DETAILED PROJECT REPORT
ON
COAL GASIFIER SYSTEM-100 TONS CAPACITY KILN
(EAST & WEST GODAVARI REFRACTORIES CLUSTER)

ENERGY IS LIFE
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Bureau of Energy Efficiency

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ISTSL

COAL GASIFIER FOR
DOWN DRAFT KILN UPTO 100 TPD

EAST AND WEST GODAVARI REFRACTORIES CLUSTER

BEE, 2010

Detailed Project Report on Coal Gasifier-Up to 100 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

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APITCO Limited

Hyderabad

Contents

List of Annexure

List of Tables

List of Figures

LISTS OF ABBREVATIONS

- 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 Coal 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 Coal 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)	62.17
2	Coal consumption in existing scenario	Tons/annum	2800.0
3	Coal consumption in proposed scenario	Tons/annum	2133.4
4	Coal saving	Tons/annum	666.6
5	Cost of electricity consumption in Gasifier	` /annum	1.20
6	Monetary benefit	` (in Lakh)	28.80
7	Simple payback period	Years	2.16
8	NPV	` (in Lakh)	43.21
9	IRR	%age	29.19
10	ROI	%age	25.86
11	Average DSCR	Ratio	1.84
12	Process down time	Week	1
13	CO_2 emission reduction	Tons/annum	1200

The projected profitability and cash flow statements indicate that the project implementation i.e. installation of Coal 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^{o}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 ^{o}C to 1050 ^{o}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.

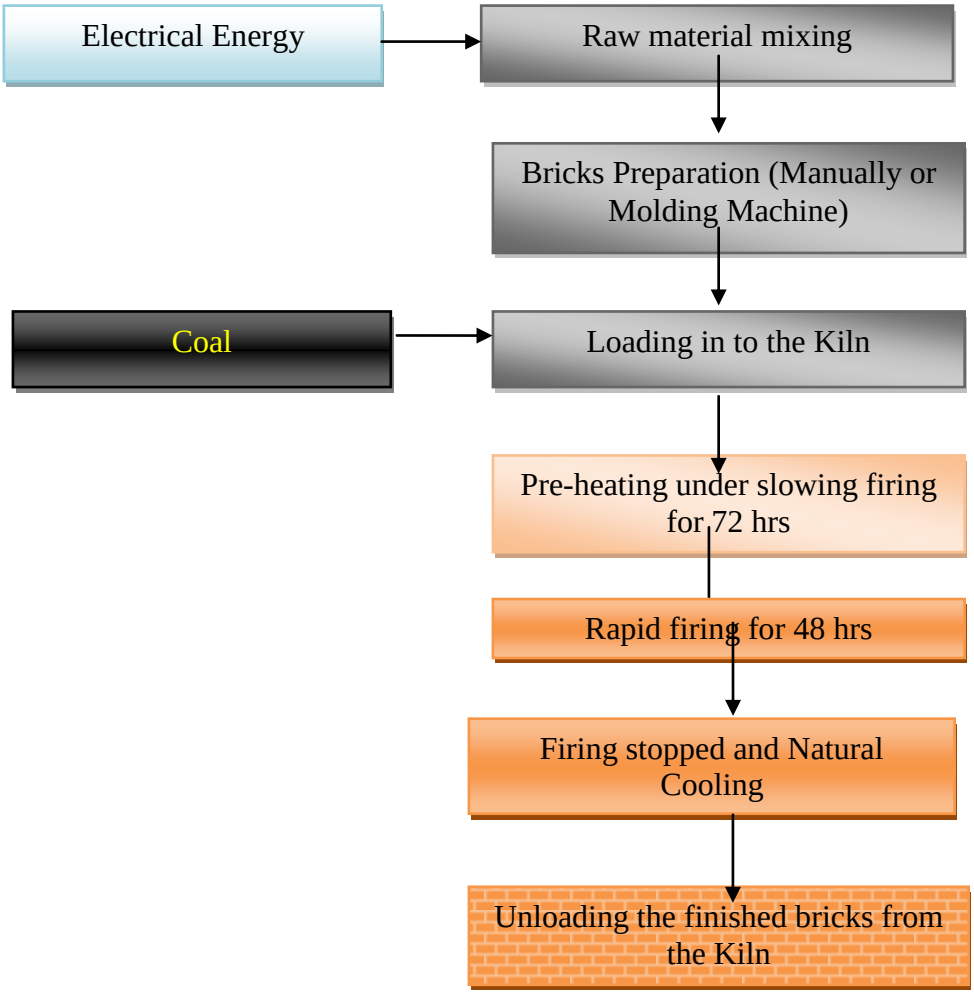


Figure 1: General Process Flowchart of a Typical Refractory Manufacturing Unit

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	Pioneer Ceramics	1350	32144	300

