to remove the moisture content level of upto 2 to 3 % and the kiln is used for final baking of the tiles.

1.4 Baseline establishment for existing technology

1.4.1 Design and operating parameters

Natural gas consumption in the thermal energy consuming equipments is given in Table 1.8 below:

Table 1.8 Natural gas consumption in different drying equipment

S. No.	*Equipment*	*Unit*	*Value*
1	Spray dryer	SCM/year	76,02,808
2	Dryer	SCM/year	6,84,253
3	Kiln	SCM/year	107,19,958

1.4.2 Operating efficiency and how it is determined

Energy consumption taken as baseline for the saving calculation is given in Annexure 1.

1.4.3 Specific electricity consumption

Specific electrical energy consumption in different drying equipment is given in Table 1.9 below:

Table 1.9 Specific energy consumption in different drying equipment

S. No.	Section	Unit	Value
1	Spray dryer	SCM/MT	40
2	Dryer	SCM/m^2	0.17
3	Kiln	SCM/m^2	2.62

1.5 Barriers in adoption of proposed technology

1.5.1 Technological barrier

In Morbi cluster, overall technical understanding on ceramic manufacturing is good and rapidly increasing. Important equipments like kiln, polishing machine etc are bought from Italy (Sacmi) and China (Modena), which are leading suppliers of these equipments worldwide. Many of the unit owners are frequently visiting international ceramic fairs and ceramic process equipment suppliers, thus keeping them informed. It has been observed that at cluster level there is committed interested for leadership and following up is quick. In general, there is readiness to adopt provided delivery, outcome and results are demonstrated.

However the first change is still a challenge, upon success, later on duplication and adaptation is extremely prevalent in the cluster. The technologies need to be demonstrated within the cluster. 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

Availing finance is not the major issue. Among the SMEs, the larger units, if convinced 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.

1.5.3 Skilled manpower

In Morbi ceramic cluster, the availability of skilled manpower is one of the problems due to more number of units. One local technical persons available at Morbi takes care of about 5-10 ceramic units. Maintenance or repair work of major equipments of ceramic units like kiln, polishing machine etc, are generally taken care by the equipment suppliers itself as they station one of their experienced technical representative at Morbi for the maintenance work.

Specialized and focused training of the local service providers on better operation and maintenance of the equipments, importance of the energy and its use and energy conservation measures will improve awareness among the unit owners and workforce. Original equipment suppliers should also participate in these programs.

1.5.4 Other barrier (If any)

Many of the new technology provider's (especially some foreign technology leaders) have not shown keen interest in implementation of their new innovative technologies. This appears to be because of fear of duplication.

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2. PROPOSED EQUIPMENT FOR ENERGY EFFICENCY IMPROVEMENT

2.1 Description of proposed equipment

2.1.1 Detailed of proposed equipment

Briquette fired hot air generator generate hot air upto a temperature of about 300 ^{o}C which is used as a combustion air in spray dryer and dryer equipment. Presently combustion air is used at atmospheric temperature.

If proper awareness is created on this concept the unit owners may find it interesting for implementation

2.1.2 Equipment/technology specification

Briquette fired hot air generator of capacity 10 Lakh kCal will be required for implementation of this project. Other specification details are given in the quotation in Annexure – 8.

2.1.3 Integration with existing equipment

For implementation of this project, a briquette fired hot air generator need to be installed. Hot air is then supplied through the pipeline with proper insulation to the required equipment. This will reduce the fuel consumption of that equipment.

This technology has been selected because of the following reasons

- Easily implemented without any major changes in the existing equipment
- It reduces the plant energy cost
- It reduces the GHG emissions
- It is a clean technology

2.1.4 Superiority over existing system

Implementation of this technology will results in saving in thermal energy cost which is the major energy cost in ceramic industry. Also the use of this technology will reduces the GHG emissions.

