DETAILED PROJECT REPORT
ON
WOOD GASIFIER
(JAGADHRI BRASS & ALUMINIUM CLUSTER)

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Prepared By

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WOOD GASIFIER FOR ANNEALING FURNACE (BELOW 3 TONNE)

JAGADHRI BRASS AND ALUMINIUM CLUSTER

BEE, 2010

Detailed Project Report on Wood Gasifier for Annealing Furnace (Below 3 Tonne)

Brass & Aluminium SME Cluster, Jagadhri, Haryana (India)

New Delhi: Bureau of Energy Efficiency;

Detail Project Report No.: **JAG/MET/GAS (A)/01**

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Zenith Energy Services Pvt. Ltd.

Hyderabad

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Lists of Abbreviations

- BEE - Bureau of Energy Efficiency
- DPR - Detailed Project Report
- DSCR - Debt Service Coverage Ratio
- FD - Forced Draft
- GHG - Green House Gases
- HP - Horse Power
- IRR - Internal Rate of Return
- ID - Induced Draft
- MoP - Ministry of Power
- MoMSME - Ministry of Micro Small and Medium Enterprises
- NPV - Net Present Value
- ROI - Return On Investment
- SIDBI - Small Industries Development of India
- MSME - Micro Small and Medium Enterprises

EXECUTIVE SUMMARY

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

Jagadhri is renowned for the brass utensils, sheets, coils, strips and also & Stainless steel utensils, there are about 150 to 200 brass and aluminium industries in the cluster. The brass & copper sheets, strips, coils and aluminium utensils produced in Jagadhri cluster are renowned in the country. Majority of the industries have been in operation for the last 15 to 30 years. The main raw materials are brass, copper and aluminium scrap is being procured from local agents.

The major Energy forms used in the cluster are electricity and fuels like Coke, Wood, and Furnace Oil etc. Electricity is used for driving the prime movers of pumps, fans, drives, rolling machine motors, induction and annealing furnaces and for lighting. Coke and Furnace oil is used for brass and aluminium melting in Pit Furnaces. Wood is used as a fuel in Annealing furnaces.

The cost of energy as a percentage of manufacturing cost varies anywhere between 12 to 5%, which includes electrical as well as thermal. Majority of the industries located in Jagadhri uses coke and furnace oil as energy in process for pit melting and a very few units are using electricity for wood Gasifiers for melting. Wood annealing process requires large amount of thermal energy, inducing a second highest share of energy cost. The energy cost is next to the raw materials cost.

This DPR is prepared for reducing fuel consumption as well as production cost by the help of wood fired gasifier for annealing furnace. The DPR highlights the details of the study conducted for assessing the potential for possible fuel saving and its monetary benefit, availability of the technologies/design, local service providers, technical features and proposed equipment specifications, various barriers in implementation, environmental aspects, estimated GHG reductions, capital cost, financial analysis, and schedule of Project Implementation.

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

S.No	Particular	Unit	Value
1	Project cost	`(in Lakh)	9.31
2	Wood consumption in base case scenario (calorific Value 3200 kCal/kg)	tonne/year	125
3	Wood consumption in proposed case (calorific Value 3500 kCal/kg)	tonne/year	106
4	Monetary benefit	` (in Lakh)/ year	2.45
5	Simple payback period	years	3.80
6	NPV	` (in Lakh)	0.38
7	IRR	%age	11.05
8	ROI	%age	19.15
9	Average DSCR	Ratio	1.24
10	Estimated CO_2 reduction	tCO_2/year	31
11	Process down time	days	7

The projected profitability and cash flow statements indicate that the project implementation i.e. installation of wood Gasifier for annealing furnace will be financially viable and technically feasible.

ABOUT BEE'S SME PROGRAM

Bureau of Energy Efficiency (BEE) is implementing a BEE-SME Programme to improve the energy performance in 29 selected SMEs clusters. Jagadhri Brass & Aluminium 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

Jagadhri is renowned for the brass utensils, sheets, coils, strips and also Aluminium & Stainless steel utensils, there are about 150 to 200 brass and aluminium industries in the cluster. The brass & copper sheets, strips, coils and aluminium utensils produced in Jagadhri cluster are renowned in the country. The main raw materials are brass, copper and aluminium scrap is being procured from local agents.

The cost of energy as a percentage of manufacturing cost varies anywhere between 3% to 5%. Majority of the industries located in Jagadhri uses coke and furnace oil as energy in process for pit melting and a very few units are using electricity for wood gasifiers for melting. Pit melting process requires large amount of thermal energy, inducing a high share of energy cost. The energy cost is next to the raw materials cost.

1.1.1 Production process

The main process operation for Brass melting and products manufacturing adopted in cluster units are as follows:

Brass Melting

Pit Furnace is a common type of furnace used in all cluster units for melting the scrap brass in the crucibles. Coke is used as fuel. The pit furnace is a rectangular pit lined with refractories and the crucible is inserted in the furnace and coke is fired underneath and side of the pit furnace. The outer side of the furnace is lined with red bricks. After feeding Furnace Oil and inserting crucible in the pit and the firing of the coke is started. The normal time for each batch of melting is two and half hours and subsequently the batch time reduces by about 20 minutes to 30 minutes than the initial batch.

Aluminium melting

Pit Furnace is a common type of furnace used in all cluster units for melting the Aluminium scrap in the crucibles. The furnace oil is used as fuel. The pit furnace is a circular pit lined with refractories and the crucible is inserted in the furnace and combustible furnace oil with air blower from bottom side of the pit furnace. The outer side of the furnace is lined with red bricks. The normal time for each batch of melting is one and half hours and subsequently the batch time reduces by about 15 minutes to 20 minutes than the initial batch.

Annealing

The common type of furnace for annealing is wood fired annealing. The temperature required for annealing and re-heating the brass billets is 600 to 650 ^{o}C and Aluminium billets is 400-450 ^{o}C. The brass & aluminium sheets, billets and brass coils are heat treated for about 10 to 12 hours in a day.

Hot Rolling

The primary function of the Hot rolling is to reheat aluminium billets or hot casted billets nearly to their melting point, then roll them thinner and longer sheets through rolling machine driven by motors having capacity around 60 to 100 HP and annealing up the lengthened brass or aluminium sheets and used for the next process.

Cold Rolling

Cold rolling is carried out to allow desirable metal qualities that cannot be obtained by hot working such as eliminating shrinkage errors for higher dimensional accuracy of the metal. Furthermore, to have smoother surface of the final products, enhance strength and hardness. As such, the metal must be heated from time to time (annealed) during the rolling operation to remove the undesirable effects of cold working and to increase the workability of the metal.

Shearing

In the shearing process, the sheets are cut to required size out of larger sheets such as roll sheets. Shears are used as the intermediate or finished step in preparing for cold rolling or circle cutting processes.