1.2.2 Average production by a typical unit in the cluster

The average production in a year in a typical unit is 1350 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	1.00
2	Grid Electricity consumption	kWh/ kg of Product	23.81
3	Wood consumption	kg of Wood/ kg of Product	7.50

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 100 tons/batch. Wood is also used in small quantities for enhancing the burning of the coal in the kiln. About 2 to 3 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 35 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 : 8 days
- Products : hollow refractory bricks
- Designed capacity :100Tons

- Production : 90 tons
- Coal consumption : 140 tons
- Calorific value of coal : 4200 kcal/kg
- Excess air measured : 30%
- Slow firing : 2 days
- Rapid firing : 4 days
- Heat maintained : 1 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	Pioneer Ceramics	1350	32144	13.75

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 coal gasifier in the cluster are:

- No single unit has Coal 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 Coal 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 Coal 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 Coal 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 Coal 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 Coal gasifier was also one of the major barrier that prevented implementation of the Coal 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 Coal gasifier and vigorous circulation of the financial incentives of the Coal 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

Coal 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 m^3 of producer gas in the burner. Flame temperatures as high as 1250 0C 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

Coal Gasifier

Gasification is a process that converts organic or fossil based carbonaceous materials into carbon monoxide, hydrogen, carbon dioxide and methane. This is achieved by reacting the material at high temperatures (>700°C), without combustion, with a controlled amount of oxygen and/or steam. The resulting gas mixture is called syngas (from synthesis gas or synthetic gas) or producer gas and is itself a fuel. The power derived from gasification of biomass and combustion of the resultant gas is considered to be a source of renewable energy, the gasification of fossil fuel derived materials such as plastic is not considered to be renewable energy.

The advantage of gasification is that using the syngas is potentially more efficient than direct combustion of the original fuel because it can be combusted at higher temperatures or even in fuel cells, so that the thermodynamic upper limit to the efficiency defined by Carnot's rule is higher or not applicable. Syngas may be burned directly in gas engines, used to produce methanol and hydrogen, or converted via the Fischer-Tropsch process into synthetic fuel. Gasification can also begin with material which would otherwise have been disposed of such as biodegradable waste. In addition, the high-temperature process refines out corrosive ash elements such as chloride and potassium, allowing clean gas production from otherwise problematic fuels. Gasification of fossil fuels is currently widely used on industrial scales to generate electricity.

During gasification, the coal is blown through with oxygen and steam (water vapor) while also being heated (and in some cases pressurized). If the coal is heated by external heat sources the process is called "allothermal", while "autothermal" process assumes heating of the coal via exothermal chemical reactions occurring inside the gasifier itself. It is essential that the oxidizer supplied is insufficient for complete oxidizing (combustion) of the fuel. During the reactions mentioned, oxygen and water molecules oxidize the coal and produce a gaseous mixture of carbon dioxide (CO2), carbon monoxide (CO), water vapor (H2O), and molecular hydrogen (H2). (Some by-products like tar, phenols, etc. are also possible end products, depending on the specific gasification technology utilized.) This process has been conducted in-situ within natural coal seams (referred to as underground coal gasification) and in coal refineries. The desired end product is usually syngas (i.e., a combination of H2 + CO), but the produced coal gas may also be further refined to produce additional quantities of H2.

2.1.2 Technology /Equipment specifications

The technical specifications of the proposed Coal gasifier for 50 tons per batch of refractories in down draft kilns are furnished below:

Table 2.1 Proposed Technology Equipment Specifications

S. No	Parameter	Details
1	Model	UT-TE-1000
2	Installed capacity	1000 kW
3	Thermal Output	200x10^4 Kcal/hr
4	Fuel	Coal
5	Feed size	>20mm to 80mm

S. No	Parameter	Details
6	Fuel Consumption	3 to 5 kg
7	Moisture content of fuel	<10%
8	Calorific Value of Producer Gas	1200-1375 kcal/Nm3
9	Producer Gas Temp. at Gasifier outlet in C	120-140
10	Maximum Flame Temp in C	1350

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 Coal 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 coal gasifier. Overall, the energy cost per ton of refractories is low than the normal 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

2.1.4 Superiority over existing technology/equipment

The following are the benefits of the Coal 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 Coal gasifier suppliers are available India. The details of the local service provider are furnished in Annexure 5.

