DETAILED PROJECT REPORT
ON
WOOD GASIFIER (400 KG)
(JAGADHRI BRASS & ALUMINIUM CLUSTER)

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WOOD GASIFIER FOR ALUMINIUM MELTING
(400 KG CAPACITY)

JAGADHRI BRASS AND ALUMINIUM CLUSTER

BEE, 2010

Detailed Project Report on Wood Gasifier for Aluminium Melting (400 kg)

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

Bureau of Energy Efficiency; New Delhi:

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

For more information

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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
- MSME - Micro Small and Medium Enterprises
- 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

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 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. 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 3 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. 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.

This DPR is prepared for installation of Wood Gasifiers for aluminium melting for reducing energy/production cost. The DPR highlights the details of the study conducted for assessing the potential for possible reduction in energy/production cost and its monetary benefit, availability of the technologies/design, local service providers, technical features and proposed equipment specifications, various barriers in implementation, environmental aspects, estimated GHG reductions, capital cost, financial analysis, 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)	16.38
2	Furnace oil consumption in base case	kilolitre/year	76.80
3	Wood consumption in proposed case	Tonne/year	268.8
4	Electricity consumption in proposed case	kWh/year	10933
5	Monetary benefit	`(in Lakh)	9.69
6	Simple payback period	years	1.69
7	NPV	`(in Lakh)	19.32
8	IRR	%age	41.39
9	ROI	%age	26.96
10	Average DSCR	Ratio	2.42
11	Estimated CO_2 reduction	tCO_2/year	Nil
12	Process down time	Week	1

The projected profitability and cash flow statements indicate that the project implementation i.e. installation of wood gasifier for aluminium melting 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 gasifier 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 aluminium melting and products manufacturing adopted in cluster units are as follows:

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 furnace. Temperature required for annealing and re-heating the billets is 400 ^{o}C. The aluminium sheets are heat treated for about 10 to 12 hours for billets and about 5 to 6 hours for aluminium sheets.

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.

