DETAILED PROJECT REPORT
ON
ENERGY EFFICIENT BOILER FEED WATER PUMP
(40 M^3/HR)
(MUZAFFARNAGAR PAPER CLUSTER)







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ENERGY EFFICIENT BOILER FEED WATER PUMP
(40 M^3/HR)

MUZAFFARNAGAR PAPER CLUSTER

BEE, 2010
Detailed Project Report on Energy Efficient Boiler Feed Water Pump (40 m^3/hr)
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Deloitte Touche Tohmatsu India Pvt. Ltd.

Gurgaon

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List of Abbreviation

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

EXECUTIVE SUMMARY

Deloitte Touche Tohmatsu India Private Limited is executing BEE-SME program in Muzaffarnagar Paper Cluster, supported by Bureau of Energy Efficiency (BEE) with an overall objective of improving the energy efficiency in cluster units.

Muzaffarnagar cluster is one of the largest SME paper clusters in India; accordingly this cluster was chosen for energy efficiency improvements by implementing energy efficient measures/technologies, so as to facilitate maximum replication in other paper units/clusters in India. The main energy forms used in the cluster units are grid electricity, coal and biomass. Rice husk, pith and bagasse are the major biomass used in the cluster. In few mills wood chips are also used as a supplementary fuel.

Energy consumption (thermal energy & electrical energy) in Paper unit depends on capacity of unit and raw material used in the unit. The paper mills in Muzaffarnagar cluster have energy saving opportunities both in the process and utility side. During the energy audit carried out, it was observed that a few paper mills were performing fairly well in terms of energy efficiency. These mills have adopted the latest and energy efficient technologies available both on the process and utility side. Still there are fairly large numbers of unit that have potential to improve energy efficiency.

The boiler feed water pump is used to supply boiler feed water to the boiler drum at the required pressure. Replacement of the present low efficiency pump with a higher efficiency pump will lead to energy savings. The high efficiency pump will consume less electricity as compared to the present low efficiency pump.

At many instances it was observed that the pump is operating on lower efficiency range. The pumps installed are old with low design efficiency. The boiler feed water pump operating efficiency was estimated to be 44%. Higher efficiency pumps are available for the same application. New high efficiency pumps are available. Replacement of the present low efficiency pump with a higher efficiency pump will lead to energy savings. The high efficiency pump will consume less electricity as compared to the present low efficiency pump. It is possible to operate the new efficient pump at an efficiency level of around 68%. This will lead to an energy saving of approximately 50 kW.

This DPR highlights the energy, environment, economic and social benefits of energy efficient boiler feed water pump project. Replacement of the present low efficiency pump with a higher efficiency pump will lead to energy savings. The high efficiency pump will consume less electricity as compared to the present low efficiency pump.

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)	19.85
2	Electricity Saving	kWh/year	400,941
3	Monetary benefit	` (in Lakh)	15.68
4	Simple payback period	years	1.27
5	NPV	` (in Lakh)	36.90
6	IRR	%age	58.52
7	ROI	%age	27.55
8	DSCR	Ratio	3.20
9	Process down time	Days	NIL

The projected profitability and cash flow statements indicate that the project implementation i.e. installation of efficient boiler feed water pump in a boiler will be financially viable and technically feasible solution for paper cluster.

ABOUT BEE'S SME PROGRAM

Bureau of Energy Efficiency (BEE) is implementing a BEE-SME Programme to improve the energy performance in selected SMEs clusters. Muzaffarnagar Paper 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 audit

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

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 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 (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 Brief Introduction about cluster

Muzaffarnagar is situated in Western Uttar Pradesh and is important industrial town with paper, sugar and steel being the major products. Muzaffarnagar paper cluster has around 29 paper units. The entire paper cluster is geographically divided into three areas, namely Bhopa Road, Jansath Road and Shamli in Muzaffarnagar district. The reason for such high concentration of mills is easy availability of raw material in the area. Paper units are normally having out-dated technologies characterized by inefficient energy and water management systems. In terms of raw material usage, mills can be broadly put in two categories – waste paper based and agro-waste based. Similarly, for finished products too, though bulk of the mills produces only kraft paper, a few of them have started producing writing paper. These mills are quite closely networked and successful development in one mill is very rapidly replicated in large number of similar mills.

The total installed capacity of all the paper mills in Muzaffarnagar is approximately 542,700 MTPA. These mills are a mix of waste paper & agro. While 12 mills under the BEE SME Program are agro-cum waste paper based, 16 of them are solely waste paper based and 1 mill which is recently established is agro based.

An important aspect of the mills here is that some of these units have a common business operational structure due to fact that they share the same management. As such the cluster based advantage is already being derived by most of these units. A large percentage of these mills were set up in 80's and 90's in the small and medium sector.

The capacity utilization of all these mills ranges from 20% to 90%. Out of the total mills, 43% are based upon both agro and waste material whereas 57% are waste paper based. Classification can also be done based upon the product. While only 16% are involved in the manufacture of only duplex board, a healthy 66% are into making Kraft paper only & 22% make writing/printing paper along with small quantities of either duplex board or Kraft paper.

The paper mills in the Muzaffarnagar cluster use various types of fuels like coal, biomass, pet coke etc. The primary fuel used in all the mills is coal and biomass. Rice husk, pith and bagasse are the major biomass used in the cluster. In few mills wood chips are also used as a supplementary fuel. Details of total energy consumption at Muzaffarnagar Paper cluster are furnished in Table 1 below:

Table 1 Details of annual energy consumption

S. No	Type of Energy	Unit	Value	% contribution
1	Electricity	TOE	15,280	14.89
2	Fuel	TOE	87,365	85.11

Classification of Units

Units can be classified broadly with respect to size/capacity, raw material used and the product.

Table 2 Classification of Units

Size	Raw Material	Product
1750 TPA to 875,00 TPA	• Agro and waste paper based • Waste paper based • Agro based	• Kraft paper • Writing paper • Other

The paper mills in the cluster vary widely in capacity. There are mills with capacities as low as 1750 TPA and as high as 87500 TPA. The variation with respect to capacity is represented in the chart below.