2.1.5 Source of equipment

The technology of using hot air as a combustion air which is generated by the briquette fired hot air generator is already in use in most of the industries in India.

2.1.6 Availability of technology/equipment

This technology is easily available in market. From last few years, the use of this technology increases tremendously.

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

Performance warranty of one year will be provided from the supply of the equipment.

2.1.9 Process down time

Process down time required will be of about 5 days. Details of process down time are shown in Annexure 6.

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 as follows:

- High capital investment requirement
- Availability of space requirement for implementation of the proposed project
- Availability of skilled operator for the proposed equipment

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 21,600 m^2 per day and having total Natural gas consumption is about 19,007,019 SCM per year.

3. ECONOMIC BENEFITS FROM PROPOSED TECHNOLOGY

3.1 Technical benefit

3.1.1 Fuel saving

Implementation of this project results in Natural gas saving in spray dryer and dryer due to preheating of combustion air upto a temperature of around 300 ^{O}C. But at the same time briquette consumption increases because it is used as a fuel to preheat the air in hot air generator. Hence about 671,700 SCM of Natural gas will be save per year while at the same time about 1,847,400 kg briquette will be needed in a year.

3.1.2 Electricity saving

This project is not contributing to the saving in electricity consumption. However, electricity consumption will increase due to requirement of one blower for air circulation but it is very less as compared to the saving potential by implementation of this project.

3.1.3 Improvement in product quality

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

3.1.4 Increase in production

Implementation of this project will not lead to any increase in production.

3.1.5 Reduction in raw material

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

3.1.6 Reduction in other losses

There is no other reduction losses

3.2 Monetary benefits

Project implementation will save about 671,700 SCM Natural gas with 1,847,400 kg of briquette consumption per year. Since cost of Natural gas is more than the cost of briquettes hence overall monetary benefit is ₹ 36.08 lakh per year. Detail of monetary saving is furnished in table 3.1 below:

Table 3.1 Energy and monetary benefit

S.No	Parameter	Unit	Spray dryer	Dryer
1	Present Natural gas consumption in a unit	SCM/day	18000	600
2	Natural gas saving after project implementation	SCM/day	2096	143
3	Briquette consumption	kg/day	5765	393
4	Total operating hours	hr/days	24	24
5	Total working days	days	300	300
6	Cost of Natural gas	₹ /SCM	15	15
7	Cost of briquette	₹ /kg	3.5	3.5
8	Total monetary benefit	₹ /day	11260	769
9	Total monetary benefit	₹ in lakh/year	36.08	

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

3.3 Social benefits

3.3.1 Improvement in working environment

No improvement on the working environment in the plant.

3.3.2 Improvement in workers skill

Technical skills of persons will definitely be improved. As the training will be provided by equipment suppliers which improve the technical skills of manpower required for operating of the equipment and also the technology implementation will create awareness among the workforce about energy efficiency and energy saving.

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

Implementation of this project will result in saving of Natural gas consumption. As the briquette is the renewable fuel, this will leads to 1370 tCO_2/year emission reduction. Similar to this, there are about 400 ceramic units at Morbi. Implementation of this project in all the ceramic units will

reduce the significant amount of CO_2 emissions. Availing carbon credit benefits against implementation of this project will generate extra revenue from this.

3.4.3 Reduction in other emissions like SO_X

Significant amount of SO_X will emit due to use briquette as a fuel.

4 INSTALLATION OF PROPOSED EQUIPMENT

4.1 Cost of project

4.1.1 Equipment cost

Total cost of new energy efficient motors will be about ₹ 35.50 lakh.

