DETAILED PROJECT REPORT
ON
ENERGY EFFICIENT BOILER (400 kg/hr)
(VAPI CHEMICALS & DYES CLUSTER)



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Bureau of Energy Efficiency

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ENERGY EFFICIENT BOILER (400 kg/hr)

VAPI DYES & CHEMICALS CLUSTER

BEE, 2010

Detailed Project Report on Energy Efficient Boiler 400 kg/hr

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

New Delhi: Bureau of Energy Efficiency;

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Zenith Energy Services Pvt. Ltd.

Hyderabad

Contents

List of Annexure……..….*vii*

List of Tables……...*vii*

List of Figures……*viii*

List of Abbreviation……....*viii*

Executive summary……*ix*

About BEE'S SME program……..*x*

1 INTRODUCTION 1

1.1 About the SME cluster 1

1.2 Energy performance in Vapi Dyes & Chemicals cluster 4

1.2.1 Specific energy consumption 4

1.3 Identification of technology/equipment 5

1.3.1 Description of technology/equipment to be replaced 5

1.3.2 Role in process 6

1.4 Establishing the baseline for the technology/equipment 6

1.4.1 Energy audit methodology adopted 7

1.4.2 Operating Efficiency 7

1.5 Barriers in adoption of proposed technology / equipments 8

1.5.1 Technological Barrier 8

1.5.2 Financial Barrier 8

1.5.3 Manpower skill 9

1.5.4 Other barrier (if any) 9

2 TECHNOLOGY/EQUIPMENT FOR ENERGY EFFICIENCY IMPROVEMENTS 10

2.1 Detail description of equipment 10

2.1.1 Description of technology 10

2.1.2 Technology /Equipment specifications 11

2.1.3 Justification of the technology selected & Suitability 12

2.1.4 Superiority over existing technology/equipment 12
2.1.5 Availability of the proposed technology/equipment 12
2.1.6 Source of technology/equipment for the project 12
2.1.7 Terms of sales 13
2.1.8 Process down time during implementation 13
2.2 Life cycle assessment and risks analysis 13
2.3 Suitable unit/plant size for proposed equipment 13
3 ECONOMIC BENEFIT OF NEW ENERGY EFFICIENT PUMPS 14
3.1 Technical benefit 14
3.1.1 Fuel saving 14
3.1.2 Electricity saving 14
3.1.3 Improvement in production quality 14
3.1.4 Increase in production 14
3.1.5 Reduction in raw material consumption 14
3.1.6 Reduction in other losses 14
3.2 Monetary benefits 14
3.3 Social benefits 15
3.3.1 Improvement in working environment in the plant 15
3.3.2 Improvement in skill set of workers 15
3.4 Environmental benefits 15
3.4.1 Reduction in effluent generation 15
3.4.2 Reduction in GHG emission such as CO2, NOx, etc 15
3.4.3 Reduction in other emissions like SOx 15
3.4.4 Reduction of deforestation 15
4 INSTALLATION OF NEW ENERGY EFFICIENT EQUIPMENT 16
4.1 Cost of project 16
4.1.1 Cost of equipment 16

4.1.2 Other costs 16
4.2 Arrangement of funds 16
4.2.1 Entrepreneur's contribution 16
4.2.2 Loan amount 16
4.2.3 Terms & conditions of loan 16
4.3 Financial indicators 17
4.3.1 Cash flow analysis 17
4.3.2 Simple payback period 17
4.3.3 Net Present Value (NPV) 17
4.3.4 Internal rate of return (IRR) 17
4.3.5 Return on investment (ROI) 17
4.4 Sensitivity analysis 17
4.5 Procurement and implementation schedule 18

List of Annexure

Annexure – 1 Efficiency of the existing Pumps 19

Annexure – 2 Process flow diagram 21

Annexure - 3 Detailed technology assessment report 22

Annexure – 4 Drawings for proposed electrical & civil works 23

Annexure – 5 Detail financial calculations 24

Annexure – 6 Details of procurement and implementation plan 28

Annexure – 7 Details of equipment service providers 29

Annexure – 8 Quotations or Techno-commercial bids 30

List of Table

Table 1.1 Annual Energy consumption of a typical unit 1

Table 1.2 Specific fuel consumption 4

Table 2.1 Comparison of Inefficient boiler with Energy efficient boiler 11

Table 2.2: Technical specifications 12

Table 3.1: Energy and cost benefit analysis of energy efficient boiler 14

Table 4.1: Details of project cost 16

Table 4.2: Financial indicator of project 17

Table 4.3: Sensitivity analysis in different scenario 18

List of Figure

Figure 1.1 General Process Flow Diagram.....3

Figure 1.2 In-efficient boiler operations at typical chemicals & dyes industry.....5

Figure 1.3 Energy audit methodology.....7

Figure 2.1: Energy efficient wood fired boiler.....10

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
VAM	Vapour Absorption Machine

EXECUTIVE SUMMARY

Zenith Energy Services Pvt. Ltd is executing BEE - SME program in Vapi Dyes & Chemicals 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 Dyes & Chemicals 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 Dyes & Chemicals clusters in India.

Vapi Dyes & Chemicals 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.

The raw material is different for the industries and depends on the product manufactured in the respective industry. Main energy forms used in the cluster units are Wood, Imported Coal, LDO, Furnace Oil, Ground Nut Briquettes and 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.

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 in the range of 40 to 45% only.

Installation of new energy efficient boiler having efficiency more than 65% due to waste heat recovery system, better insulation, better combustion system, induced draft system etc. and installation of new energy efficient boiler would lead to fuel consumption.