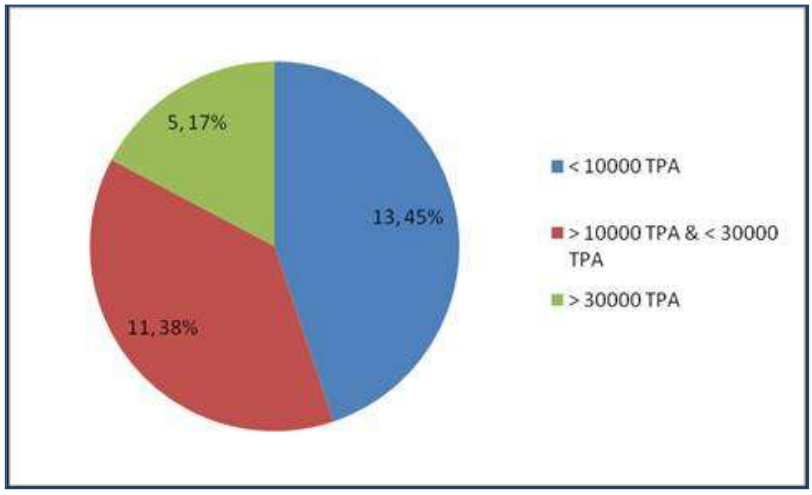


Figure 1 Classification of Units - Capacity

The paper mills in Muzaffarnagar are either based on waste paper or agro residue. While 12 mills under the BEE SME Program are agro-cum waste paper based, 16 of them are solely waste paper based and 1 mill which is recently established is agro based. The variation with respect to raw materials used is represented in the chart below.

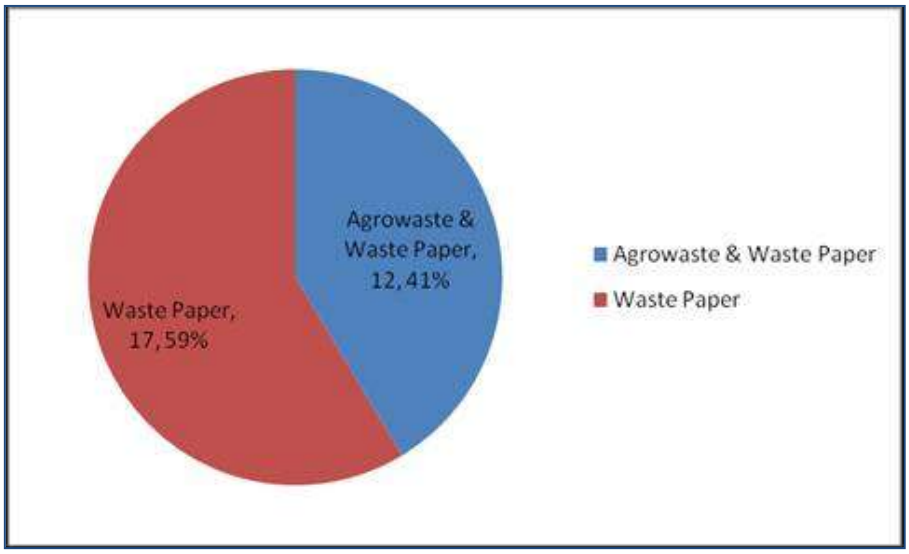


Figure 2 Classification of Units – Raw Material

Majority of paper mills produce Kraft Paper of varying BF (Breaking Factor) and Duplex Board. A few of them have started producing writing paper. In addition to Kraft paper and writing paper some units also produces Printing paper, Filter paper, Gray board, Poster paper and Hard tissue paper.

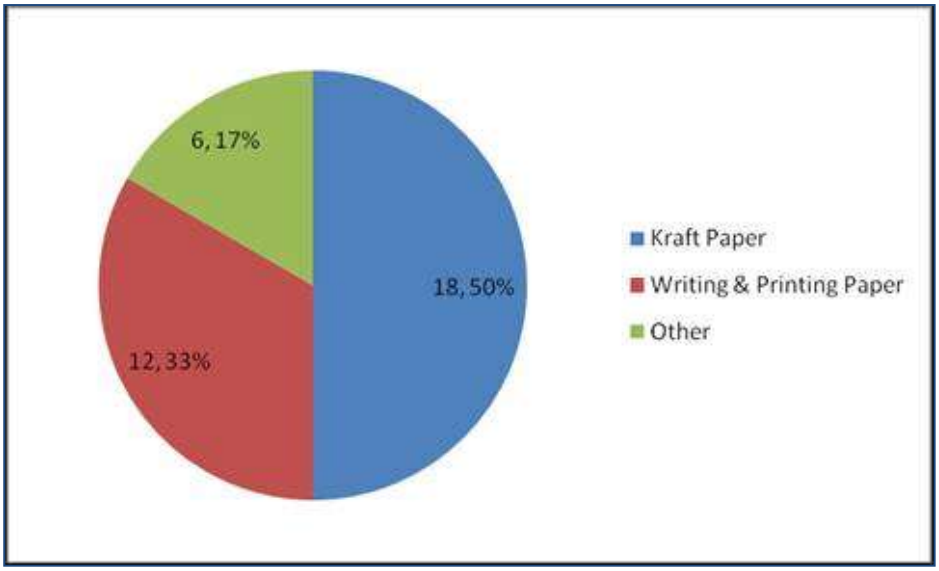


Figure 3 Classification of Units - Product

Energy usages pattern

Energy consumption (thermal energy & electrical energy) in Paper unit depends on capacity of unit and raw material used in the unit. The paper mills in the Muzaffarnagar cluster use various types of fuels like coal, biomass, pet coke etc. The primary fuel used in all the mills is coal and biomass. Rice husk, pith and bagasse are the major biomass used in the cluster. In few mills wood chips are also used as a supplementary fuel. The details are of the same are provided in table 3 below:

Table 3 Details of annual energy consumption

Sr. No	*Fuel*	*Approx. Calorific Value of Fuels kCal/kg*	*Price*
1	Coal	3800	2,770 to 3800 `/MT
2	Rice Husk	3300	2,500 `/MT
3	Bagasse	2000	550 to 750 `/MT
4	Wood	3500	1200 `/MT
5	Electricity	-	3.00 to 4.45 `/kWh

General production process for paper cluster

Paper is a natural product, manufactured from a natural and renewable raw material, wood. Wood is the primary raw material for the pulp and paper industry. Wood is made from cellulose fibres that are bound together by a material called lignin. The paper industry in Muzaffarnagar cluster uses either the waste paper or agro residue as a source of lignin needed for paper manufacturing process. Recovered paper has become as important a source of new paper as wood - recovered paper now accounts for more than half of the fibres used in the production of paper. However, fibre cannot be usefully recycled endlessly; so there is an ongoing need to feed the supply of recovered fibre with virgin fibre in the form of agri residue. The papermaking process can be broadly divided into three stages:

- Pulping
- Papermaking
- Finishing

PULPING

Paper is made from the cellulose fibres that are present in hardwood and softwood trees. In a pulp mill, the fibres are separated from one another into a mass of individual fibres. Whether using wood or recovered paper, the first step is to dissolve the material into pulp. Regardless of the type of pulping process used, the wood or recovered paper is broken down into its component elements so that the fibres can be separated. After separation, the fibres are washed and screened to remove any remaining fibre bundles. The pulp may then be used directly to make unbleached papers, or bleached for white papers. The water is then pressed out and the residue is dried. The pulping results in a mass of individual fibres being produced. In an 'integrated paper mill' the pulp will be fed directly to a paper machine. Alternatively, it will be dried and pressed into bales ready for use as a raw material in paper mills.