4.1.2 Erection, commissioning and other misc. cost

Other cost includes cost of commissioning, implementation during implementation and man power cost. Details of total project cost requires for implementation of proposed technology are furnished in Table 4.1 below:

Table 4.1 Details of proposed technology project cost

S.No	*Particular*	*Unit*	*Value*
1	Cost of Equipment	₹ (in lakh)	35.50
2	Professional Charges	₹ (in lakh)	5.00
3	Erection & Commissioning cost	₹ (in lakh)	5.33
4	Interest during implementation	₹ (in lakh)	1.15
5	Taxes(CST)	₹ (in lakh)	0.71
6	Other misc. cost	₹ (in lakh)	5.33
7	Total cost	₹ (in lakh)	53.01

4.2 Arrangements of funds

4.2.1 Entrepreneur's contribution

The total cost of the proposed technology is estimated at ₹ 53.01 lakh. The entrepreneur's contribution is 25% of total project cost, which is ₹ 13.25 lakh.

4.2.2 Loan amount.

The term loan is 75% of the total project cost, which is ₹ 39.75 lakh.

4.2.3 Subsidy by Government

As the overall energy efficiency in the project is more than 15% it qualifies for subsidy of 25 % of the project cost as per the NMCP scheme of Ministry of MSME, GoI. 25 % of the project cost in this case works out to ₹ 13.25 lakh. As the subsidy is normally available after implementation of the project the same has not been taken in the project cost and means of finance. On receipt of subsidy from Ministry of MSME, GoI through the nodal agency the amount of subsidy is generally set off [reduced] from the loan outstanding by the lender bank. Availability of this subsidy will make the project economically more attractive.

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. 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 6 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 of ₹ 36.10 lakh per year.

- The Operation and Maintenance cost is estimated at 5% of cost of total project with 3% 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, net cash accruals starting with ₹ 26.86 lakh in the first year operation and gradually increases to ₹ 97.01 lakh at the end of sixth year.

4.3.2 Simple payback period

The total project cost of the proposed technology is ₹ 53.01 lakh and monetary savings is ₹ 36.10 lakh hence the simple payback period works out to be 1.47 years.

4.3.3 Net Present Value (NPV)

The Net present value of the investment at 10% works out to be ₹ 57.79 lakh.

4.3.4 Internal rate of return (IRR)

The after tax internal rate of return of the project works out to be 46.08%. 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 32.64%.

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	Month	18
2	IRR	%age	46.08
3	NPV	lakh	57.79
4	ROI	%age	32.64
5	DSCR	Ratio	3.28

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	DSCR	IRR	ROI	NPV
Normal	3.28	46.08%	32.64%	57.79
5% increase in fuel savings	3.45	49.41%	32.90%	63.54
5% decrease in fuel savings	3.10	42.72%	32.34%	52.05

4.5 Procurement and implementation schedule

Total procurement period for implementation of this technology requires 8 month and process down requires 5 days and their breakups are shown in Annexure 6.

