DETAILED PROJECT REPORT
ON
WOOD GASIFIER (5 Lakh kCal/hr)
(VAPI CHEMICALS & DYES CLUSTER)



ENERGY IS LIFE
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Bureau of Energy Efficiency

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WOOD GASIFIER 5 LAKH KCAL CAPACITY

VAPI CHEMICALS & DYES CLUSTER

BEE, 2011

Detailed Project Report on Wood gasifier 5 lakh kcal capacity

Chemicals & Dyes SME Cluster, Vapi, Gujarat (India)

New Delhi: Bureau of Energy Efficiency;

Detail Project Report No.: **VAPI/C&D/WGF/01**

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Zenith Energy Services Pvt. Ltd.

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List of Abbreviation

BEE	Bureau of Energy Efficiency
DPR	Detailed Project Report
DSCR	Debt Service Coverage Ratio
GHG	Green House Gases
HP	Horse Power
IRR	Internal Rate of Return
MoMSME	Ministry of Micro Small and Medium Enterprises
NPV	Net Present Value
ROI	Return on Investment
SME	Small and Medium Enterprises
SIDBI	Small Industries Development Bank of India

EXECUTIVE SUMMARY

Zenith Energy Services Pvt. Ltd is executing BEE - SME program in Vapi chemicals & dyes cluster, supported by Bureau of Energy Efficiency with an overall objective of improving the energy efficiency in cluster units.

Since Vapi cluster is one of the largest clusters in chemicals & dyes sector in India, accordingly this cluster was chosen for energy efficiency improvements by implementing energy efficient technologies, so as to facilitate maximum replication in other chemicals & dyes clusters in India.

Vapi chemicals & dyes cluster is famous for the production of Organic/Inorganic chemicals, Specialty chemicals, Disperse dyes, Dye Intermediates, Reactive dyes, Acid dyes, Direct dyes etc. In fact majority of the chemical units in the cluster are manufacturing two or three types of products as per the demand for the products in the market.

During energy use and technology audit studies in various chemicals & dyes industries in Vapi various chemicals & dyes cluster, it has been observed that most of the units are using inefficient boilers and Thermopac in the process.

Installation of wood gasifier for heat source in both boiler and Thermopac would replace fossil fuel consumption in boiler and Thermopac and overall reduce the energy cost in operational cost.

This DPR highlights the details of the study conducted for assessing the potential for installation of gasifier in both boiler and Thermopac, possible energy saving, and its monetary benefit, availability of the technologies/design, local service providers, technical features & proposed equipment specifications, various barriers in implementation, environmental aspects, estimated GHG reductions, capital cost, financial analysis, sensitivity analysis for three different scenarios 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:

S.No	*Particular*	*Unit*	*Value*
1	Project cost	` (in Lakh)	15.60
2	Furnace oil consumption in existing scenario	Tons/annum	34.44

S.No	Particular	Unit	Value
3	Biomass (Wood) consumption in proposed scenario	Tons/annum	131.2
4	Electricity consumption in Gasifier	kWh /annum	6266
5	Monetary benefit	` (in Lakh)	5.38
6	Simple payback period	Years	2.90
7	NPV	` (in Lakh)	5.17
8	IRR	%age	19.50
9	ROI	%age	24.40
10	Average DSCR	Ratio	1.46
11	Process down time	Week	1
12	CO_2 emission reduction	Tons/annum	105

The projected profitability and financial indicators shows that the project will be able to earn profit from inception and replacement of F.O with Wood gasifier system project is financially viable and technically feasible.

ABOUT BEE SME PROGRAMME

Bureau of Energy Efficiency (BEE) is implementing a BEE-SME Programme to improve the energy performance in 29 selected SMEs clusters. Vapi Chemicals & Dyes Cluster is one of them. The BEE's SME Programme intends to enhance the energy efficiency awareness by funding/subsidizing need based studies in SME clusters and giving energy conservation recommendations. For addressing the specific problems of these SMEs and enhancing energy efficiency in the clusters, BEE will be focusing on energy efficiency, energy conservation, and technology up gradation through studies and pilot projects in these SMEs clusters.

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

Activity 1: Energy use and technology studies

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

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 SMEs on energy efficiency improvement in their units as well as clusters. The local service providers will be trained in order to be able to provide the local services in setting of energy efficiency projects in the clusters

Activity 3: Implementation of energy efficiency measures

To implement the technology up gradation projects in clusters, BEE has proposed to prepare the technology based detailed project reports (DPRs) for a minimum of five technologies in three capacities for each technology.

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 About the SME cluster

The products manufactured in Vapi Chemicals & Dyes Cluster are Organic/Inorganic chemicals, Specialty chemicals, Disperse dyes, Dye Intermediates, Reactive dyes, Acid dyes, Direct dyes etc. In fact majority of the chemical units in the cluster are manufacturing two or three types of products as per the demand for the products in the market. The cost of energy (electrical and thermal energy) as percentage of manufacturing cost varies between 8 and 10%.

The raw material is different for the industries and depends on the product manufactured in the respective industry. The energy cost is second to the raw materials cost.

The main energy forms used in the cluster units are Wood, Imported Coal, LDO, Furnace Oil, Ground Nut Briquettes & Natural Gas as fuels for boilers, Thermopacs, Tray Dryers & Spray Dryers. Electricity is used to run reactors, motors, pumps, centrifuges, blowers, fans, & Air Compressors etc.

The details of annual energy consumption of a typical unit having a production of chemicals & dyes are furnished in the Table 1.1 below:

Table 1.1 Annual Energy consumption of a typical unit (M/s. Dilip Chemicals)

S.No	Particular	Unit	Value
1	Electricity consumption	kWh	32,640
2	Fuel consumption	Kgs	28290
3	Production	Kgs	60000

Production process

The process adopted by different units in the Vapi cluster varies with the type of product manufactured in the unit. However, the general processes & operations involved in a typical dyes & chemical manufacturing are as indicated below:

a) Raw material selection/ preparation

b) Preparation of solution

c) Precipitation

d) Filtration

e) Drying

f) Pulverization

g) Packing

The process flow diagram of a typical unit producing dyes & chemicals is shown above. The brief description of process is explained below:

Raw material selection/preparation

Raw materials are selected in various proportions to prepare the required product or to the customer requirements.

Preparation of solution

Solution is prepared by mixing different proportions of solute and solvent in a reactor vessel with the help of varying thermal inputs like steam or chilled water to make a chemical reaction (i.e. endothermic or exothermic reactions) and this process will continue until the required raw product is produced. In this step, both thermal energy and electrical energy is used in the reactor vessel for maintaining temperature and pumping & mixing of solution during the process to undergo chemical reaction.