The pulp-making process

1. Timber and debarking
2. Pulp is graded and classified according to: the method of the production (e.g. chemical or mechanical pulp); the species of tree used (e.g. softwood or hardwood); and by level of processing (e.g. bleached or unbleached). Pulp generated from recovered paper is similarly graded.

Making Pulp from Agro residue

In chemical pulping, the Agro Residue (Baggasse)/Wood chips are cooked in a digester with chemicals. Cooking removes lignin, breaking up the wood into fibres. The process results in a slurry, where fibres are loose but intact and have maintained their strength. Generally, chemical pulp is based on one of two processes: sulphate or sulphite. Most chemical pulp is made by the alkaline kraft or sulphate process which uses caustic soda and sodium sulphate to "cook" the wood chips. In the unbleached stage, a dark brown, but very strong pulp results which can be bleached to a high brightness if required. The cooking chemicals are recovered back to the process through evaporation and burning plants. Cooked pulp is washed and screened to achieve more uniform quality.

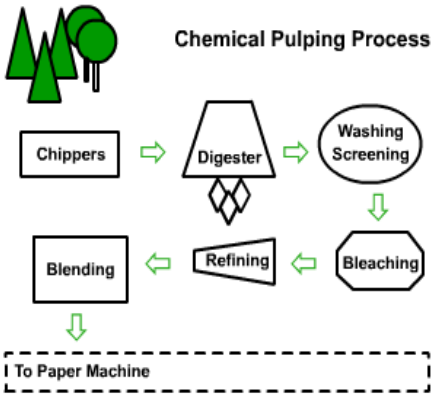


Figure 4 Agro-residue Chemical Pulping Process

The alternative method is the sulphite pulping process. This method is based on an acid cooking liquor process, and it is best suited for specialty pulp. The sulphite mills produce easily bleached pulps, generally with hydrogen peroxide. These pulps fulfil today's demand for "chlorine free" products in the disposables sector and also in printing and writing papers.

The yield in both chemical processes is much lower than in the manufacture of ground wood, as the lignin is completely dissolved and separated from the fibres. However, the waste lignin from the sulphate and some sulphite processes can be burnt as a fuel oil substitute. In modern mills, recovery boiler operations and the controlled burning of bark and other residues makes the chemical pulp mill a net energy producer which can often supply power to the grid, or steam to local domestic heating plants.

Making pulp from recovered paper

Recycled paper is a type of paper that completely or partially consists of recycled fibres. These fibres can have very different origins and therefore also very different characteristics when it comes to being a component in new paper. Newsprint, tissue and paperboard are the products primarily produced using recycled paper as raw material. Collected paper must first be sorted into different categories. The sorting can take place either directly in the paper mill or at special sorting stations. How the sorting takes place depends to a large extent on how the collection of the paper takes place, which varies from country to country. In most cases bales or loose paper waste is transported to the pulper using conveyor belts. Before printed paper, such as office waste and newspapers, can be processed into graphical paper grades, the ink needs to be removed. There are two main processes for de-inking waste paper - washing and flotation.

In the washing process the waste paper is placed in a pulper - a huge tank that liberates the paper fibres from the paper web by agitation with large quantities of water - and broken down to slurry. Staples and other undesirable material are removed by using centrifugal screens, thereby diminishing the risk of damage in the processes that follow. Most of the water containing the dispersed ink is drained through slots or screens that allow ink particles through. The pulp does not pass through. Adhesive particles, known as 'stickies', are removed by fine screening.

In the flotation process the waste is made into slurry and contaminants are removed. Special surfactant chemicals are added to the slurry, which produces froth on the top of the pulp. Air is then blown into the slurry. The ink adheres to the bubbles of air and rises to the surface. As the bubbles reach the top, a foam layer is formed that traps the ink. The foam is removed before the bubbles break so the ink does not go back into the pulp.

When completed, the clean, useful fibre is piped to a storage chest and consequently to the papermaking machine, while the excess materials are skimmed off or dropped through centrifugal force into a sludge that is then burned for fuel, otherwise used or landfilled.

Pulpwood normally arrives at the paper mill in the form of very thick sheets and recovered paper normally arrives in the form of large, compressed bales. Both these materials have to be broken down so that the individual fibres they contain are completely separated from each other. This process is performed in large vessels, known as 'pulpers', where the raw materials are diluted with up to 100 times their weight of water and then subjected to violent mechanical action using steel rotor blades.

The resulting slurry (known as papermaking stock) is then passed to holding tanks. During this preliminary stage, auxiliary chemicals and additives may be added. The auxiliary chemicals are usually combined with the fibrous raw materials at levels from below 1% to 2% and can be sizing agents, which reduce ink and water penetration, and process anti-foaming agents. Common additives consist of clay, chalk or titanium dioxide that is added to modify the optical properties of the paper and board or as a fibre substitute. The stock is then pumped through various types of mechanical cleaning equipment to the paper machine.

PAPER MAKING

In the pulp and papermaking industry 95% of the water used is cleaned and reused on-site. On the paper machine, more water is added to produce a fibre suspension of as little as 1-to-10 parts fibre to 1000 parts water and the resulting mixture is passed into a head-box which squirts it through a thin, horizontal slit across the full machine width (typically 2 - 6 m) on to a moving, endless wire mesh.

Raw material fibres and chemicals (and 99 % of water) are pumped to the head box, which feeds the stock evenly onto the wire section. This is a woven plastic mesh conveyor belt that can be 35 meters long and as wide as the machine. As the paper stock flows from the head box onto the wire, water is removed on this wire section by a mixture of gravity and suction in a process known as sheet formation where the fibres start to spread and consolidate into a thin mat, which is almost recognizable as a layer of paper on top of the wire mesh. The paper machine can travel at speeds of up to 2000m/minute and by the time the paper stock has traveled half way down the wire, a high percentage of water has drained away. By the time the thin mat of fibres has reached the end of the wire section, it has become a sheet of paper, although very moist and of little strength. It then passes to the press section.

This consists of a number of sets of heavy cylinders through which the moist paper passes. More moisture is squeezed out and drawn away by suction. The paper then passes to the drier section. This consists of a large number of steam-heated drying cylinders which have a temperature of slightly over 100°c. Synthetic drier fabrics carry the web of paper round the cylinders until the paper is completely dry.