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 Coal gasifier is one week.

2.2 Life cycle assessment and risks analysis

The life of the Coal gasifier is considered at 20 years.

2.3 Suitable unit/plant size

The proposed Coal gasifier capacity is suitable for up to 100 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 Coal gasifier is for reducing production cost. Based on the detailed studies undertaken, the coal consumption in of DD kiln for 90 tonne production is 140 tons however in coal gasifier total coal required would be 106.67 ton/batch. Hence, for total 20 batches in a year, saving in coal consumption would be 666.6 tonne per year.

3.1.2 Electricity savings per year

No electrical savings is envisaged by Coal gasifier, further, the coal gasifier consumes electricity consumption for operation. Total electricity cost would be ` 1.20 lakh/year.

3.1.3 Improvement in product quality

The project activity is installation of new Coal 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 Coal gasifier reduces production cost and monetary savings is estimated at ` 28.80 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 coal gasifier and the gas combusted is 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 CO_2, NO_X, etc

The proposed project saves about 666.6 tons coal per year. This roughly corresponds to 1200 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 SOx 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 coal gasifier for down draft kiln up to 100 tons capacity per batch is estimated at ` 54.55 lakhs, which includes cost of coal gasifier, gas burner, gas distribution lines and wood chipper as per quotation 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 coal gasifier, gas burner and wood dryer, pipe lines, etc	`in lakh	54.55
2	Civil Works, Erection and Commissioning	`in lakh	2.0
	Applicable taxes	`in lakh	5.62
3	Total Investment	`in lakh	62.17

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 ` 15.54 lakhs.

4.2.2 Loan amount

The term loan is 75% of the total project cost, which works out at ` 46.63 lakhs.

4.2.3 Terms & conditions of loan

The interest rate is considered at 10.00% which is prevailing 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 ` 19.10 lakhs in first year operation and ` 88.20 lakhs at the end of eighth year.

4.3.2 Simple payback period

The total project cost of the proposed technology is ` 62.17 lakhs and monetary savings due to reduction in energy/production cost is ` 28.80 lakhs and payback period works out to be 2.16 years.

4.3.3 Net Present Value (NPV)

The Net present value of the investment at 10.0% interest rate works out to be ` 43.21 lakhs

4.3.4 Internal rate of return (IRR)

The after tax Internal Rate of Return of the project works out to be 29.19%. Thus the project is financially viable. The average DSCR works out at 1.84.

4.3.5 Return on investment (ROI)

The average return on investment of the project activity works out at 25.86%.

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	2.16
2	NPV	` in lakh	43.21
3	IRR	%age	29.19
4	ROI	%age	25.86
5	DSCR	Ratio	1.84

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

Table 4.3 Sensitivity analysis

Particulars	*IRR* %	*NPV* ` in lakh	*ROI* %	*DSCR*
Normal	29.19	43.21	25.86	1.84
5% increase in fuel savings	31.56	48.95	26.12	1.94
5% decrease in fuel savings	26.80	37.46	25.56	1.74