This DPR highlights the details of the study conducted for assessing the potential for replacement of inefficient boiler for steam generation by new energy efficient boiler, 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:

Sr. No.	Particular	Unit	Value
1	Project cost	` (in Lakh)	5.10
2	Fuel saving (Wood)	tons/year	49
3	Monetary benefit	`(in Lakh)	1.72
4	Debit equity ratio	Ratio	3:1
5	Simple payback period	Year	2.96
6	NPV	`(in Lakh)	1.51
7	IRR	% age	18.53
8	ROI	% age	24.25
9	DSCR	Ratio	1.44
10	Process down time	Days	7
11	CO_2 emission reduction	Tons/year	68

The projected profitability and cash flow statements indicate that the proposed project will be 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 25 selected SMEs clusters; Vapi Dyes & Chemicals 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 Dyes & Chemicals 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 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 capacity of approximately 80 tons per annum of M/s Swapnil Organics Ltd are furnished in the Table 1.1 below:

Table 1.1 Annual Energy consumption of a typical unit

S.No	Particular	Unit	Value
1	Electricity consumption	kWh/annum	3,08,621
2	Wood consumption	Tonne/annum	135
3	Production	Kg/annum	80000

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.

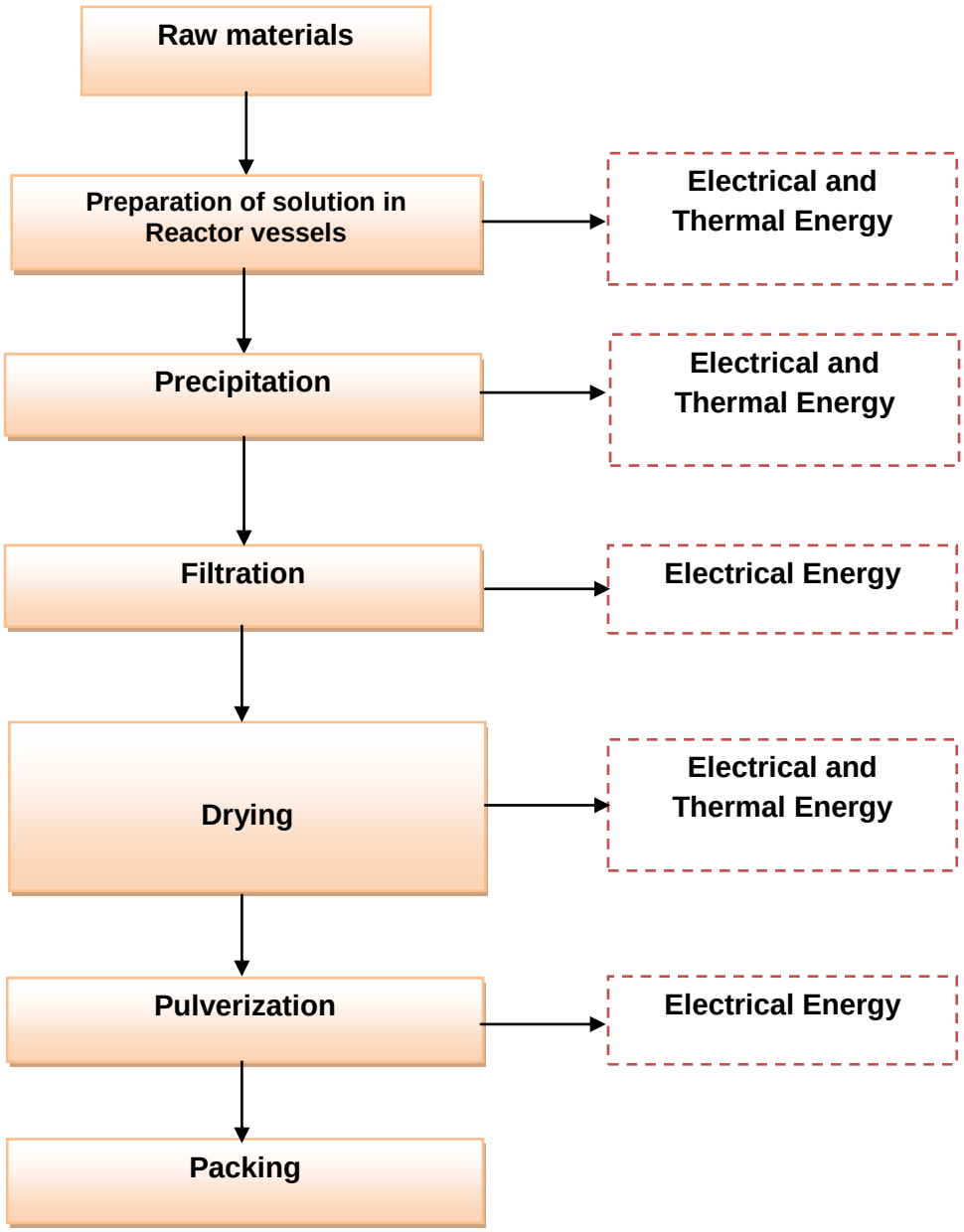


Figure 1.1 General Process Flow Diagram

The production process as depicted above is not similar for all units in Vapi Dyes & Chemicals 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 Dyes & Chemicals 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 42 percent of the total energy cost and remaining accounts for electrical energy.

In a typical manufacturing unit, the annual electricity and wood consumption is 3,08,621 kWh and 135 tonnes respectively. Average production capacity of a typical chemical & dyes manufacturing unit is around 80 tonnes per annum.

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.

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 typical units is furnished below in Table 1.2.

Table 1.2 Specific fuel consumption

S.No	*Name of unit*	*wood Consumption kg*	*Production kg*	*Specific energy consumption kg of wood /kg of final product*
1	M/s Swapnil organics Pvt Ltd	135000	80000	1.68
2	M/s Haatkesh	84000	48000	1.75
3	M/s Asin dye chem	81000	43000	1.88

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 In-efficient boiler 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:

- Huge potential of energy efficiency improvement opportunities
- Environment and working conditions improvement opportunities
- Design flaws in the conventional technology/system
- Operational & maintenance practices in conventional system

Technical gap analysis in wood fired boiler

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 system 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 conventional boiler is poor in terms of energy, environment, and social aspects. Based on above facts, the present inefficient boiler is to be replaced with new energy efficient boiler.

1.3.2 Role in process

For production of chemicals & dyes, the process requires steam and boiler is used for steam generation which is further used in process.