Part way down the bank of drying cylinders is the size press, where a solution of water and starch can be added in order to improve the surface for printing purposes. Instead of size, a coater can be used which is what happens when coated papers are produced. At the end of the drying process, the paper is smoothed using an "ironing" method, which consists of hot polished iron rollers mounted in pairs, one above the other (calenders or soft calenders). This also helps to consolidate, polish and glaze the surface of the paper.

Still traveling at very high speeds, the paper comes off the machine ready for reeling up into large reels (also called parent reels), which can be cut or slit into smaller ones, according to customer requirement. These large reels are produced and changed without any interruption to the production process.

PAPER FINISHING

The characteristics, appearance and properties of paper and board are supplemented and enhanced by their final treatments. These may be simple processes where the reel is slit into a number of more narrow reels or cut into sheets or more complicated processes such as coating.

Coating improves the opacity, lightness, surface smoothness, luster and colour-absorption ability of paper. It meets exacting quality demands regarding surface smoothness. Coating means that a layer is applied to the paper, either directly in the papermaking machine or separately. Varieties of coated paper range from pigmented to cast-coated. The coat consists

of a mix of pigments, extenders such as china clay and chalk, and binders such as starch or latex. In addition, various chemicals are added to give the paper the desired characteristics.

For even smoother paper surface, super-calendering is required. This is done primarily for magazines and coated papers. The paper passes through rollers, which are alternately hard and soft. Through a combination of heat, pressure and friction, the paper acquires a high luster surface. The paper becomes somewhat compressed during the process and is therefore thinner than its matt finished equivalent.

General production process flow diagram for manufacturing of paper is shown in Figure.

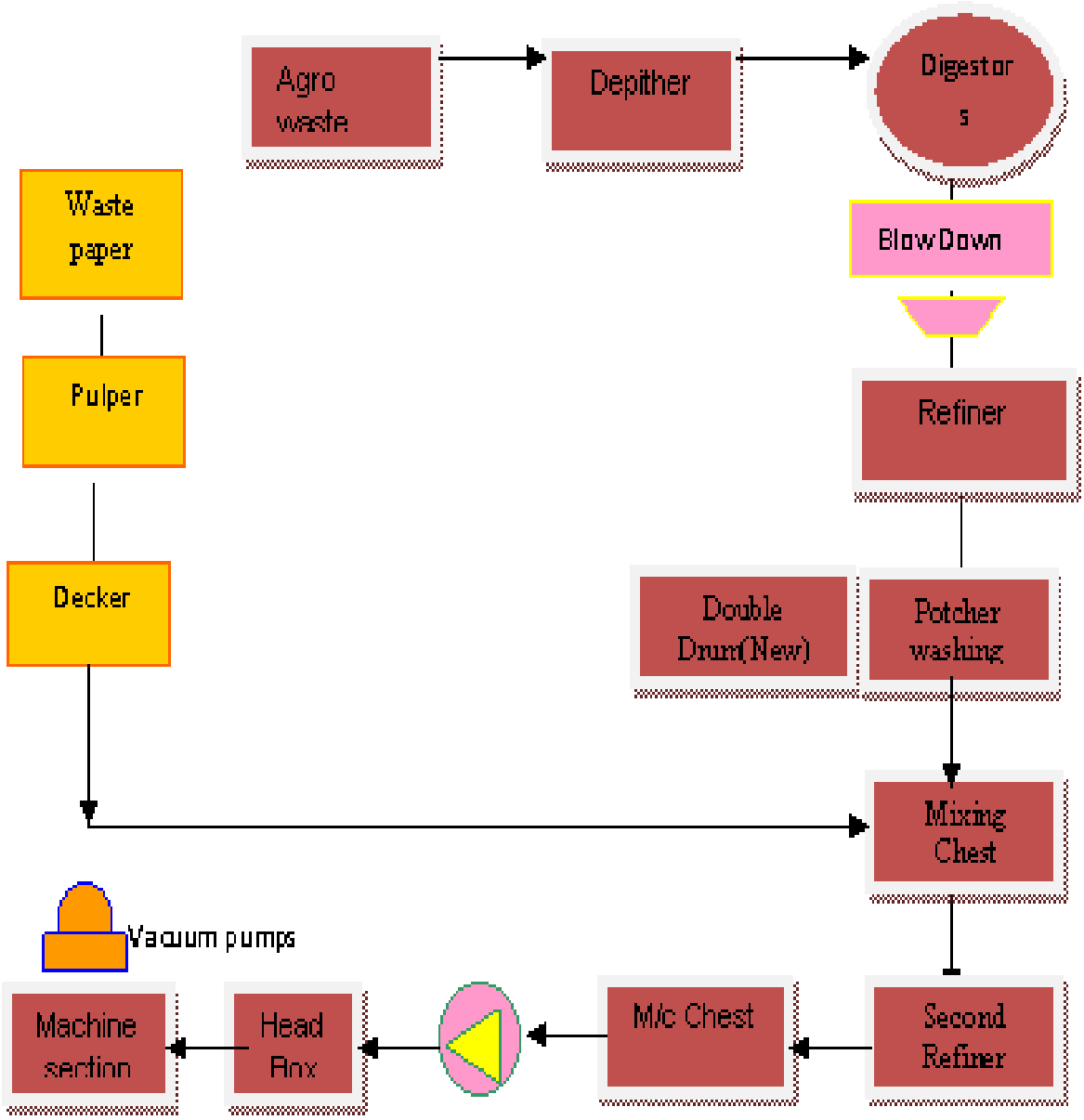


Figure 5 Process flow diagram

1.2 Energy performance in existing system

1.2.1 Fuel consumption

Average fuel and electricity consumption in a typical paper unit is given in Tables 4 & 5 below:

Table 4 Annual Energy consumption in different capacities of Agro Waste based units

Parameter	*Unit*	*<= 10000 TPA*	*10000 to 30000 TPA*	*> 30000 TPA*
Electricity[1]				
Annual Consumption	kWh	6,165,556	9,387,530	-
Rate	`/kWh	4.23	3.72	-
Fuel				
Annual Consumption	MT	2,141	13,633	36,074
Gross Calorific Value	kCal/kg	2,877	2,664	3,727
Rate	`/MT	1,622	2,124	3,217
No. of Units	-	2	6	4
Gross Electricity Consumption	kWh	12,331,112	56,325,180	-
Gross Fuel Consumption	Heat, GJ	51,561	912,290	2,250,896
Gross Energy Consumption	MTOE	2,288	26,564	53,593
Total Energy Consumption	MTOE	82,445		

Table 5 Annual Energy consumption in different capacities of Waste Paper based units