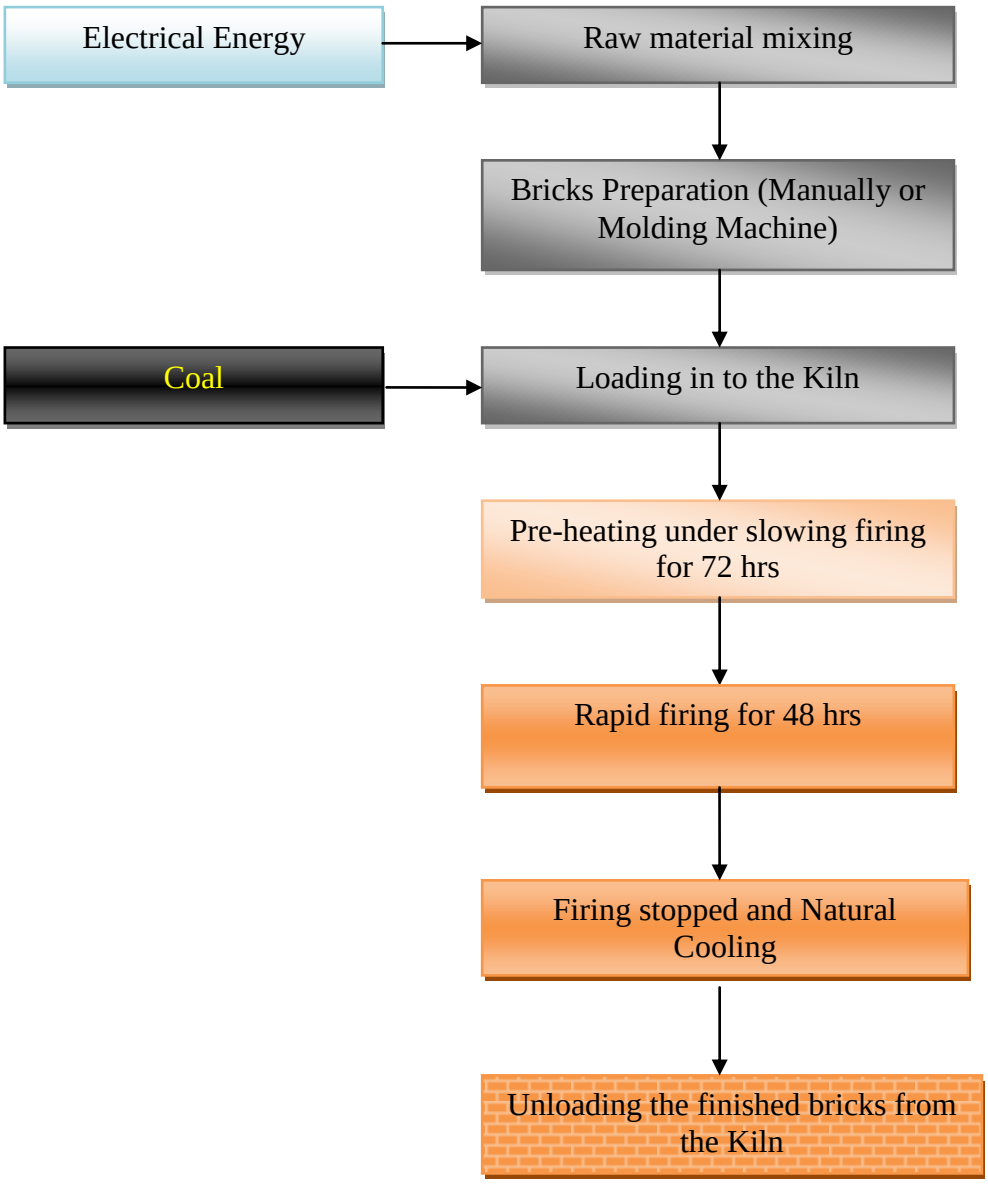
In each scenario, other inputs are assumed as constant.

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- Coal Gasifier

S.No	Parameter	Unit	Value
1	Installed Capacity	Tons/batch	100
2	Coal consumption during rapid firing	Tons/batch	140
3	Coal Calorific Value	kcal/kg	4200
4	Cost of coal	Rs./Ton	4500
5	Total Heat Generated by input Coal	kcal/Batch	588000000
6	Total Heat Losses	%	55
7	Actual heat Supplied (Utilized)	kcal/Batch	264600000
8	Total No of Days/Batch	Days	8
9	Total Heat Supplied Avg.	kcal/Day	33075000
10	Capacity of Gasifier	kcal/hr	2000000
11	Total heat supplied by Gasifier	kcal/Day	48000000
12	Capacity Utilization -Gasifier	%	70%
13	Total heat used from Gasifier	kcal/day	33600000
14	Equivalent to Coal	Tons/day	8.00
15	Efficiency of Gasifier	%age	60
16	Required Coal Input to Gasifier	T/day	13.33
17	Total Coal Required	Tons/batch	106.67
18	Total coal saving per batch	tons/batch	33.33
19	Cost of fuel saving	` In lakhs/batch	1.50
20	Electricity cost for Operation of gasifier	`. In lakhs/batch	0.06
21	Total energy cost	`. In lakhs/batch	1.44
22	No. of batches	batches/year	20
23	Total coal saving	tons/year	666.67
24	Total Energy Savings cost	`. in lakhs/Year	28.80
25	Investment	` in lakhs	62.17
26	Payback period	Years	2.16

Annexure 3: Technical Drawings of the Coal Gasifier

Detail technical drawing will be provided by the supplier after visit to the site and actual requirement.