Precipitation

Precipitation is the process of formation of solid particles from soluble raw product. In this process, solid blocks/ crystals are prepared from sludge raw product. This sludge raw product is produced from solution in reactor vessel as mentioned in previous step. In some units, electrical energy is used to prepare solid cakes by means of hydraulic presses.

Filtration

After precipitation, the solid/ crystal product is filtered by various filtration methods for next drying process, usually by electrically operated hydraulic filter presses.

Drying

The filtered pigment/ dyes contain moisture, which is removed by means of hot air generators. Both thermal and electrical energy is used in hot air generators.

Pulverization

Pulverization is the process of making crystal pigments/ dyes into powder form. Pulverizers use electrical energy.

Packing

The final product or solid pigments/ dyes are packed in appropriate packing without exposes to atmosphere because some products are flammable.

Production process

The detailed process flow diagram of a typical unit is furnished below

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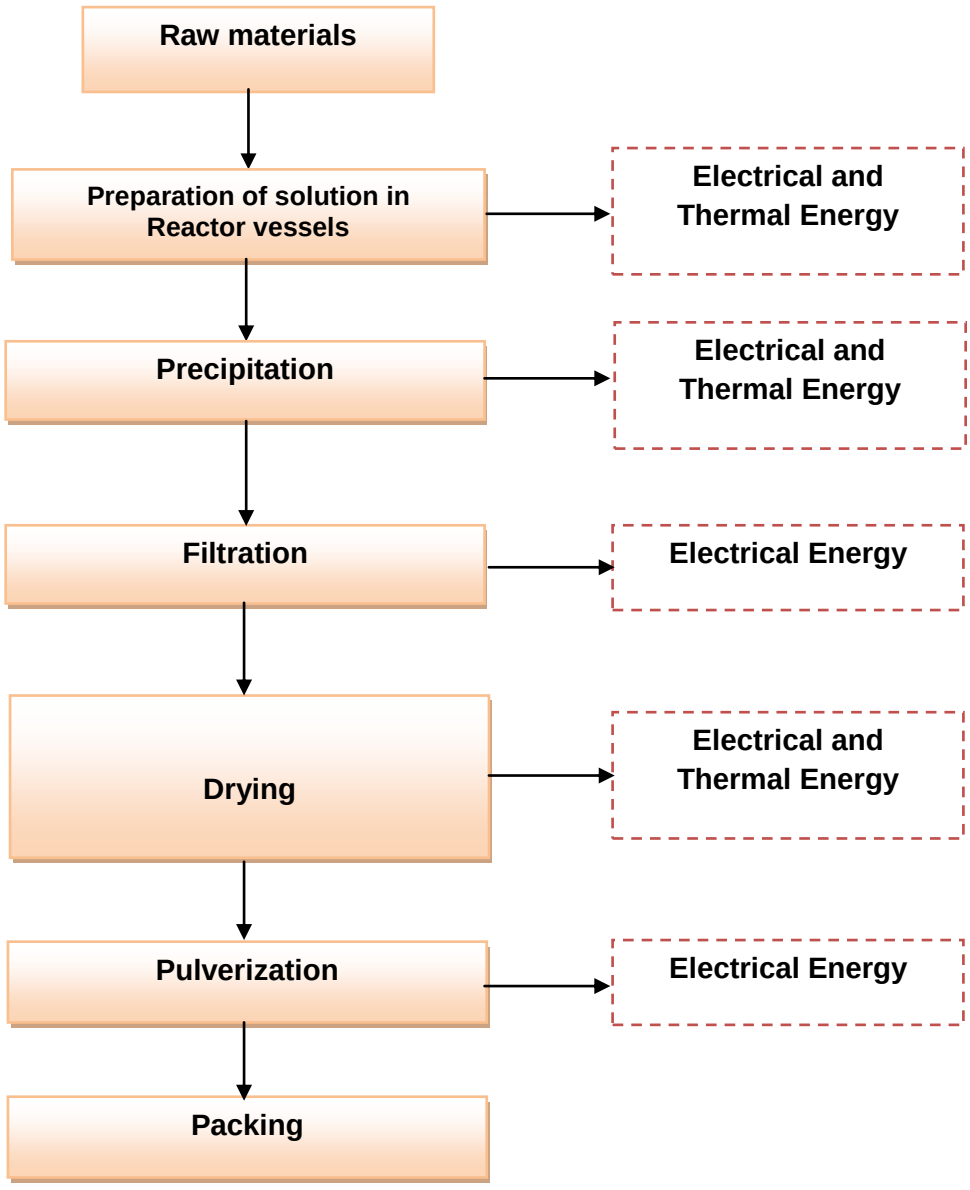


Figure 1.1 General Process Flow Diagram

The production process as depicted above is not similar for all units in Vapi chemicals & dyes cluster. However, depending on type of product and product quality, the above stated process flow varies as per the requirement.

1.2 Energy performance in Vapi chemicals & dyes cluster

The main energy sources for Vapi cluster units are Wood, Imported Coal, LDO, Furnace Oil, Ground Nut Briquettes & Natural Gas as fuels for boilers, Thermopacs, Tray Dryers & Spray Dryers. Electricity is used to run reactors, motors, pumps, centrifuges, blowers, fans & Air Compressors etc.

Energy cost is around 8 to 10 percent of manufacturing cost in typical manufacturing unit, out of which the cost of thermal energy works out to 88 percent of the total energy cost and remaining accounts for electrical energy.

In typical manufacturing unit, the annual electricity and wood consumption is 32,640 kWh and 28,290 kgs respectively.

1.2.1 Specific energy consumption

Specific electrical and thermal energy consumption in chemical & dyes units depends on the final product manufactured in that unit. Specific electrical and thermal energy consumption of typical unit of Vapi chemical & dyes cluster is 0.54 kWh/kg of final product and 0.47 kg of wood /kg of final product respectively.

The electricity consumption for the boiler is not considered, as the capacity of the boiler feed water pump is low accordingly the cost of energy consumption is negligible.

The average specific fuel consumption per kg of the product for 3 typical units is furnished below in Table 1.2.

Table 1.2 Specific energy consumption of 2 typical units

S.No	*Name of unit*	*Fuel Consumption kg*	*Production kg*	*Specific Fuel consumption kg of wood /kg of final product*
1	M/s Dilip Chemicals	28,290	60000	0.47
2	M/s Sterling Pigments	18,033	60000	0.30
3	M/s Chemodist Industries	96000	240000	0.40

1.3 Identification of technology/equipment

1.3.1 Description of technology/equipment to be replaced

During energy use and technology audit studies in various chemicals & dyes industries in Vapi various chemicals & dyes cluster, it has been observed that most of the units are using inefficient boilers for steam generation whose efficiency is low. The performance of various existing boilers are evaluated and analyzed for various losses are furnished in Annexure 1.