Parameter	*Unit*	*<= 10000 TPA*	*10000 to 30000 TPA*
Electricity			
Annual Consumption	kWh	6,054,698	8,489,054
Rate	`/kWh	4.23	3.68
Fuel			
Annual Consumption	MT	1,082	5,384
Gross Calorific Value	kCal/kg	3,047	2,687

[1] All paper units with capacity >30000 TPA have cogeneration units. As such the entire energy consumption is represented in terms of fuel only

Parameter	*Unit*	*<= 10000 TPA*	*10000 to 30000 TPA*
Rate	`/MT	2,761	1,188
No. of Units	-	11	5
Gross Electricity Consumption	kWh	66,601,683	42,445,269
Gross Fuel Consumption	Heat, GJ	151,793	302,805
Gross Energy Consumption	MTOE	9,341	10,859
Total Energy Consumption	MTOE	20,200	

1.2.2 Specific energy consumption

Specific energy consumption both electrical and thermal energy per MT of production for different type of paper mills are furnished in Table 6 below:

Table 6 Specific energy consumption

Sr. No	*Parameter*	*Value*
1	Specific Electricity Consumption	550 to 1,080 kWh/MT
2	Specific Fuel Consumption	10.13 to 18.15 GJ/MT

Equipment wise specific energy consumption

The specific energy consumption of the equipments used in the Indian paper industry is given in Table 7 below wherever possible.

Table 7 Equipment wise specific energy consumption

Section/Equipment	*Steam (T/t of paper)*	*Fuel (GJ/t of paper)*	*Electricity (KWh/t of paper)*	*Final Energy (GJ/t of paper)*
Chipper			112-128	0.4-0.5
Digester	2.7-3.9	12.5-18.0	58-62	12.7-18.2
Evaporator	2.5-4.0	11.5-185		11.5-18.5
Washing & Screening			145-155	0.5-0.6
Bleaching	0.35-0.4	1.6-1.8	88-92	1.9-2.2

Section/Equipment	Steam (T/t of paper)	Fuel (GJ/t of paper)	Electricity (KWh/t of paper)	Final Energy (GJ/t of paper)
Soda Recovery	0.5-1.1	2.3-5.1	170-190	2.9-5.8
Stock Preparation			275-286	0.99-1.03
Paper Machine	3.0-4.0	13.8-18.5	465-475	15.5-20.2
Deaerator	0.8-1.2	3.7-5.5		3.7-5.5
Utilities and Others			248-252	0.89-0.91
Total	10-16	46.2-73.8	1500-1700	51.6-80.0

&&

1.3 Existing technology/equipment

1.3.1 Description of existing technology

The boiler feed water-pumping system was studied in detail and analyzed for energy efficiency improvement. The study involved measurement of boiler feed water flow, head delivered by the pump, power consumption and pressure drop. At many instances it was observed that the pump is operating on lower efficiency range. The pumps installed are old with low design efficiency. New high efficiency pumps are available. At Muzaffarnagar, the average energy charges considered for estimation of monetary savings are as follows:

Energy charges

Table 8 Energy Charges

S. No.	Particular	Energy Charges
1	Fuel Cost	` 2,707 per Tonne
2	Fuel Calorific Value	3,338 kCal/kg
3	Electricity Cost	` 3.91/kWh

These values have been determined on the basis of the average energy cost in the cluster.

1.3.2 Role in process

The boiler feed water pump is used to supply boiler feed water to the boiler drum at the required pressure. Replacement of the present low efficiency pump with a higher efficiency

&& SOURCE: IPPTA

pump will lead to energy savings. The high efficiency pump will consume less electricity as compared to the present low efficiency pump.

1.4 Baseline establishment for existing technology

1.4.1 Design and operating parameters

Electricity consumption in boiler feed water pump depends on the operating efficiency level, which in turn depends on following parameters

- Boiler load
- Boiler Feed Water Flow
- Suction Pressure
- Discharge Pressure

Since the energy conservation measure is about improving the efficiency level of boiler feed water pump, the above mentioned parameters will be used to determine the efficiency levels.

1.4.2 Operating efficiency analysis

The boiler feed water-pumping system was studied in detail and analyzed for energy efficiency improvement. The study involved measurement of boiler feed water flow, head delivered by the pump, power consumption and pressure drop. At many instances it was observed that the pump is operating on lower efficiency range. The pumps installed are old and new high efficiency pumps are available. The boiler feed water pump considered under the study was a high pressure pump with following specifications:

Table 9 Boiler Feed Water Pump Design Parameters

Parameters	*Unit*	*Value*
Flow	m^3/hr	40
Suction Pr	m	+ve
Discharge Pr	m	600
Rated Capacity of Drive	kW	150

Table 10 Boiler Feed Water Pump Operating Parameters

Parameters	*Unit*	*Value*
Flow	m^3/hr	35
Suction Pr	M	12

Parameters	*Unit*	*Value*
Discharge Pr	M	600
Power Consumption	kW	142

The boiler feed water pump operating efficiency was estimated to be 44%. Higher efficiency pumps are available for the same application. Replacement of this pump with new efficient pump will lead to electricity savings. Detailed parameters and calculations used for evaluation of boiler feed water pump efficiency are given in the Annexure 1.

1.5 Barriers in adoption of proposed equipment

1.5.1 Technological barrier

In Muzaffarnagar cluster, overall technical understanding on paper manufacturing is good and rapidly increasing. However, majority of the entrepreneurs in paper cluster do not have any in depth technical expertise and knowledge on energy efficiency. They are dependent on local technology suppliers, service companies or limited in-house technical expertise, who normally also rely on established and commonly used technology. The lack of technical know-how has made it difficult for the paper unit owners to identify the most effective technical measures.

1.5.2 Financial barrier

The entrepreneur in Muzaffarnagar paper cluster typically makes investments related to business perspective. They are comfortable investing on project expansion for improving the production capacity as they consider it a more viable proposition as it clearly shows up in the sales ledger. Further, the energy conservation activities not being a common practice in the cluster makes them feel that it is not a viable proposition for investment. In view of this, and given the limited financial strength of paper mill entrepreneurs, they would not take the risks to invest in energy efficiency measures.

1.5.3 Skilled manpower

Skilled workers are locally available to run the paper mills in the cluster. However, there are very few engineers employed in the mills and the production process remains traditional. This is one of the lacunae of the Muzaffarnagar Paper Cluster.

Specialized and focused training of the local service providers on better operation and maintenance of the equipments, importance of the energy and its use and energy conservation measures will improve awareness among the unit owners and workforce. Original equipment suppliers should also participate in these programs.

1.5.4 Other barrier (If any)

Many of the new technology provider's (especially some foreign technology leaders) have not shown keen interest in implementation of their new innovative technologies. This appears to be because of fear of duplication.

