

DETAILED PROJECT REPORT ON BIOMASS GASIFIER SYSTEM-UP TO 200TON CAPACITY KILN (EAST & WEST GODAVARI REFRACTORIES CLUSTER)



Bureau of Energy Efficiency

Prepared By



Reviewed By



**BIO MASS GASIFIER FOR
DOWN DRAFT KILN UPTO 200 TPD**

EAST AND WEST GODAVARI REFRACTORIES CLUSTER

BEE, 2010

Detailed Project Report on Biomass Gasifier-Up to 200 Tons/Batch

Refractories SME Cluster, Rajahmundry, Andhra Pradesh (India)

New Delhi: Bureau of Energy Efficiency

Detail Project Report No.: **E&W /BMG/01**

For more information

Bureau of Energy Efficiency (BEE)

(Ministry of Power, Government of India)

4th Floor, Sewa Bhawan

R. K. Puram, New Delhi – 110066

Telephone +91-11-26179699

Fax+91-11-26178352

Websites: www.bee-india.nic.in

Email: [jsood@beenet.in/](mailto:jsood@beenet.in)

pktiwari@beenet.in

Acknowledgement

We are sincerely thankful to the Bureau of Energy Efficiency, Ministry of Power, for giving us the opportunity to implement the BEE SME project in “refractory Cluster, East & West Godavari District of Andhra Pradesh”. We express our sincere gratitude to all concerned officials for their support and guidance during the conduct of this exercise.

Dr. Ajay Mathur, Director General, BEE

Smt. Abha Shukla, Secretary, BEE

Shri Jitendra Sood, Energy Economist, BEE

Shri Pawan Kumar Tiwari, Advisor (SME), BEE

Shri Rajeev Yadav, Project Economist, BEE

Andhra Pradesh Industrial & Technical Consultancy Organization Ltd. (APITCO) is also thankful to “*The Ceramic Manufacturing Welfare Association, Rajamundry at East & west Godavari Districts*” for their valuable inputs, co-operation, support and identification of the units for energy use and technology audit studies and facilitating the implementation of BEE SME program.

We take this opportunity to express our appreciation for the excellent support provided by unit owners, local service providers, and equipment suppliers for their active involvement and their valuable inputs in making the program successful and in completion of the Detailed Project Report (DPR).

APITCO is also thankful to all the SME owners, plant in charges and all workers of the SME units for their support during the energy use and technology audit studies and in implementation of the project objectives.

APITCO Limited

Hyderabad

Contents

<i>List of Annexure</i>	<i>vii</i>
<i>List of Tables</i>	<i>vii</i>
<i>List of Figures</i>	<i>vii</i>
<i>List of Abbreviation</i>	<i>viii</i>
<i>Executive summary</i>	<i>ix</i>
<i>About BEE'S SME program</i>	<i>xi</i>
1 INTRODUCTION	1
1.1 Brief Introduction about cluster.....	1
1.1.1 Production process	1
1.2 Energy performance in existing situation	3
1.2.1 Fuel and electricity consumption of a typical unit in the cluster.....	3
1.2.2 Average production by a typical unit in the cluster.....	3
1.2.3 Specific Energy Consumption	3
1.3 Existing technology/equipment.....	3
1.3.1 Description of existing technology.....	3
1.3.2 Its role in the whole process	4
1.4 Establishing the baseline for the equipment to be changed	4
1.4.1 Design and operating parameters	4
1.4.2 Coal consumption & Operating Efficiency	5
1.5 Barriers for adoption of new and energy efficient technology / equipment	5
1.5.1 Technological Barriers	5
1.5.2 Financial Barrier.....	6
1.5.3 Skilled manpower	6
1.5.4 Other barrier(s)	6
2. TECHNOLOGY OPTION FOR ENERGY EFFICIENCY IMPROVEMENTS.....	7
2.1 Detailed description of technology/equipment selected.....	7
2.1.1 Description of technology	7
2.1.2 Technology /Equipment specifications.....	8

2.1.3	Justification of the technology selected.....	8
2.1.4	Superiority over existing technology/equipment	8
2.1.5	Availability of the proposed technology/equipment.....	9
2.1.6	Source of technology/equipment for the project	9
2.1.7	Service/technology providers	9
2.1.8	Terms of sales	9
2.1.9	Process down time during implementation	9
2.3	Suitable unit/plant size.....	9
3.	ECONOMIC BENEFITS OF NEW ENERGY EFFICIENT TECHNOLOGY	10
3.1	Technical benefits.....	10
3.1.1	Fuel savings per year	10
3.1.4	Improvement in production	10
3.1.5	Reduction in raw material consumption	10
3.1.6	Reduction in other losses	10
3.2	Monetary benefits	10
3.2.1	Monetary savings due to reduction in energy consumption	10
3.3	Social benefits.....	11
3.3.1	Improvement in working environment in the plant	11
3.3.2	Improvement in skill set of workers	11
3.4	Environmental benefits	11
3.4.1	Reduction in effluent generation.....	11
3.4.2	Reduction in GHG emission such as CO ₂ , NO _x , etc	11
3.4.3	Reduction in other emissions like SO _x	11
4.	INSTALLATION OF NEW ENERGY EFFICIENT TECHNOLOGY	12
4.1	Cost of technology/equipment implementation	12
4.1.1	Cost of technology/equipments	12
4.1.2	Other costs.....	12
4.2	Arrangement of funds	12

4.2.1	Entrepreneur's contribution	12
4.2.2	Loan amount	12
4.2.3	Terms & conditions of loan	12
4.3	Financial indicators	13
4.3.1	Cash flow analysis	13
4.3.2	Simple payback period	13
4.3.3	Net Present Value (NPV)	13
4.3.4	Internal rate of return (IRR)	13
4.3.5	Return on investment (ROI)	13
4.4	Sensitivity analysis in realistic, pessimistic and optimistic scenarios	14
4.5	Procurement and implementation schedule	14

List of Annexures

Annexure 1: Process Flow Diagram.....	15
Annexure 2: Technology Assessment Report- Bio Mass Gasifier.....	16
Annexure 3: Technical Drawings of The Bio Mass Gasifier	17
Annexure 4: Detailed Financial Calculations & Analysis	18
Annexure 5: Procurement and Implementation Plan with Schedule	19
Annexure 6: Technology/Equipment and Service Providers	24
Annexure 7: Techno-Commercial Bids	25

List of Tables

Table 1.1: Energy consumption of a typical unit	3
Table 1.2: Specific energy consumption for a typical unit	3
Table 1.3 Energy Consumption & Efficiency of units in the cluster	5
Table 2.1 Proposed Technology Equipment Specifications	8
Table 4.1: Total project cost.....	12
Table 4.2 Financial parameters	13
Table 4.3 Sensitivity analysis	14

List of Figures

Figure 1: General Process Flowchart Refractories Cluster.....	4
---	---

LISTS OF ABBREVIATIONS

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

EXECUTIVE SUMMARY

APITCO Ltd is executing BEE-SME program in East and West Godavari (Refractories) Cluster, supported by Bureau of Energy Efficiency (BEE) with an overall objective of improving the energy efficiency in cluster units. Rajahmundry is one of the oldest clusters of state of Andhra Pradesh producing refractories and potteries. These industries were in operation since last four to five decades. Earlier, these industries were used to produce potteries for domestic market, which are commonly used for storing pickles for longer time. The products called 'Jars' are the most commonly used container in Southern India specifically in the state of Andhra Pradesh for storing various food items. During the course of time, the demand for potteries (Jars) was considerably reduced due to change in economy and food habits. These pottery making units were diversified to produce refractories which are used in industries as insulation.