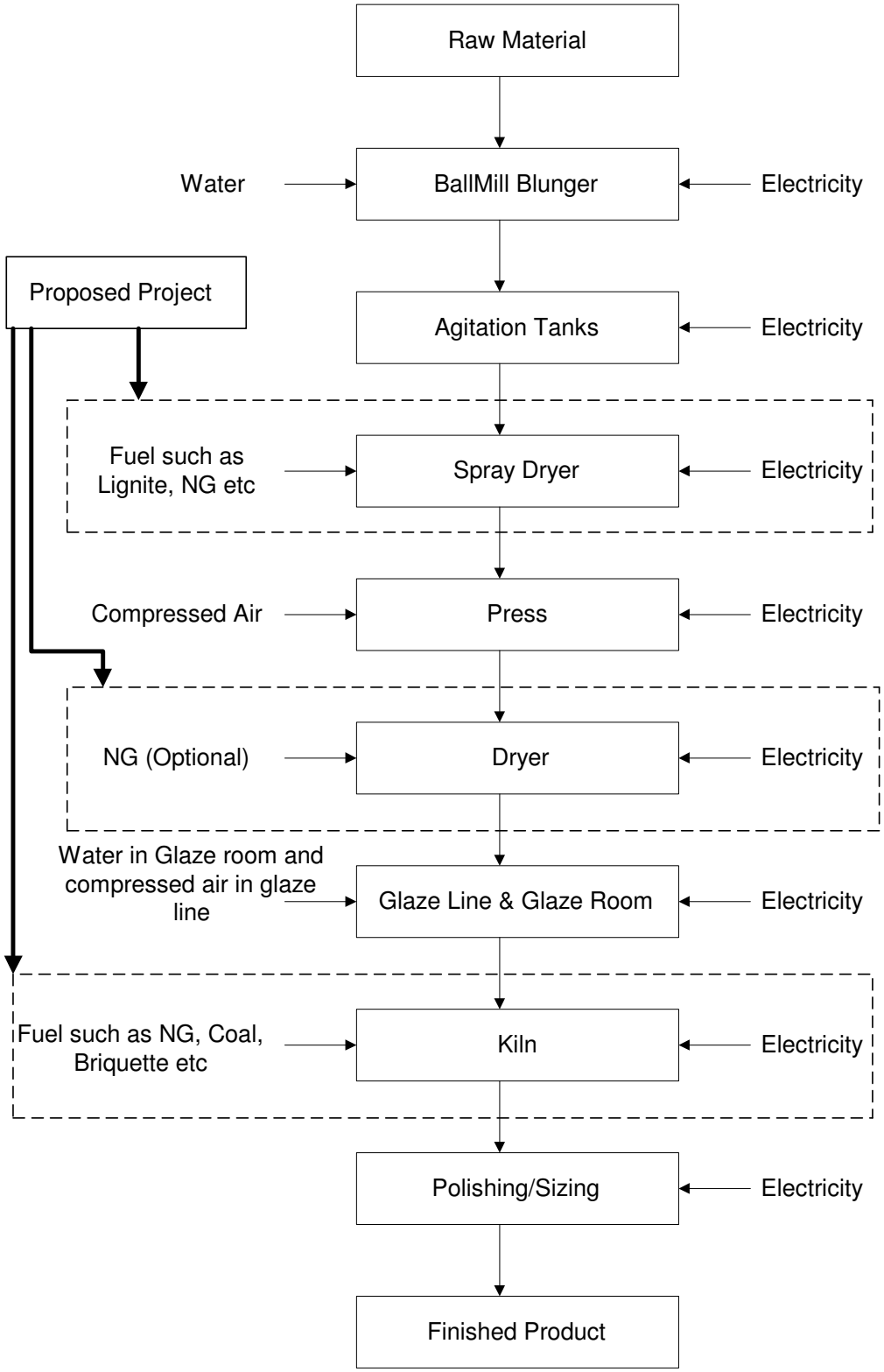
Annexure

Annexure -1: Energy audit data used for baseline establishment

Specific fuel consumption and cost for production for spray dryer and dryer equipments in ceramic industries is given below:

S.No	*Particular*	*Unit*	*Spray Dryer*	*Dryer*
1	Present fuel consumption	SCM/day	18,000	600
2	Production	MT/day m^2/day	450	3,600
3	Specific Fuel Consumption	SCM/MT SCM/m^2	40	0.17
4	Cost of Natural Gas	₹/SCM	15	15
5	Cost of fuel consumption	₹/day	2,70,000	9,000
6	Cost of fuel required per production	₹/ MT ₹/ m^2	600	2.5

Annexure -2: Process flow diagram after project implementation



Annexure -3: Detailed technology assessment report

S. No.	Particular	Unit	Spray Dryer	Dryer
1	Natural gas Consumption	SCM/day	18000	600
2	Present combustion air temperature	°C	40	40
3	Proposed combustion air temperature	°C	300	300
4	Efficiency of hot air generator	%age	80	80
5	Calorific value of fuel	kCal/kg	4000	4000
6	Briquette consumption for preheating of combustion air	kg/day	5765	393
7	Heat available in combustion air after preheating	kCal/hr	768768	52416
8	Equivalent Natural gas saving	SCM/day	2096	143
9	Equivalent cost of Natural gas saving	₹/day	31440	2145
10	Cost of briquette consumption	₹/day	20180	1375
11	Saving due to preheating of combustion air	₹/day	11260	769
12	Total Saving	₹/day	12029	
13	Working days in a year	days	300	
14	Total saving	₹in lakh/year	36.08	