Annexure 4: Financial calculation

Name of the Technology	Coal gasifier		
Rated Capacity	200* 10^4 kCal/hr		
Details	**Unit**	**Value**	**Basis**
Installed Capacity	kCal/hr	200*10^4	
No of batch	No.	20	Feasibility Study
Proposed Investment			
Cost of plant & Machinery	`(in lakh)	54.55	Feasibility Study
Erection & Commissioning	`(in lakh)	2.00	Feasibility Study
Applicable taxes	`(in lakh)	5.62	
Total Investment	`(in lakh)	62.17	Feasibility Study
Financing pattern			
Own Funds (Internal Accruals)	`(in lakh)	15.54	Feasibility Study
Loan Funds (Term Loan)	`(in lakh)	46.63	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)	4.00	Feasibility Study
Annual Escalation	%	5.00	Feasibility Study
Estimation of Revenue			
Coal saving	Tons/batch	33.33	-
Cost of coal	`./tons	4500	-
Cost of electricity consumption	`./batch	0.06	
No. of batch	No.	20	
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	46.63	1.80	44.83	5.42
2	44.83	4.80	40.03	4.26
3	40.03	7.20	32.83	3.67
4	32.83	9.60	23.23	2.85
5	23.23	12.00	11.23	1.78
6	11.23	11.23	0.00	0.30
		46.63		

WDV Depreciation ***`(in lakh)***

Particulars / years	***1***	***2***
Plant and Machinery		
Cost	62.17	12.43
Depreciation	49.73	9.95
WDV	12.43	2.49

Projected Profitability ***`(in lakh)***

Particulars / Years	***1***	***2***	***3***	***4***	***5***	***6***	***7***	***8***	***Total***
Revenue through Savings									
Fuel savings	28.80	28.80	28.80	28.80	28.80	28.80	28.80	28.80	230.40
Total Revenue (A)	28.80	28.80	28.80	28.80	28.80	28.80	28.80	28.80	230.40
Expenses									
O & M Expenses	2.49	2.61	2.74	2.88	3.02	3.17	3.33	3.50	23.75
Total Expenses (B)	2.49	2.61	2.74	2.88	3.02	3.17	3.33	3.50	23.75
PBDIT (A)-(B)	26.31	26.19	26.06	25.92	25.78	25.63	25.47	25.30	206.65
Interest	5.42	4.26	3.67	2.85	1.78	0.30	-	-	18.28
PBDT	20.90	21.92	22.38	23.08	24.00	25.33	25.47	25.30	188.37
Depreciation	3.28	3.28	3.28	3.28	3.28	3.28	3.28	3.28	26.26
PBT	17.61	18.64	19.10	19.79	20.72	22.04	22.19	22.02	162.11
Income tax	-	4.07	7.61	7.84	8.16	8.61	8.66	8.60	53.54
Profit after tax (PAT)	17.61	14.57	11.49	11.95	12.56	13.44	13.53	13.42	108.57

Computation of Tax **` (in lakh)**

Particulars / Years	***1***	***2***	***3***	***4***	***5***	***6***	***7***	***8***
Profit before tax	17.61	18.64	19.10	19.79	20.72	22.04	22.19	22.02
Add: Book depreciation	3.28	3.28	3.28	3.28	3.28	3.28	3.28	3.28
Less: WDV depreciation	49.73	9.95	-	-	-	-	-	-
Taxable profit	(28.84)	11.98	22.38	23.08	24.00	25.33	25.47	25.30
Income Tax	-	4.07	7.61	7.84	8.16	8.61	8.66	8.60