1.4 Establishing the baseline for the technology/equipment

Energy consumption in boiler would depend on below mentioned things

- Feed water temperature
- Quantity of steam required
- Climate conditions
- Operational & maintenance practices in boiler
- Type of wood/fuel and its calorific value

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:

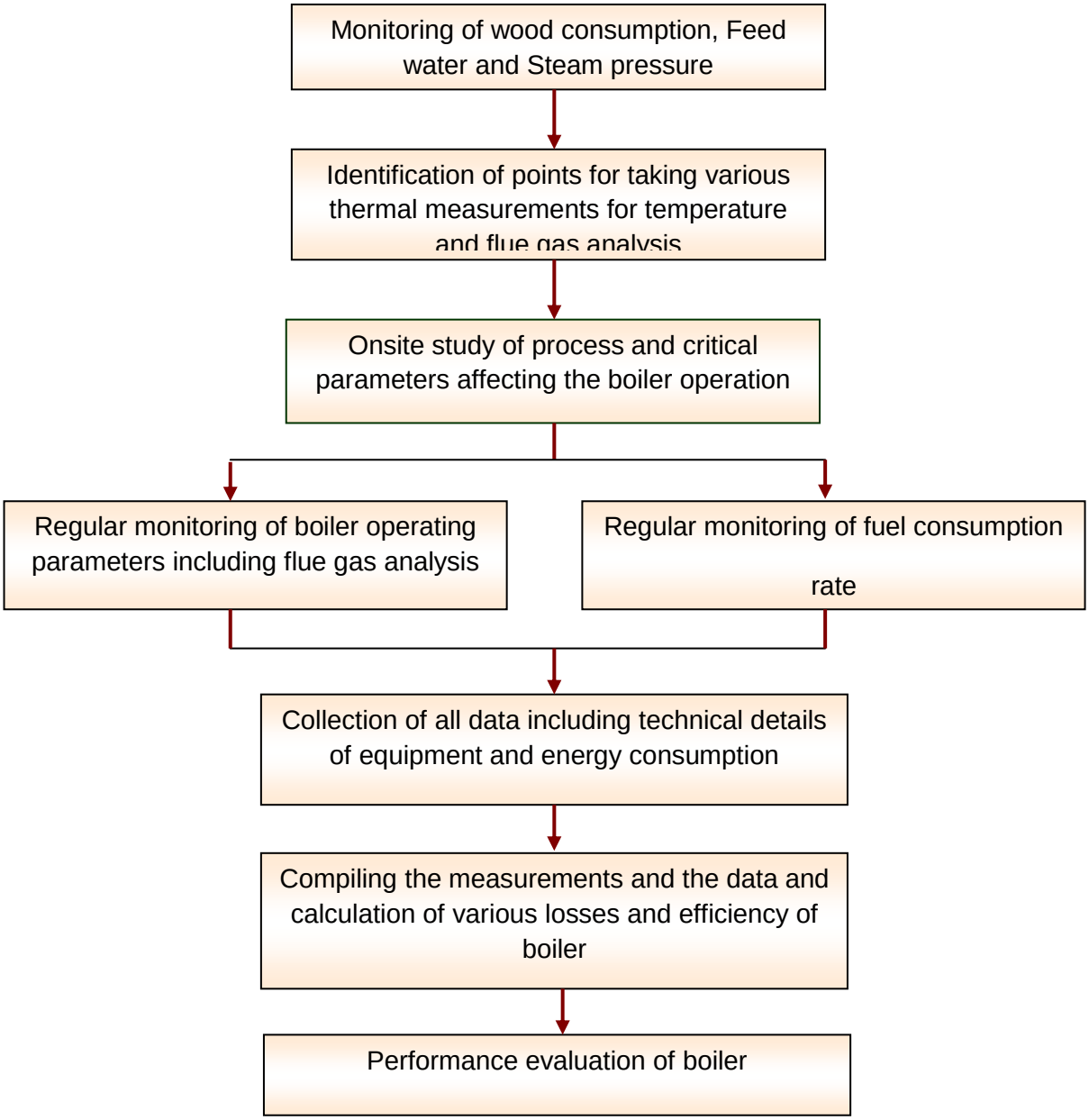


Figure 1.3 Energy audit methodology

1.4.2 Operating Efficiency

The operating efficiency of the existing boiler is 41.43% and details of operating parameters recorded and efficiency of the boilers of different units 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 new energy efficient boiler 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 textile 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 ` 5.10 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)

The non-availability of local suppliers for new energy efficient boilers

2 TECHNOLOGY/EQUIPMENT FOR ENERGY EFFICIENCY IMPROVEMENTS

2.1 Detail description of equipment

2.1.1 Description of technology

The new energy efficient wood fired boiler is a packaged, horizontal, 3 pass solid fuel fired boiler with fully wet back for high energy efficiency. The boiler is of natural draft and suitable for firing all kinds of solid fuels. The boiler is manually fired and simple designed for ease in operation and maintenance.

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Figure 2.1: Energy efficient wood fired boiler

The proposed energy efficient boiler mainly consists of the following elements.

- A feed water pump for supplying water to the boiler
- Grate and ash ports for fuel feeding and ash removal
- Refractory for minimizing radiation loss
- Control panel with fuse, temperature controls and contactors
- Insulation and mild steel cladding

Comparison of Inefficient boiler with new energy efficient boiler

The technical, economical, environmental and safety aspects of the present inefficient boiler and new energy efficient boiler are compared on life cycle of equipment, and same is presented in Table 2.1 below:

Table 2.1 Comparison of Inefficient boiler with Energy efficient boiler

S. No	Details	Inefficient boiler	Energy efficient boiler
1	Wood consumption	High	Low
2	Environment pollution	High	Low
3	Safety of workers	Poor	Good
4	Maintenance cost	High	Low
5	Operational cost	High	Low
6	Availability of local service providers	Yes	Yes / limited
7	Draught system	Natural	Induced
8	Fuel combustion	Partial	Complete
9	Waste heat recovery	No	Yes
10	Heat losses through grate and surface	High	Low
11	Radiation losses	More due to insulation damage	Less
12	Utilization of heat	Less (Single/two pass system)	Maximum (three pass system)
13	Capacity utilization	Low	Optimum
14	Combustion chamber	Conventional	Water walled
16	Operation and maintenance	Less easy	Easy
17	Time required for attaining the water temperature	More due to higher capacity	Less, as optimum size boiler selected

From the above table it is evident that energy efficient boiler has significant advantages over existing conventional boilers w.r.t. energy, environmental, economic & safety aspects. Hence, it is justifiable to install energy efficient boiler in place of conventional boiler.