Figure 1.2 boiler & Thermopac operations at typical chemicals & dyes industry

From energy use and technology gap audit studies in various chemicals & dyes industries in Vapi chemicals & dyes cluster, the following were identified:

- Energy efficiency improvement opportunities
- Environment and working conditions improvement
- Design flaws in the conventional boiler
- Operational & maintenance practices in conventional boiler

Technical gap analysis in wood fired boiler and Thermopac

Technology gaps in wood fired inefficient boilers are identified and described in details below:

Poor heat transfer efficiency:

The present boiler is of single pass system. The heat transfer is poor due to low heat transfer area and short contact time between flue gas and oil and hence leads to inefficiency and high flue gas losses.

Heat loss from charging door: The fuel charging door remains more or less open during the entire operation due to various reasons; those are human error and non compatibility of wood

logs in combustion chamber or Grate is not designed to accommodate wood log size and vice versa.

No waste heat recovery:

Though, the waste heat recovery (WHR) system doesn't have potential in smaller size boilers, as the boiler is of single pass system, hence there exists enormous potential in flue gases of the boiler. The temperature of the flue gases is found to be in the range of 240 to 270 ^{o}C, as the boiler is of single pass system. The high temperature flue gases is vented to the atmosphere without any waste heat recovery

Low loading of the boiler:

The capacity utilization of the boiler is low and is less than 20% and hence considerable reduction in thermal efficiency of the boiler.

No control on fuel firing:

In the existing boiler, there is no control over fuel firing in combustion chamber

Poor insulation on boiler:

The surface temperature of the boiler is high due to poor insulation leading to high radiation losses

From the above mentioned analysis it is clear that the performance of the existing boiler and Thermopac are poor in terms of energy, environment, and social aspects. Based on above facts, the present inefficient boiler is to be replaced with Wood Gasifier.

1.3.2 Role in process

For production of chemicals & dyes, the process requires steam. The boiler is used for steam generation. The hot oil generated in Thermopac is used in spray dryers for drying raw product.

1.4 Establishing the baseline for the technology/equipment

Energy consumption in boiler would depend on below mentioned things

- Cold water temperature
- Solution temperature
- Quantity of steam required
- Climate conditions
- Operational & maintenance practices in boiler

Energy use and technology audit studies were conducted in various units of Vapi chemicals & dyes cluster, the baseline energy consumption of present inefficient boilers and the performance of the same is carried out and attached in Annexure 1.

1.4.1 Energy audit methodology adopted

The following methodology was adopted to evaluate the performance of boilers

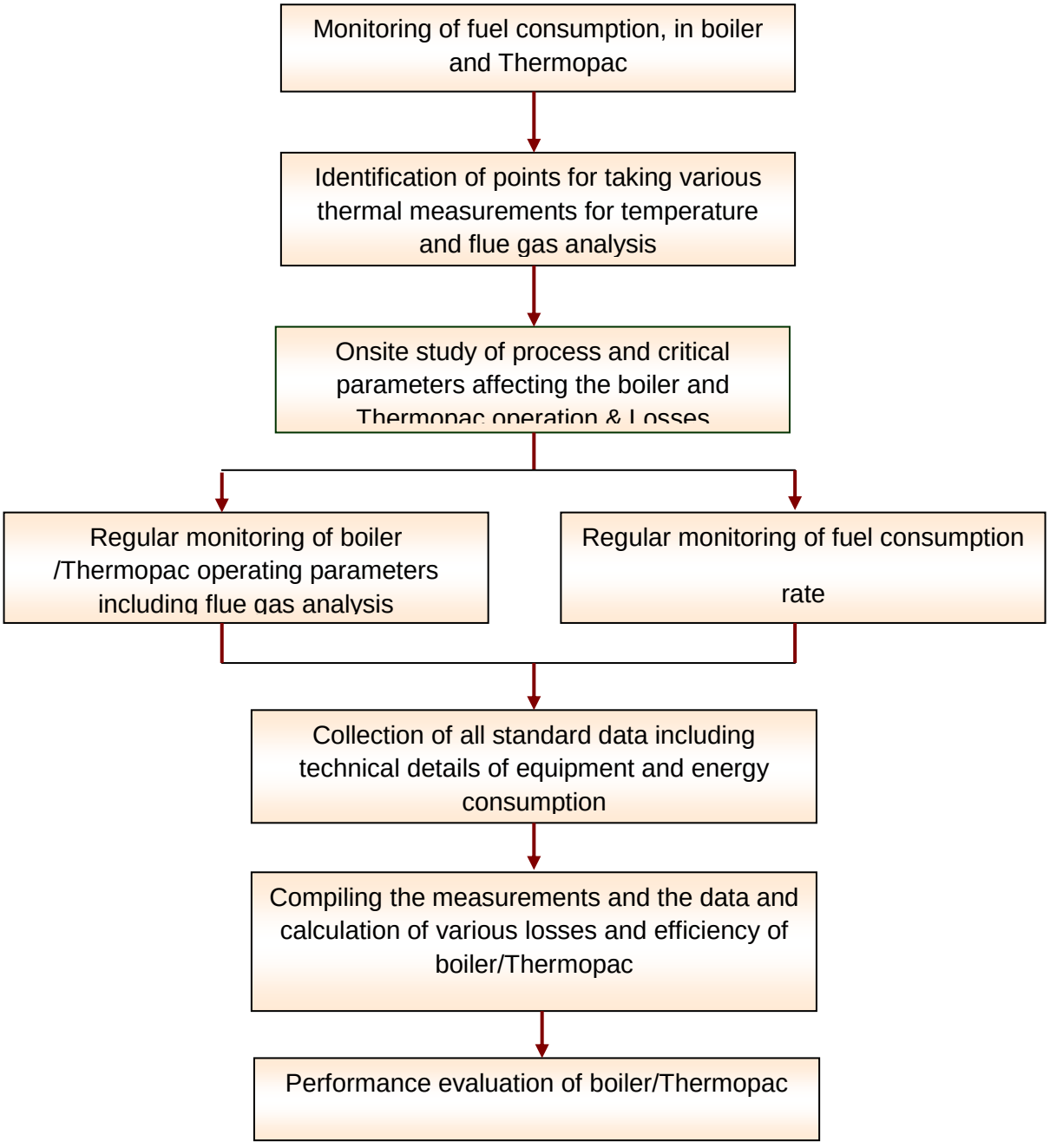


Figure 1.3 Energy audit methodology

1.4.2 Operating efficiency

The operating efficiency of the existing boiler & thermopac is 62.20% & 61.65% and details of operating parameters recorded, estimation of various associated losses and efficiency of the boilers for unit is furnished in Annexure 1.