Annexure -4 Drawings for proposed electrical & civil works

Hot air generator is readymade equipment which is available based on Lakh kCal i.e. per hour capacity. So detail engineering drawing is not available. However, requirement of accessories is mentioned in the attached quotation.

Design of the pipe and duct system at client site will be carried out to make the provision of supply of hot air from the hot air generator to the respective equipment site and the cost of this is already considered.

Specifications of Pipe and duct system

- Duct Material = MS
- Diameter of duct = 500 mm
- Insulation Material = Glass Wool
- Insulation thickness = 75 mm
- Aluminum cladding = 22 g
- Length of pipe = Decided on the basis of site and location

.

Annexure -5: Detailed financial analysis

Assumption

Name of the Technology	***HOT AIR GENERATOR***		
Rated Capacity	***100000 kCal***		
Details	***Unit***	***Value***	***Basis***
Installed Capacity	Kcal	100000	Feasibility Study
No of working days	Days	300	Feasibility Study
No of Shifts per day	Shifts	3	Feasibility Study
Capacity Utilization Factor	%		Feasibility Study
Proposed Investment			
Plant & Machinery	₹ (in lakh)	35.50	Feasibility Study
Professional charges	₹ (in lakh)	5	Feasibility Study
Erection & Commissioning	₹ (in lakh)	5.33	Feasibility Study
Investment without IDC	₹ (in lakh)	45.83	Feasibility Study
Interest During Implementation	₹ (in lakh)	1.15	Feasibility Study
Taxes(CST)	₹ (in lakh)	0.71	Feasibility Study
Other charges(Contingency)	₹ (in lakh)	5.33	Feasibility Study
Total Investment	₹ (in lakh)	53.01	Feasibility Study
Financing pattern			
Own Funds (Equity)	₹ (in lakh)	13.25	Feasibility Study
Loan Funds (Term Loan)	₹ (in lakh)	39.75	Feasibility Study
Loan Tenure	years	5	Assumed
Moratorium Period	Months	6	Assumed
Repayment Period	Months	66	Assumed
Interest Rate	%	10.00	SIDBI Lending rate
Estimation of Costs			
O & M Costs	% on Plant & Equip	5.00	Feasibility Study
Annual Escalation	%	3.00	Feasibility Study
Estimation of Revenue			
Natural Gas saving	SCM/Year	671700	
Briquette consumption	Kg/Year	1847400	
Cost of Natural gas	₹ / SCM	15	
Cost of Briquette	₹ / Kg	3.5	
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	39.75	3.00	36.75	3.59
2	36.75	7.20	29.55	3.35
3	29.55	7.80	21.75	2.63
4	21.75	8.40	13.35	1.82
5	13.35	9.00	4.35	0.94
6	4.35	4.35	0.00	0.13
		39.75		

WDV Depreciation

Particulars / years	1	2	3	4	5	6
Plant and Machinery						
Cost	46.97	9.39	1.88	0.38	0.08	0.02
Depreciation	37.58	7.52	1.50	0.30	0.06	0.01
WDV	9.39	1.88	0.38	0.08	0.02	0.00