Projected Balance Sheet

Particulars / Years	***1***	***2***	***3***	***4***	***5***	***6***	***7***	***8***
Liabilities								
Share Capital (D)	15.54	15.54	15.54	15.54	15.54	15.54	15.54	15.54
Reserves & Surplus (E)	17.61	32.18	43.68	55.63	68.19	81.62	95.15	108.57
Term Loans (F)	44.83	40.03	32.83	23.23	11.23	0.00	0.00	0.00
TOTAL LIABILITIES (D)+(E)+(F)	77.98	87.75	92.05	94.40	94.95	97.16	110.69	124.11
Assets								
Gross Fixed Assets	62.17	62.17	62.17	62.17	62.17	62.17	62.17	62.17
Less Accm. depreciation	3.28	6.57	9.85	13.13	16.41	19.70	22.98	26.26
Net Fixed Assets	58.89	55.60	52.32	49.04	45.76	42.47	39.19	35.91
Cash & Bank Balance	19.10	32.15	39.72	45.36	49.20	54.69	71.50	88.20
TOTAL ASSETS	77.98	87.75	92.05	94.40	94.95	97.16	110.69	124.11
Net Worth	33.16	47.73	59.22	71.17	83.73	97.16	110.69	124.11
Debt Equity Ratio	2.88	2.58	2.11	1.49	0.72	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	15.54	-	-	-	-	-	-	-	-
Term Loan	46.63								
Profit After tax		17.61	14.57	11.49	11.95	12.56	13.44	13.53	13.42
Depreciation		3.28	3.28	3.28	3.28	3.28	3.28	3.28	3.28
Total Sources	62.17	20.90	17.85	14.78	15.23	15.84	16.72	16.81	16.70
Application									
Capital Expenditure	62.17								
Repayment Of Loan	-	1.80	4.80	7.20	9.60	12.00	11.23	-	-
Total Application	62.17	1.80	4.80	7.20	9.60	12.00	11.23	-	-
Net Surplus	-	19.10	13.05	7.58	5.63	3.84	5.49	16.81	16.70
Add: Opening Balance	-	-	19.10	32.15	39.72	45.36	49.20	54.69	71.50
Closing Balance	-	19.10	32.15	39.72	45.36	49.20	54.69	71.50	88.20

IRR **` (in lakh)**

Particulars / months	***0***	***1***	***2***	***3***	***4***	***5***	***6***	***7***	***8***
Profit after Tax		17.61	14.57	11.49	11.95	12.56	13.44	13.53	13.42
Depreciation		3.28	3.28	3.28	3.28	3.28	3.28	3.28	3.28
Interest on Term Loan		5.42	4.26	3.67	2.85	1.78	0.30	-	-
Cash outflow	(62.17)	-	-	-	-	-	-	-	-
Net Cash flow	(62.17)	26.31	22.12	18.45	18.08	17.62	17.02	16.81	16.70
IRR	29.19%								

NPV	43.21

Break Even Point

Particulars / Years	***1***	***2***	***3***	***4***	***5***	***6***	***7***	***8***
Variable Expenses								
Oper. & Maintenance Exp (75%)	1.87	1.96	2.06	2.16	2.27	2.38	2.50	2.62
Sub Total*(G)*	1.87	1.96	2.06	2.16	2.27	2.38	2.50	2.62
Fixed *Expenses*								
Oper. & Maintenance Exp (25%)	0.62	0.65	0.69	0.72	0.76	0.79	0.83	0.87
Interest on Term Loan	5.42	4.26	3.67	2.85	1.78	0.30	0.00	0.00
Depreciation *(H)*	3.28	3.28	3.28	3.28	3.28	3.28	3.28	3.28
Sub Total (I)	9.32	8.20	7.64	6.85	5.82	4.38	4.12	4.16
Sales (J)	28.80	28.80	28.80	28.80	28.80	28.80	28.80	28.80
Contribution (K)	26.93	26.84	26.74	26.64	26.53	26.42	26.30	26.18
Break Even Point (L= G/I)	34.61%	30.55%	28.58%	25.70%	21.93%	16.56%	15.65%	15.88%
Cash Break Even {(I)-(H)}	22.42%	18.32%	16.30%	13.38%	9.55%	4.14%	3.17%	3.34%
Break Even Sales (J)*(L)	9.97	8.80	8.23	7.40	6.31	4.77	4.51	4.57

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

Particulars / Years	***1***	***2***	***3***	***4***	***5***	***6***	***7***	***8***	***Total***
Net Profit Before Taxes	17.61	18.64	19.10	19.79	20.72	22.04	22.19	22.02	162.11
Net Worth	33.16	47.73	59.22	71.17	83.73	97.16	110.69	124.11	626.96
									25.86%

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

Particulars / Years	***1***	***2***	***3***	***4***	***5***	***6***	***7***	***8***	***Total***
Cash Inflow									
Profit after Tax	17.61	14.57	11.49	11.95	12.56	13.44	13.53	13.42	81.62
Depreciation	3.28	3.28	3.28	3.28	3.28	3.28	3.28	3.28	19.70
Interest on Term Loan	5.42	4.26	3.67	2.85	1.78	0.30	0.00	0.00	18.28
Total (M)	26.31	22.12	18.45	18.08	17.62	17.02	16.81	16.70	119.60