1.5 Barriers in adoption of proposed technology / equipments

Major barriers in the up gradation of technology in the cluster are

- Non availability of technology
- Distrust on technology supplier
- Lack of information about energy efficiency among all unit still persists

The other barriers identified for implementation of energy efficient in Vapi chemicals & dyes cluster are presented in below sections.

1.5.1 Technological Barrier

The major technical barriers that prevented the implementation of wood gasifier are

- Lack of awareness and information about the new and emerging energy efficient technologies available in the market.
- Dependence on local equipment suppliers for uninterrupted after sales service
- The majority of the textile unit owners / entrepreneurs do not have in-depth technical expertise
- The lack of technical know-how made it impossible for the chemical unit owners to identify the most effective technical measures.

1.5.2 Financial Barrier

Some major financial barriers which prevent the implementation of proposed technology are:

- Implementation of the proposed project activity requires considerable investment of ` 15.60 lakh, which is a significant investment and not commonly seen in the cluster for energy efficiency.
- The majority of the unit owners are of the view that it makes business sense for them to invest in enhancing production capacity rather than making investment in energy efficiency.

- The unit owners in the cluster are wary of approaching banks for financial assistance due to their old perception that getting loan sanctioned from Banks involves lot of paper work / documentation and needs collateral security.

However, the financial attractiveness of the project activity may motivate the owners to move forward in taking up initiatives in energy conservation and efficiency.

1.5.3 Manpower skill

The non-availability of skilled manpower in the cluster is one of the major barriers. Though, the skilled manpower is available in the cluster, they are not aware of energy conservation / efficiency and its importance.

The training with equipment suppliers for importance of energy use and conservation will create awareness among workforce thereby make them aware about efficient use of energy and its conservation.

1.5.4 Other barrier (if any)

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

2 TECHNOLOGY/EQUIPMENT FOR ENERGY EFFICIENCY IMPROVEMENTS

2.1 Detail description of equipment

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 vapour 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 melting the brass. Like other gaseous fuels, producer gas can also controlled critically. This also paves way for more efficient and cleaner operation. The producer gas can be conveniently used for thermal energy requirement.

Thermal Energy

Thermal energy of the order of 5 MJ is released, by flaring 1 m3 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 (~650 - 1000 oC) are required for melting metals and alloys and normally melting is done by expensive fuel oils or electrical heaters. Gasifiers are well suited for such applications.

Wood 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 Equipment specification

The Technical specifications of the wood gasifier of 5, 00,000 kcal is furnished below:

S.No	Parameter	Details
1	Model	RG-300
2	Mode	Burning Application
3	Rated output	600 KW (Can replace up to 50 L/Hr of HSD)
4	Design	Down Draft with Throat
5	Fuel	Wood Chips
6	Feed size	2" - 3" (any dimensions)
7	Fuel Consumption	175 Kg/Hour (Corresponds to Max.rated output)
8	Moisture content of fuel	15%
9	Fuel Feeding Cycle	Hourly once
10	Fuel charging	Manually
11	Hopper Holding Capacity	800 Kg (Approx.)
12	Auxiliary Power	10 HP

2.1.3 Suitability with existing process

New proposed equipment is used as source of heat in boiler and Thermopac for steam generation and oil heating which is earlier generated by firing of fuel in boiler and Thermopac. Hence new proposed equipment is completely suitable with existing process.

2.1.4 Availability of equipment

The technology/equipment identified for implementation is available in Vapi. Though, the local service providers are available, they don't have technical capability of fabricating the wood gasifier system

2.1.5 Source of equipment supplier

Technology/Service provider selected for implementation of the proposed energy efficiency project is having experience in producing and supplying of biomass wood gasifier system etc. Details of equipment supplier are given in Annexure 7.

2.1.6 Terms and conditions in sales of Energy efficient boiler

The terms and conditions of sale of wood gasifier from supplier is given at annexure 8.

2.1.8 Process down time during Implementation

For implementation of the project activity, it is proposed to take about 10 weeks and 7 days may be required as a process down time. Details of complete procurement and implementation schedules are given in Annexure 6.

2.2 Life of the equipment

Life of the system is proposed to be 15 years depends upon operation and its maintenance.

2.2 Suitable unit for Implementation of proposed equipment

The wood gasifier selected is of 5 lakh kcal/hr and suitable for units having heat requirement upto 5 lakh kCal/hr.

3 ECONOMIC BENEFIT DUE USES OF NEW ENERGY EFFICIENT BOILER

3.1 Technical benefit

3.1.1 Fuel saving

Based on the detailed studies carried out in various units of Vapi chemicals & dyes cluster, the average furnace oil consumption in a typical unit is 34.44 tons annum. Installation of wood gasifier will replace the furnace oil consumption in boiler and Thermopac. However, at the same time, wood consumption in wood gasifier would be 131.2 ton per annum for the same production.

3.1.2 Electricity saving

Use of wood gasifier will increase the electricity consumption for operation of fan and wood cutter etc. Total power consumption would be 6266 kW per annum.

3.1.3 Improvement in product quality

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

3.1.4 Increase in production

The proposed equipment does not contribute to any increase in production.

3.1.5 Reduction in raw material consumption

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

3.2 Monetary benefits

Annual monetary savings due to implementation of wood gasifier in place of the F.O is ` 5.38 lakh per annum. Energy & monetary benefit analysis of wood gasifier system is presented in Table 3.1 below:

Table 3.1: Energy and cost benefit analysis of wood gasifier

S.No	*Parameter*	*Unit*	*Value*
1	Fuel consumption in existing system	ton/annum	34.44
2	Wood consumption in gasifier	Days	131.2
3	Electricity consumption	kWh/year	6266
4	Monetary benefit	` in lakh/annum	5.38

3.3 Social benefits

3.3.1 Improvement in working environment in the plant

The energy measures identified will utilize state-of-the-art technologies to ensure energy efficiency and energy conservation of non renewable wood. The installation of wood gasifier will eliminate the fossil fuel consumption and will improve the work condition and environment. As the project activity will have less radiation losses.

3.3.2 Improvement in skill set of workers

The training provided by equipment suppliers will improve the technical skills of manpower for better operation and maintenance of boiler. Hence the technology implemented will create awareness about energy conservation among the worker and improves skill set of workers.