Projected Profitability

Particulars / Years	1	2	3	4	5	6
Revenue through Savings						
Fuel savings	36.10	36.10	36.10	36.10	36.10	36.10
Total Revenue (A)	36.10	36.10	36.10	36.10	36.10	36.10
Expenses						
O & M Expenses	2.65	2.73	2.81	2.90	2.98	3.07
Total Expenses (B)	2.65	2.73	2.81	2.90	2.98	3.07
PBDIT (A)-(B)	33.45	33.37	33.28	33.20	33.11	33.02
Interest	3.59	3.35	2.63	1.82	0.94	0.13
PBDT	29.86	30.02	30.65	31.38	32.17	32.89
Depreciation	2.80	2.80	2.80	2.80	2.80	2.80
PBT	27.06	27.22	27.85	28.58	29.37	30.09
Income tax	0.00	7.65	9.91	10.56	10.91	11.18
Profit after tax (PAT)	27.06	19.57	17.95	18.01	18.46	18.92

Computation of Tax ₹ (in lakh)

Particulars / Years	1	2	3	4	5	6
Profit before tax	27.06	27.22	27.85	28.58	29.37	30.09
Add: Book depreciation	2.80	2.80	2.80	2.80	2.80	2.80
Less: WDV depreciation	37.58	7.52	1.50	0.30	0.06	0.01
Taxable profit	(7.72)	22.50	29.15	31.07	32.11	32.88
Income Tax	-	7.65	9.91	10.56	10.91	11.18

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

Particulars / Years	1	2	3	4	5	6
Liabilities						
Share Capital (D)	13.25	13.25	13.25	13.25	13.25	13.25
Reserves & Surplus (E)	27.06	46.63	64.58	82.59	101.05	119.97
Term Loans (F)	36.75	29.55	21.75	13.35	4.35	0.00
Total Liabilities D)+(E)+(F)	77.07	89.44	99.58	109.20	118.66	133.22
Assets						
Gross Fixed Assets	53.01	53.01	53.01	53.01	53.01	53.01
Less: Accm. Depreciation	2.80	5.60	8.40	11.19	13.99	16.79
Net Fixed Assets	50.21	47.41	44.61	41.81	39.01	36.21
Cash & Bank Balance	26.86	42.03	54.97	67.39	79.64	97.01
TOTAL ASSETS	77.07	89.44	99.58	109.20	118.66	133.22
Net Worth	40.31	59.88	77.83	95.84	114.30	133.22
Dept equity ratio	0.91	0.49	0.28	0.14	0.04	0.00

Projected Cash Flow: ***₹(in lakh)***

Particulars / Years	0	1	2	3	4	5	6
Sources							
Share Capital	13.25	-	-	-	-	-	-
Term Loan	39.75	-	-	-	-	-	-
Profit After tax		27.06	19.57	17.95	18.01	18.46	18.92
Depreciation		2.80	2.80	2.80	2.80	2.80	2.80
Total Sources	53.01	29.86	22.37	20.74	20.81	21.26	21.72
Application							
Capital Expenditure	53.01						
Repayment of Loan	-	3.00	7.20	7.80	8.40	9.00	4.35
Total Application	53.01	3.00	7.20	7.80	8.40	9.00	4.35
Net Surplus	-	26.86	15.17	12.94	12.41	12.26	17.37
Add: Opening Balance	-	-	26.86	42.03	54.97	67.39	79.64
Closing Balance	-	26.86	42.03	54.97	67.39	79.64	97.01

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

Particulars / months	0	1	2	3	4	5	6
Profit after Tax		27.06	19.57	17.95	18.01	18.46	18.92
Depreciation		2.80	2.80	2.80	2.80	2.80	2.80
Interest on Term Loan		3.59	3.35	2.63	1.82	0.94	0.13
Salvage/Realizable value	-	-	-	-	-	-	-
Cash outflow	(53.01)	-	-	-	-	-	-
Net Cash flow	(53.01)	33.45	25.72	23.38	22.64	22.20	21.85
IRR	46.08%						