2.1.2 Technology /Equipment specifications

Equipment specification of new wood fire energy efficiency boiler is furnished in Table 2.2 below:

Table 2.2: Technical specifications

S.No.	Details	Units	Value
1	Model	--	RSBW 400
2	Capacity	kg/hr	400
3	Maximum working pressure	kg/cm^2	10.5
4	Maximum temperature	^oC	179
5	Fuel used	--	Wood
6	Thermal efficiency	% age	65±2
7	Feed control	---	Manual
8	Combustion Draft	---	Induced
9	Water pump motor	hp	1.0
10	Total connected load	hp	2.0
11	Electric supply	---	3 PH,415 V,50 HZ,AC,4 wire
12	Dry weight (approx)	kg	2300

2.1.3 Justification of the technology selected & Suitability

New proposed equipment is used for steam generation which is earlier generated by conventional boiler. Hence new proposed equipment is completely suitable with existing process.

2.1.4 Superiority over existing technology/equipment

The new energy efficiency boiler is superior over the existing boiler for the following:

- Higher efficiency than conventional boiler
- Low operation and maintenance cost
- Life of the equipment is multifold than the present boiler

2.1.5 Availability of the proposed technology/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 new energy efficient designed boiler.

2.1.6 Source of technology/equipment for the project

Technology/Service provider selected for implementation of the proposed energy efficiency project is having experience in producing and supplying of energy efficient boilers, hot water

generators, waste heat recovery systems etc. Details of equipment supplier are given in Annexure 7.

2.1.7 Terms of sales

A general terms and conditions of the equipment and scope of supply of energy efficient boiler given by the vendors are given in the annexure 7.

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 cycle assessment and risks analysis

The total operational life of the proposed energy efficient boiler is considered to be 10 years.

2.3 Suitable unit/plant size for proposed equipment

The cluster units has boilers of different capacities ranging from 400 kg/hr to 2000 kg/hr. based on the detailed studies undertaken, there are considerable number of units in the cluster having boiler of 400 kg/hr capacity and hence, a 400 kg/hr rated capacity energy efficient boiler is suggested for the cluster units.

3 ECONOMIC BENEFIT OF NEW ENERGY EFFICIENT PUMPS

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 efficiency of boiler is 41.43% and average wood consumption in a typical unit is 135 tonnes per annum. Whereas, the efficiency of new energy efficient boiler is 65% and wood consumption in proposed energy efficient boiler would be 86 tonne for the same production and steam generation thereby, wood saving would be 49 tonnes per annum.

3.1.2 Electricity saving

Project implementation will lead no saving of electricity consumption.

3.1.3 Improvement in production 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

There is no significant impact on production.

3.1.5 Reduction in raw material consumption

No significant impact on the raw materials consumption.

3.1.6 Reduction in other losses

There is no other reduction loss.

3.2 Monetary benefits

Annual monetary savings due to implementation of energy efficient boiler in place of the conventional boiler is ` 1.72 lakh per annum. Energy & monetary benefit analysis of energy efficient boiler is presented in Table 3.1 below:

Table 3.1: Energy and cost benefit analysis of energy efficient boiler

S.No	*Parameter*	*Unit*	*Value*
1	Wood consumption in existing boiler	Tonne/annum	135
2	Wood consumption in proposed boiler	Tonne/annum	86
3	Wood saving	Tonne/annum	49
4	Cost of wood	`/tonne	3500
5	Total monetary benefit	` in lakh	1.72

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 replacement of inefficient boiler with energy efficient boiler will reduce the 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 technology selected for the implementation is new and energy efficient. Hence the technology implemented will create awareness about energy conservation among the worker and improves skill set of workers.

3.4 Environmental benefits

3.4.1 Reduction in effluent generation

The project activity will reduce effluent generation, as with new pumps, the leakages may reduce.

3.4.2 Reduction in GHG emission such as CO2, NOx, etc

Implementation of this project will lead to reduction in CO_2 emissions due to reduction in overall fuel consumption. Implementation of this project will result in saving of 49 Tonne of wood per year thereby; reduce 68 tonne CO_2 emissions per year from one unit. Similarly, there are many similar type of unit in Vapi, and if all units will implement this project then significant amount of CO_2 emission reduction possible per year.

Taking CO_2 emission factor is 1.4 tCO_2 per tonne of wood consumption.

3.4.3 Reduction in other emissions like SOx

No significant impact on SOx emissions.

3.4.4 Reduction of deforestation

Reduction in wood consumption will automatically reduce the deforestation.

4 INSTALLATION OF NEW ENERGY EFFICIENT EQUIPMENT

4.1 Cost of project

4.1.1 Cost of equipment

The cost of boiler set is estimated at ` 4.40 lakh, which includes boiler and accessories as per the quotation provided by the supplier given at Annexure 8.

4.1.2 Other costs

Other cost includes civil work and all applicable taxes. Details of total cost of installation of the proposed system are furnished in table 4.1 below:

Table 4.1: Details of project cost

S.No	*Details*	*Cost (` in lakh)*
1	Energy efficient boiler	4.40
2	Civil work	0.10
3	All applicable taxes	0.60
4	Total Investment	5.10

4.2 Arrangement of funds

4.2.1 Entrepreneur's contribution

The total cost of the proposed technology is estimated at ` 5.10 lakh. The entrepreneur's contribution is 25% of total project cost, which is ` 1.28 lakh.

4.2.2 Loan amount

The term loan is 75% of the total project cost, which is ` 3.83 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 ` 0.93 lakh in the first year operation and gradually increases to ` 4.26 lakh at the end of eighth year.

4.3.2 Simple payback period

The total project cost of the proposed technology is ` 5.10 lakh and monetary savings due to reduction in electricity consumption is ` 1.72 lakh hence the simple payback period works out to be 2.96 year.

4.3.3 Net Present Value (NPV)

The net present value of the investment at 10% works out to be ` 1.51 lakh.