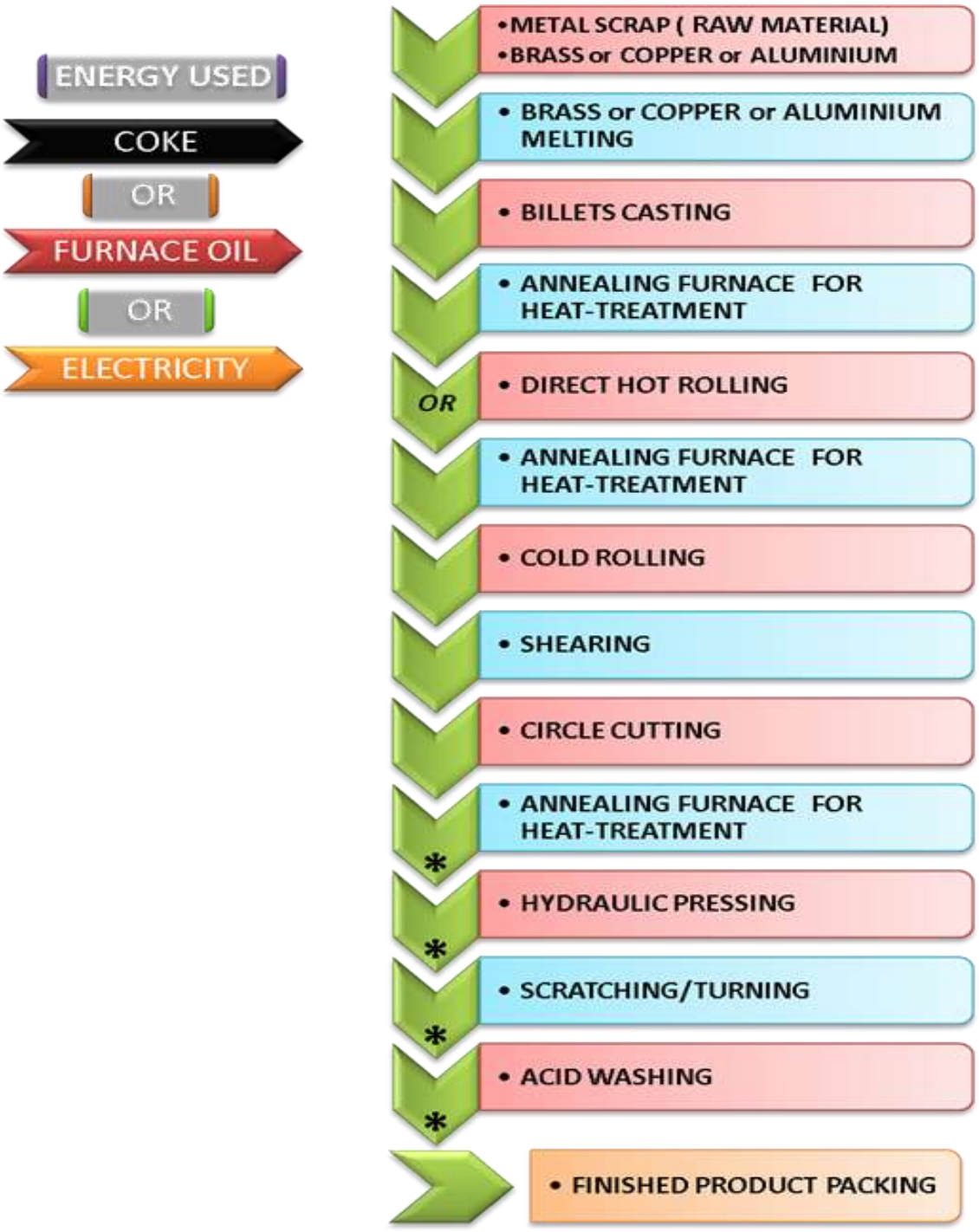


Figure 1.1: General Process Flowchart

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, furnace oil and wood. Electricity is used for driving the prime movers of blowers, hot and cold rolling machines, shearing machines and press. Furnace oil is used as fuel in Pit Furnaces for aluminium melting and wood is used as fuel for annealing furnaces. The energy consumption of a typical unit in the cluster having pit furnace for aluminium melting is furnished in Table 1.1 below:

Table 1.1: Energy consumption of a typical unit (Chanana Udyog)

S.No	Details	Unit	Value
1	Furnace oil Consumption	kilolitre/annum	76.8
2	Grid Electricity consumption	MWh/annum	213
3	Wood Consumption	tonne/annum	432

1.2.2 Average production by a typical unit in the cluster

The average production in a year in a typical unit is 480 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 ton or kg of Production for a typical unit is furnished in Table 1.2 below:

Table 1.2: Specific energy consumption for a typical unit (Chanana Udyog)

S. No.	Type of Fuel	Units	Specific Energy Consumption
1	Furnace oil Consumption	kilolitre/ tonne of production	0.16
2	Grid Electricity consumption	MWh/ tonne of production	0.44
3	Wood consumption	tonne/ tonne of production	0.9

Equipment wise Specific Energy Consumption

The specific energy consumption of the equipments used in the Jagadhri Aluminium 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	0.116	0.14	0.128
2	Annealing Furnace	0.30	0.90	0.60

1.3 Existing technology/equipment

1.3.1 Description of existing technology

Pit Furnace is a common type of furnace used in all cluster units for melting the scrap aluminium in the crucibles. Furnace oil is used as fuel and the production capacity of the pit furnace in the cluster units is varying from 400 kg to 800 kg per batch. Normally about 4 to 5 batches are produced in a day. The furnace is operated on single shift basis which is normally 12 hours.

The pit furnace is a circular pit lined with refractories and the crucible is inserted in the. The outer side of the furnace is lined with red bricks. The furnace oil burners are placed underneath of the crucible. The normal time for each batch of melting is 1.5 hours and subsequently the batch time reduces by about 15 minutes than the initial batch. A small blower of local make of 5 HP is used for supplying combustion air and then casting of billets of required sizes.

1.3.2 Its role in the whole process

The pit furnace is used for melting the aluminium scrap. The size of the pit furnaces vary as per the production capacity of the industry.

1.4 Establishing the baseline for the equipment to be changed

1.4.1 Design and operating parameters

The main energy forms used for pit furnace are furnace oil. Electricity is also used in small quantities for operation of blower for supplying combustion air. The pit furnace is constructed by the in house workers and doesn't have name plate details. The furnace oil consumption depends on the following parameters such as quantity of aluminium to be melted, temperature required, furnace oil heat value and design of the pit furnace. The operating parameters of the pit 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	Capacity of the pit furnace	kg/ batch	400
2	Quantity of aluminium melted	kg/ batch	400
3	Average Furnace oil consumption	litre/batch	64
4	Melting temperature measured	^{0}C	690

1.4.2 Furnace oil & Electricity consumption and Operating Efficiency

The operating efficiency of the pit furnace in various units had been evaluated during energy use and technology audits using furnace oil as fuel for aluminium melting. The efficiencies of the pit furnaces are found to be in the range of 9.8% to 12.5% in various units of the cluster. The details of furnace oil consumption, electricity consumption, efficiencies and energy cost involved for aluminium melting per kg for pit furnaces for 3 typical units is furnished below in Table 1.4below:

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

S. No	Name of the unit	Fuel Consumption (kilolitre/annum)	Electricity Consumption (MWh/annum)	Efficiency of pit furnace (% age)	Energy cost per kg of aluminium melting
1	Chanana udyog	76.8	213	9.8	` 4.00
2	Dharam Udyog	75	80	12.5	` 3.125
3	Aggarwal dhatu udyog	132	133	11.4	` 3.437

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 aluminium 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.