Pressing

Pressing is a metal forming process in which sheet metal is stretched into the desired part shape. A tool pushes downward on the sheet metal, forcing it into a die cavity in the shape of the desired part. The tensile forces applied to the sheet cause it to plastically deform into a utensil-shaped part. Pressing is most effective with ductile metals, such as aluminum, brass, copper, and mild steel. Examples of parts formed with Pressing include milk tanks, cans, cups, kitchen utensil sinks, pots and pans.

The Pressing processes machine either in cam or hydraulic type is used having capacity 25 HP to 63 HP motors.

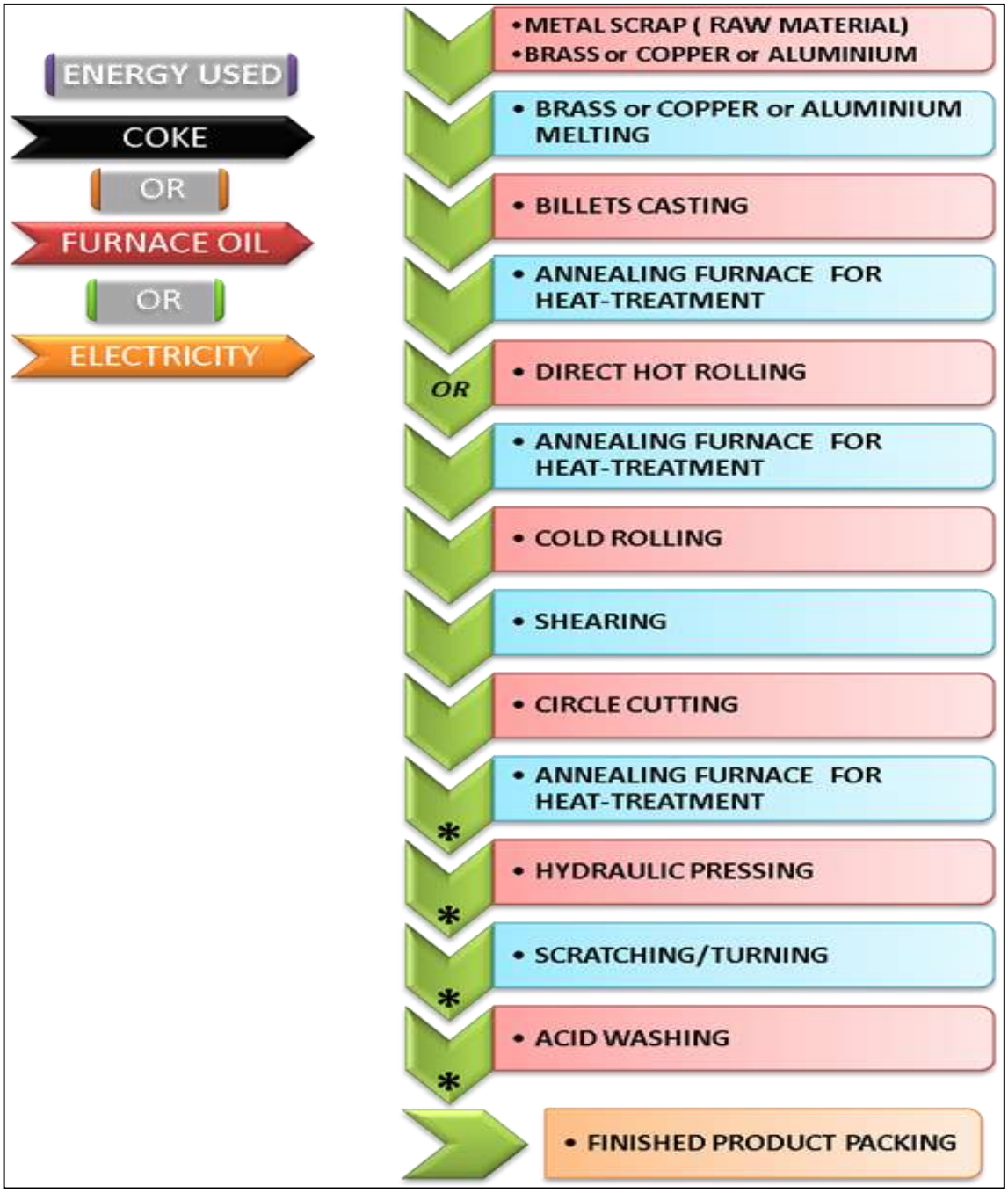


Figure 1.1: General Process Flowchart

For Product / Utensils Manufacturing

1.2 Energy performance in existing situation

1.2.1 Fuel and electricity consumption of a typical unit

The main energy forms used in a typical unit in the cluster are electricity, coke and wood. Electricity is used for driving the prime movers of blowers, hot and cold rolling machines, shearing machines and press. Coke is used as fuel in Pit Furnaces for brass melting and wood is used as fuel for annealing furnaces. The energy consumption of a typical unit in the cluster having wood fired annealing furnace for heat treatment of brass is furnished in Table 1.1 below:

Table 1.1: Energy consumption of a typical unit (Ahuja Metal Industries)

S.No	Details	Unit	Value
1	Coke consumption	tonne/annum	96
2	Grid Electricity consumption	MWh/annum	170
3	Wood Consumption	tonne/annum	240

1.2.2 Average production by a typical unit in the cluster

The average production in a year in a typical unit is 720 tonne

1.2.3 Specific Energy Consumption

The main energy forms used in the aluminium processing units are electricity, furnace oil and wood. The Specific energy consumption for electrical and thermal energy per tonne of Production for a typical unit is furnished in Table 1.2 below:

Table 1.2: Specific energy consumption for a typical unit

S. No.	Type of Fuel	Units	Specific Energy Consumption
1	Coke Consumption	tonne/ tonne of production	0.133
2	Grid Electricity consumption	MWh/ tonne of production	0.236
3	Wood consumption	tonne/ tonne of production	0.333

Equipment wise Specific Energy Consumption

The specific energy consumption of the equipments used in the Jagadhri Aluminium & Brass Industries is given in Table 1.3 below wherever possible.