Majority of the industries are producing refractories and very few units are producing potteries. These industries have been in operation for the last 25 to 30 years. The main raw materials are clay, refractory grog, other chemicals etc.

The major Energy used in cluster is Coal and Wood as a fuel and Electricity. Coal and wood are used as fuel in down draft kilns for heat treatment of refractory bricks. Electricity is used for drive the prime movers used in Brick Press, grinding machines, clay mixers, crushers etc. The total energy cost in refractory industries varies from 40% to 50 % of production cost. The down draft kilns requires higher thermal energy, which is major share of total energy consumed.

The Down Draft kiln is a common type of kiln used in all cluster units for curing/heat treatment of refractory bricks. Coal is used as fuel and the capacity of the down draft kiln is 50 tons/batch. Wood is also used in small quantities for enhancing the burning of the coal in the kiln. These kilns are very old design and are constructed with the local masonries and the thermal efficiency of the kilns is found to be low. The design of the down draft kilns is more or less identical in all cluster units.

This DPR is prepared for installation of Bio mass gasifier for supply of heat to down draft kiln for enhancing the combustion efficiency and reducing fuel consumption.

The DPR highlights the details of the study conducted for assessing the potential for implementation of Biomass gasifier for kiln, potential of energy saving, possible 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)	37
2	Coal consumption in existing scenario	Tons/annum	4200
3	Biomass (Wood) consumption in proposed scenario	Tons/annum	6000
4	Cost of electricity consumption in Gasifier	` /annum	1.5
5	Monetary benefit	` (in Lakh)/year	37.50
6	Simple payback period	Years	0.99
7	NPV	` (in Lakh)	91.20
8	IRR	%age	74.22
9	ROI	%age	27.73
10	Average DSCR	Ratio	3.82
11	Process down time	Week	1
12	CO ₂ emission reduction	Tons/annum	7560

The projected profitability and cash flow statements indicate that the project implementation i.e. installation of Bio Gasifier System for improving the efficiency will be financially viable and technically feasible.

ABOUT BEE'S SME PROGRAM

Bureau of Energy Efficiency (BEE) is implementing a BEE-SME Program to improve the energy performance in 29 selected SME's clusters. East and West Godavari Refractories Cluster is one of them. The BEE's SME Program 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 SME's 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 SME's clusters.

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

Activity 1: Energy use and technology audit

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

Activity 2: Capacity building of stake holders in cluster on energy efficiency

In most of the cases SME entrepreneurs are dependent on the locally available technologies, service providers for various reasons. To address this issue BEE has also undertaken capacity building of local service providers and entrepreneurs/ Managers of SME's 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.

Activity 3: 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 (DPR's) for a minimum of five technologies in three capacities for each technology.

Activity 4: Facilitation of innovative financing mechanisms for implementation of energy efficiency projects

The objective of this activity is to facilitate the uptake of energy efficiency measures through innovative financing mechanisms without creating market distortion.

1 INTRODUCTION

1.1 Brief Introduction about cluster

Rajahmundry is one of the oldest Industrial clusters and located in state of Andhra Pradesh and manufacturing refractories products and potteries. These industries were in operation since last four to five decades. Earlier, these industries were used to manufacture potteries for domestic market, which are commonly used for storing pickles for longer time. The products called 'Jars' are the most commonly used container in Southern India specifically in the state of Andhra Pradesh for storing various food items. During the course of time, the demand for potteries (Jars) was considerably reduced due to change in economy and food habits. These pottery making units were diversified to refractory manufacturing due to demand.

Majority of the industries are manufacturing refractories and very few units are potteries. There are about 83 industries in the cluster. These industries have been in operation for the last 20 to 30 years. The main raw materials are clay, refractory grog, other chemicals etc. The major Energy used in refractory cluster is Electricity and Fuels like Coal and Wood. Electricity is used for drive the prime movers of brick making units, grinding machines, mixers etc. Coal and wood are used as fuel in down draft kilns for heat treatment of the bricks.

The cost of energy is varies from 30% to 50% of production cost which is depending up on the kilns and capacities. In refractory industries, major cost is contributed by energy cost followed by raw material cost and labor cost.

1.1.1 Production process

The main process operation for manufacturing refractory bricks adopted in cluster units are as follows:

The raw material i.e. Clay 60%, refractory Greg 40% and water is feed manually and sent to clay mister for uniform mixing . The refractory bricks are either prepared by manually (Hollow bricks) or in molding machines (Solid bricks) and the bricks are dried naturally/ using fans for 2 to 3 days and naturally dried bricks are loaded to the kiln.

The heating of the bricks is done under slow firing in kiln for 72 hours for removing the moisture content. In the slow firing, for every one hour, about one shovel of coal (3.5 kgs) in each grate is burnt. The temperature is maintained between 100 – 200°C. During this period all the doors and damper existing in the kiln are kept open.

After slow firing firstly raw material charging door in kiln is closed. Out of 24 holes provided in kiln, 4 no's of top holes are closed every 8 hrs from the time of charging door closed. After closing the all the doors, rapid firing system started by adding 1 shovel of coal per hour in every coal feeding doors.

After 72 hours, the full firing period is carried out for 48 hours and the temperature of the kiln is increased from 200 °C to 1050 °C. The damper position in kiln is kept opened for about 25%. After completion of the rapid firing for 48 hours, all the coal feed points /grates and damper are closed and firing is stopped. Then the kiln is left for maintain the temperature (soaking) for 24 hours and then the kiln is taken for natural cooling and the bricks are unloaded after 24 hours of natural cooling.