DEBT

Interest on Term Loan	5.42	4.26	3.67	2.85	1.78	0.30	0.00	0.00	18.28
Repayment of Term Loan	1.80	4.80	7.20	9.60	12.00	11.23	0.00	0.00	46.63
Total (N)	7.22	9.06	10.87	12.45	13.78	11.53	0.00	0.00	64.91
DSCR	3.65	2.44	1.70	1.45	1.28	1.48	0.00	0.00	1.84
Average DSCR (M/N)	1.84								

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
Coal gasifier	India	Urja Thermal Solutions 1st Floor, Samruddhi Apartments Shivaji Nagar Sinnar Nasik-42210

Annexure 7: Techno-Commercial Bids

UTS/Q11/192 **Date: 25.05.2011**

To,
M/s Apitco Ltd.,
8th floor, Parisrama Bhavan,
Bhasheerbagh,
Hyderabad (A. P.) – 500 004.
Email Id. - sudheesh1974@yahoo.co.in

Kind Attn: Mr. M. A. Sudheesh [+91 96188 81042]

Sub.: Total Extended shaft type coal gasifier system model no. UT – TE – 03.

Dear Sir,

As discussed with you we have incorporated Combustion air blowers & Recuperators in our offer.

We hope that you will find our offer in line with your requirement, If you desire further information / Clarifications we will furnish the same on hearing from you.

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

Yours faithfully,

URJA THERMAL SOLUTIONS.

[Swapnil Gautam]

M/s APTICO LTD.

TOTAL EXTENDE SHAFT TYPE COAL GASIFIER SYSTEM MODEL NO. UT – TE –03

COAL GASIFIER SYSTEM

- Model : UT-TE - 03.
- Installed capacity (Thermal) : 2500 Kilowatts
- Thermal Output : 200 X 10^4 K.Cal/Hr.
- Liquid Fuel Replacement capacity : 215 Liters/Hr.
- Gas Outout : 1600 Nm3/ Hr.

APPLICABLE SOLID FUEL

- Steam coal in B, C and D grades.

COAL FUEL CONSUMPTION RATIO (Approx)

- Steam Coal – B Grade (GCV 5500 Kcals/Kg.) : 2.2 – 2.5 Kg / Litre of Liquid Fuel.
- Steam Coal – C & D Grade (GCV4500 – 5200 Kcals/Kg) : 2.5 – 3.5 Kg/ Litre of Liquid Fuel.

SOLID FUEL DATA

- Solid Fuel Size : > 15 mm to 80mm
- Moisture content : < 10 %
- Ash content : 20-25%

CHEMICAL COMPOSITION OF PRODUCR GAS (Approx)

The Gasifier can convert any type of coal into Producer Gas. The chemical composition of Producer Gas is as under;

- CO (Carbon Monoxide) : 22 ±2%
- CH4 (Methane) : 03 ±1%
- H2 (Hydrogen) : 16 ±2%
- CO2 (Carbon Dioxide) : 8 ±2%
- N2 (Nitrogen) : Rest

CHARACTERISTIC OF PRODUCER GAS (Approx)

- Calorific Value of Producer Gas : 1350 – 1500 K.Cal/NM^3
- Producer gas temp. at gasifier outlet : 120 – 140^0 C (Before filteration); 40 – 60^0 C (After filteration).
- Max. Flame temperature : 1350 ^{o} C

TOTAL EXTENDE SHAFT TYPE COAL GASIFIER SYSTEM MODEL NO. UT – TE –03

ANNEXURE – 2

SCOPE, PRICES, TERMS & CONDITIONS

2.1 :- SCOPE OF URJA THERMAL SOLUTIONS

Scope of supply shall be Design, Preparation of constructional drawings, procurement of material, fabrication, erection & commissioning of plant.

1. Rotary grate.
2. Automatic Coal Feeding Bunker assembly.
3. Automatic fuel feeding system.
4. Centrifugal blower with air piping up to gasifier.
5. Operating panel board with required instrumentation & Automation systems.
6. Lift Bucket assembly with drive unit.
7. Water scrubbing system (Sprinklers & pump) for tar separation.
8. Double Hydraulic cylinder operated type drive mechanism for rotation of grate.
9. Jacket feed pumps 2 Nos. (1 running + 1 standby)
10. Hardware required for erection of plant.
11. Commissioning of plant.
12. Drawings & Technical support.
13. Main Shell
14. Structure
15. Hoppers
16. Outlet pipes

M/s APITCO LTD.