Table 1.3 Equipment wise Specific Energy Consumption

S.No.	Equipments	Minimum SEC	Maximum SEC	Average SEC (for whole cluster)
1	Pit Furnace	0.110	0.15	0.130
2	Annealing Furnace	0.15	0.26	0.205

1.3 Existing technology/equipment

1.3.1 Description of existing technology

Wood Fired Annealing Furnace is a common type of annealing furnace found in the cluster and is normally installed in smaller and medium size units. The wood fired furnace is used for heat treatment of the brass sheets and circles and also reheating of the billets before hot rolling. The wood is used as fuel and the production capacity of the wood fired furnace in the cluster units is varying from 2000 kg to 4000 kg per batch. The temperature required for annealing and re-heating the billets is 600 to 650 ^{O}C. The brass sheets are heat treated for about 10 to 12 hours in a day. The annealing furnaces are of very old design and are constructed with red bricks and only the hearth of the furnace is constructed with the refractory bricks. The design of the annealing furnace is more or less identical in all cluster units. The major drawbacks of the existing wood furnaces are:

- There is no proper provision for supplying of combustion air and the combustion air intake also flue gas exit takes place from the front door through which material is being fed.
- Inadequacies in maintaining and controlling uniform furnace temperature resulting in uneven surface hardness
- Excess temperature resulting in oxide formation on the surface of the products, the temperature in the furnace was found to be more than required due to lack of monitoring of fuel feeding to the furnace.
- Low efficiency of the furnaces

1.3.2 Its role in the whole process

The wood fired annealing furnace is used for heat treatment of the brass sheets and circles. The furnace is also used for pre-heating of the billets before hot rolling. The heat treatment is carried out for improving the physical properties of the metal such as for increasing the

strength, malleability etc. the brass sheets and circles are heat treated for about 10 to 12 hours per batch and the temperature is maintained about 600 ^{o}C.

1.4 Establishing the baseline for the equipment to be changed

1.4.1 Design and operating parameters

Wood is used as fuel for annealing furnace. The furnace is constructed by the local masonries and doesn't have name plate details. The capacity of the furnace in the cluster varies from 2 tons to 4 tons respectively. The wood consumption depends on the following parameters such as quantity of brass to be annealed, temperature required, wood heat value and design of the pit furnace. The operating parameters of the annealing furnace collected for a typical unit during the field visit is furnished in Table 1.4 below:

Table 1.4 Details of Operating parameter

S. No.	Particular	Units	Value
1	Present quantity of Annealing per day	kg/day	2700
2	Wood Used	kg/day	416
3	Temperature maintained	^{0}C	600
4	Efficiency of pit furnace	% age	11.1

1.4.2 Fuel & Electricity consumption and Operating Efficiency

The operating efficiency of the wood fired annealing furnace in various units had been evaluated during energy use and technology audits, the efficiencies of the furnaces are found to be in the range of 7% to 12% in various units of the cluster. The details of wood consumption and efficiencies of annealing furnaces for 3 typical units is furnished below in Table 1.4 below:

Table 1.4 Energy Consumption & Efficiency of three typical units in the cluster

S. No	Name of the unit	Wood Consumption (tonne/annum)	Electricity Consumption (MWh/annum)	Efficiency of annealing furnace (% age)
1	Ahuja Metal Industries	240	170	11.1
2	Usha Enterprises	180	159	7.0
3	Arun metals	240	159	8.2

1.5 Barriers for adoption of new technology/equipment

1.5.1 Technological Barriers

The major technical barriers that prevented the implementation of the wood Gasifier in the cluster are:

- The penetration of wood Gasifier in the cluster units is low, this may be due to lack of awareness of the technology among SME owners and though some of the unit owners are interested, no demonstration projects or no single unit were installed or implemented wood Gasifier, this was also one of major reason for not taking up the project in the cluster.
- Secondly, due to lack of knowledge of the technical benefits of the wood Gasifier among the SME owners in the cluster
- Thirdly, majority of the owners of the cluster are more focused on the successful implementation of the proposed technology in the cluster before going to implement it as so far, no unit had been implemented wood Gasifier.

1.5.2 Financial Barrier

- Though, many SME owners are interested to install wood Gasifier for brass melting, but due to high initial investment required, SME owners do not want to invest such amount in implement of proposed technology.
- Further, lack of awareness of the losses and monetary benefit of the wood Gasifier was also one of the major barrier that prevented implementation of the wood Gasifier in cluster units
- Energy Efficiency Financing Schemes such as SIDBI's, if taken up in the cluster, many SME owners will come forward to up taken up the technology due to financial attractiveness of the technology.

1.5.3 Skilled manpower

Lack of skilled manpower was also one of the major barriers in the cluster.

1.5.4 Other barrier(s)

Majority of the SME owners doesn't have knowledge of the financial incentives offered by government agencies for the wood Gasifier and vigorous circulation of the financial incentives of the wood Gasifier and motivation from the local renewable energy nodal agencies among the unit's owners may affect the owners in taking up the technology for implementation.

2. DESCRIPTION OF PROPOSED TECHNOLOGY/EQUIPMENT

2.1 Detailed description of technology/equipment selected

2.1.1 Description of technology

Biomass Gasification

Gasification is the process of converting solid fuels to gaseous fuel. It is not simply pyrolysis process; pyrolysis is only one of the steps in the conversion process. It is combusted with air (partial supply of air) and reduction of the product of combustion (water vapour and carbon dioxide) into combustible gases (carbon monoxide, hydrogen, methane, some higher hydrocarbons) and inert gas (carbon dioxide and nitrogen). This process produces gas with some fine dust and condensable compounds such as tar.

The producer gas generated is used for thermal application and heat generated by combustion of biogas is used for melting the brass. Like other gaseous fuels, producer gas can also controlled critically. This also paves way for more efficient and cleaner operation. The producer gas can be conveniently used for thermal energy requirement.

Thermal Energy

Thermal energy of the order of 5 MJ is released, by flaring 1 m^3 of producer gas in the burner. Flame temperature can be obtained as high as 1250 ^{0}C by optimal pre-mixing of air with gas. For applications where requires thermal energy, Gasifier can be a good option as a gas generator, and retrofitted with existing devices. The biomass gasifier system is best suited for hot air dryers, kilns, furnaces and boilers.

In non-ferrous metallurgical and foundry industries where high temperatures (~650 - 1000 ^{o}C) are required for melting metals and alloys and normally melting is done by expensive fuel oils or electrical heaters, Gasifier are well suited for such applications. And the temperature will also be reduced and maintained at 500^{0}C

Wood Gasifier

This system is meant for biomass having density in excess of 250 kg/m^3. Theoretically, the ratio of air-to-fuel required for the complete combustion of the wood, defined as stoichiometric ratio is 6:1 to 6.5:1, with the end products being CO_2 and H_2O whereas, in gasification the combustion is carried at sub-stoichiometric conditions with air-to-fuel ratio being 1.5:1 to 1.8:1. The product gas thus generated during the gasification process is combustible. This process is made possible in a device called Gasifier with limited supply of air. A Gasifier system basically comprises of a reactor where the gas is generated, cooled, cleaned and

burned. The clean combustible gas generated can be used for power generation in diesel-generators or for thermal use by directly supplying to the combustor through an ejector.