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 400 kg capacity for aluminium melting are furnished in Table 2.1 below:

Table 2.1 Technical specification of wood Gasifier

S.No	Parameter	Details
1	Model	RG-300
2	Mode	Burning Application
3	Rated output	200 kW (Can replace up to 50 L/Hr of FO)
4	Design	Down Draft with Throat
5	Fuel	Wood Chips
6	Feed size	2" - 3" (any dimensions)
7	Fuel Consumption	175 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 melting in the present conventional pit furnaces is costly due to low efficiency, high furnace oil cost. The melting in wood Gasifiers is low comparatively with oil fired pit furnaces due to high efficiency of wood Gasifier, less manpower cost, more yields of aluminium and low energy cost. Further, the parameters can be critically controlled in the wood gasifier. Overall, the energy cost per tonne of aluminium melting is low than the oil fired pit furnaces. The following are the reasons for selection of this technology:

- The melting furnace gives higher yield.
- The natural stirring helps in the uniform melting.
- Melting 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 melting 400 kg per batch and can be installed in all the aluminium melting units of various capacities having pit furnaces of 400 kg capacity and above.

3. ECONOMIC BENEFITS OF NEW ENERGY EFFICIENT TECHNOLOGY

3.1 Technical benefits

3.1.1 Fuel savings per year

The furnace oil consumption in base case is 76.8 kiloliter per annum and total wood consumption in the proposed system will be about 268.8 tonne. Hence 76.8 kiloliter of furnace oil will be replaced by total 268.8 tonne of wood annually.

3.1.2 Electricity savings per year

It increases electricity consumption due to increases of electrical load. Total electricity consumption would be 10933 kWh per year.

3.1.3 Improvement in product quality

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

3.1.4 Increase in production

The melting of aluminium in wood gasifier is faster than melting in pit furnaces and hence, more production will achieve for the same time period.

3.1.5 Reduction in raw material consumption

The main raw material for aluminium manufacturing is aluminium scrap. The melting of scrap in wood gasifier's will result in more yield than pit furnaces.

3.1.6 Reduction in other losses

There is no significant reduction 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 ` 9.69 lakh per annum.

3.3 Social benefits

3.3.1 Improvement in working environment in the plant

Operation of wood Gasifier & gas combusted for melting 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. The technology implemented will create awareness and operation and maintenance of the new technology and hence 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

No GHG emission reduction will occur due to Implementation of wood gasifier, as the project will increases the GHG emissions than the base line.

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 aluminium melting for a 400 kg/batch capacity is estimated at ` 14.38 lakh, which includes the cost of Wood Gasifier, gas burner, gas distribution lines and wood dryer.

4.1.2 Other costs

The civil works, erection, commissioning charges and trial operation for the Wood gasifier is estimated at ` 2.00 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	14.38
2	Civil Works, Erection and Commissioning	` in lakh	2.00
3	Investment without IDC	` in lakh	16.38
4	Interest During Implementation	` in lakh	0.00
5	Total Investment	` in lakh	16.38

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 ` 4.10 lakh.

4.2.2 Loan amount

The term loan is 75% of the total project cost, which works out at ` 12.29 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 5 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 ` 6.71 lakh

in the first year operation and increases to ` 35.31 lakh at the end of eighth year.

4.3.2 Simple payback period

The total project cost of the proposed technology is Rs. 16.38 lakh and monetary savings due to reduction in energy/production cost is Rs. 9.69 lakh and payback period works out to be 1.69 years.

4.3.3 Net Present Value (NPV)

The Net present value of the investment at 10.0% interest rate works out to be ` 19.32 lakh.

4.3.4 Internal rate of return (IRR)

The after tax Internal Rate of Return of the project works out to be 41.39%. Thus the project is financially viable. The average DSCR works out at 2.42.

4.3.5 Return on investment (ROI)

The average return on investment of the project activity works out at 26.96%.

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	41.39%	19.32	26.96	2.42
5% increase in monetary savings	44.18%	21.18	27.14	2.55
5% decrease in monetary savings	38.59%	17.47	26.76	2.30

As can be seen from above, the project is highly sensitive to fuel savings, the debt service coverage ratio works out to be 2.30 times in worst scenario, which indicates the strength of the project.