2. PROPOSED EQUIPMENT FOR ENERGY EFFICENCY IMPROVEMENT

2.1 Description of proposed equipment

2.1.1 Detailed of proposed equipment

Replacement of the present low efficiency pump with a higher efficiency pump will lead to energy saving. The high efficiency pump will consume less electricity as compared to the present low efficiency pump. It is possible to operate the new efficient pump at an efficiency level of around 68%. This will lead to an energy saving of approximately 50 kW.

2.1.2 Equipment/technology specification

A new boiler feed water pump will be required to install. Detailed offer by supplier along with technical specification of new pump is furnished in Annexure 5.

2.1.3 Integration with existing equipment

The new efficient boiler feed water pump will replace the current installed in the boiler used in the paper mill. The installation will lead to electricity savings. Over all energy cost of plant will be reduced. The efficiency of pump can increase from the present level of 44% upto a level of 68%.

The following are the reasons for selection of this technology

- Boiler feed water pump is one of the major electricity consuming equipment in the paper mill
- It will reduce the total operating energy cost of the plant.
- It reduces the GHG emissions
- This project is also applicable for getting the carbon credit benefits.

2.1.4 Superiority over existing system

Use of this technology reduces the overall plant energy cost. It will also lead to efficient utilization of electricity and help in its conservation. The installation of this measure will lead to revenue generation through electricity savings.

2.1.5 Source of equipment

This technology is already implemented and in operation in many of the boilers in India. These are running successfully and the unit owners had observed the savings in terms of rupees due to savings in electricity consumption.

2.1.6 Availability of technology/equipment

Suppliers of this technology are available at local level.

2.1.7 Service providers

Details of technology service providers are shown in Annexure 4.

2.1.8 Process down time

There is no process down time of boiler envisaged with the installation of the new pump and its integration. The new pump can be installed with the standby pump in operation. Upon installation the new pump can be taken in line, hence no down time is envisaged.

2.2 Life cycle assessment and risks analysis

Life of the equipment is about 15 years. There are as such no risks perceived in the installation of proposed project.

2.3 Suitable unit for Implementation of proposed technology

Suitable unit for implementation of this technology are paper unit having the boiler capacity of about 30 to 40 TPH.

3. ECONOMIC BENEFITS FROM PROPOSED TECHNOLOGY

3.1 Technical benefit

3.1.1 Fuel saving

Project implementation will lead to indirect saving of fuel equivalent to the amount of electricity saved, in case electricity is generated in captive power plant.

3.1.2 Electricity saving

After implementation of project, the project will lead to 400,941 kWh per annum of electricity saving.

3.1.3 Improvement in product quality

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

3.1.4 Increase in production

Production will be the same as in present case.

3.1.5 Reduction in raw material

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

3.1.6 Reduction in other losses

There is no reduction in other losses.

3.2 Monetary benefits

Details of energy and monetary benefit due to implementation of project are furnished in Table 11 below:

Table 11 Energy and monetary benefit

SN	*Description*	*Value*
1	Present Efficiency Level (Calculated in Annexure 1)	44%
2	Present Electricity Consumption (kW)	142
3	Proposed Efficiency Level (Refer to the quotation)	68%
4	Proposed Electricity Consumption (kW)	91.88
5	Electricity Savings (kW)	50
6	Annual Operating Hours	8,000

SN	Description	Value
7	Energy savings (kWh/yr)	400,941
8	Monetary savings (` in lakh/yr) @ ` 3.91 per kWh	15.68

Further details of total monetary benefit are given in Annexure 2.

3.3 Social benefits

3.3.1 Improvement in working environment

Use of high efficiency feed water pump in boilers in paper industry reduces the overall emission of GHG from combustion of fuel for electricity generation, hence improve the working environment.

3.3.2 Improvement in workers skill

Technical skills of persons will definitely be improved. As the training will be provided by equipment suppliers which improve the technical skills of manpower required for operating of the equipment and also the technology implementation will create awareness among the workforce about energy efficiency and energy saving.

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

Implementation of this technology will reduce the CO_2 emissions. This project results in reduction of about 162 tCO_2 per year for a single unit considering that 50% of electricity is from coal and rest is from biomass. This project is also eligible to avail the carbon credit benefits through CDM project and generates the extra income.

3.4.3 Reduction in other emissions like SO_X

Significant amount of SO_X will be reducing due to reduced consumption of electricity/coal.

4 INSTALLATION OF PROPOSED EQUIPMENT

4.1 Cost of project

4.1.1 Equipment cost

Cost of boiler feed water pump is ` 16.39 lakh.

4.1.2 Erection, commissioning and other misc. cost

Other cost includes cost of P&F, CST & ED, erection & commissioning cost, service tax, interest during implementation, civil work and other misc. cost of. Details of total project cost required for implementation of proposed technology are furnished in Table 12 below:

Table 12 Details of proposed technology project cost

S.No	Particular	Unit	Value
1	Cost of system	` (in lakh)	16.39
2	Erection & Commissioning	` (in lakh)	0.33
3	Taxes including CST, Excise duty, Service tax etc.	` (in lakh)	0.84
4	Cost of civil work	` (in lakh)	1.64
5	Packaging & Forwarding	` (in lakh)	0.33
6	Other misc. cost	` (in lakh)	0.33
7	Total cost	` (in lakh)	19.85

4.2 Arrangements of funds

4.2.1 Entrepreneur's contribution

Entrepreneur will contribute 25% of the total project cost which is ` 4.96 lakh.

4.2.2 Loan amount.

The term loan is 75% of the total project cost, which is `14.89 lakh.

4.2.3 Terms & conditions of loan

The interest rate is considered at 10% which is SIDBI's 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

Profitability and cash flow statements have been worked out for a period of 8 years. The financials have been worked out on the basis of certain reasonable assumptions, which are outlined below.

The project is expected to achieve monetary savings of ` 15.68 lakh per.

- The Operation and Maintenance cost is estimated at 5% of cost of total project with 10% increase in every year as escalations.
- Interest on term loan is estimated at 10%.
- Depreciation is provided as per the rates provided in the companies act.

Considering the above mentioned assumptions, the net cash accruals starting with ` 11.77 lakh in the first year operation and gradually increases to ` 62.48 lakh at the end of eighth year.

4.3.2 Simple payback period

The total project cost of the proposed technology is ` 19.85 lakh and monetary saving is ` 15.68 lakh hence, the simple payback period works out to be 1.27 years.

4.3.3 Net Present Value (NPV)

The Net present value of the investment at 10% works out to be ` 36.90 lakh.

4.3.4 Internal rate of return (IRR)

The after tax IRR of the project works out to be 58.52%.

4.3.5 Return on investment (ROI)

The average return on investment of the project activity works out at 27.55%.