4.3.4 Internal rate of return (IRR)

The after tax internal rate of return of the project works out to be 18.53%. Thus the project is financially viable.

4.3.5 Return on investment (ROI)

The average return on investment of the project activity works out at 24.25%.

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	Year	2.96
2	IRR	%age	18.53
3	NPV	` in lakh	1.51
4	ROI	%age	24.25
5	DSCR	Ratio	1.44

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 fuel savings by 5%
- Decrease in fuel 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	***NPV*** ` in lakh	***IRR*** %age	***ROI*** %age	***DSCR***
Normal	1.51	18.53	24.25	1.44
5% increase in fuel savings	1.84	20.29	24.58	1.51
5% decrease in fuel savings	1.18	16.73	23.87	1.37

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 – 1 Efficiency of the existing Pumps

Unit 1 - (M/s Swapnil Organics Pvt Ltd))

S.No	Particular	Value	Unit
1	Fuel used	--	wood
2	Capacity of Boiler	kg	400
3	Fuel Consumption	kg/hr	83.5
4	Calorific Value	kCal/kg	3800
5	Total heat input	kCal/hr	317300
6	Steam Generated	kg/hr	210
7	Steam pressure	kg/cm^2	5
8	feed water Temperature (Enthalpy)	kCal/kg	30.0
9	Enthalpy of steam at 5 kg/cm^2	kCal/kg	656
10	Net heat gain	kCal/kg	626
11	Heat output	kCal/hr	131460
12	Efficiency	% age	41.4

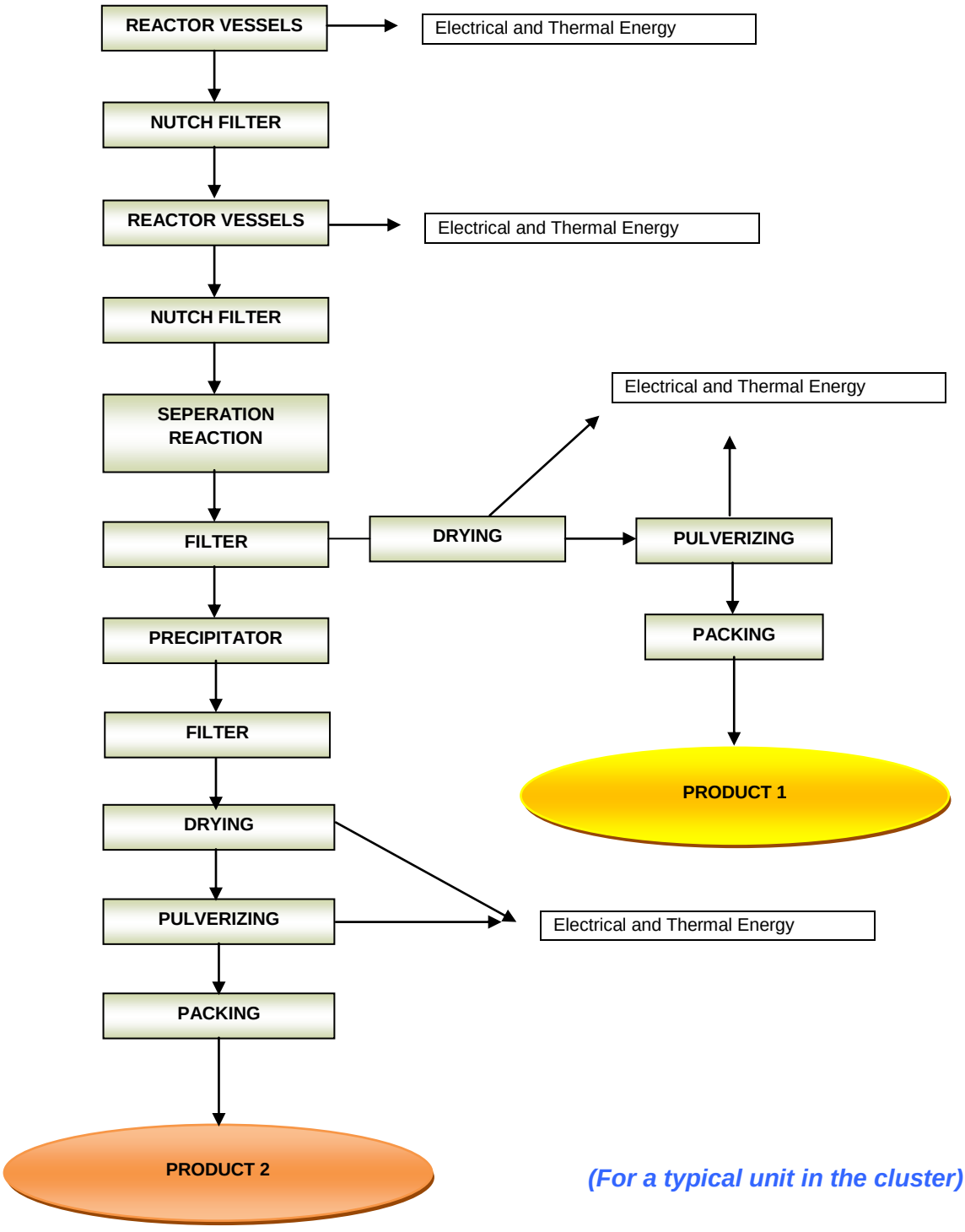
Unit 2 - (M/s Hatkesh Chem and Engineering Industries))

S.No	Particular	Value	Unit
1	Fuel used	---	wood
2	Capacity of Boiler	kg	400
3	Fuel Consumption	kg/hr	78
4	Calorific Value	kcal	3800
5	Total heat input	kcal/hr	296400
6	Steam Generated	kg/hr	180
7	Steam pressure	kg/cm^2	4
8	feed water Temperature (Enthalpy)	kcal/kg	29.0
9	Enthalpy of steam at 5 kg/cm^2	kcal/kg	653
10	Net heat gain	kcal/kg	624
11	Heat output	kcal/hr	112320
12	Efficiency	% age	37.9

Unit 3 - (M/s Asian Dye Chem Industries))