NPV	57.79

Break Even Point ***₹ (in lakh)***

Particulars / Years	1	2	3	4	5	6
Variable Expenses						
Oper. & Maintenance Exp (75%)	1.99	2.05	2.11	2.17	2.24	2.30
Sub Total (G)	1.99	2.05	2.11	2.17	2.24	2.30
Fixed Expenses						
Oper. & Maintenance Exp (25%)	0.66	0.68	0.70	0.72	0.75	0.77
Interest on Term Loan	3.59	3.35	2.63	1.82	0.94	0.13
Depreciation *(H)*	2.80	2.80	2.80	2.80	2.80	2.80
Sub Total (I)	7.05	6.83	6.13	5.35	4.49	3.70
Sales (J)	36.10	36.10	36.10	36.10	36.10	36.10
Contribution (K)	34.11	34.05	33.99	33.92	33.86	33.79
Break Even Point (L= G/I)	20.66%	20.06%	18.05%	15.76%	13.25%	10.95%
Cash Break Even {(I)-(H)}	12.46%	11.84%	9.81%	7.51%	4.98%	2.67%
BREAK EVEN SALES (J)*(L)	7.46	7.24	6.51	5.69	4.78	3.95

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

Particulars / Years	1	2	3	4	5	6	Total
Net Profit Before Taxes	27.06	27.22	27.85	28.58	29.37	30.09	170.18
Net Worth	40.31	59.88	77.83	95.84	114.30	133.22	521.39
							32.64%

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

Particulars / Years	1	2	3	4	5	6	Total
Cash Inflow							
Profit after Tax	27.06	19.57	17.95	18.01	18.46	18.92	119.97
Depreciation	2.80	2.80	2.80	2.80	2.80	2.80	16.79
Interest on Term Loan	3.59	3.35	2.63	1.82	0.94	0.13	12.46
TOTAL **(M)**	33.45	25.72	23.38	22.64	22.20	21.85	171.07

Debt

Interest on Term Loan	3.59	3.35	2.63	1.82	0.94	0.13	12.46
Repayment of Term Loan	3.00	7.20	7.80	8.40	9.00	4.35	39.75
TOTAL (N)	6.59	10.55	10.43	10.22	9.94	4.48	52.21
Average DSCR (M/N)	3.28						

Annexure:-6 Procurement and implementation schedule

S. No.	Activity	Months							
		1	2	3	4	5	6	7	8
1	Release of purchase order								
2	Design of the hot air generator								
3	Fabrication of the hot air generator								
4	Construction of civil foundation at client site								
5	Fabrication of pipeline with insulation								
6	Procurement and receipt of the hot air generator at client site								
7	Commissioning of all the components								
8	Trial								

Break up of shut down period with day wise justification

S. No.	Activity	No. of Days				
		1	2	3	4	5
1	Cooling of the thermal energy consuming equipments					
2	Dismantling					
3	Assemble all the components with the thermal equipments					
4	Trial					

Annexure -7: Details of technology service providers

S.No.	Name of Service Provider and address	Contact Person mobile no. and email ID
1.	Yajna Fuel Services B – 15, Dattaviahar Co – Operative Housing Society, Ground Floor, Shivaji Nagar, B – Cabin, Thane (W) – 400602	Mr. Mukund Gharpure 09969410594, 022 – 25424983 yajnafuel@vsnl.net

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

Yajna
FUEL SERVICES
Work Centre.: B-15, Dattavihar co-op Hsg.So., Gr. Floor, Shivaji Nagar, B- Cabin,
Thane (W) 400602. Tel.: 022- 2538 4681, Tel/Fax.: 2542 4983
e-mail.: yajnafuel@vsnl.net web site.: www.yajnafuelindia.com

Date: 28/03/2010

To,
M/s.See-Tech Solution Pvt Ltd.
11/5, MIDC, Info Tech Park,
Near VRCE Telephonic Exchange,
South Ambazari Road,
Nagar – 440 022.

Kind Attention: - Mr. Milind Chittawar

Subject: Budgettory offer for Hot air Generator **at 280 ± 5^{0}c** (capacity 10, 00,000 Kcal / hr)

Dear Sir,

We thank you for your enquiry. We note your keen interest in reducing SO2 pollution & inculcate use of renewable fuels.