Financial indicator of proposed technology is furnished in Table 13 below:

Table 13 Financial indicators of proposed technology/equipment

S.No	Particulars	Unit	Value
1	Simple Pay Back period	Month	15
2	IRR	%age	58.52
3	NPV	Lakh	36.90
4	ROI	%age	27.55
5	DSCR	Ratio	3.20

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 electricity savings or decrease in electricity savings. For the purpose of sensitive analysis, two following scenarios has been considered

- Optimistic scenario (Increase in electricity savings by 5%)
- Pessimistic scenario (Decrease in electricity savings by 5%)

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

Details of sensitivity analysis at different scenarios are shown in Table 14 below:

Table 14 Sensitivity analysis at different scenarios

Scenario	IRR	NPV	ROI	DSCR
Normal	58.52	36.90	27.55	3.20
5% increase in electricity saving	62.20	39.90	27.69	3.37
5% decrease in electricity saving	54.84	33.90	27.39	3.04

4.5 Procurement and implementation schedule

The project is expected to be completed in 6 weeks from the date of financial closure. The detailed schedule of project implementation is furnished in Annexure 4.

Annexure

Annexure -1: Energy audit data used for baseline establishment

SN	Description	Value
1	Flow (m^3/hr)	35
2	Flow (m3/sec)	0.010
3	Density of water (kg/m^3)	996
4	Suction Pr (m)	12
5	Discharge Pr (m)	600
6	Power Consumption (kW)	142
7	Efficiency of pump motor	90%
8	hydraulic power kW	55.86
9	Overall system efficiency	39.34
10	Present Efficiency Level of pump	44%

Annexure -2: Detailed technology assessment report

SN	Description	Value
1	Flow (m^3/hr)	35
2	Suction Pr (m)	12
3	Discharge Pr (m)	600
4	Power Consumption (kW)	142
5	Present Efficiency Level	44%
6	Proposed Efficiency Level (Refer to the quotation)	68%
7	Proposed Electricity Consumption (kW)	91.88
8	Electricity Savings (kW)	50
9	Annual Operating Hours	8,000
10	Energy savings (kWh/yr)	400,941
11	Monetary savings (` (in lakh)/yr) @ ` 3.91 per kWh	15.68

Annexure -3: Detailed financial analysis

Assumption

Name of the Technology	**Energy Efficient Feed Water Pump**		
Rated Capacity	**40 m3/hr**		
Details	***Unit***	***Value***	***Basis***
Installed Capacity	M3/hr	40	
No of Operating Hours	Hrs./Annum	8000	Feasibility Study
Proposed Investment			
Equipment cost	` (in lakh)	16.39	
Erection & commissioning	% on Plant & Machinery	0.33	
Taxes viz. CST, Excise duty, Service tax	` (in lakh)	0.84	
Cost of Civil works	` (in lakh)	1.64	
Packaging & Forwarding	` (in lakh)	0.33	
Other Misc. Cost	` (in lakh)	0.33	
Total Investment	` (in lakh)	19.85	
Financing pattern			
Own Funds (Equity)	` (in lakh)	4.96	
Loan Funds (Term Loan)	` (in lakh)	14.89	
Loan Tenure	years	5	Assumed
Moratorium Period	Months	6	Assumed
Repayment Period	Months	66	Assumed
Interest Rate	%age	10.00%	SIDBI Lending rate
Estimation of Costs			
O & M Costs	% on Plant & Equip	5.00	Feasibility Study
Annual Escalation	%age	10.00	Feasibility Study
Estimation of Revenue			
Electricity saving	kWh/annum	400941	
Cost	`/kWh	3.91	
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	14.89	1.20	13.69	1.72
2	13.69	2.40	11.29	1.26
3	11.29	2.76	8.53	1.01
4	8.53	2.97	5.56	0.72
5	5.56	3.40	2.16	0.41
6	2.16	2.16	0.00	0.06
		14.89		

WDV Depreciation **` (in lakh)**

Particulars / years	*1*	*2*
Plant and Machinery		
Cost	19.85	3.97
Depreciation	15.88	3.18
WDV	3.97	0.79

Projected Profitability **` (in lakh)**

Particulars / Years	*1*	*2*	*3*	*4*	*5*	*6*	*7*	*8*
Fuel savings	15.68	15.68	15.68	15.68	15.68	15.68	15.68	15.68
Total Revenue (A)	15.68	15.68	15.68	15.68	15.68	15.68	15.68	15.68
Expenses								
O & M Expenses	0.99	1.09	1.20	1.32	1.45	1.60	1.76	1.93
Total Expenses (B)	0.99	1.09	1.20	1.32	1.45	1.60	1.76	1.93
PBDIT (A)-(B)	14.68	14.59	14.48	14.36	14.22	14.08	13.92	13.74
Interest	1.72	1.26	1.01	0.72	0.41	0.06	0.00	0.00
PBDT	12.97	13.33	13.47	13.64	13.82	14.01	13.92	13.74
Depreciation	1.05	1.05	1.05	1.05	1.05	1.05	1.05	1.05
PBT	11.92	12.28	12.42	12.59	12.77	12.97	12.87	12.69
Income tax	0.00	3.45	4.58	4.64	4.70	4.76	4.73	4.67
Profit after tax (PAT)	11.92	8.83	7.84	7.95	8.07	8.20	8.14	8.02

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

Particulars / Years	*1*	*2*	*3*	*4*	*5*	*6*	*7*	*8*
Profit before tax	11.92	12.28	12.42	12.59	12.77	12.97	12.87	12.69
Add: Book depreciation	1.05	1.05	1.05	1.05	1.05	1.05	1.05	1.05
Less: WDV depreciation	15.88	3.18	-	-	-	-	-	-
Taxable profit	(2.91)	10.15	13.47	13.64	13.82	14.01	13.92	13.74
Income Tax	-	3.45	4.58	4.64	4.70	4.76	4.73	4.67

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

Particulars / Years	*1*	*2*	*3*	*4*	*5*	*6*	*7*	*8*
Liabilities								
Share Capital (D)	4.96	4.96	4.96	4.96	4.96	4.96	4.96	4.96
Reserves & Surplus (E)	11.92	20.75	28.59	36.54	44.62	52.82	60.96	68.98
Term Loans (F)	13.69	11.29	8.53	5.56	2.16	0.00	0.00	0.00
Total Liabilities (D)+(E)+(F)	30.57	37.00	42.08	47.06	51.74	57.78	65.92	73.94