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) Chanana Udyog

S.No	Parameter	Units	Details
1	Fuel used	---	Furnace oil
2	Quantity of Aluminium melted in the pit furnace in the crucible	kg/day	2000
3	Specific heat of Aluminium	kCal/kg ^{o}C	0.22
4	Initial temperature of Aluminium	^{o}C	30
5	Final temperature of Aluminium (molten metal)	^{o}C	690
6	Heat output	kCal/day	290400
7	Quantity of Furnace oil consumption	kg/day	297.6
8	Calorific value of Furnace oil	kCal/kg	10000
9	Heat input	kCal/day	2976000
10	Efficiency	% age	9.8

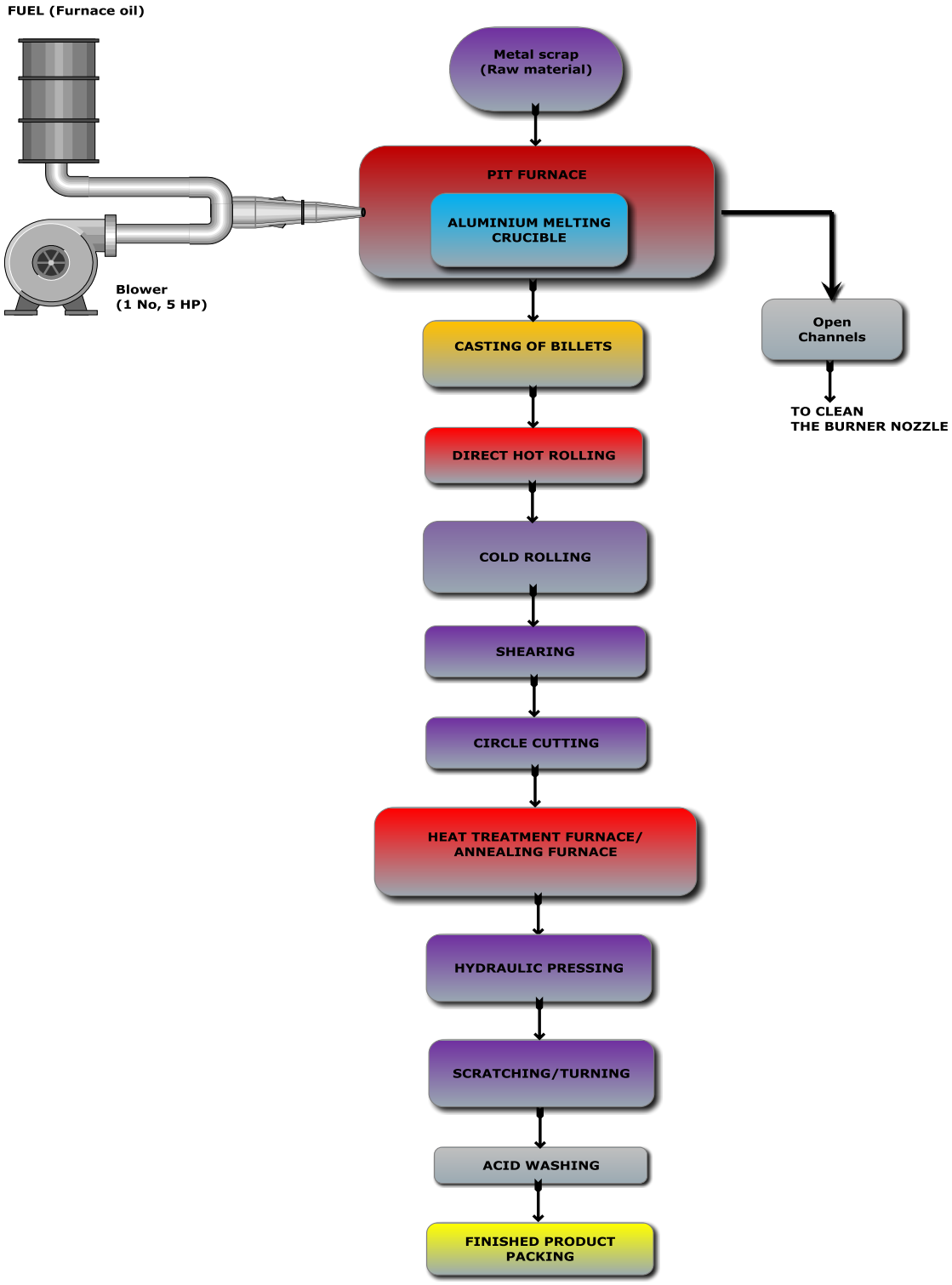
2) Dharam Udyog

S.No	Parameter	Units	Details
1	Fuel used	---	Furnace oil
2	Quantity of Aluminium melted in the pit furnace in the crucible	kg/day	2,400
3	specific heat of Aluminium	kCal/kg ^{o}C	0.22
4	Initial temperature of Aluminium	^{o}C	30
5	Final temperature of Aluminium (molten metal)	^{o}C	690
6	Heat output	kCal/day	3,48,480
7	Quantity of Furnace oil consumption	kg/day	279
8	Calorific value of Furnace oil	kCal/kg	10,000
9	Heat input	kCal/day	27,90,000
10	Efficiency	% age	12.5