3.3.3 Impact on wages/emoluments

The awareness about the technologies and training imparted during implementation of the project will lead to direct and indirect increase in the wages of the employees, as it improves the technical skills of the workforce

3.4 Environmental benefits

3.4.1 Reduction in effluent generation

There is no significant impact in effluent generation due to implementation of the project

3.4.2 Reduction in GHG emission such as CO_2, NOx

Implementation of this project will lead to reduction in CO_2 emissions due to reduction in overall emissions fuel consumption. Implementation of this project will result in saving of 34.44 Tonne of F.O per year thereby; CO_2 reduced is 105 tones.

Considering wood as renewable source of energy

3.4.3 Reduction in other emissions like SOx

As wood doesn't contain sulphur and hence there is no impact on SO_x emissions.

4 INSTALLATION OF NEW ENERGY EFFICIENT EQUIPMENT

4.1 Cost of project

4.1.1 Cost of equipment

The total cost of equipment and machinery is estimated ` 14.40 lakh, which includes wood gasifier, pumps, refractory lining, insulation, induced draft fan, chimney, electrical works, and control panel with temperature controllers and taxes.

4.1.2 Other costs

Other cost includes civil work, erection & commissioning cost and misc. cost. The total cost of implementation of the energy efficient boiler is furnished in Table 4.1 below:

Table 4.1: Details of project cost

S.No	*Details*	*Cost (` in lakh)*
1	Equipment and machinery	14.40
2	Civil works	0.20
3	Misc .cost	0.50
4	Erection and commission cost	0.50
5	Total	15.60

4.2 Arrangement of funds

4.2.1 Entrepreneur's contribution

The total cost of the proposed technology is estimated at ` 15.60 lakh. The entrepreneur's contribution is 25% of total project cost, which is ` 3.90 lakh.

4.2.2 Loan amount

The term loan is 75% of the total project cost, which is `11.70 lakh.

4.2.3 Terms & conditions of loan

The interest rate is considered at 10% which is normal rate of interest for energy efficient projects. The loan tenure is 5 years excluding initial moratorium period is 6 months from the date of first disbursement of loan.

4.3 Financial indicators

4.3.1 Cash flow analysis

Considering the above mentioned assumptions, the net cash accruals starting with ` 3.30 lakh in the first year operation and gradually increases to ` 13.99 lakh at the end of eighth year.

4.3.2 Simple payback period

The total project cost of the proposed technology is ` 15.60 lakh and monetary savings due to reduction in wood consumption is ` 5.38 lakh hence the simple payback period works out to be 2.90 years.

4.3.3 Net Present Value (NPV)

The net present value of the investment at 10 % works out to be ` 5.17 lakh.

4.3.4 Internal rate of return (IRR)

The after tax internal rate of return of the project works out to be 19.50 %.

4.3.5 Return on investment (ROI)

The average return on investment of the project activity works out at 24.40%.

Details of financial indicator are shown in Table 4.2 below:

Table 4.2: Financial indicator of project

S.No	*Particulars*	*Unit*	*Value*
1	Simple Pay Back period	Years	2.90
2	IRR	%age	19.50
3	NPV	lakh	5.17
4	ROI	%age	24.40
5	DSCR	Ratio	1.46

4.4 Sensitivity analysis

A sensitivity analysis has been carried out to ascertain how the project financials would behave in different situations like when there is an increase in fuel savings or decrease in fuel savings. Following two scenarios has been considered

- Increase in monetary savings by 5%

- Decrease in monetary savings by 5%

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

Table 4.3: Sensitivity analysis in different scenario

Particulars	*IRR*	*NPV*	*ROI*	*DSCR*
Normal	19.50%	5.17	24.40%	1.46
5% increase in monetary savings	21.29%	6.20	24.73%	1.53
5% decrease in monetary savings	17.68%	4.14	24.03%	1.39

4.5 Procurement and implementation schedule

The project is expected to be completed in 10 weeks from the date of financial closure. The detailed of procurement and implementation schedule of project implementation is furnished in Annexure 6.

Annexure

Annexure – 1 Efficiency of the existing Boiler and Thermopac

Unit 1 - (M/s Dilip Chemicals)

Boiler

S.No	Particular	Unit	Value
1	Boiler Capacity	kg/hr	300
2	Steam pressure	kg/cm^2	6
3	Operating hours	hrs	3
4	Quantity of steam generated	kg/day	200
5	Boiler feed water temperature	^0C	30
6	Fuel Consumption	kg/hr	20
7	Calorific value of fuel	kCal/Kg	10000
8	Enthalpy of steam at 3.5 kg/cm^2	kCal/Kg	652
9	Heat Input	kCal/day	200000
10	Heat output	kCal/day	124400
11	Efficiency	%age	62.2

Thermopac

S.No	Particular	Unit	Value
1	Fuel used		LDO
2	Capacity	kcal	600000
3	LDO consumption	kgs/hr	21
4	Calorific value of LDO	kcal/kg	10000
5	Total Heat Input	kcal	210000
6	Thermic fluid oil inlet temp	oC	170
7	Thermic fluid oil outlet temp	oC	199
8	Oil temperature difference	oC	29
9	Thermic fluid oil flow	lit/hr	8000
10	Specific heat of oil	kcal/kg	0.62
11	Density of oil	kg/m3	0.9
12	Net heat Output	kcal	129456
13	efficiency of the heater	%	61.65

Unit 2 - (M/s Sterling pigments) boiler

S.No	Particular	Unit	Value
1	Fuel used		LDO
2	Make		Baby boiler
3	Capacity of Boiler	kg	600
4	Fuel Consumption	kg/hr	30
5	Calorific Value	kcal	10000
6	Total heat input	kcal/hr	300000
7	Steam Generated	kg/hr	250
8	Steam pressure	kg/cm2	5
9	feed water Temperature (Enthalpy)	kcal/kg	70.0
10	Enthalpy of steam	kcal/kg	656.24
11	net heat generated	kcal/kg	586
12	Heat output	kcal/hr	146560
13	Efficiency	%	48.9

Unit 3 - (M/s Chemodist Industries) thermopac

S.No	Particular	Unit	Value
1	Fuel used		LDO
2	Capacity	kcal	600000
3	Furnace oil	kg	50
4	Calorific value of FO	kcal/kg	10000
5	Total Heat input	kcal	500000
6	Thermic fluid oil inlet temp	oC	186
7	Thermic fluid oil outlet temp	oC	200
8	Oil temperature difference	oC	14
9	Thermic fluid oil flow	lit/hr	60000
10	Specific heat of oil	kcal/kgoC	0.62
11	Density of oil	kg/lit	0.8
12	Net heat output	kcal	322896.0
13	efficiency of the heater	%	64.6