S.No	Particular	Value	Unit
1	Fuel used	---	wood
2	Capacity of Boiler	kg	400
3	Fuel Consumption	kg/hr	75
4	Calorific Value	kcal	3800
5	Total heat input	kcal/hr	285000
6	Steam Generated	kg/hr	205
7	Steam pressure	kg/cm^2	3.5
8	feed water Temperature (Enthalpy)	kcal/kg	30.0
9	Enthalpy of steam at 5 kg/cm^2	kcal/kg	652
10	Net heat gain	kcal/kg	622
11	Heat output	kcal/hr	127510
12	Efficiency	% age	44.7

Annexure – 2 Process flow diagram

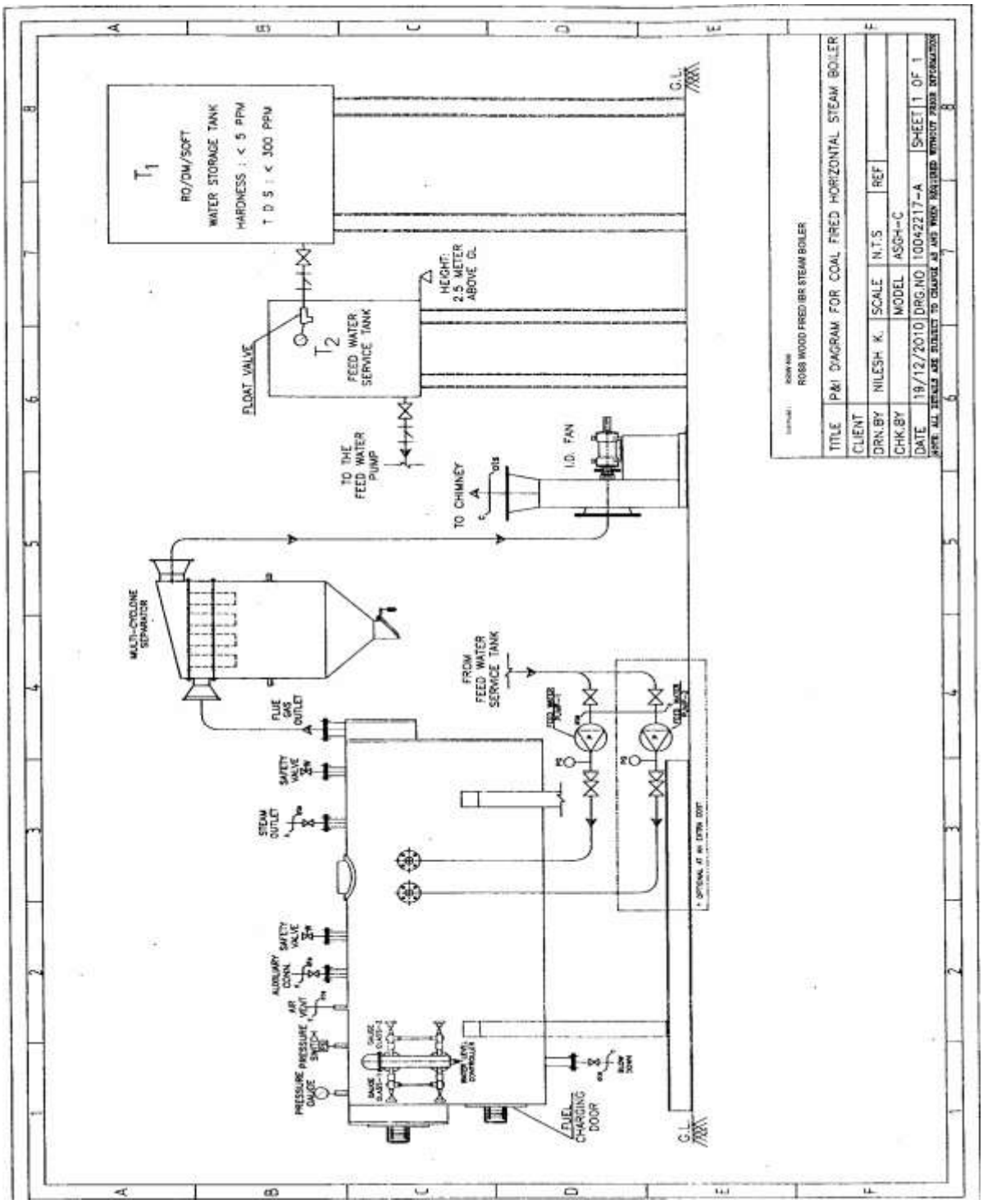


(For a typical unit in the cluster)

Annexure 3 Detailed technology assessment report

S.No	Particular	Unit	Value	
			Existing Boiler	Proposed Boiler
1	Operating hour	hrs	9	9
2	Operating days	Days/year	180	180
3	Temperature of feed water	^{0}C	30	30
4	Calorific value of wood	kCal/kg	3800	3800
5	Efficiency of boiler	% age	41.4	65
6	Wood consumption	Tonne/annum	135	86
7	Saving of wood consumption	Tonne		49
8	Cost of wood	` / Tonne		3500
9	Monetary saving	` in lakh		1.72
10	Cost of project	` in lakh		5.10
11	Simple payback period	Years		2.96

Annexure – 4 Drawings for proposed electrical & civil works



Annexure – 5 Detail financial calculations

Assumption

Name of the Technology	**Energy Efficient Boiler**		
Rated Capacity	**400 kg/hr**		
Details	***Unit***	***Value***	***Basis***
No of Operating Hours	Hrs.	9	
Total operating days	Days	180	
Proposed Investment			
Equipment cost	` (in lakh)	4.40	
Taxes viz. Excise duty, Service tax	` (in lakh)	0.60	
Total Investment	` (in lakh)	5.10	
Financing pattern			
Own Funds (Equity)	` (in lakh)	1.28	
Loan Funds (Term Loan)	` (in lakh)	3.83	
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	2.00	Feasibility Study
Annual Escalation	%age	5.00	Feasibility Study
Estimation of Revenue			
Fuel saving (Wood)	tons/annum	49	
Cost	`/tons	3500	
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	3.83	0.30	3.53	0.38
2	3.53	0.66	2.87	0.35
3	2.87	0.84	2.03	0.29
4	2.03	0.76	1.27	0.20
5	1.27	0.84	0.42	0.13
6	0.42	0.43	-0.01	0.04
		3.83		