Based on the discussions & data furnished by you, we are pleased to submit offer for the mentioned subject, as follows: -

1) Annexure I : Scope of Supply.
2) Annexure II : Technical Specification
3) Annexure III : Quotation, Payment Terms & Exclusions

We hope you will find the details & information submitted in order and in line with your requirement. However if you have any quarries (Technical/Commercial), Kindly feel free to call on us.

We assure you of our best services & hope to hear a favorable reply soon.

Thanking you,

Yours Faithfully,
For YAJNA FUEL SERVICES.

(Dr.M.G.Gharpure)

ANNEXURE I

Scope of work:

1. Preparation of site plan for furnace, Hot air Generator, Storage space, Chimney connection, Firing orientation, trolley movements, Ducting to Chimney
2. Preparation of civil drawing, wiring diagrams.
3. Fabrication of furnace, Hot air Generator, Refractory lining, Insulation lining, Grate bar support fixation, stand for ID fan, ID fan isolation dampers.
4. Commissioning.
5. Performance testing and Economic Evaluation.

ANNEXURE-II

Technical Specification:

- Furnace suitable for handling 530 kg/hr (max.) of briquette (Grate Area: 6 M^2).
- Ducting from furnace to Hot air generator.
- Hot air generator (Heat Duty: 10,00,000 Kcal/hr)
- ID Fans with Motors & Dampers. (Specification: 7000 m^3/hr, -225 & + 50 mm WC at 150 $^{\circ}$ C, Motor: 15 H.P)
- **Space requirement: (12 m × 08 m× 08 m)**

ANNEXURE III

QUOTATION:

Sr. no.	ITEM	Description/ MOC	Value (Approx) Rs.
01	FURNACE	Suitable	800000
02	Hot air generator	Suitable	1000000
03	ID fan with base plate Motor	Suitable	350000
04	Control Panel	Suitable	150000
05	Water preheater/air preheater	Suitable	450000
06	Chimney (self supported 40 m height)	Suitable	800000
07	Professional Charges against designing, erection & Commissioning		500000
	TOTAL		40,50,000/- **

"": 2 % CST is applicable extra to item No: (01) (02) (3) (4) (5) (6) & 10.36 % service tax on Item no. (8).**

NB: - Delivery period 4 to 6 months.

Payment Terms:

For Material Supply:

- Advance 20%
- 80% Within SEVEN days of Unloading of Materials at your site.
- **For Professional Charges :(Item No: (08)**
- 50 % with technically & Commercially clear Purchase Order
- 30 % after completion of erection
- 20% after 500 MT of fuel firing (Briquetted Fuel).

Note: Commissioning will be completed within five weeks after receipt of payments against complete material supply (i.e. Item No: 01, 02, 03, 04, 05, 06, 07)

Exclusion: (Buyer's Scope)

1) ESI, PPF payments will be born by our subcontractor, if company has any other Obligations please inform. Any unforeseen expenses on safety practice.
2) Any damage to living or nonliving object.
3) Any penalty related to delay in execution. Shut down for change over & non-availability of fuel.
4) Welding facility at site
5) Water required for castable.
6) Taxes and duties.
7) Transportation/Freight.
8) Any instrumentation and control other than supplied with the furnace.
9) Start up fuel expense.
10) Expenses required for aesthetic.
11) Civil work & Electrical connections to all motors.
12) Any other item not included in scope of work.
13) Unloading/shifting of equipment at site.
14) Responsibility of any theft of material at site.
15) Connection from BFW tank to Economizer, Related Piping, Insulation.

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

SEE-Tech Solutions Pvt. Ltd
11/5, MIDC, Infotech Park,
Near VRCE Telephone Exchange,
South Ambazari Road,
Nagpur – 440022
Website: www.letsconserve.org

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