Annexure – 2 Process flow diagram

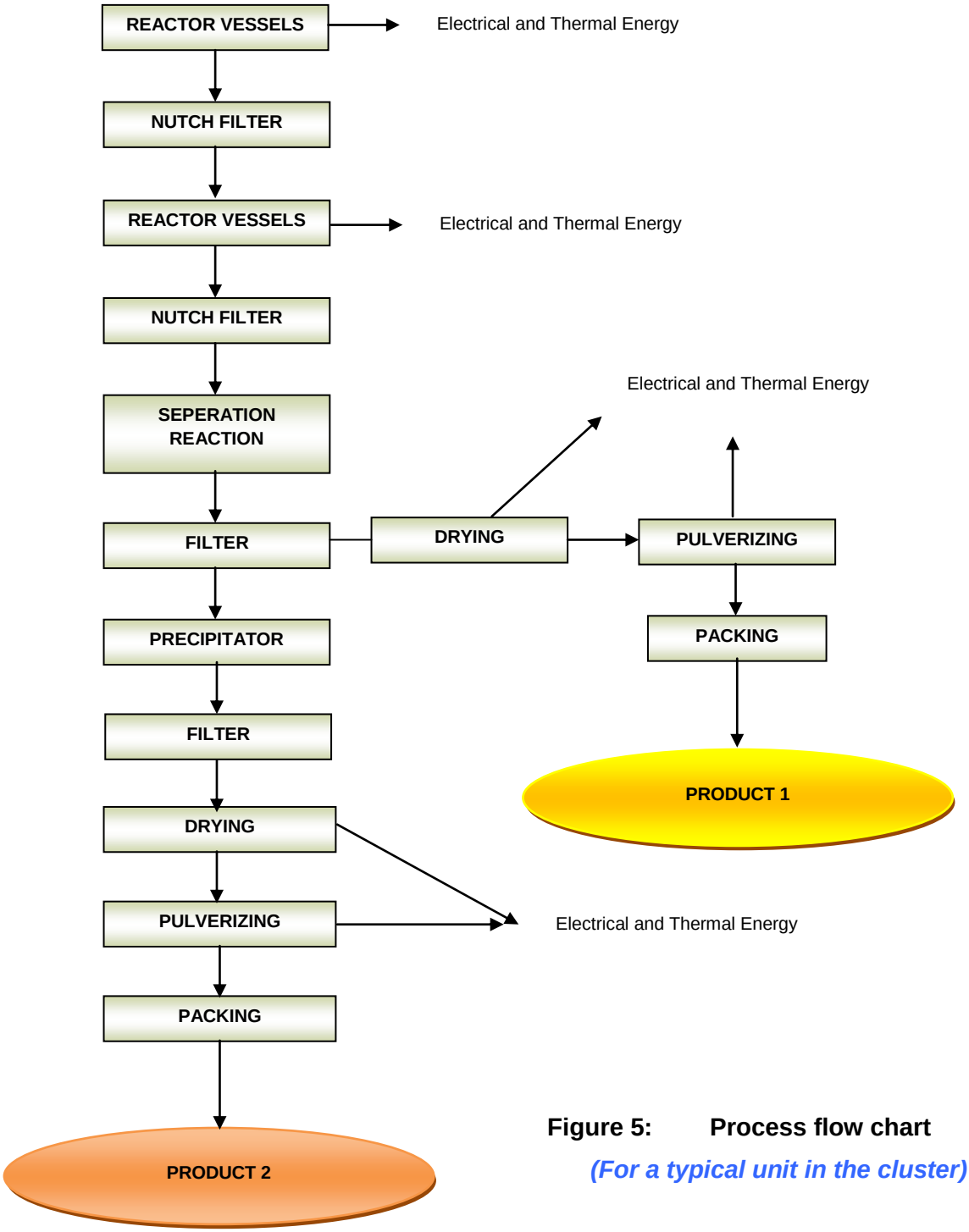


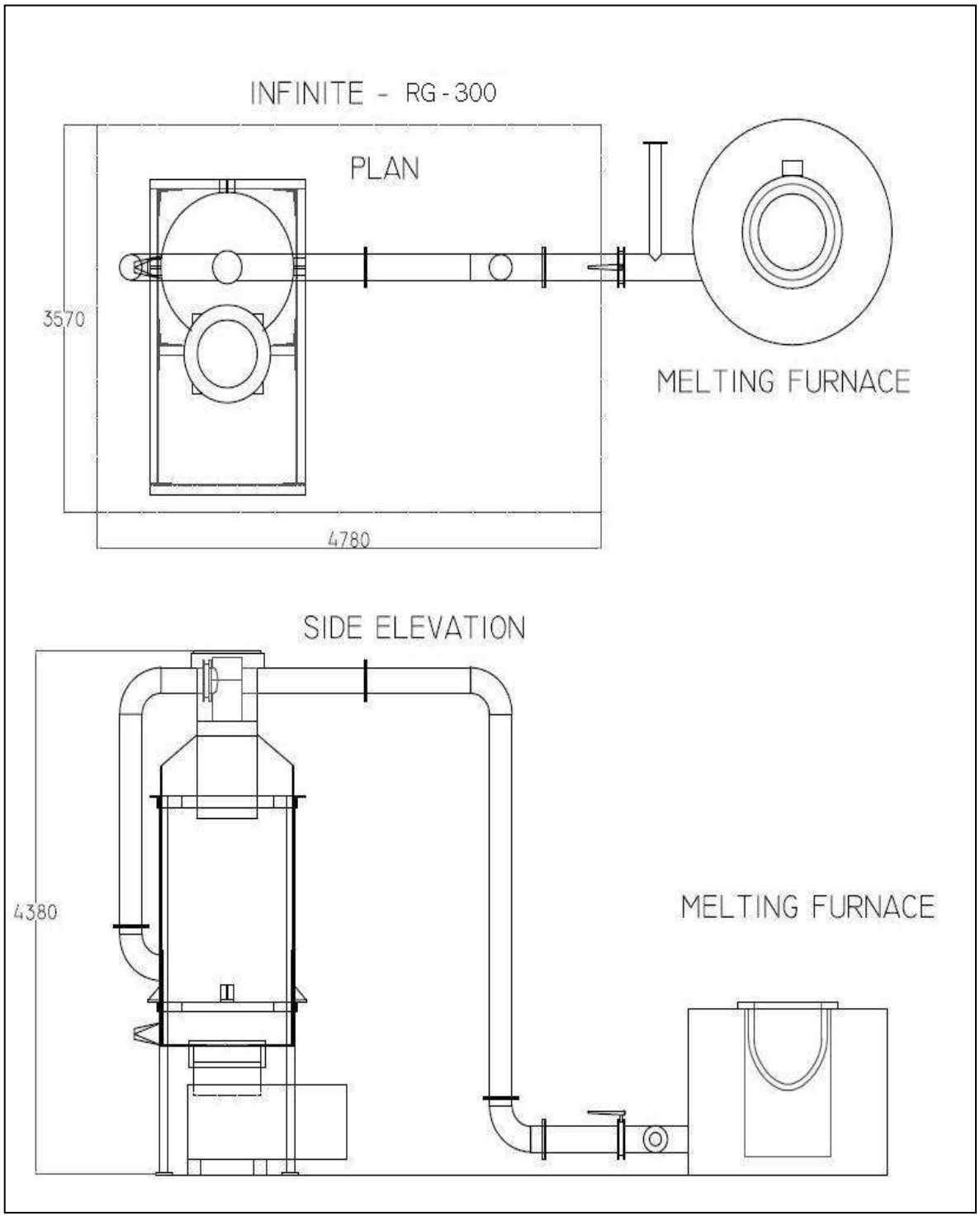
Figure 5: Process flow chart

(For a typical unit in the cluster)

Annexure – 3 Detail technical assessment report

S.No	Particular	Unit	Value
1	Total operating hours	hrs	3
2	total operating days	Days/annum	280
3	Present fuel (LDO/FO) consumption	kg/hr	41
4	GCV of LDO/FO	kCal/kg	10,000
5	Total heat input required	kCal/hr	410,000
6	total furnace oil consumption	tons/annum	34.44
7	Efficiency of gasifier	%age	75%
8	GCV of wood	kg/hr	3,500
9	Wood consumption in the proposed gasifier	kg/hr	156.2
10	Wood consumption per annum	Ton/annum	131.2
11	Electricity consumption	kWh/annum	6,266
12	Cost of furnace oil	`/ton	30000
13	Cost of wood	`./Ton	3500
14	Cost of electricity	`./kWh	5.7
15	Total monetary benefit	`.in lakh/annum	5.38
16	Total investment required	`.in lakh	15.6
17	Simple payback period	years	2.90

Annexure – 4 Drawings for proposed civil works



Annexure – 5 Detail Financial Calculation

Assumptions

Name of the Technology	**Wood Gasifier**		
Rated Capacity	**5,00,000 kCal/hr**		
Details	***Unit***	***Value***	***Basis***
No of Operating Hours	Hrs.	3	
Total operating days	Days	280	
Proposed Investment			
Plant & Machinery	` (in lakh)	14.40	
Civil work	` (in lakh)	0.20	
Erection & commissioning	` (in lakh)	0.50	
Misc. cost	` (in lakh)	0.50	
Total Investment	` (in lakh)	15.60	
Financing pattern			
Own Funds (Equity)	` (in lakh)	3.90	
Loan Funds (Term Loan)	` (in lakh)	11.70	
Loan Tenure	years	5	Assumed
Moratorium Period	Months	6	Assumed
Repayment Period	Months	66	Assumed
Interest Rate	%age	10.00%	
Estimation of Costs			
O & M Costs	% on Plant & Equip	5.38	Feasibility Study
Annual Escalation	%age	5.00	Feasibility Study
Estimation of Revenue			
Total monetary benefit	`/annum in lakh	5.38	Refer: Annexure 3
St. line Depn.	%age	5.28	Indian Companies Act
IT Depreciation	%age	80.00	Income Tax Rules