TOTAL EXTENDE SHAFT TYPE COAL GASIFIER SYSTEM MODEL NO. UT – TE –03

2.2 PRICES

Sr.	Particular	Qty	Rate	Amount
01.	**Coal Gasifier with Water scrubbing System** **Model : UT- TE – 03**	01	**40,55,000=00**	**40,55,000=00**
Rupees: Fourty Lacs Fifty Five Thousands Only.			**Total Rs.**	**40,55,000=00**

2.3 SCOPE OF PURCHASER:

SR NO.	ITEM DESCRIPTION	APPROX COST [RS.]
3.1	Foundations & Civil works for all equipment, RCC tank of capacity (10 KL + 15KL) as per our drawings.	2,50,000=00
3.2	Water storage tank, Water pipe line, Plumbing work, fittings, over head Tank etc. IInd stage filteration.	1,50,000=00
3.3	Producer gas pipe line between gasifier and burners. (Up to 200 Feet) With supports, hardware & flanges.	2,00,000=00
3.4	Producer gas pipe line work - Labour Charges.(Up to 200 Feet)	70,000=00
3.6	Power connection up to panel board & field cabling work on site. (Panel Board supply by URJA). For cable laying 3 Nos. helpers are required.	50,000=00
3.7	Transportation cost up to site.	3,00,000=00
3.8	Crane facility for erection of the gasifier	1,00,000=00
3.9	Consumables such cutting set, welding rods etc. for erection	60,000=00
3.10	Hydraulic oil – 100 ltrs. & gear oil – 20 ltrs. manufactured by servo no. 68 & no. 90 respectively	20,000=00
3.11	Shed at top of the Gas plant	1,00,000=00
3.12	Castable Firecrete Super ACC makes.	40,000=00
3.13	Lighting & Painting of the plant	60,000=00
3.14	Accommodation for our workers during Erection & comm. (Inside factory)	-
3.15	Lodging, Boarding & Local conveyance for our engineers	-
3.16	Tools & tackles such as welding machine, cutting set, spanners etc.	-
3.17	Row material for plant start-up (Coal & refractory pitcher)	-
3.18	Lodging, Boarding & Local Conveyance for our Engineers during project execution	-
Total		**14,00,000=00**

M/s APITCO LTD.

TOTAL EXTENDE SHAFT TYPE COAL GASIFIER SYSTEM MODEL NO. UT – TE –03

2.5 Prices, Terms & Conditions:

Price Basis	:	Our offer is Ex-Mumbai, on F.O.T. basis. Freight, Transportation, Unloading, Transit Insurance, will be to purchaser's A/c.
Sales Tax	:	As applicable at the time of delivery.
Excise duty	:	Not Applicable.
Octroi	:	If any applicable, shall be borne by you.
Delivery period	:	40 days from the date of your order with advance payment.
Payment terms	:	40 % Advance along with the Purchase Order. 50% + Taxes against Proforma Invoice supply on pro rata basis. 10% after 2 months of commissioning.
Validity	:	10 days, thereafter is subjected to our confirmation.

Performance Guarantee:

- **Our unit will replace up to 200 Lit. F.O. per hour.**
- **We guarantee that, If the unit is installed as per our guide lines then there wont be any stoppages due to line chocking (Neither by Coal dust nor by Tar) till Minimum 8 months.**
- **Frequent burner cleaning is not required.**
- **Plant will not require frequent cleaning of grate (Mandir jamming). Minimum 8 months with C – grade coal.**
- **In case the coal gas plant is not able to meet your [Rated as 200 Lit./ Hr] production requirement, we will take back the plant and will refund the full amount to you.**

Company Address.	:	M/s Urja Thermal Solutions Ist Floor, Samruddhi Apartment Shivaji Nagar, Sinnar - 422105 Nashik (MS)
Correspondance Add.	:	Swapnil Gautam (+91 97696 81001) 703-4, Garnet Building, Nirmal Residency Road Behind Nirmal Lifestyle, Off L.B.S. Road Mulund (W), Mumbai – 400 080 (MS)

URJA THERMAL SOLUTIONS

[Swapnil Gautam]

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