2.1.2 Technology /Equipment specifications

The technical specifications of the proposed wood gasifier of below 3 tonne capacity for Brass melting are furnished in Table 2.1 below:

Table 2.1 Technical specification of wood Gasifier

S.No	Parameter	Details
1	Model	RG-200
2	Mode	Burning Application
3	Rated output	360 kW (Can replace up to 30 L/Hr of FO)
4	Design	Down Draft with Throat
5	Fuel	Wood Chips
6	Feed size	2" - 3" (any dimensions)
7	Fuel Consumption	120 kg/Hour (Corresponds to Max. rated output)
8	Moisture content of fuel	15%
9	Fuel Feeding Cycle	Hourly once
10	Fuel charging	Manually
11	Hopper Holding Capacity	800 kg (Approx.)
12	Auxiliary Power	6 HP

2.1.3 Justification & Suitability of the technology selected

The Aluminium or brass annealing in the present conventional wood fired furnaces is costly due to low efficiency. The annealing in wood gasifier is low comparatively with present conventional wood fired furnaces due to more efficiency of wood gasifier, less manpower cost, easily control on fuel feeding, more yields of metal and low energy cost. Further, the parameters can be critically controlled in the wood gasifier. Overall, the energy cost per ton of aluminium or brass annealing is low than the conventional wood fired annealing furnaces. The annealing furnace gives higher yield.

- The natural stirring helps in the uniform annealing.

- Annealing is cleaner.
- It is energy efficient.

2.1.4 Superiority over existing technology/equipment

The following are the benefits of the wood Gasifiers:

- Low cost of energy cost
- Low operating costs
- Reduces GHG emissions
- Improved combustion
- The fuel feeding can be critically controlled
- Reliable, continuous delivery of cost effective energy and reduces dependence on fossil fuels

2.1.5 Availability of the proposed technology/equipment

The wood gasifier suppliers are available locally in Jagadhri and also in Delhi. The details of the local service providers for construction of wood gasifier are given in Annexure 7.

2.1.6 Source of technology/equipment for the project

The technology is indigenous and is locally available.

2.1.7 Service/technology providers

The service providers are available locally.

2.1.8 Terms of sales

Terms of payment

40% advance and Balance payment together with taxes and duties and other expenses before Despatch

Performance guarantee

The warranty is for 12 months from the date of commissioning or 15 months from the date of dispatch, whichever is earlier.

After Sales Service

During the warranty period as said above, the seller shall depute their Service Engineer(s) free of cost to the works of the buyer, as and when necessary. However, the buyer shall bear the expenses on boarding and lodging of the Service Engineer(s) during stay at buyer's place,

the local conveyance and to and fro travel expenses. Thereafter, our regular service charge will be charged besides to and fro air/rail fare boarding and lodging, conveyance and any other incidental expenses.

2.1.9 Process down time during implementation

The process down time is considered for installation of wood gasifier is one week.

2.2 Life cycle assessment and risks analysis

The life of the wood gasifier is considered at 15 years.

2.3 Suitable unit in terms of capacity

The proposed wood gasifier capacity is suitable for annealing 2000 kg per batch and can be installed in all the aluminium and brass annealing units of various capacities having wood fired furnaces of capacity 2000 - 4000 kg and above.

3. ECONOMIC BENEFITS OF NEW ENERGY EFFICIENT TECHNOLOGY

3.1 Technical benefits

3.1.1 Fuel savings per year

The project activity is installation of new wood gasifier for reducing production cost. Overall wood saving would be about 19 tonne per year.

3.1.2 Electricity savings per year

No electrical savings is envisaged by wood gasifier, as the wood gasifier replaces fossil fuels, instead the electricity consumption increases due more electrical loads for the operation off fans and wood cutting.

3.1.3 Improvement in product quality

The project activity is installation of new wood gasifier, due to better control of the annealing or thermal parameters, the product quality may improve to certain extent.

3.1.4 Increase in production

The annealing of Aluminium and brass in wood gasifiers is faster than annealing in conventional wood fired furnaces and hence, more production will achieve for the same time period.

3.1.5 Reduction in raw material consumption

The annealing of Aluminium or brass in wood gasifier's results in more yield than conventional wood fired furnaces.

3.1.6 Reduction in other losses

There is no significant reduction in other losses.

3.2 Monetary benefits

The installation of new wood gasifier reduces production cost and monetary savings due to low cost of fuel and better thermal efficiency is ` 2.45 lakh per annum. Details enclosed in Annexure 3.

3.3 Social benefits

3.3.1 Improvement in working environment in the plant

Operation of wood Gasifier & gas combusted for annealing of metal is based on a renewable and clean energy and also heat dissipation reduces at work place therefore, working environment will improve considerably.

3.3.2 Improvement in skill set of workers

The technology selected for the implementation is new. Implementation and operation & maintenance of technology will create awareness among workers and hence it improves skills of the workers.

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 activity.

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

Project implementation would save about 19 tonne of wood per year hence; total amount of CO_2 would be 31 tonne per year.

3.4.3 Reduction in other emissions like SOx

As the project activity reduces furnace oil consumption, the SOx emissions also reduces to some extent.

4. IMPLEMENTATION OF PROPOSED EQUIPMENT

4.1 Cost of technology/equipment implementation

4.1.1 Cost of technology/equipments

The total cost for installation of wood gasifier for annealing of aluminium and brass having above 3 tonne capacity is estimated at ` 8.31 lakh which includes the cost of Wood Gasifier, gas burner, gas distribution lines and wood dryer. As per the Quotation the project shall be eligible for the subsidy of ` 2.4 lakh.

4.1.2 Other costs

The civil works, erection, commissioning charges and trial operation for the Wood gasifier is estimated at `1.0 lakh. The details of the item wise cost are furnished in Table 4.1 below:

Table 4.1 Total Project cost

S.No	Particular	Unit	Value
1	Cost of wood gasifier, gas burner and wood dryer, pipe lines, wood chipper, etc	` in lakh	8.31
2	Civil Works, Erection and Commissioning	` in lakh	1.00
3	Investment without IDC	` in lakh	9.32
4	Interest During Implementation	` in lakh	0.00
5	Total Investment	` in lakh	9.31

4.2 Arrangement of funds

4.2.1 Entrepreneur's contribution

The entrepreneur's contribution is 25% of total project cost, which works out at ` 2.33 lakh.

4.2.2 Loan amount

The term loan is 75% of the total project cost, which works out at ` 6.98 lakh.

4.2.3 Terms & conditions of loan

The interest rate is considered at 10.00% which is prevailing interest rate of SIDBI for energy efficiency projects. The loan tenure is 7 years and the moratorium period is 6 months.

4.3 Financial indicators

4.3.1 Cash flow analysis

Considering the above discussed assumptions, the net cash accruals starting with ` 0.90 lakh in the first year operation and increases to ` 4.93 lakh at the end of tenth year.

4.3.2 Simple payback period

The total project cost of the proposed technology is ` 9.31 lakh and monetary savings due to reduction in energy/production cost is ` 2.45 lakh and payback period works out to be 3.80 years.

4.3.3 Net Present Value (NPV)

The Net present value of the investment at 10.0% interest rate works out to be ` 0.38 lakh.

4.3.4 Internal rate of return (IRR)

The after tax Internal Rate of Return of the project works out to be 11.05%. Thus the project is financially viable. The average DSCR works out at 1.24.