Income Tax	%age	33.99	Income Tax

Estimation of Interest on Term Loan

` (In lakh)

Years	***Opening Balance***	***Repayment***	***Closing Balance***	***Interest***
1	11.70	0.60	11.10	1.17
2	11.10	1.80	9.30	1.11
3	9.30	2.40	6.90	0.93
4	6.90	2.76	4.14	0.69
5	4.14	2.76	1.38	0.41
6	1.38	1.38	0.00	0.14
		11.70		

WDV Depreciation **` (in lakh)**

Particulars / years	*1*	*2*
Plant and Machinery		
Cost	6.78	1.36
Depreciation	5.42	1.08
WDV	1.36	0.27

Projected Profitability **` (in lakh)**

Particulars / Years	*1*	*2*	*3*	*4*	*5*	*6*	*7*	*8*
Fuel savings	5.38	5.38	5.38	5.38	5.38	5.38	5.38	5.38
Total Revenue (A)	5.38	5.38	5.38	5.38	5.38	5.38	5.38	5.38
Expenses								
O & M Expenses	0.31	0.33	0.34	0.36	0.38	0.40	0.42	0.44
Total Expenses (B)	0.31	0.33	0.34	0.36	0.38	0.40	0.42	0.44
PBDIT (A)-(B)	5.07	5.06	5.04	5.02	5.00	4.98	4.96	4.94
Interest	1.17	1.11	0.93	0.69	0.41	0.14	-	-
PBDT	3.90	3.95	4.11	4.33	4.59	4.85	4.96	4.94
Depreciation	0.82	0.82	0.82	0.82	0.82	0.82	0.82	0.82
PBT	3.08	3.12	3.29	3.51	3.77	4.02	4.14	4.12
Income tax	-	0.49	1.40	1.47	1.56	1.65	1.69	1.68
Profit after tax (PAT)	3.08	2.63	1.89	2.04	2.21	2.38	2.45	2.44

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

Particulars / Years	*1*	*2*	*3*	*4*	*5*	*6*	*7*	*8*
Profit before tax	3.08	3.12	3.29	3.51	3.77	4.02	4.14	4.12
Add: Book depreciation	0.82	0.82	0.82	0.82	0.82	0.82	0.82	0.82
Less: WDV depreciation	12.48	2.50	-	-	-	-	-	-
Taxable profit	(8.58)	1.45	4.11	4.33	4.59	4.85	4.96	4.94
Income Tax	-	0.49	1.40	1.47	1.56	1.65	1.69	1.68

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

Particulars / Years	*1*	*2*	*3*	*4*	*5*	*6*	*7*	*8*
Liabilities								
Share Capital (D)	3.90	3.90	3.90	3.90	3.90	3.90	3.90	3.90
Reserves & Surplus (E)	3.08	5.71	7.59	9.63	11.84	14.21	16.67	19.10
Term Loans (F)	11.10	9.30	6.90	4.14	1.38	0.00	0.00	0.00
Total Liabilities (D)+(E)+(F)	18.08	18.91	18.39	17.67	17.12	18.11	20.57	23.00