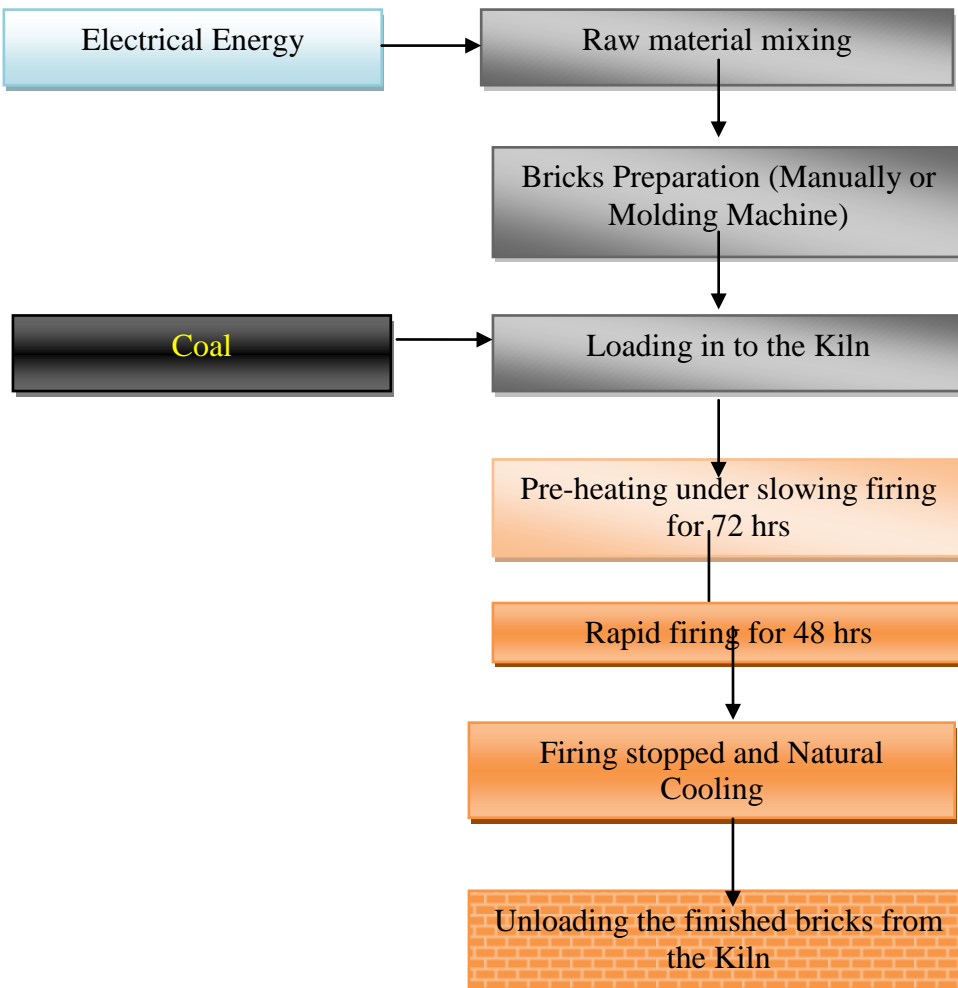


Figure 1: General Process Flowchart of a Typical Refractory Manufacturing Unit

1.2 Energy performance in existing situation

1.2.1 Fuel and electricity consumption of a typical unit in the cluster

The main energy forms used in a typical unit in the cluster are electricity, coal, and wood. Electricity is used for drive the prime mover of brick making unit, mixers, grinding machine, etc. Coal and wood is used as fuel in the down draft kiln. The energy consumption of a typical unit in cluster is furnished in Table 1.1 below:

Table 1.1: Energy consumption of a typical unit

S.No	Name of Unit	Yearly Consumption		
		Coal (Tons)	Electricity (kWh)	Wood (Tons)
1	M/s. Padma Sree Refractories	1500	17695	800

1.2.2 Average production by a typical unit in the cluster

The average production in a year in a typical unit is 1500 tons.

1.2.3 Specific Energy Consumption

The main energy forms used in the refractories production are electricity, coal, and wood. The Specific energy consumption for electrical and thermal energy per ton 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	Sp. Energy Consumption
1	Coal Consumption	kg of coal / kg of Product	0.94
2	Grid Electricity consumption	kWh/ kg of Product	11.05
3	Wood consumption	kg of Wood/ kg of Product	8.00

1.3 Existing technology/equipment

1.3.1 Description of existing technology

The D.D kiln is a common type of kiln used in all cluster units for curing/heat treatment of refractory bricks. Coal is used as fuel and the capacity of the down draft kiln is 50 tons/batch. Wood is also used in small quantities for enhancing the burning of the coal in the kiln. About 1 to 2 batches of products are produced in a month. The DD kiln is operated on continuous basis for 6 days for each batch as per the requirement.

These kilns are very old design and are constructed with the local masonries and the thermal efficiency of the kilns is found to be low. The design of the down draft kilns is more or less identical in all cluster units. The major draw backs of the existing down draft kilns are:

- There is no proper provision for supplying combustion air and the combustion air intake and resulting high unburnt carbon.
- Less heat transfer between flue gases and refractories
- Inadequacies in maintaining and controlling uniform furnace temperature resulting in uneven surface hardness
- Low combustion efficiency due to poor control system
- High radiation losses from the charging ports of the kiln
- No control over the temperature and fuel feeding
- High flue gas temperature and no proper heat utilization in the furnace
- Low efficiency of the furnaces

1.3.2 Its role in the whole process

The down draft kiln is essential structure for manufacturing of refractory Products where heat treatment and curing of the refractory bricks will be done.

1.4 Establishing the baseline for the equipment to be changed

1.4.1 Design and operating parameters

The main energy forms used for DD kiln are coal and wood. Electricity is also used in small quantities for operation of clay mixing, crushers, ball mills, brick press and lighting etc.

The down draft kiln is one of the old design kiln and constructed locally and doesn't have any name plate details. The life of the DD kiln is considered at 25 to 30 years. The production capacity of the DD kiln is 200 tons/ batch. The coal consumption depends on quantity of Refractories and types, grade of coal and calorific value, temperature required. The operating parameters of the DD kiln collected for a typical unit during the field visit is furnished below:

- Duration of the batch : 15-18 days
- Products : hollow refractory bricks

- Designed capacity :200 Tons
- Production : 180 tons
- Coal consumption : 280 tons
- Calorific value of coal : 4200 kcal/kg
- Excess air measured : 30%
- Slow firing : 5 days
- Rapid firing : 8 days
- Heat maintained : 2 day
- Normal cooling : 1 day

1.4.2 Coal consumption & Operating Efficiency

The operating efficiency of the DD Kilns in various units had been evaluated during energy use and technology audits using coal as fuel. The efficiencies of the DD kilns are found to be in the range of 10 % to 15 % in various units of the cluster. The details of coal consumption, electricity consumption and efficiencies of DD kilns are furnished below in table 1.3 below:

Table 1.3 Energy Consumption & Efficiency of units in the cluster

S.No	Name of the unit	Coal Consumption (Tons/annum)	Electricity Consumption (kWh/annum)	DD Kiln Efficiency (%)
1	Padma Sree Refractories	1500	17695	15

1.5 Barriers for adoption of new and energy efficient technology / equipment

1.5.1 Technological Barriers

The major technical barriers that prevented the implementation of the Bio mass gasifier in the cluster are:

- No single unit has Bio mass gasifier in the cluster units, 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 implemented Bio mass gasifier system, 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 Bio mass gasifier among the SME owners in the cluster
- Thirdly, majority of the owners of the cluster are more focused on the successful technologies implementation in the cluster before implementation and as so far, no unit had been implemented Bio mass gasifier.
- Lastly, there is a strong feeling in the unit owners, that gasifier are not suitable for down draft kilns; this may be due to lack of awareness.