4.3.5 Return on investment (ROI)

The average return on investment of the project activity works out at 19.15%.

4.4 Sensitivity analysis in realistic, pessimistic and optimistic scenarios

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

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

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

Table 4.2 Sensitivity analysis at different scenario

Particulars	IRR %	NPV ` in lakh	ROI %	DSCR
Normal	11.05%	0.38	19.15%	1.24
5% increase in monetary savings	11.60%	0.58	19.27%	1.27
5% decrease in monetary savings	10.50%	0.18	19.02%	1.22

4.5 Procurement and implementation schedule

The project is expected to be completed in 12 weeks from the date of financial closure and release of work order to the supplier. The detailed schedule of project implementation is furnished in Annexure 6.

ANNEXURES

Annexure 1: Evaluation of efficiency of furnace

1) Ahuja Metal Industries

S.No	Parameter	Units	Details
1	Fuel used	---	Fire wood
2	Quantity of metal annealing	kg/day	5,400
3	Specific heat of aluminium	kCal/kg ^{o}C	0.092
4	Initial temperature of aluminium	^{o}C	30
5	Final temperature of aluminium	^{o}C	600
6	Heat output	kCal/day	2,83,176
7	Quantity of wood consumption	kg/day	800
8	Calorific value of Furnace oil	kCal/kg	3,200
9	Heat input	kCal/day	25,60,000
10	Efficiency	% age	11.1

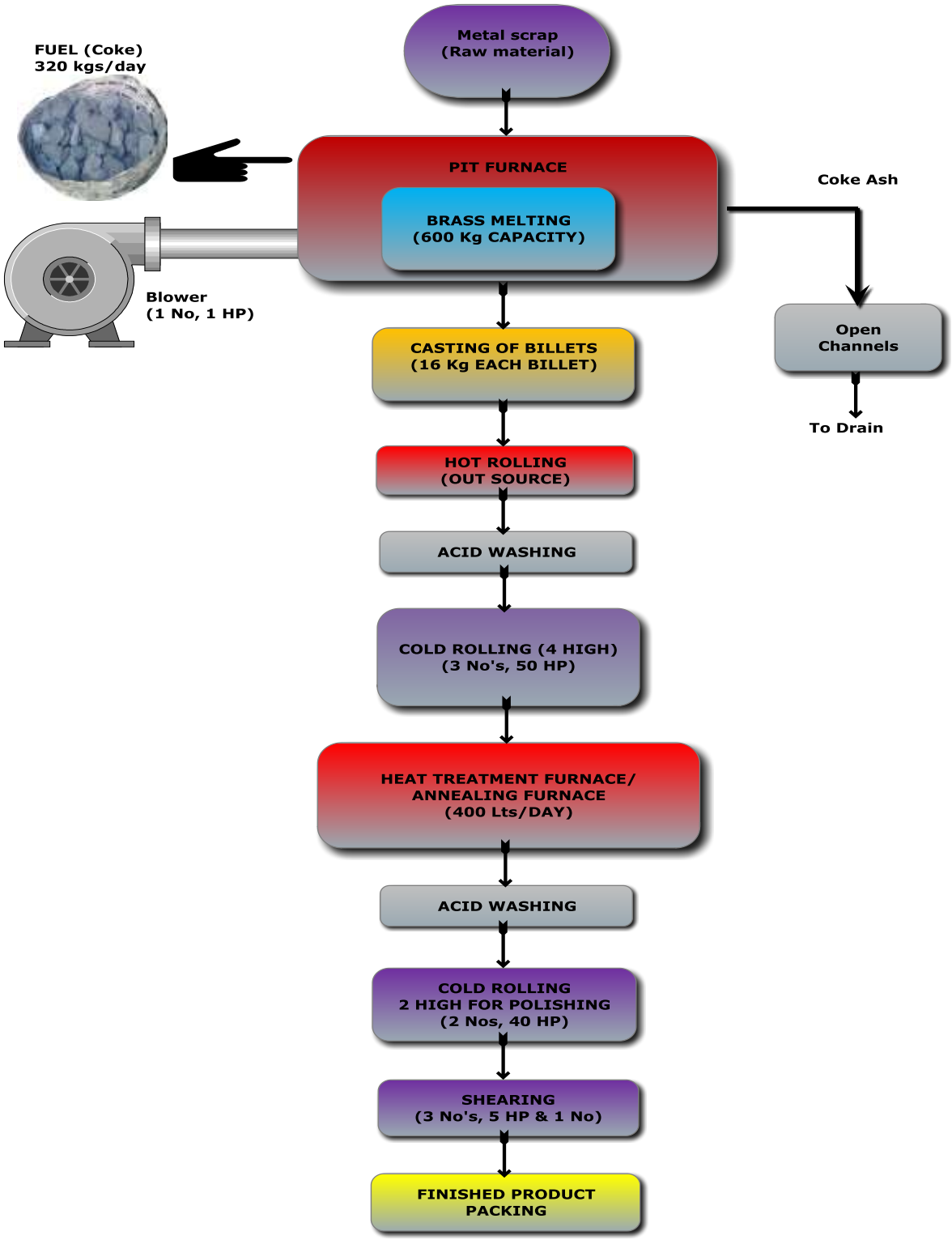
2) Usha Enterprises

S.No	Parameter	Units	Details
1	Fuel used	---	Fire wood
2	Quantity of metal annealing	kg/day	2,000
3	Specific heat of aluminium	kCal/kg ^{o}C	0.092
4	Initial temperature of aluminium	^{o}C	30
5	Final temperature of aluminium	^{o}C	600
6	Heat output	kCal/day	1,04,880
7	Quantity of wood consumption	kg/day	500
8	Calorific value of Furnace oil	kCal/kg	3,200
9	Heat input	kCal/day	16,00,000
10	Efficiency	% age	7.0

3) Arun Metals

S.No	Parameter	Units	Details
1	Fuel used	---	Fire wood
2	Quantity of Brass melted in the pit furnace in the crucible	kg/day	4,000
3	Specific heat of aluminium	kCal/kg ^{o}C	0.092
4	Initial temperature of aluminium	^{o}C	30
5	Final temperature of aluminium	^{o}C	600
6	Heat output	kCal/day	2,09,760
7	Quantity of wood consumption	kg/day	800
8	Calorific value of Furnace oil	kCal/kg	3,200
9	Heat input	kCal/day	25,60,000
10	Efficiency	% age	8.2

Annexure 2: Process flow diagram



Annexure 3: Detailed technology assessment report- wood gasifier

The cost benefit analysis of installing gasifier system for annealing is furnished below:

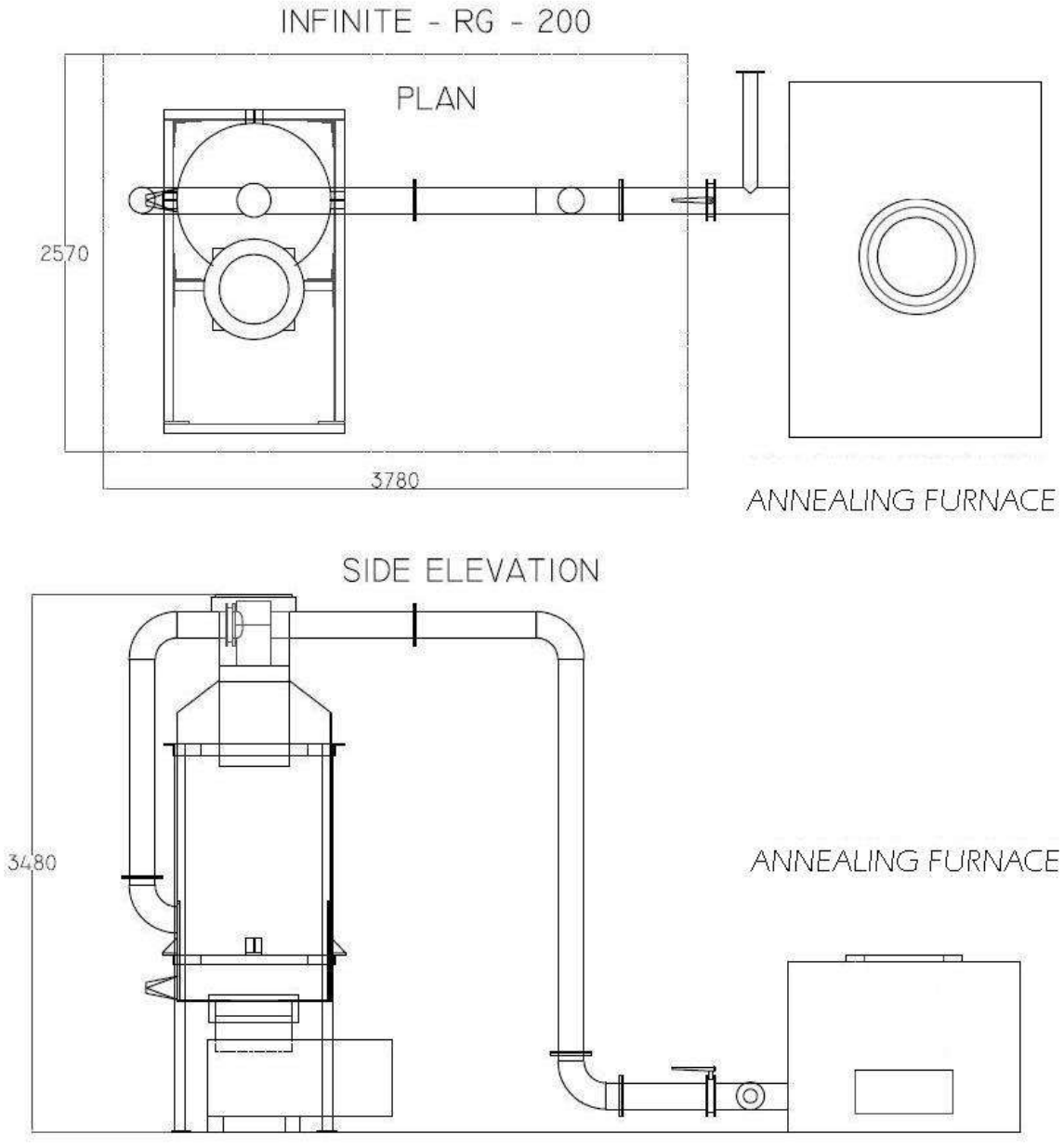
S.No	Parameter	Units	Value
1	Present quantity of Annealing per day	kg/day	2700
2	Initial Temperature	^{0}C	30
3	Final Temperature	^{0}C	620
4	Sp heat of Aluminium		0.092
5	Heat required	kcal/day	146556
6	Heat input	kcal/day	1332327
7	Wood consumption per day	kg/day	416
8	Calorific Value of Wood	kcal/kg	3200
9	Wood cost	`./kg	4.5
10	Fuel cost per day	`. /day	1874
11	No of working days	Days/ annum	300
12	No of batch	No.	1
13	Present wood consumption	tonnes/annum	125
14	Present Efficiency of the furnace	% age	11.1
15	Proposed wood consumption	tonne/annum	106
16	Initial Temperature	^{0}C	30
17	Final Temperature	^{0}C	620
18	Sp heat of Aluminium		0.092
19	Heat required	kcal/day	116748
20	Heat input	kcal/day	1061345
21	Wood consumption per day	kg/day	354
22	Calorific Value of Wood	kcal/kg	3500
23	Wood cost	`/kg	3
24	Fuel cost per day	`/day	1062

S.No	Parameter	Units	Value
25	wood savings per annum	tonne/annum	19
26	Monetary savings per annum	` in lakh	2.45
27	Total Investment	` in lakh	9.31
28	Payback period	year	3.80

Monetary savings			
S.no.	Parameter	Unit	Value
1	Present wood consumption	Tonne/Annum	125
2	Rate of Wood	` / Tonne	4500
3	Total Cost of Wood (A)	` / Annum	562500
4	Proposed Wood Consumption	Tonne/Annum	106
5	Rate of Wood	` / Tonne	3000
6	Total Cost of Wood (B)	` / Annum	318000
	Total Savings (A-B)	` / Annum	244500

***** Savings are on the basis of reduction in fuel and lower fuel costs.***

Annexure 4: Technical drawings of the wood gasifier



Annexure 5: Detailed financial calculations & analysis

Assumptions

Name of the Technology	**Wood Gasifier - Annealing(360kW th) above 3 ton capacity**		
Rated Capacity	**NA**		
Details	***Unit***	***Value***	***Basis***
Installed Capacity	kW	360	
No of working days	Days	300	
No of Shifts per day	Shifts	1	
Proposed Investment			
Wood gasifier - Aluminium Melting	` (in lakh)	8.31	
Civil works, erection and Commisioning	` (in lakh)	1.00	
Investment without IDC	` (in lakh)	9.31	
Total Investment	` (in lakh)	9.31	
Financing pattern			
Own Funds (Equity)	` (in lakh)	4.28	Feasibility Study
Loan Funds (Term Loan)	` (in lakh)	12.84	Feasibility Study
Loan Tenure	years	4.00	Assumed
Moratorium Period	Months	3.00	Assumed
Repayment Period	Months	51.00	Assumed
Interest Rate	%age	10.00%	SIDBI Lending rate
Estimation of Costs			
O & M Costs	% on Plant & Equip	4.00	Feasibility Study
Annual Escalation	%age	5.00	Feasibility Study
Estimation of Revenue			
Wood saving per annum	Tons	19	
Cost	`/tons	4500	
Cost reduction due to coal	`/tons	1500	
Amount of coal	tons	106	
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 lakhs)**