3) Aggarwal Dhatu Udyog

S.No	Parameter	Units	Details
1	Fuel used	---	Furnace oil
2	Quantity of Aluminium melted in the pit furnace in the crucible	kg/day	3200
3	specific heat of Aluminium	kCal/kg ^{o}C	0.22
4	Initial temperature of Aluminium	^{o}C	30
5	Final temperature of Aluminium (molten metal)	^{o}C	690
6	Heat output	kCal/day	4,64,640
7	Quantity of Furnace oil consumption	kg/day	409.2
8	Calorific value of Furnace oil	kCal/kg	10,000
9	Heat input	kCal/day	40,92,000
10	Efficiency	% age	11.40

Annexure 2: Process flow diagram



Annexure 3: Detailed technology assessment report- wood gasifier

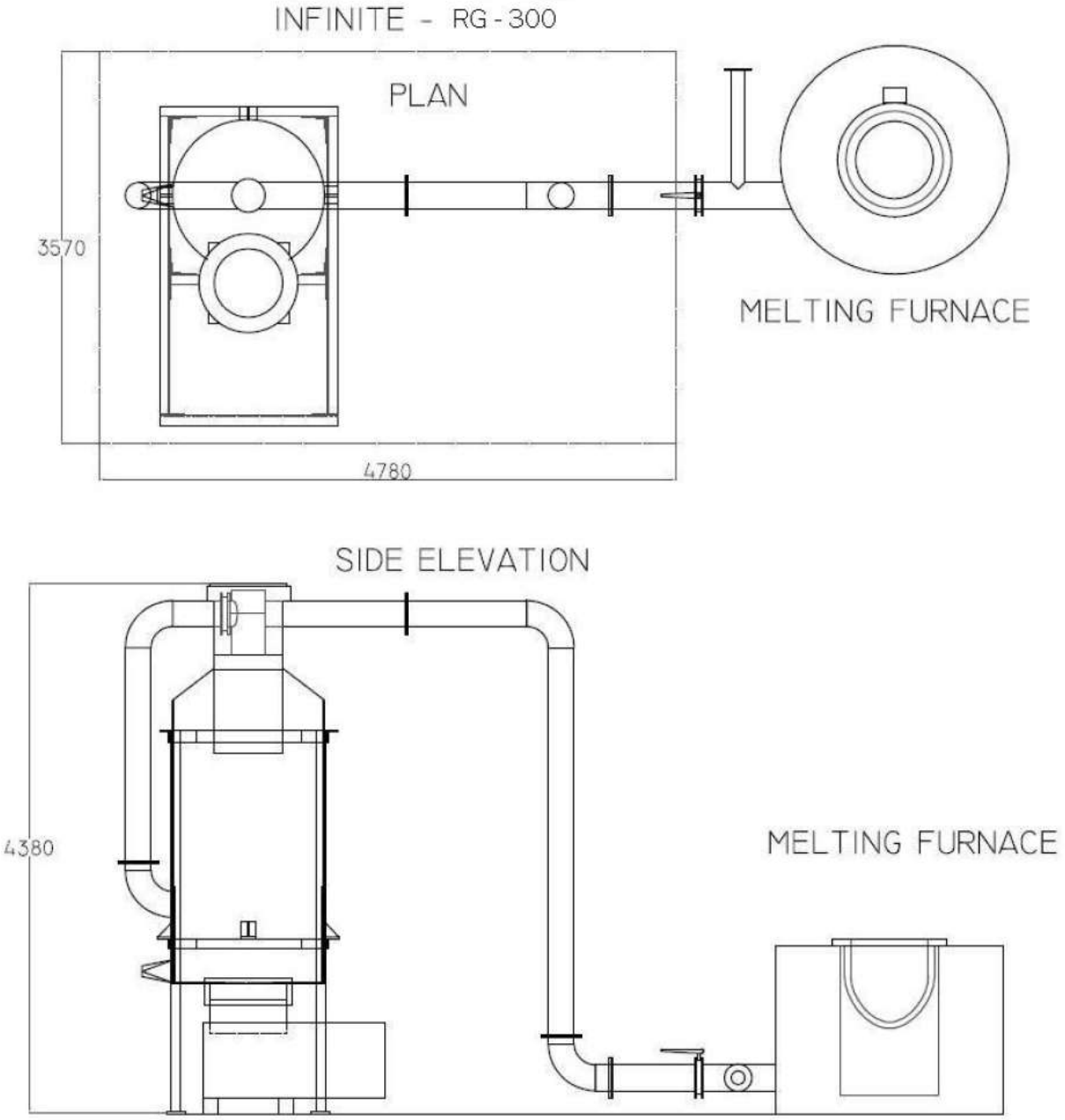
The cost benefit analysis of installing gasifier system for aluminum melting is furnished below:

S.No	Parameter	Unit	Value
1	Present quantity of aluminum melting per batch	kg/batch	400
2	Furnace oil consumption per batch	liter/batch	64
3	Cost of furnace oil	`/liter	25
4	Fuel cost per batch	`/batch	1600
Wood Gasifier			
1	Present quantity of aluminum melting per batch	kg/batch	400
2	Wood consumption in gasifier	kg/batch	224
3	Cost of wood	`/kg	3
4	Wood cost per batch	`/batch	672
5	Electricity cost	`/batch	41
6	Man power cost	`/batch	80
7	Total energy cost per batch	`/batch	793
Cost Benefit analysis			
1	Monetary savings due to wood gasifier per batch	`/batch	807
2	Monetary savings due to wood gasifier per tonne	`/tonne	2018
3	No. of batches per day	batch/day	5
4	No. of days of operation per annum	days/annum	240
5	Monetary savings per annum	` in lakh	9.69
6	Investment required	` in lakh	16.38

Wood Gasifier			
1	Present quantity of aluminum melting per batch	kg/batch	400
2	Furnace oil consumption per batch	liter/batch	64
3	Wood consumption in gasifier	kg/batch	224
4	Calorific value of FO	kcal/kg	10500
5	Calorific value of wood (used in gasifier)	kcal/kg	3500
6	Calorific value of Producer Gas (Biogas)	kcal/kg	3000
7	Heat Required in the Process	kcal/batch	672000
8	Heat equivalent produced by the gasifier	kcal/ batch	674240

**** For every 3.5 kgs of wood produce producer gas which have equivalent energy of 1 liter of furnace oil (Production Factor 0.86 or 86% of the Gasifier, stated in the DPR).***

Annexure 4: Technical drawings of the wood gasifier



Annexure 5: Detailed financial calculations & analysis

Assumptions

Name of the Technology	**Wood gasifier.400kg capacity**		
Rated Capacity	**400 kg**		
Details	***Unit***	***Value***	***Basis***
Installed Capacity	kg	400	
No of working days	Days	240	
No of operating hours	Hours	12	
Proposed Investment			
Wood gasifier - Aluminium Melting	` (in lakh)	14.38	
Service Charge Towards design and engineering for Electromechanical works and Cabling & Switches	` (in lakh)	2.00	
Investment without IDC	` (in lakh)	16.38	
Interest During Implementation	` (in lakh)	0.00	
Total Investment	` (in lakh)	16.38	
Financing pattern			
Own Funds (Equity)	` (in lakh)	4.10	Feasibility Study
Loan Funds (Term Loan)	` (in lakh)	12.29	Feasibility Study
Loan Tenure	years	5.00	Assumed
Moratorium Period	Months	6.00	Assumed
Repayment Period	Months	66.00	Assumed
Interest Rate	%age	10.00%	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			
Monetary savings per ton of Aluminium melting	`/tons	2018	
Annual production	tons	480	
St. line Depn.	%age	5.28	Indian Companies Act
IT Depreciation	%age	15.00	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	12.29	0.90	11.39	1.42
2	11.39	1.80	9.59	1.06
3	9.59	2.16	7.43	0.86
4	7.43	2.40	5.03	0.63
5	5.03	3.00	2.03	0.37
6	2.03	2.03	0.00	0.06
		12.29		

WDV Depreciation **(` in lakh)**

Particulars / years	*1*	*2*
Plant and Machinery		
Cost	16.38	3.28
Depreciation	13.10	2.62
WDV	3.28	0.66

Projected Profitability (` in lakh)

Particulars / Years	*1*	*2*	*3*	*4*	*5*	*6*	*7*	*8*
Revenue through Savings								
Fuel savings	9.69	9.69	9.69	9.69	9.69	9.69	9.69	9.69
Total Revenue (A)	9.69	9.69	9.69	9.69	9.69	9.69	9.69	9.69
Expenses								
O & M Expenses	0.66	0.69	0.72	0.76	0.80	0.84	0.88	0.92
Total Expenses (B)	0.66	0.69	0.72	0.76	0.80	0.84	0.88	0.92
PBDIT (A)-(B)	9.03	9.00	8.96	8.93	8.89	8.85	8.81	8.76
Interest	1.42	1.06	0.86	0.63	0.37	0.06	-	-
PBDT	7.61	7.94	8.10	8.29	8.52	8.79	8.81	8.76
Depreciation	0.86	0.86	0.86	0.86	0.86	0.86	0.86	0.86
PBT	6.75	7.08	7.24	7.43	7.66	7.92	7.94	7.90
Income tax	-	1.81	2.75	2.82	2.90	2.99	2.99	2.98
Profit after tax (PAT)	6.75	5.27	4.48	4.61	4.76	4.94	4.95	4.92