1.5.2 Financial Barrier

- Though, many SME owners are interested to install Bio mass gasifier, due to high initial investment and the SME owners could not implement in the cluster.
- Further, lack of awareness of the losses and monetary benefit of the Bio mass gasifier was also one of the major barrier that prevented implementation of the Bio mass 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 Bio mass gasifier and vigorous circulation of the financial incentives of the Bio mass gasifier and motivation from the local state nodal agencies among the unit's owners may affect the owners in taking up the technology for implementation.

2. TECHNOLOGY OPTION FOR ENERGY EFFICIENCY IMPROVEMENTS

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; pyrolysis is only one of the steps in the conversion process and is combusted with air (partial supply of air) and reduction of the product of combustion, (water vapor and carbon dioxide) into combustible gases, (carbon monoxide, hydrogen, methane, some higher hydrocarbons) and inerts, (carbon dioxide and nitrogen). The 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 down draft kiln. 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 m³ of producer gas in the burner. Flame temperatures as high as 1250 °C can be obtained by optimal pre-mixing of air with gas. For applications which require 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 high temperatures (400- 650 oC) are required for kilns and normally are done by conventional burning of coal in down draft kilns. Gasifier is well suited for such applications.

Bio mass Gasifier

This system is meant for biomass having density in excess of 250 kg/m³. Theoretically, the ratio of air-to-fuel required for the complete combustion of the wood, defined as stoichiometric combustion is 6:1 to 6.5:1, with the end products being CO₂ and H₂O. 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, and is cooled, cleaned and is 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 Bio mass gasifier for 200 tons per batch and of above 50 ton capacity per batch of refractories in down draft kilns are furnished below:

Table 2.1 Proposed Technology Equipment Specifications

S. No	Parameter	Details
1	Model	---
2	Mode	Burning Application
3	Rated output	1250000 kCal/hr
4	Design	Down Draft with Throat
5	Fuel	Wood Chips
6	Feed size	2" - 3" (any dimensions)
7	Moisture content of fuel	15%
8	Fuel Feeding Cycle	Hourly once
9	Fuel charging	Manually
10	Hopper Holding Capacity	1000 Kg (Approx.)
11	Auxiliary Power	10 HP

2.1.3 Justification of the technology selected

The present down draft kilns has low efficiency due to poor combustion, less air supply resulting high unbrunt carbon, high flue gas losses, no proper monitoring of air and fuel supply. The Bio mass gasifier will have more efficiency due to better combustion, high combustion efficiency, less flue gas losses, less manpower cost, easily control on fuel feeding, less fuel consumption etc. Further, the parameters can be critically controlled in the Bio mass gasifier. Overall, the energy cost per ton of refractories is low than the coal firing. The following are the reasons for selection of this technology:

- Low energy cost
- Better control of the kiln temperature
- Low flue gas losses hence more efficiency
- Zero GHG emissions

2.1.4 Superiority over existing technology/equipment

The following are the benefits of the Bio mass gasifier:

- 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 Bio mass gasifier suppliers are available locally i.e. Tanuku which is 50 km's from the Rajahmundry town. The details of the local service provider are furnished in Annexure 6.

2.1.6 Source of technology/equipment for the project

The technology is indigenous and is locally available nearby cluster location.

2.1.7 Service/technology providers

The service providers are available locally.

2.1.8 Terms of sales

Details term and condition of sale of supplier is given at annexure 7.

2.1.9 Process down time during implementation

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

2.2 Life cycle assessment and risks analysis

The life of the Bio mass gasifier is considered at 20 years.

2.3 Suitable unit/plant size

The proposed Bio mass gasifier capacity is suitable for up to 200 tons per batch and can be installed in all the units having similar capacity.

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 Bio mass gasifier is for reducing production cost. Based on the detailed studies undertaken, the coal consumption in of DD kiln for 180 tonne production is 280 tons however in gasifier total wood required would be 400 ton/batch. Hence, for total 15 batches in a year, saving in coal consumption would be 4200 tonne per year however; at the same time total biomass consumption would be 6000 tons per year.

3.1.2 Electricity savings per year

No electrical savings is envisaged by Bio mass gasifier, further, the Bio mass gasifier consumes electricity consumption for operation of fans and wood cutting. Total electricity cost would be ` 1.5 lakh/year.

3.1.3 Improvement in product quality

The project activity is installation of new Bio mass gasifier, due to better control of the thermal parameters; the product quality may improve to certain extent.

3.1.4 Improvement in production

The combustion of gas is faster and hence, the batch time may reduce and production may be increased.

3.1.5 Reduction in raw material consumption

No significant effect on the raw materials consumption.

3.1.6 Reduction in other losses

None

3.2 Monetary benefits

3.2.1 Monetary savings due to reduction in energy consumption

The installation of new Bio mass gasifier reduces production cost and monetary savings is estimated at ` 37.50 lakhs per annum. Detailed energy and monetary benefits calculation is shown in annexure 2.

3.3 Social benefits

3.3.1 Improvement in working environment in the plant

The project activity is Bio mass gasifier and the gas combusted is a renewable and clean energy, the heat dissipation outside is lower than the present kiln and hence the 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 CO₂, NO_x, etc

Due to implementation of the Bio mass gasifier, the consumption of the coal is avoided and replaced with renewable form of energy and displaces fossil fuels. The proposed project saves about 4200 tons coal per year. This roughly corresponds to 7560 tonnes of CO₂ emission reduction per year.

3.4.3 Reduction in other emissions like SO_x

As the project activity reduces coal consumption, the SO_x emissions also reduces to some extent.

4. INSTALLATION OF NEW ENERGY EFFICIENT TECHNOLOGY

4.1 Cost of technology/equipment implementation

4.1.1 Cost of technology/equipments

The total cost for installation of Bio mass gasifier for down draft kiln up to 200 tons capacity per batch is estimated at ` 28.00 lakhs, which includes cost of Bio mass gasifier, gas burner, gas distribution lines and wood chipper etc as per quotation provided at annexure 7.

4.1.2 Other costs

Other cost includes applicable taxes and erection and commissioning cost. The details of the item wise cost are furnished 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	28.00
2	Civil Works, Erection and Commissioning	`in lakh	5.0
	Applicable taxes	`in lakh	4.00
3	Total Investment	`in lakh	37.00

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 ` 9.25 lakhs.

4.2.2 Loan amount

The term loan is 75% of the total project cost, which works out at ` 27.75 lakhs.

4.2.3 Terms & conditions of loan

The interest rate is considered at 10.00% which is normal interest rate 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 ` 29.38 lakhs in first year operation and ` 147.95 lakhs at the end of sixth year.