Years	*Opening Balance*	*Repayment*	*Closing Balance*	*Interest*
1	6.98	0.36	6.62	0.81
2	6.62	0.72	5.90	0.63
3	5.90	0.76	5.14	0.56
4	5.14	0.96	4.18	0.48
5	4.18	1.00	3.18	0.38
6	3.18	1.20	1.98	0.27
7	1.98	1.26	0.72	0.14
8	0.72	0.72	0.00	0.02
		6.98		

WDV Depreciation (` in lakhs)

Particulars / years	*1*	*2*
Plant and Machinery		
Cost	9.31	1.86
Depreciation	7.45	1.49
WDV	1.86	0.37

Projected Profitability (` in lakhs)

Particulars / Years	*1*	*2*	*3*	*4*	*5*	*6*	*7*	*8*	*9*	*10*
Revenue through Savings										
Fuel savings	2.45	2.45	2.45	2.45	2.45	2.45	2.45	2.45	2.45	2.45
Total Revenue (A)	2.45	2.45	2.45	2.45	2.45	2.45	2.45	2.45	2.45	2.45
Expenses										
O & M Expenses	0.37	0.39	0.41	0.43	0.45	0.48	0.50	0.52	0.55	0.58
Total Expenses (B)	0.37	0.39	0.41	0.43	0.45	0.48	0.50	0.52	0.55	0.58
PBDIT (A)-(B)	2.07	2.05	2.03	2.01	1.99	1.97	1.95	1.92	1.89	1.87
Interest	0.81	0.63	0.56	0.47	0.38	0.26	-	-	-	-
PBDT	1.26	1.42	1.48	1.54	1.62	1.71	1.95	1.92	1.89	1.87
Depreciation	0.49	0.49	0.49	0.49	0.49	0.49	0.49	0.49	0.49	0.49
PBT	0.77	0.93	0.99	1.05	1.13	1.21	1.45	1.43	1.40	1.38
Income tax	-	-	0.50	0.52	0.55	0.58	0.66	0.65	0.64	0.63
Profit after tax (PAT)	0.77	0.93	0.48	0.53	0.58	0.63	0.79	0.78	0.76	0.74

Computation of Tax (` in lakhs)

Particulars / Years	*1*	*2*	*3*	*4*	*5*	*6*	*7*	*8*	*9*	*10*
Profit before tax	0.77	0.93	0.99	1.05	1.13	1.21	1.45	1.43	1.40	1.38
Add: Book depreciation	0.49	0.49	0.49	0.49	0.49	0.49	0.49	0.49	0.49	0.49
Less: WDV depreciation	7.45	1.49	-	-	-	-	-	-	-	-
Taxable profit	(6.18)	(0.07)	1.48	1.54	1.62	1.71	1.95	1.92	1.89	1.87
Income Tax	-	-	0.50	0.52	0.55	0.58	0.66	0.65	0.64	0.63

Projected Balance Sheet

Particulars / Years	*1*	*2*	*3*	*4*	*5*	*6*	*7*	*8*	*9*	*10*
Liabilities										
Share Capital (D)	2.33	2.33	2.33	2.33	2.33	2.33	2.33	2.33	2.33	2.33
Reserves & Surplus (E)	0.77	1.70	2.19	2.72	3.29	3.93	4.72	5.50	6.25	7.00
Term Loans (F)	6.62	5.90	5.14	4.18	3.18	1.98	0.72	0.00	0.00	0.00
Total Liabilities D)+(E)+(F)	9.72	9.93	9.66	9.23	8.80	8.24	7.77	7.83	8.58	9.33
Assets	**1**	**2**	**3**	**4**	**5**	**6**	**7**	**8**	**9**	**10**
Gross Fixed Assets	9.31	9.31	9.31	9.31	9.31	9.31	9.31	9.31	9.31	9.31
Less: Accm. Depreciation	0.49	0.98	1.47	1.97	2.46	2.95	3.44	3.93	4.42	4.92
Net Fixed Assets	8.82	8.33	7.84	7.34	6.85	6.36	5.87	5.38	4.89	4.39
Cash & Bank Balance	0.90	1.61	1.82	1.88	1.95	1.88	1.90	2.45	3.70	4.93
TOTAL ASSETS	9.72	9.93	9.66	9.23	8.80	8.24	7.77	7.83	8.58	9.33
Net Worth	3.10	4.03	4.52	5.04	5.62	6.25	7.05	7.82	8.58	9.32
Dept equity ratio	2.85	2.54	2.21	1.80	1.37	0.85	0.31	0.00	0.00	0.00

Projected Cash Flow:

Particulars / Years	*0*	*1*	*2*	*3*	*4*	*5*	*6*	*7*	*8*	*9*	*10*
Sources											
Share Capital	2.33	-	-	-	-	-	-	-	-	-	-
Term Loan	6.98										
Profit After tax		0.77	0.93	0.48	0.53	0.58	0.63	0.79	0.78	0.76	0.74
Depreciation		0.49	0.49	0.49	0.49	0.49	0.49	0.49	0.49	0.49	0.49
Total Sources	9.31	1.26	1.42	0.98	1.02	1.07	1.13	1.28	1.27	1.25	1.23
Application											
Capital Expenditure	9.31										
Repayment of Loan	-	0.36	0.72	0.76	0.96	1.00	1.20	1.26	0.72	-	-
Total Application	9.31	0.36	0.72	0.76	0.96	1.00	1.20	1.26	0.72	-	-
Net Surplus	-	0.90	0.70	0.22	0.06	0.07	(0.07)	0.02	0.55	1.25	1.23
Add: Opening Balance	-	-	0.90	1.61	1.82	1.88	1.95	1.88	1.90	2.45	3.70
Closing Balance	-	0.90	1.61	1.82	1.88	1.95	1.88	1.90	2.45	3.70	4.93

Calculation of Internal Rate of Return **(` in lakhs)**

Particulars / year	*0*	*1*	*2*	*3*	*4*	*5*	*6*	*7*	*8*
Profit after Tax		0.77	0.93	0.48	0.53	0.58	0.63	0.79	0.78
Depreciation		0.49	0.49	0.49	0.49	0.49	0.49	0.49	0.49
Interest on Term Loan		0.81	0.63	0.56	0.47	0.38	0.26	-	-
Cash outflow	(9.31)	-	-	-	-	-	-	-	-
Net Cash flow	(9.31)	2.07	2.05	1.53	1.49	1.44	1.39	1.28	1.27
IRR	11.05%								
NPV	0.38								