Assets	1	2	3	4	5	6	7	8
Gross Fixed Assets	15.60	15.60	15.60	15.60	15.60	15.60	15.60	15.60
Less Accm. Depreciation	0.82	1.65	2.47	3.29	4.12	4.94	5.77	6.59
Net Fixed Assets	14.78	13.95	13.13	12.31	11.48	10.66	9.83	9.01
Cash & Bank Balance	3.30	4.95	5.27	5.36	5.63	7.45	10.73	13.99
TOTAL ASSETS	18.08	18.91	18.39	17.67	17.12	18.11	20.57	23.00
Net Worth	6.98	9.61	11.49	13.53	15.74	18.11	20.57	23.00
Debt Equity Ratio	2.85	2.38	1.77	1.06	0.35	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	3.90	-	-	-	-	-	-	-	-
Term Loan	11.70								
Profit After tax		3.08	2.63	1.89	2.04	2.21	2.38	2.45	2.44
Depreciation		0.82	0.82	0.82	0.82	0.82	0.82	0.82	0.82
Total Sources	15.60	3.90	3.45	2.71	2.86	3.03	3.20	3.28	3.26
Application									
Capital Expenditure	15.60								
Repayment Of Loan	-	0.60	1.80	2.40	2.76	2.76	1.38	-	-
Total Application	15.60	0.60	1.80	2.40	2.76	2.76	1.38	-	-
Net Surplus	-	3.30	1.65	0.31	0.10	0.27	1.82	3.28	3.26
Add: Opening Balance	-	-	3.30	4.95	5.27	5.36	5.63	7.45	10.73
Closing Balance	-	3.30	4.95	5.27	5.36	5.63	7.45	10.73	13.99

IRR **` (in lakh)**

Particulars / months	***0***	***1***	***2***	***3***	***4***	***5***	***6***	***7***	***8***
Profit after Tax		3.08	2.63	1.89	2.04	2.21	2.38	2.45	2.44
Depreciation		0.82	0.82	0.82	0.82	0.82	0.82	0.82	0.82
Interest on Term Loan		1.17	1.11	0.93	0.69	0.41	0.14	-	-
Cash outflow									
Net Cash flow	(15.60)	-	-	-	-	-	-	-	-
IRR	19.50%								

NPV	5.17

Break Even Point **` (in lakh)**

Particulars / Years	***1***	***2***	***3***	***4***	***5***	***6***	***7***	***8***
Variable Expenses								
Oper. & Maintenance Exp (75%)	0.23	0.25	0.26	0.27	0.28	0.30	0.31	0.33
Sub Total*(G)*	0.23	0.25	0.26	0.27	0.28	0.30	0.31	0.33
Fixed Expenses								
Oper. & Maintenance Exp (25%)	0.08	0.08	0.09	0.09	0.09	0.10	0.10	0.11
Interest on Term Loan	1.17	1.11	0.93	0.69	0.41	0.14	0.00	0.00
Depreciation *(H)*	0.82	0.82	0.82	0.82	0.82	0.82	0.82	0.82
Sub Total (I)	2.07	2.02	1.84	1.60	1.33	1.06	0.93	0.93
Sales (J)	5.38	5.38	5.38	5.38	5.38	5.38	5.38	5.38
Contribution (K)	5.15	5.14	5.12	5.11	5.10	5.08	5.07	5.05
Break Even Point (L= G/I)	40.24%	39.24%	35.90%	31.38%	26.14%	20.87%	18.31%	18.47%
Cash Break Even {(I)-(H)}	24.24%	23.20%	19.82%	15.26%	9.98%	4.67%	2.06%	2.17%
Break Even Sales (J)*(L)	2.17	2.11	1.93	1.69	1.41	1.12	0.99	0.99

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

Particulars / Years	***1***	***2***	***3***	***4***	***5***	***6***	***7***	***8***	***Total***
Net Profit Before Taxes	3.08	3.12	3.29	3.51	3.77	4.02	4.14	4.12	29.04
Net Worth	6.98	9.61	11.49	13.53	15.74	18.11	20.57	23.00	119.03
									24.40%

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

Particulars / Years	***1***	***2***	***3***	***4***	***5***	***6***	***7***	***8***	***Total***
Cash Inflow									
Profit after Tax	3.08	2.63	1.89	2.04	2.21	2.38	2.45	2.44	14.21
Depreciation	0.82	0.82	0.82	0.82	0.82	0.82	0.82	0.82	4.94
Interest on Term Loan	1.17	1.11	0.93	0.69	0.41	0.14	0.00	0.00	4.45
Total (M)	5.07	4.56	3.64	3.55	3.44	3.34	3.28	3.26	23.61

DEBT

Interest on Term Loan	1.17	1.11	0.93	0.69	0.41	0.14	0.00	0.00	4.45
Repayment of Term Loan	0.60	1.80	2.40	2.76	2.76	1.38	0.00	0.00	11.70
Total (N)	1.77	2.91	3.33	3.45	3.17	1.52	0.00	0.00	16.15
	2.86	1.57	1.09	1.03	1.08	2.20	0.00	0.00	1.46
Average DSCR (M/N)	1.46								

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

Details of procurement and implementation –Wood Gasifier

S. No	Activity	Weeks				
		1 - 2	2 - 4	4 - 6	6 - 8	8 - 10
1	Collection of quotations and order finalization					
2	Designing by the supplier as per the requirement					
3	Fabrication at the equipment supplier workshop					
4	Delivery					
5	Commissioning , Trial runs and Insulation					

Break up of process down time

S. No.	*Activities*	*Days*						
		1	*2*	*3*	*4*	*5*	*6*	*7*
1	Time required for dismantling or re-location of the existing boiler							
2	Civil works and curing							
3	Installation							
4	Commissioning, Trial & Insulation							

Note: The Process down time is considered for item 1, 3 and 4 only. As the civil foundations and installation of water storage tanks and water distribution lines are laded during plant in operation.

Annexure -7 Details of equipment service providers

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

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

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

Infinite\mktg\10-11\ 9th July. 2010

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

09652000590

Ref: Your mail

Sub : Offer for Biomass gasifier plant– reg

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

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

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

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

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

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

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

Very Truly yours

Naval Kishore Agarwal
(Mobile no. 09212084933)

Infinite Energy Pvt. Ltd.

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

Infinite\mktg\10-11\ 9th July. 2010

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

09652000590

Sub : Offer for Biomass Gasification Plant – reg

Quotation

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

Terms and Conditions : As per offer enclosed

For Infinite Energy (P) Ltd

(Director)

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

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

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