WDV Depreciation **` (in lakh)**

Particulars / years	*1*	*2*
Plant and Machinery		
Cost	5.10	1.02
Depreciation	4.08	0.82
WDV	1.02	0.20

Projected Profitability **` (in lakh)**

Particulars / Years	*1*	*2*	*3*	*4*	*5*	*6*	*7*	*8*
Fuel savings	1.72	1.72	1.72	1.72	1.72	1.72	1.72	1.72
Total Revenue (A)	1.72	1.72	1.72	1.72	1.72	1.72	1.72	1.72
Expenses								
O & M Expenses	0.10	0.11	0.11	0.12	0.12	0.13	0.14	0.14
Total Expenses (B)	0.10	0.11	0.11	0.12	0.12	0.13	0.14	0.14
PBDIT (A)-(B)	1.61	1.61	1.60	1.60	1.59	1.59	1.58	1.57
Interest	0.38	0.36	0.29	0.21	0.13	0.05	-	-
PBDT	1.23	1.25	1.31	1.39	1.46	1.54	1.58	1.57
Depreciation	0.27	0.27	0.27	0.27	0.27	0.27	0.27	0.27
PBT	0.96	0.98	1.04	1.12	1.19	1.27	1.31	1.30
Income tax	-	0.15	0.45	0.47	0.50	0.52	0.54	0.53
Profit after tax (PAT)	0.96	0.83	0.60	0.65	0.70	0.75	0.77	0.77

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

Particulars / Years	*1*	*2*	*3*	*4*	*5*	*6*	*7*	*8*
Profit before tax	0.96	0.98	1.04	1.12	1.19	1.27	1.31	1.30
Add: Book depreciation	0.27	0.27	0.27	0.27	0.27	0.27	0.27	0.27
Less: WDV depreciation	4.08	0.82	-	-	-	-	-	-
Taxable profit	(2.85)	0.44	1.31	1.39	1.46	1.54	1.58	1.57
Income Tax	-	0.15	0.45	0.47	0.50	0.52	0.54	0.53

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

Particulars / Years	*1*	*2*	*3*	*4*	*5*	*6*	*7*	*8*
Liabilities								
Share Capital (D)	1.28	1.28	1.28	1.28	1.28	1.28	1.28	1.28
Reserves & Surplus (E)	0.96	1.80	2.39	3.04	3.74	4.49	5.26	6.03
Term Loans (F)	3.58	2.92	2.08	1.32	0.47	-0.01	-0.01	-0.01
Total Liabilities (D)+(E)+(F)	5.81	5.99	5.74	5.63	5.49	5.76	6.53	7.30

Assets	1	2	3	4	5	6	7	8
Gross Fixed Assets	5.10	5.10	5.10	5.10	5.10	5.10	5.10	5.10
Less Accm. Depreciation	0.27	0.54	0.81	1.08	1.35	1.62	1.88	2.15
Net Fixed Assets	4.83	4.56	4.29	4.02	3.75	3.48	3.22	2.95
Cash & Bank Balance	0.98	1.43	1.45	1.61	1.74	2.27	3.31	4.35
TOTAL ASSETS	5.81	5.99	5.74	5.63	5.49	5.76	6.53	7.30
Net Worth	2.24	3.07	3.67	4.32	5.01	5.76	6.53	7.30
Debt Equity Ratio	2.80	2.29	1.63	1.03	0.37	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	1.28	-	-	-	-	-	-	-	-
Term Loan	3.83								
Profit After tax		0.96	0.83	0.60	0.65	0.70	0.75	0.77	0.77
Depreciation		0.27	0.27	0.27	0.27	0.27	0.27	0.27	0.27
Total Sources	5.10	1.23	1.10	0.87	0.92	0.96	1.02	1.04	1.04
Application									
Capital Expenditure	5.10								
Repayment Of Loan	-	0.25	0.66	0.84	0.76	0.84	0.48	-	-
Total Application	5.10	0.25	0.66	0.84	0.76	0.84	0.48	-	-
Net Surplus	-	0.98	0.44	0.03	0.16	0.12	0.54	1.04	1.04
Add: Opening Balance	-	-	0.98	1.43	1.45	1.61	1.74	2.27	3.31
Closing Balance	-	0.98	1.43	1.45	1.61	1.74	2.27	3.31	4.35

IRR **` (in lakh)**

Particulars / months	***0***	***1***	***2***	***3***	***4***	***5***	***6***	***7***	***8***
Profit after Tax		0.96	0.83	0.60	0.65	0.70	0.75	0.77	0.77
Depreciation		0.27	0.27	0.27	0.27	0.27	0.27	0.27	0.27
Interest on Term Loan		0.38	0.36	0.29	0.21	0.13	0.05	-	-
Cash outflow									
Net Cash flow	(5.10)	1.61	1.46	1.16	1.12	1.09	1.06	1.04	1.04
IRR	18.56								

NPV	1.52

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

Particulars / Years	***1***	***2***	***3***	***4***	***5***	***6***	***7***	***8***
Variable Expenses								
Oper. & Maintenance Exp (75%)	0.08	0.08	0.08	0.09	0.09	0.10	0.10	0.11
Sub Total*(G)*	0.08	0.08	0.08	0.09	0.09	0.10	0.10	0.11
Fixed Expenses								
Oper. & Maintenance Exp (25%)	0.03	0.03	0.03	0.03	0.03	0.03	0.03	0.04
Interest on Term Loan	0.38	0.36	0.29	0.21	0.13	0.05	0.00	0.00
Depreciation *(H)*	0.27	0.27	0.27	0.27	0.27	0.27	0.27	0.27
Sub Total (I)	0.68	0.65	0.59	0.51	0.43	0.35	0.30	0.31
Sales (J)	1.72	1.72	1.72	1.72	1.72	1.72	1.72	1.72
Contribution (K)	1.64	1.64	1.63	1.63	1.62	1.62	1.61	1.61
Break Even Point (L= G/I)	41.29%	39.94%	36.08%	31.10%	26.59%	21.58%	18.80%	18.96%
Cash Break Even {(I)-(H)}	24.87%	23.48%	19.58%	14.56%	10.01%	4.94%	2.12%	2.23%
Break Even Sales (J)*(L)	0.71	0.69	0.62	0.53	0.46	0.37	0.32	0.33