4.3.2 Simple payback period

The total project cost of the proposed technology is ` 37.00 lakhs and monetary savings due to reduction in energy/production cost is ` 37.50 lakhs and payback period works out to be 0.99 year.

4.3.3 Net Present Value (NPV)

The Net present value of the investment at 10.0% interest rate works out to be `91.20 lakhs

4.3.4 Internal rate of return (IRR)

The after tax Internal Rate of Return of the project works out to be 74.22%. Thus the project is financially viable. The average DSCR works out at 3.82.

4.3.5 Return on investment (ROI)

The average return on investment of the project activity works out at 27.73%.

Details of all the financial parameters for the replacement of conventional furnace with energy efficient furnace are presented in Table 4.2 below:

Table 4.2 Financial parameters

S. No	Parameter	Unit	Value
1	Simple payback period	Years	0.99
2	NPV	` in lakh	91.20
3	IRR	%age	74.22
4	ROI	%age	27.73
5	DSCR	Ratio	3.82

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

Table 4.3 Sensitivity analysis

<i>Particulars</i>	<i>IRR</i> %	<i>NPV</i> ` in lakh	<i>ROI</i> %	<i>DSCR</i>
Normal	74.22	91.20	27.73	3.82
5% increase in monetary savings	78.95	98.38	27.87	4.04
5% decrease in monetary savings	69.48	84.01	27.57	3.61

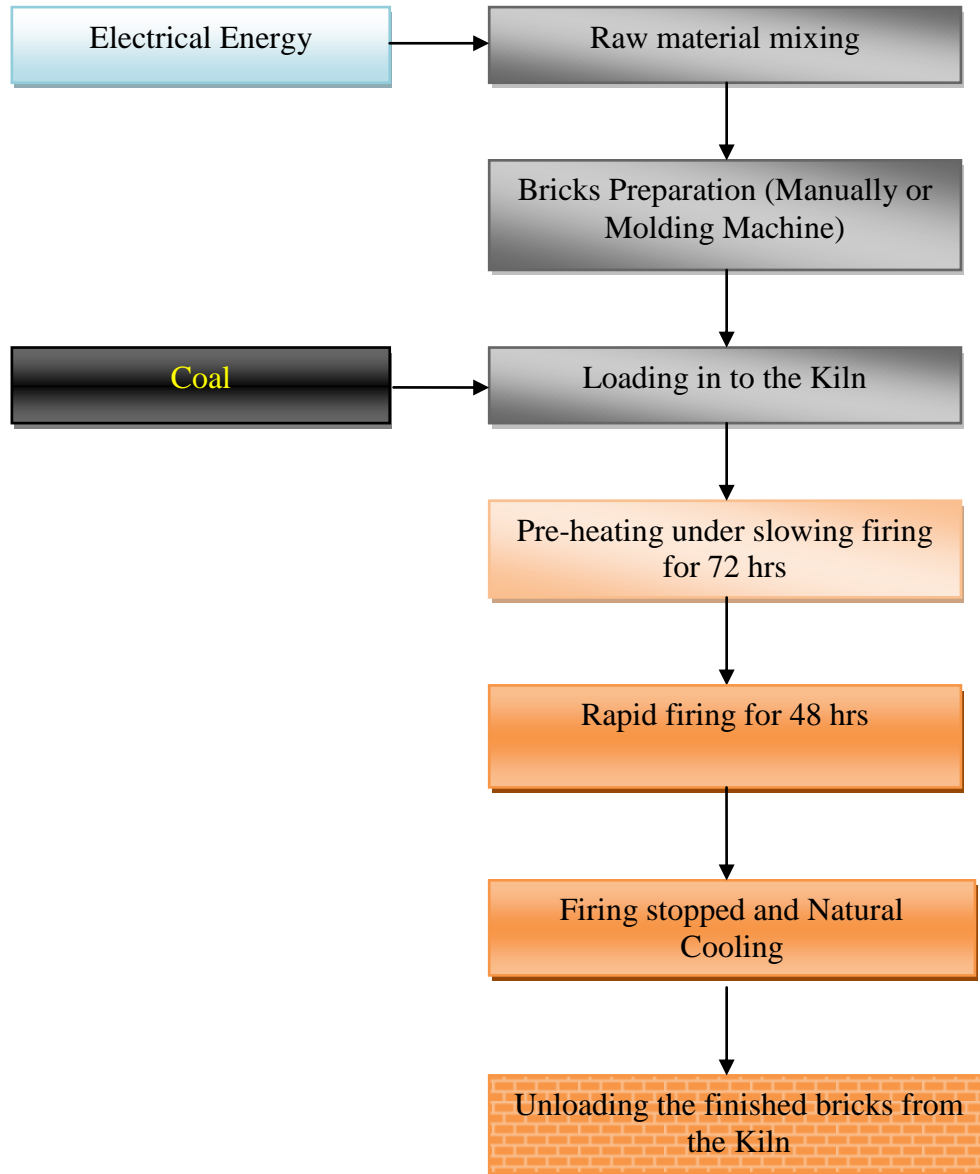
In each scenario, other inputs are assumed as constant.

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 5.