Assets	1	2	3	4	5	6	7	8
Gross Fixed Assets	19.85	19.85	19.85	19.85	19.85	19.85	19.85	19.85
Less Accm. Depreciation	1.05	2.10	3.14	4.19	5.24	6.29	7.34	8.38
Net Fixed Assets	18.80	17.75	16.71	15.66	14.61	13.56	12.51	11.46
Cash & Bank Balance	11.77	19.24	25.37	31.41	37.13	44.22	53.41	62.48
TOTAL ASSETS	30.57	37.00	42.08	47.06	51.74	57.78	65.92	73.94
Net Worth	16.88	25.71	33.55	41.51	49.58	57.78	65.92	73.94
Debt Equity Ratio	2.76	2.27	1.72	1.12	0.43	0.00	0.00	0.00

Projected Cash Flow **` (in lakh)**

Particulars / Years	***0***	***1***	***2***	***3***	***4***	***5***	***6***	***7***	***8***
Sources									
Share Capital	4.96	-	-	-	-	-	-	-	-
Term Loan	14.89								
Profit After tax		11.92	8.83	7.84	7.95	8.07	8.20	8.14	8.02
Depreciation		1.05	1.05	1.05	1.05	1.05	1.05	1.05	1.05
Total Sources	19.85	12.97	9.88	8.89	9.00	9.12	9.25	9.19	9.07
Application									
Capital Expenditure	19.85								
Repayment Of Loan	-	1.20	2.40	2.76	2.97	3.40	2.16	0.00	0.00
Total Application	19.85	1.20	2.40	2.76	2.97	3.40	2.16	0.00	0.00
Net Surplus	-	11.77	7.48	6.13	6.03	5.72	7.09	9.19	9.07
Add: Opening Balance	-	-	11.77	19.24	25.37	31.41	37.13	44.22	53.41
Closing Balance	-	11.77	19.24	25.37	31.41	37.13	44.22	53.41	62.48

IRR **` (in lakh)**

Particulars / months	***0***	***1***	***2***	***3***	***4***	***5***	***6***	***7***	***8***
Profit after Tax		11.92	8.83	7.84	7.95	8.07	8.20	8.14	8.02
Depreciation		1.05	1.05	1.05	1.05	1.05	1.05	1.05	1.05
Interest on Term Loan		1.72	1.26	1.01	0.72	0.41	0.06	-	-
Cash outflow	(19.85)	-	-	-	-	-	-	-	-
Net Cash flow	(19.85)	14.68	11.14	9.90	9.72	9.53	9.32	9.19	9.07
IRR	58.52 %								

NPV	36.90

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

Particulars / Years	***1***	***2***	***3***	***4***	***5***	***6***	***7***	***8***
Variable Expenses								
Oper. & Maintenance Exp (75%)	0.74	0.82	0.90	0.99	1.09	1.20	1.32	1.45
Sub Total*(G)*	0.74	0.82	0.90	0.99	1.09	1.20	1.32	1.45
Fixed Expenses								
Oper. & Maintenance Exp (25%)	0.25	0.27	0.30	0.33	0.36	0.40	0.44	0.48
Interest on Term Loan	1.72	1.26	1.01	0.72	0.41	0.06	0.00	0.00
Depreciation *(H)*	1.05	1.05	1.05	1.05	1.05	1.05	1.05	1.05
Sub Total (I)	3.01	2.58	2.36	2.10	1.82	1.51	1.49	1.53
Sales (J)	15.68	15.68	15.68	15.68	15.68	15.68	15.68	15.68
Contribution (K)	14.93	14.86	14.78	14.69	14.59	14.48	14.36	14.23
Break Even Point (L= G/I)	20.18%	17.37%	15.94%	14.28%	12.46%	10.44%	10.36%	10.77%
Cash Break Even {(I)-(H)}	13.16%	10.31%	8.85%	7.14%	5.27%	3.21%	3.06%	3.40%
Break Even Sales (J)*(L)	3.16	2.72	2.50	2.24	1.95	1.64	1.62	1.69

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

Particulars / Years	***1***	***2***	***3***	***4***	***5***	***6***	***7***	***8***	***Total***
Net Profit Before Taxes	11.92	12.28	12.42	12.59	12.77	12.97	12.87	12.69	100.51
Net Worth	16.88	25.71	33.55	41.51	49.58	57.78	65.92	73.94	364.88
									27.55%

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

Particulars / Years	***1***	***2***	***3***	***4***	***5***	***6***	***7***	***8***	***Total***
Cash Inflow									
Profit after Tax	11.92	8.83	7.84	7.95	8.07	8.20	8.14	8.02	52.82
Depreciation	1.05	1.05	1.05	1.05	1.05	1.05	1.05	1.05	6.29
Interest on Term Loan	1.72	1.26	1.01	0.72	0.41	0.06	0.00	0.00	5.17
Total (M)	14.68	11.14	9.90	9.72	9.53	9.32	9.19	9.07	64.28

DEBT

Interest on Term Loan	1.72	1.26	1.01	0.72	0.41	0.06	0.00	0.00	5.17
Repayment of Term Loan	1.20	2.40	2.76	2.97	3.40	2.16	0.00	0.00	14.89
Total (N)	2.92	3.66	3.77	3.69	3.81	2.22	0.00	0.00	20.06
	5.03	3.04	2.63	2.64	2.50	4.19	0.00	0.00	3.20
Average DSCR (M/N)	3.20								

Annexure -4: Procurement and implementation schedules

S. No.	Activities	Weeks					
		1	2	3	4	5	6
1	Procurement						
2	Erection & commissioning						
3	Cabling & electrical panel fitting						
4	Testing and trial						
5	On site operator training						

Annexure -5: Details of technology service providers

S.No.	Name of Service Provider	Address	Contact Person and No.
1	Associated Pumps & Valves KSB	206, Vardhman, D Block, Central Market, Prashant Vihar, Delhi	Mr. Sunil Thakur - 011-2786 7035

Annexure–6: Quotations or Techno-commercial bids for new technology/equipment

ASSOCIATED PUMPS & VALVES KSB Authorised Dealer

To

M/s. Deloitte Touche Tohmatsu India Pvt Ltd , Gurgaon

Offer No. 35/2011, 9/1/2011

Kind Attn. Mr Puneet Sethi

Sub: Your requirement of KSB pumps

Dear Sir,

Please refer your enquiry, we are pleased to submit our offer as under.

No.	PUMP	PUMP MODEL	CAP (M3/HR)	SUCTION PRESSURE (KG/CM2)	DISCHARGE PR (KG/CM2)	QTY	EFF%	BKW	MK W	RPM	UNIT PRICE[Rs]
1	BFW PUMP	HAD 750/11	40	1.2	60	1	68	120	150	2980	1638721.00

Terms and conditions

Price for Delhi

Payment 100% against performa invoice.

Delivery within 4 weeks from the date of your po.

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