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

Particulars / Years	***1***	***2***	***3***	***4***	***5***	***6***	***7***	***8***	***Total***
Net Profit Before Taxes	0.96	0.98	1.04	1.12	1.19	1.27	1.31	1.30	9.19
Net Worth	2.24	3.07	3.67	4.32	5.01	5.76	6.53	7.30	37.91
									24.23%

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

Particulars / Years	***1***	***2***	***3***	***4***	***5***	***6***	***7***	***8***	***Total***
Cash Inflow									
Profit after Tax	0.96	0.83	0.60	0.65	0.70	0.75	0.77	0.77	4.49
Depreciation	0.27	0.27	0.27	0.27	0.27	0.27	0.27	0.27	1.62
Interest on Term Loan	0.38	0.36	0.29	0.21	0.13	0.05	0.00	0.00	1.42
Total (M)	1.61	1.46	1.16	1.13	1.10	1.06	1.04	1.04	7.52

DEBT

Interest on Term Loan	0.38	0.35	0.29	0.20	0.13	0.04	0.00	0.00	1.39
Repayment of Term Loan	0.30	0.66	0.84	0.76	0.84	0.43	0.00	0.00	3.83
Total (N)	0.68	1.01	1.13	0.96	0.97	0.47	0.00	0.00	5.22
	2.37	1.44	1.03	1.17	1.13	2.25	0.00	0.00	1.44
Average DSCR (M/N)	1.44								

Annexure – 6 Details of procurement and implementation plan

Details of procurement and implementation –Energy Efficient Boiler

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	Service/technology providers
Energy efficient Pumps	**Ross Boilers** Address: 33, Al Ameen Society, Gultekdi, Pune - 411037, Maharashtra, India Phone: 91-20-24269393/24272293/24274717 Fax : 91-20-24272293/24269562 ***Industrial Boilers Limited*** 227 Vapi Industrial Township, Vapi, Gujarat - 396195 (India) Phone : +(91)-(260)-2432899 / 2431549 / 2422614 ***THERMAX LTD.*** 85/b, 85 B, Amin Chamber, Sampatrao Colony, Vadodara, Gujarat, 390005

Annexure – 8 Quotations or Techno-commercial bids

Quotation :

Unit Model : **RSBW 400**

ROSS WOOD FIRED IBR STEAM BOILER

Technical Specifications :

Steam output (From & at 100 Deg. C):	400 kgs/hr
Working pressure :	10.5 kg /sq.cm
Steam Temperature :	179 deg C
Fuel :	WOOD
Fuel Consumption : (E = 65 %, N.C.V. = 3500 KCal/Kg)	95 kgs/hr#
Thermal efficiency (NCV) :	65 ± 2%
Feed Control :	Manual
Water Pump Motor:	1.0 HP
Combustion Draft :	Induced
Total Connected Load :	2 HP
Electric Supply :	3 PH, 415 V, 50HZ, AC, 4 Wire system
Overall Dimentions (approx.) :	
Width :	1600 mm
Depth :	1800 mm
Height :	2300 mm
Dry Weight (approx.) :	2000 kgs

Fuel consumption is based on N.C.V. (net calorific value) of fuel at 3,500 Kcals/kg. & Steam Boiler efficiency of 65 %. The efficiency is guaranteed subject to clean internal & external heat transfer surfaces.

* Specifications are subject to reasonable change without prior notice.

BATTERY LIMITS : As specified in the P & I diagram.

Price Annexture :

Price :	**440,000.00** (Ex-Works Unpacked)
Packing & Forwarding :	At actuals.
Insurance :	1% of Ex-works price
Taxes :	Excise : 8.24% Or As applicable at the time of delivery Sales tax : 12.50% VAT OR 3% CST against Form C.
Payment Terms :	Advance 50% along with firm order. Balance 50% against performa invoice prior to despatch.
Delivery Period :	6-8 weeks from the date of order with advance.
Commissioning :	Rs 2500/- per day plus to & fro charges at actuals. Lodging & boarding of our service engineer to be arranged by the customer.
Inspection :	At our works prior to despatch
Validity :	The quotation is valid for 60 days.
Jurisdiction :	Subject to Pune Juridiction

Unit Model : **RSBW 400**

ROSS WOOD FIRED IBR STEAM BOILER

Design Features :

- Water tube coil type IBR approved boiler.
- Designed for ease of operation and maintenance.
- Manual firing with induced draught.
- Refractory type combustion chamber assembly.
- Pressure part made of MS ERW tubes.
- Designed for maximum efficiency.
- All Standard parts ensures easy availability of spares.

Scope Of Supply :

- Pressure parts fabricated out of IBR quality ERW tubes, duly certified by IBR Inspector
- Refractory type wood firing furnace with fire door, ash door & firing grate.
- Pre-wired control panel with fuse, temperature controller & contactors.
- Reciprocating water pump motor assembly.
- Mineral wool insulation with mild steel cladding.
- Induced draught fan.
- Steam dryer.

Control Instruments and Safeties :

- Pressure indicator to indicate steam pressure.
- Temperature indicator to indicate steam temperature & to give alarm in case of high temp (high pressure).
- Steam safety valve at the unit outlet.
- Pressure switch to cutoff water pump in case of high steam pressure.

This Offer Excludes :

- This offer excludes all civil & structural work for installing the boiler.
- Spares for installation, operation and maintenance.
- Main chimney and flue gas ducting from boiler to chimney.
- All water piping from tank to unit inlet and from unit outlet to utility.
- Main switch and supply cable upto control panel.
- Erection and commissioning of the unit at site.
- Raw water, soft water and fuel storage & service tanks.
- Water softener assembly.
- IBR inspection, registration & other formalities to becarried out at site.
- Any other items or services not specifically mentioned in our scope of supply.

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

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Fax No.040 23322517
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