ANNEXURES

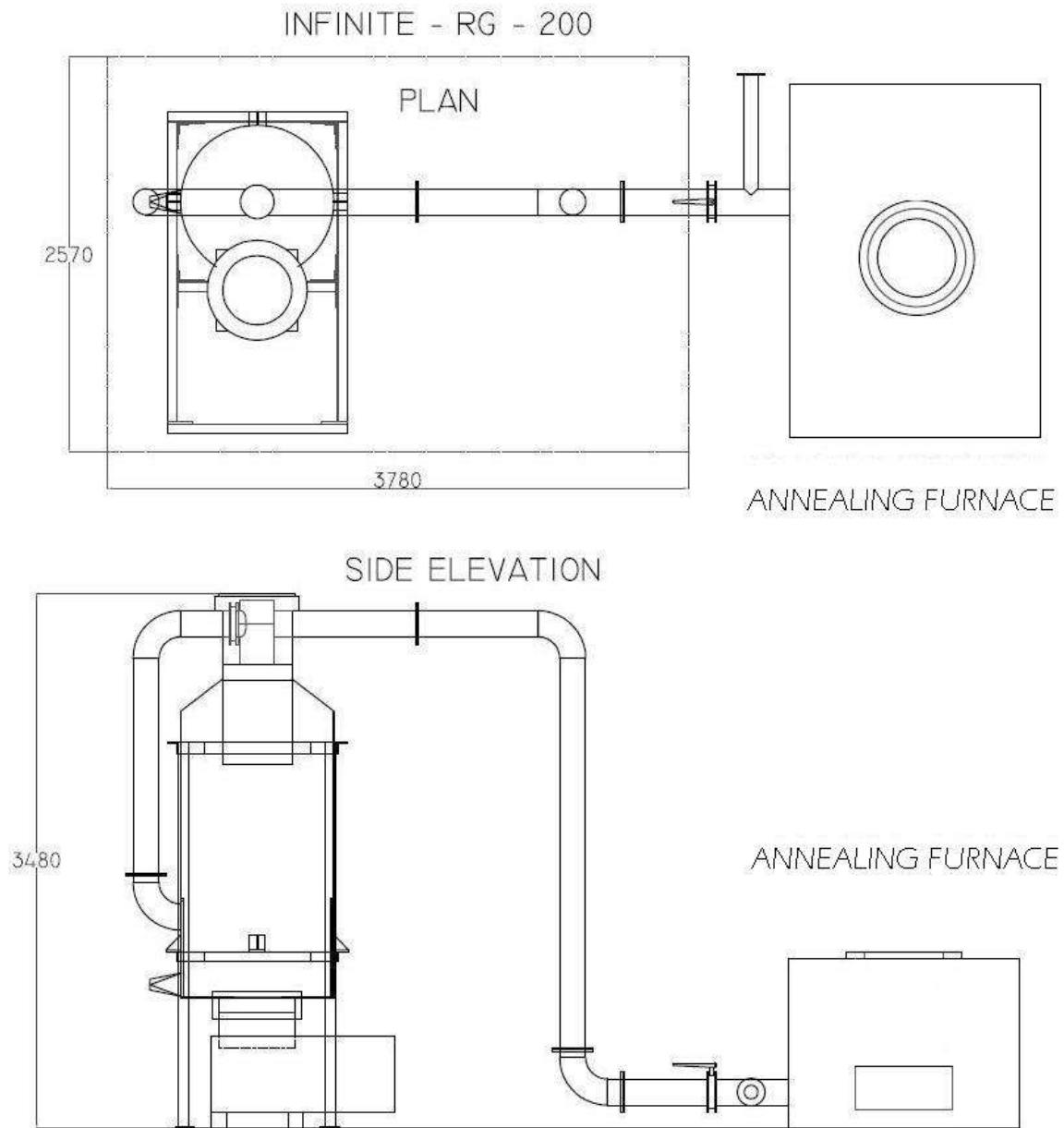
Annexure 1: Process Flow Diagram



Annexure 2: Technology Assessment Report- Bio Mass Gasifier

S.No	Parameter	Unit	Value
1	Installed Capacity	Tons/batch	200
2	Coal consumption during rapid firing	Tons/batch	280
3	Coal Calorific Value	kcal/kg	4200
4	Cost of coal	`./Ton	4500
5	Total Heat Generated by input Coal	kcal/Batch	1176000000
6	Total Heat Losses	%	60
7	Actual heat Supplied (Utilized)	kcal/Batch	470400000
8	Total No of Days/Batch	Days	16
9	Total Heat Supplied Avg.	kcal/Day	29400000
10	Capacity of Gasifier	kcal/hr	1250000
11	Total heat supplied by Gasifier	kcal/Day	30000000
12	Total heat available from Gasifier	kcal/day	30000000
13	Fuel cost	`In lakhs/batch	12.60
14	Wood Calorific Value	kcal/kg	2000
15	Wood consumption required in gasifier	tons/Day	25.00
16	Total Wood Required in gasifier	Tons/Batch	400.00
17	Cost of wood	`./batch	2500
18	Total Wood Cost in gasifier	` In lakhs/batch	10.00
19	Electricity cost for Operation of gasifier	` In lakhs/batch	0.10
20	Total energy cost	` In lakhs/batch	10.10
21	Savings due to Bio Mass gasifier System	` In lakhs/batch	2.50
22	No. of batches	batches/year	15
23	Total Energy Savings cost	` lakhs/Year	37.50
24	Investment	` lakhs	37.00
25	Payback period	Years	0.99

Annexure 3: Technical Drawings of The Bio Mass Gasifier



Annexure 4: Detailed Financial Calculations & Analysis

Details design and drawing will be provided by the supplier after placing of order.

Annexure 5: Financial calculation

Name of the Technology	Bio Mass gasifier		
Rated Capacity	1250000 kCal/hr		
Details	Unit	Value	Basis
Installed Capacity	kCal/hr	1250000	
No of batch	No.	15	Feasibility Study
Proposed Investment			
Cost of plant & Machinery	₹(in lakh)	28.00	Feasibility Study
Erection & Commissioning	₹(in lakh)	5.0	Feasibility Study
Applicable taxes	₹(in lakh)	4.00	
Total Investment	₹(in lakh)	37.00	Feasibility Study
Financing pattern			
Own Funds (Internal Accruals)	₹(in lakh)	9.25	Feasibility Study
Loan Funds (Term Loan)	₹(in lakh)	27.75	Feasibility Study
Loan Tenure	Years	5	Assumed
Moratorium Period	Months	6	Assumed
Repayment Period	Months	66	Assumed
Interest Rate	%	10.00	
Estimation of Costs			
O& M Costs	%(on Plant & Equip)	10.00	Feasibility Study
Annual Escalation	%	10.00	Feasibility Study
Estimation of Revenue			
Monetary saving per batch	₹/Batch	2.50	-
No. of batch per year	No.	15	-
St. line Depreciation	%	5.28	Indian Companies Act
IT Depreciation	%	80.00	Income Tax Rules
Income Tax	%	33.99	Income Tax Act 2008-09

Estimation of Interest on term loan**₹(in lakh)**

Years	Opening Balance	Repayment	Closing Balance	Interest
1	27.75	1.20	26.55	3.22
2	26.55	3.60	22.95	2.49
3	22.95	4.80	18.15	2.08
4	18.15	6.00	12.15	1.54
5	12.15	7.90	4.25	0.87
6	4.25	4.25	0.00	0.11
		27.75		

WDV Depreciation**₹(in lakh)**

Particulars / years	1	2
Plant and Machinery		
Cost	37.00	7.40
Depreciation	29.60	5.92

WDV	7.40	1.48
-----	------	------

Projected Profitability

` (in lakh)

Particulars / Years	1	2	3	4	5	6	7	8
Fuel savings	37.50	37.50	37.50	37.50	37.50	37.50	37.50	37.50
Total Revenue (A)	37.50	37.50	37.50	37.50	37.50	37.50	37.50	37.50
Expenses								
O & M Expenses	3.70	4.07	4.48	4.92	5.42	5.96	6.55	7.21
Total Expenses (B)	3.70	4.07	4.48	4.92	5.42	5.96	6.55	7.21
PBDIT (A)-(B)	33.80	33.43	33.02	32.58	32.08	31.54	30.95	30.29
Interest	3.22	2.49	2.08	1.54	0.87	0.11	-	-
PBDT	30.58	30.94	30.95	31.03	31.21	31.43	30.95	30.29
Depreciation	1.95	1.95	1.95	1.95	1.95	1.95	1.95	1.95
PBT	28.62	28.99	28.99	29.08	29.26	29.47	28.99	28.34
Income tax	-	8.50	10.52	10.55	10.61	10.68	10.52	10.30
Profit after tax (PAT)	28.62	20.48	18.47	18.53	18.65	18.79	18.47	18.04