Break Even Point

Particulars / Years	*1*	*2*	*3*	*4*	*5*	*6*	*7*	*8*
Variable Expenses								
Oper. & Maintenance Exp (75%)	0.28	0.29	0.31	0.32	0.34	0.36	0.37	0.39
Sub Total (G)	0.28	0.29	0.31	0.32	0.34	0.36	0.37	0.39
Fixed Expenses								
Oper. & Maintenance Exp (25%)	0.09	0.10	0.10	0.11	0.11	0.12	0.12	0.13
Interest on Term Loan	0.81	0.63	0.56	0.47	0.38	0.26	0.00	0.00
Depreciation *(H)*	0.49	0.49	0.49	0.49	0.49	0.49	0.49	0.49
Sub Total (I)	1.39	1.22	1.15	1.07	0.98	0.87	0.62	0.62
Sales (J)	2.45	2.45	2.45	2.45	2.45	2.45	2.45	2.45
Contribution (K)	2.17	2.15	2.14	2.12	2.11	2.09	2.07	2.05
Break Even Point (L= G/I)	64.37%	56.64%	53.88%	50.43%	46.54%	41.85%	29.76%	30.34%
Cash Break Even {(I)-(H)}	41.67%	33.80%	30.88%	27.26%	23.20%	18.31%	6.03%	6.38%
Break Even Sales (J)*(L)	1.57	1.38	1.32	1.23	1.14	1.02	0.73	0.74

Return on Investment

Particulars / Years	*1*	*2*	*3*	*4*	*5*	*6*	*7*	*8*	*Total*
Net Profit Before Taxes	0.77	0.93	0.99	1.05	1.13	1.21	1.45	1.43	1.40
Net Worth	3.10	4.03	4.52	5.04	5.62	6.25	7.05	7.82	8.58
									19.15%

Debt Service Coverage Ratio

Particulars / Years	*1*	*2*	*3*	*4*	*5*	*6*	*7*	*8*	*9*	*10*	*Total*
Cash Inflow											
Profit after Tax	0.77	0.93	0.48	0.53	0.58	0.63	0.79	0.78	0.76	0.74	5.50
Depreciation	0.49	0.49	0.49	0.49	0.49	0.49	0.49	0.49	0.49	0.49	3.93
Interest on Term Loan	0.81	0.63	0.56	0.47	0.38	0.26	0.00	0.00	0.00	0.00	3.11
TOTAL (M)	2.07	2.05	1.53	1.49	1.44	1.39	1.28	1.27	1.25	1.23	12.53

DEBT

Interest on Term Loan	0.81	0.63	0.56	0.47	0.38	0.26	0.00	0.00	0.00	0.00	3.11
Repayment of Term Loan	0.36	0.72	0.76	0.96	1.00	1.20	1.26	0.72	0.00	0.00	6.98
Total (N)	1.17	1.35	1.32	1.43	1.38	1.46	1.26	0.72	0.00	0.00	10.09
	1.77	1.52	1.16	1.04	1.05	0.95	1.02	1.76	0.00	0.00	1.24
Average DSCR (M/N)	1.24										

Annexure 6: Details of procurement and implementation plan with schedule/timelines

Project Implementation Schedule – Wood gasifier

S. No.	Activities	Weeks							
		1	2	3	4	5/6	7/8	9/10	11/12
1	Release of work orders								
2	Fabrication work								
3	Gas lines, platform construction and civil works								
4	Delivery, Commissioning and Trial Runs								

Process Breakdown

S. No.	Activities	Weeks							
		1	2	3	4	5/6	7/8	9/10	11/12
1	Civil works								
2	Gas lines, plat form construction and								
3	Electrical cabling								
4	Commissioning and Trial Runs								

Annexure 7: Details of technology/equipment and service providers with contact nos.

Equipment details	Source of technology	Service/technology providers
Wood Gasifier	**India**	**INFINITE ENERGY PVT LTD** **First floor, baba house.149-A, kilokri, Opp. Maharani Bagh,** **New Delhi -110014** Email id: infiniteenergy@vsnl.net infenergy@gmail.com **Contact person/number:** a) Naval Kishore Aggarwal/09212084933 b) Manoj / 92124654117 c) land line : 65191937, 65273819

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

Infinite Energy Pvt. Ltd.
First Floor, Baba House, 149 - A, Kilokri, Opp. Maharani Bagh, New Delhi - 110 014
Ph : 65191937, 65273819 Fax : 011 26903696 Email : infiniteenergy@vsnl.net

Infinite\mktg\10-11\ 22th November 2010

To
Mr. T Venu Gopal
Zenith Energy Services (P) Limited
10-5-6/B, My Home Plaza, Masab Tank,
Hyderabad - 500 028
Andhra Pradesh, India
Mob: 9652000590, 9541888499

Sub: Offer for Biomass gasifier plant– reg

Dear Sir,
Please refer our telephonic discussion regarding Gasifier System

We are pleased to submit our offer for One no. of biomass gasifier system Model INFINITE -RG – 200(360 KWth)

The system is designed for feeding producer gas to one producer gas burners with manual control for one gasifier system. The maximum gas piping can be done with this system is 30 ft with one system. The maximum diesel replacement would be limited to 30 lph. The wood consumption (dry wood with 15% moisture) would be 120 kg/h max. The actual wood consumption (wood with 18-22% moisture) would be 4.0 times the fuel oil requirement, viz., if the actual oil consumption is 20 lph, the wood consumption would not exceed 80 kg/h.

You would be eligible for availing capital subsidy provided by Ministry of New & Renewable Energy Sources, Government of India of Rs 2,40,000/- on installation of Model INFINITE - DG – 200 (360 KWth) the system offered.

If you require any further information / clarifications, please feel free to contact us.

Very Truly yours

Amit Tiwari
(mobile no. 09212284683)
Infinite Energy Pvt Ltd
New Delhi

Infinite Energy Pvt. Ltd.
First Floor, Baba House, 149 - A, Kilokri, Opp. Maharani Bagh, New Delhi - 110 014
Ph : 65191937, 65273819 Fax : 011 26903696 Email : infiniteenergy@vsnl.net

TIN NO : 06391328301

Infinite\mktg\10-11\

22th November 2010

To
Mr. T Venu Gopal
Zenith Energy Services (P) Limited
10-5-6/B, My Home Plaza, Masab Tank,
Hyderabad - 500 028
Andhra Pradesh, India
Mob: 9652000590, 9541888499

Quotation

S No	Item	Qty	Unit Price(Rate)	Price in Rupees
1	INFINITE Vergassen 3G Series gasifier, UPDRAFT Type Model INFINITE - RG – 200 (360 KWth)	1 No's	6,00,000	6,00,000
2	Gas Pipe Line including insulation (Maximum 30 ft each)	30 feet	1450/-	43,500
3	Gas Burner	1 nos.	58,500/-	58,500
4	Erection & Commissioning		25,000	25,000
5	Total			7,27,000/-
6	VAT 2% against C- FORM			14,540/-
7	Grand Total		Rs. 7,41,540/- (Rupees Seven Lakhs Forty One Thousand Five Hundred Fourty Only	
	Wood Dryer (optional) extra	1		90,000/-

Terms and Conditions : As per offer enclosed

For

Amit Tiwari

Infinite Energy (P) Ltd
New Delhi

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

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

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