Computation of Tax (` in lakh)

Particulars / Years	*1*	*2*	*3*	*4*	*5*	*6*	*7*	*8*
Profit before tax	6.75	7.08	7.24	7.43	7.66	7.92	7.94	7.90
Add: Book depreciation	0.86	0.86	0.86	0.86	0.86	0.86	0.86	0.86
Less: WDV depreciation	13.10	2.62	-	-	-	-	-	-
Taxable profit	(5.49)	5.32	8.10	8.29	8.52	8.79	8.81	8.76
Income Tax	-	1.81	2.75	2.82	2.90	2.99	2.99	2.98

Projected Balance Sheet

Particulars / Years	*1*	*2*	*3*	*4*	*5*	*6*	*7*	*8*
Liabilities								
Share Capital (D)	4.10	4.10	4.10	4.10	4.10	4.10	4.10	4.10
Reserves & Surplus (E)	6.75	12.02	16.50	21.11	25.87	30.81	35.76	40.68
Term Loans (F)	11.39	9.59	7.43	5.03	2.03	0.00	0.00	0.00
Total Liabilities D)+(E)+(F)	22.23	25.70	28.02	30.23	31.99	34.90	39.85	44.77
Assets	**1**	**2**	**3**	**4**	**5**	**6**	**7**	**8**
Gross Fixed Assets	16.38	16.38	16.38	16.38	16.38	16.38	16.38	16.38
Less: Accm. Depreciation	0.86	1.73	2.59	3.46	4.32	5.19	6.05	6.92
Net Fixed Assets	15.52	14.65	13.79	12.92	12.06	11.19	10.33	9.46
Cash & Bank Balance	6.71	11.05	14.24	17.31	19.94	23.71	29.52	35.31
TOTAL ASSETS	22.23	25.70	28.02	30.23	31.99	34.90	39.85	44.77
Net Worth	10.84	16.11	20.60	25.21	29.97	34.90	39.85	44.77
Dept equity ratio	2.78	2.34	1.81	1.23	0.49	0.00	0.00	0.00

Projected Cash Flow: (` In lakh)

Particulars / Years	*0*	*1*	*2*	*3*	*4*	*5*	*6*	*7*	*8*
Sources									
Share Capital	4.10	-	-	-	-	-	-	-	-
Term Loan	12.29								
Profit After tax		6.75	5.27	4.48	4.61	4.76	4.94	4.95	4.92
Depreciation		0.86	0.86	0.86	0.86	0.86	0.86	0.86	0.86

Total Sources	16.38	7.61	6.13	5.35	5.48	5.63	5.80	5.81	5.79
Application									
Capital Expenditure	16.38								
Repayment of Loan	-	0.90	1.80	2.16	2.40	3.00	2.03	-	-
Total Application	16.38	0.90	1.80	2.16	2.40	3.00	2.03	-	-
Net Surplus	-	6.71	4.33	3.19	3.08	2.63	3.77	5.81	5.79
Add: Opening Balance	-	-	6.71	11.05	14.24	17.31	19.94	23.71	29.52
Closing Balance	-	6.71	11.05	14.24	17.31	19.94	23.71	29.52	35.31

Calculation of Internal Rate of Return `** **(` In lakh)

Particulars / year	***0***	***1***	***2***	***3***	***4***	***5***	***6***	***7***	***8***
Profit after Tax		6.75	5.27	4.48	4.61	4.76	4.94	4.95	4.92
Depreciation		0.86	0.86	0.86	0.86	0.86	0.86	0.86	0.86
Interest on Term Loan		1.42	1.06	0.86	0.63	0.37	0.06	-	-
Cash outflow	(16.38)	-	-	-	-	-	-	-	-
Net Cash flow	(16.38)	9.03	7.19	6.21	6.11	5.99	5.86	5.81	5.79
IRR	41.39%								
NPV	19.32								

Break Even Point

Particulars / Years	***1***	***2***	***3***	***4***	***5***	***6***	***7***	***8***
Variable Expenses								
Oper. & Maintenance Exp (75%)	0.49	0.52	0.54	0.57	0.60	0.63	0.66	0.69
Sub Total (G)	0.49	0.52	0.54	0.57	0.60	0.63	0.66	0.69
Fixed Expenses								
Oper. & Maintenance Exp (25%)	0.16	0.17	0.18	0.19	0.20	0.21	0.22	0.23
Interest on Term Loan	1.42	1.06	0.86	0.63	0.37	0.06	0.00	0.00
Depreciation *(H)*	0.86	0.86	0.86	0.86	0.86	0.86	0.86	0.86
Sub Total (I)	2.45	2.09	1.91	1.69	1.43	1.14	1.08	1.10
Sales (J)	9.69	9.69	9.69	9.69	9.69	9.69	9.69	9.69
Contribution (K)	9.20	9.17	9.14	9.12	9.09	9.06	9.03	8.99
Break Even Point (L= G/I)	26.61%	22.83%	20.84%	18.51%	15.74%	12.54%	12.01%	12.18%
Cash Break Even {(I)-(H)}	17.21%	13.40%	11.38%	9.02%	6.22%	2.99%	2.43%	2.56%
Break Even Sales (J)*(L)	2.58	2.21	2.02	1.79	1.52	1.21	1.16	1.18