Computation of Tax

` (in lakh)

Particulars / Years	1	2	3	4	5	6	7	8
Profit before tax	28.62	28.99	28.99	29.08	29.26	29.47	28.99	28.34
Add: Book depreciation	1.95	1.95	1.95	1.95	1.95	1.95	1.95	1.95
Less: WDV depreciation	29.60	5.92	-	-	-	-	-	-
Taxable profit	0.98	25.02	30.95	31.03	31.21	31.43	30.95	30.29
Income Tax	-	8.50	10.52	10.55	10.61	10.68	10.52	10.30

Projected Balance Sheet

Particulars / Years	1	2	3	4	5	6	7	8
Liabilities								
Share Capital (D)	9.25	9.25	9.25	9.25	9.25	9.25	9.25	9.25
Reserves & Surplus (E)	28.62	49.11	67.58	86.11	104.76	123.55	142.03	160.07
Term Loans (F)	26.55	22.95	18.15	12.15	4.25	0.00	0.00	0.00
TOTAL LIABILITIES (D)+(E)+(F)	64.42	81.31	94.98	107.51	118.26	132.80	151.28	169.32
Assets								
Gross Fixed Assets	37.00	37.00	37.00	37.00	37.00	37.00	37.00	37.00
Less Accm. Depreciation	1.95	3.91	5.86	7.81	9.77	11.72	13.68	15.63
Net Fixed Assets	35.05	33.09	31.14	29.19	27.23	25.28	23.32	21.37
Cash & Bank Balance	29.38	48.21	63.84	78.33	91.03	107.53	127.95	147.95
TOTAL ASSETS	64.42	81.31	94.98	107.51	118.26	132.80	151.28	169.32
Net Worth	37.87	58.36	76.83	95.36	114.01	132.80	151.28	169.32
Debt Equity Ratio	2.87	2.48	1.96	1.31	0.46	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	9.25	-	-	-	-	-	-	-	-
Term Loan	27.75								
Profit After tax		28.62	20.48	18.47	18.53	18.65	18.79	18.47	18.04
Depreciation		1.95	1.95	1.95	1.95	1.95	1.95	1.95	1.95
Total Sources	37.00	30.58	22.44	20.43	20.49	20.60	20.75	20.43	19.99
Application									
Capital Expenditure	37.00								
Repayment Of Loan	-	1.20	3.60	4.80	6.00	7.90	4.25	-	-
Total Application	37.00	1.20	3.60	4.80	6.00	7.90	4.25	-	-
Net Surplus	-	29.38	18.84	15.63	14.49	12.70	16.50	20.43	19.99
Add: Opening Balance	-	-	29.38	48.21	63.84	78.33	91.03	107.53	127.95
Closing Balance	-	29.38	48.21	63.84	78.33	91.03	107.53	127.95	147.95

IRR

₹ (in lakh)

Particulars / months	0	1	2	3	4	5	6	7	8
Profit after Tax		28.62	20.48	18.47	18.53	18.65	18.79	18.47	18.04
Depreciation		1.95	1.95	1.95	1.95	1.95	1.95	1.95	1.95
Interest on Term Loan		3.22	2.49	2.08	1.54	0.87	0.11	-	-
Cash outflow	(37.00)	-	-	-	-	-	-	-	-
Net Cash flow	(37.00)	33.80	24.93	22.50	22.03	21.47	20.86	20.43	19.99
IRR	74.22%								

NPV	91.20
-----	-------

Break Even Point

Particulars / Years	1	2	3	4	5	6	7	8
Variable Expenses								
Oper. & Maintenance Exp (75%)	2.78	3.05	3.36	3.69	4.06	4.47	4.92	5.41
Sub Total(G)	2.78	3.05	3.36	3.69	4.06	4.47	4.92	5.41
Fixed Expenses								
Oper. & Maintenance Exp (25%)	0.93	1.02	1.12	1.23	1.35	1.49	1.64	1.80
Interest on Term Loan	3.22	2.49	2.08	1.54	0.87	0.11	0.00	0.00
Depreciation (H)	1.95	1.95	1.95	1.95	1.95	1.95	1.95	1.95
Sub Total (I)	6.10	5.46	5.15	4.73	4.18	3.56	3.59	3.76
Sales (J)	37.50	37.50	37.50	37.50	37.50	37.50	37.50	37.50
Contribution (K)	34.73	34.45	34.14	33.81	33.44	33.03	32.58	32.09
Break Even Point (L= G/I)	17.57%	15.86%	15.08%	13.98%	12.50%	10.77%	11.02%	11.70%
Cash Break Even {(I)-(H)}	11.94%	10.19%	9.36%	8.20%	6.66%	4.85%	5.03%	5.62%
Break Even Sales (J)*(L)	6.59	5.95	5.66	5.24	4.69	4.04	4.13	4.39

Return on Investment

₹ (in lakh)

Particulars / Years	1	2	3	4	5	6	7	8	Total
Net Profit Before Taxes	28.62	28.99	28.99	29.08	29.26	29.47	28.99	28.34	231.74
Net Worth	37.87	58.36	76.83	95.36	114.01	132.80	151.28	169.32	835.83
									27.73%

Debt Service Coverage Ratio

₹ (in lakh)

Particulars / Years	1	2	3	4	5	6	7	8	Total
Cash Inflow									
Profit after Tax	28.62	20.48	18.47	18.53	18.65	18.79	18.47	18.04	123.55
Depreciation	1.95	1.95	1.95	1.95	1.95	1.95	1.95	1.95	11.72
Interest on Term Loan	3.22	2.49	2.08	1.54	0.87	0.11	0.00	0.00	10.31
Total (M)	33.80	24.93	22.50	22.03	21.47	20.86	20.43	19.99	145.59

DEBT

Interest on Term Loan	3.22	2.49	2.08	1.54	0.87	0.11	0.00	0.00	10.31
Repayment of Term Loan	1.20	3.60	4.80	6.00	7.90	4.25	0.00	0.00	27.75
Total (N)	4.42	6.09	6.88	7.54	8.77	4.36	0.00	0.00	38.06
DSCR	7.64	4.09	3.27	2.92	2.45	4.78	0.00	0.00	3.82
Average DSCR (M/N)	3.82								

Annexure 5: Procurement and Implementation Plan with Schedule

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 6: Technology/Equipment and Service Providers

Equipment details	Source of technology	Service/technology providers
Bio mass gasifier	India	<p>ASSOCIATED ENGINEERING WORKS</p> <p>Street : Gamini Compound, Main Road</p> <p>City : Tanuku</p> <p>91-8819-222950</p> <p>+91-9347067901</p> <p>91-8819-224801</p> <p>Website : http://www.gasifiers.co.in</p>

Annexure 7: Techno-Commercial Bids



**ASSOCIATED
ENGINEERING
WORKS**

Manufacturers of Renewable Energy Divices : Biomass Gasifiers

G.M. Satyanarayana, M.E., (Mechanical) D.V.H.S., (Oil Hydraulics) U.S.A., M.I.I.F.
Managing Director

Ref :

GF/AP/55/2010-11

Date :

Dt.19-03-2011

To
M/s APITCO Ltd
8th Floor,
Parishrama Bhavan,
Basheer Bagh
HYDERABAD - 500 004.

Ph : 040-23237333 Fax : 040-23298945
email: sudheesh1974@yahoo.co.in

Dear Sir,

Sub: Quotation for Gasifiers for Refractory Kilns-Regd.

We refer this letter to our phone discussions and also your mail enquiry wherein you indicated that you are looking for Wood Gasifiers to replace present coal burning for Refractory Kilns of various sizes. We wish to introduce ourselves as Developers and manufacturers of Gasifiers useful for industrial heating applications for economical replacement of fossil fuels.

Our Gasifiers are downdraft design and our systems are based on our own in-house development. Our Industry is recognized by DSIR (Government of India) as an In-house R & D industry. We are proud to inform that we received " DSIR-National Award" from Government of India, Ministry of Science & Technology for developing innovative Gasifiers. Regarding the capacities suited for the Kilns described by you, we sent separate letter and below we are submitting Quotation for 2 Gasifiers Viz.,

GT-1000 Model system with an output of 12,50,000 Kcal/Hr and
GT-700 Model System having an output of 5,00,000 Kcal/Hr.

Contd..2..

GAMINI COMPOUND, MAIN ROAD, TANUKU - 534 211 (A.P),INDIA. PH.: 08819-222950, 223410 FAX : 91-8819-224801

TIN : 28640136167 ★ e-mail : aewgamini@rediffmail.com & gastrumwood@gmail.com ★ URL : www.gastrumwood.com

Associated Engineering Works.,

Continuation Sheet.,

Page..2..

The equipment description is similar to both but specifications will be changing.

SPECIFICATIONS FOR GT-1000 GASIFIER:

- 1) Thermal Mode Wood Gasifier having an output of 12,50,000 K.Cal/Hr for Kiln application.

SPECIFICATIONS:

Model	: GT-1000
Mode	: Heating Application
Rated output	: 12,50,000 K.Cal/Hr.
Design	: Down Draft
Fuel	: Wood Chips
Wood Chip Size	: 3" - 4" (any dimension)
Fuel Consumption	: 500 Kg/Hr.(Max.)
Fuel Feeding	: Continuous / Manual Loading
Fuel Lifting	: By Motorized Hoist
Acceptable Moisture content of fuel	: Below 15%
Hopper Holding capacity	: 1000 Kg (Approx.)
Auxiliaries	: 10 HP
Floor space required	: 1250 Sq.ft.(125 Sq.Mtrs)apprx. (25 feet Ht.)

- 2) Thermal Mode Wood Gasifier having an output of 5,00,000 K.Cal/Hr for Kiln application.

SPECIFICATIONS FOR GT-700 GASIFIER:

Model	: GT-700
Mode	: Heating Application
Rated output	: 5,00,000 Kcal/Hr (200 KW)
Design	: Down Draft with Throat
Fuel	: Wood Chips
Feed size	: 2" - 3" (any dimensions)
Fuel Consumption	: 200 Kg/Hour(Max)
Moisture content of fuel	: 15%
Fuel Feeding Cycle	: Hourly once
Fuel charging	: Manually
Hopper Holding Capacity	: 800 Kg (Approx.)
Auxiliary Power	: 6 HP
Floor Space	: 400 Sq.ft(20' Ht).

The description of various items are as below:

GASIFIER:

This is a downdraft Gasifier with throat and vertical in nature. The feed is in the form of wood chips charged from top hopper. Air is admitted into the reactor zone and gas is formed by high temperature oxidation and subsequent reduction. A moving grate is provided at the bottom & supports the burning mass in the combustion zone.

Contd..3..

Associated Engineering Works.,

Continuation Sheet.,

Page..3..

A Motorized hoist is provided (for GT-1000 Model) for lifting the wood chips onto the loading platform. The woodchips are to be loaded into the hopper manually at regular intervals. The Gasifier bottom is open and stands in a water seal. The ash & cinder from the combustion of Biomass fall into this water tank and to be collected on a regular basis. The Gasifier is provided with a loading platform for ease of charging woodchips.

REFRACTORY LINING:

The Gasifier inside portions are lined with refractory linings for conserving heat and protecting the surfaces. The refractory coating is laid in-situ.

GAS CLEANING SUB-SYSTEM:

The gas from the Gasifier enters a chamber wherein the dust particles are separated by gravity from the hot gas.

GAS BURNER:

The Burner is specially developed and fabricated for burning the Producer gas generated in the Gasifier. The combustion air for burning the gas is supplied using a separate Air Blower.

OUR SCOPE OF SUPPLY:

GASIFIER -consisting of Reaction Chamber,
Stock Hopper,
Loading Hopper,
Platform &
Interconnects

Air Blower with Motor Blower for gas generation,
Producer Gas Burner,
Gas line upto a max. of 20 length
Air Blower with Motor for Burner(combustion air),
Panel Board,
AND
Installation of system at site.

ITEMS IN USER SCOPE:

- * Construction of Water tank
for installing Gasifier.
- * Transportation of system to user's installation site.
- * Unloading of material at site and arranging Masons &
Labourers during installation.
- * Giving power supply to all Motors.
- * Providing water tap near the Gasifier water tank.

Contd..4..

Associated Engineering Works.,

Continuation Sheet.,

Page..4..

PRICE OF THE SYSTEM:

The cost of GT-700 Gasifier(200 KW) Capacity described as above is

Rs.14,00,000 (Rupees Fourteen Lacs only)

The cost of GT-1000 Gasifier (500 KW) Capacity described as above is Rs.28,00,000/-

(Rupees Twenty Eight Lacs only)

SALES TAX:

VAT @ 4% is extra.

PAYMENT TERMS:

Advance of 50% with Order

Second installment of 30% before dispatch the system and

balance 20% after installing system at site.

DELIVERY:

The system will be delivered in 3 months time after receipt of order with advance.

GUARANTEE:

The Gasifier is guaranteed for one year.

INCOME TAX DEPRECIATION:

Central Government is allowing 80% accelerated income tax depreciation on the investment made on the Gasifier.

Please study the details and revert for any clarifications.

Thanking You,

Yours faithfully,
for ASSOCIATED ENGINEERING WORKS.,

(G.M.SATYANARAYANA)

Mg.Director

Mobile: 093470 67901



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



APITCO Limited

8th floor, Parisrama Bhavan

Basheerbagh, Hyderabad -500004

Phones: +91- 040-23237333, 23237981,

Fax: +91-40-23298945

E-mail: hyd1_apitco@bsnl.in

Website: www.apitco.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