Return on Investment

Particulars / Years	***1***	***2***	***3***	***4***	***5***	***6***	***7***	***8***	***Total***
Net Profit Before Taxes	6.75	7.08	7.24	7.43	7.66	7.92	7.94	7.90	59.92
Net Worth	10.84	16.11	20.60	25.21	29.97	34.90	39.85	44.77	222.25
									26.96%

Debt Service Coverage Ratio

Particulars / Years	***1***	***2***	***3***	***4***	***5***	***6***	***7***	***8***	***Total***
Cash Inflow									
Profit after Tax	6.75	5.27	4.48	4.61	4.76	4.94	4.95	4.92	30.81
Depreciation	0.86	0.86	0.86	0.86	0.86	0.86	0.86	0.86	5.19
Interest on Term Loan	1.42	1.06	0.86	0.63	0.37	0.06	0.00	0.00	4.40
TOTAL (M)	9.03	7.19	6.21	6.11	5.99	5.86	5.81	5.79	40.40

DEBT

Interest on Term Loan	1.42	1.06	0.86	0.63	0.37	0.06	0.00	0.00	4.40
Repayment of Term Loan	0.90	1.80	2.16	2.40	3.00	2.03	0.00	0.00	12.29
Total (N)	2.32	2.86	3.02	3.03	3.37	2.09	0.00	0.00	16.69
Average DSCR (M/N)	2.42								

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\ 9th July. 2010

To
Mr. Venu Gopal
M/s Zenith energy services pvt ltd

09652000590

Ref: Your mail

Sub : Offer for Biomass gasifier plant– reg

Si r,
We are pleased to submit our offer for INFINITE –RG – 300 (600 KW_{th}) biomass gasifier system for your Aluminium melting furnace.

INFINITE –RG – 300 (600 KW_{th}) has a thermal rating of 600 KWth (5,15,000 kcal/hr). The system can generate sufficient producer gas to fire one burner in your melting furnace. The system shall be provided with one manual type burner of 600 KW_{th} capacity .The maximum diesel replacement would be limited to 50ph. The wood consumption (**dry wood with 15% moisture**) would be 200 kg/h max.

The actual wood consumption (wood with 20-22% moisture), would be 4 times the fuel oil requirement, viz., if the actual oil consumption is 35 lph, the wood consumption would not exceed 140 kg/h.

Our gasifiers have several unique features which make it ideal for any industry, viz.

- Very small foot print of 800 sq.ft. for a 600 KW_{th} (50 lph oil equivalent) system.
- Total dry processing and consequently no water pollution and related pollution control requirements.
- Quick start capability of the system can be started in 12 minutes.
- Short delivery schedule of less than 8 weeks.
- Installation & commissioning within 4 days and minimum distruption in plant operation.

You would be eligible for availing capital subsidy provided by Ministry of New & Renewable Energy Sources, Government of India of Rs 4,00,000 /- on installation of Model INFINITE –RG – 300 (600 KW_{th}) the system offered.

If you require any further information / clarifications, please feel free to contact us. For any further Information you can also visit our website www.infiniteenergyindia.com

Very Truly yours

Naval Kishore Agarwal
(Mobile no. 09212084933)

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\ 9th July. 2010

To
Mr. Venu Gopal
M/s Zenith energy services pvt ltd

09652000590

Sub : Offer for Biomass Gasification Plant – reg

Quotation

S No	Item	Qty	Unit Price	Price in Rupees
1	INFINITE Vergassen 3G Series gasifier Model INFINITE - RG – 300 (600 KW_{th}) As per offer enclosed Including Filter	1	11,50,000	11,50,000
2	Gas burner (INFINITE Vortex -85 – 115KW_{th}) with valve modulating type	1	1,12,500	1,12,500
3	Erection & Commissioning		60,000	60,000
4	Sub Total			13,22,500/-
4	VAT @ 2 % against c- form			26,450/-
	Total			13,48,950/-
			Rupees Thirteen Lakhs Fourty Eight thousand nine hundred & fifty only	
	Gas piping with insulation (as per actual layout)			As per Actual Layout Rs 1750/ ft length
	Wood Dryer (optional) extra	1		90,000/-

Terms and Conditions : As per offer enclosed

For Infinite Energy (P) Ltd

(Director)

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