DETAILED PROJECT REPORT
ON
SEMI MECHANIZED (62 LAKH)
(VARANASI BRICK CLUSTER)













Bureau of Energy Efficiency

Prepared By

FEEDBACK VENTURES
Making Infrastructure Happen

Reviewed By

ISTSL

SEMI MECHANIZED BRICK KILN
(62 LAKH)

VARANASI BRICK CLUSTER

BEE, 2010

Detailed Project Report on Semi Mechanized Brick Kiln (62 Lakh)

Brick SME Cluster, Varanasi, Uttar Pradesh (India)

New Delhi: Bureau of Energy Efficiency;

Detail Project Report No

For more information

Bureau of Energy Efficiency (BEE)
(Ministry of Power, Government of India)
4th Floor, Sewa Bhawan
R. K. Puram, New Delhi – 110066

Telephone +91-11-26179699
Fax +91-11-26178352
Websites: www.bee-india.nic.in

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Dr. Ajay Mathur, Director General, BEE

Smt. Abha Shukla, Secretary, BEE

Shri Jitendra Sood, Energy Economist, BEE

Shri Pawan Kumar Tiwari, Advisor (SME), BEE

Shri Rajeev Yadav, Project Economist, BEE

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Feedback Ventures Pvt. Ltd.

Gurgaon

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List of Abbreviations

BEE	Bureau of Energy Efficiency
MoMSME-	Ministry of Micro Small & Medium Enterprise
BTK-	Bull's Trench kiln
VSBK-	Vertical Shaft Brick Kiln
ID	Induced Draft
IRR	Internal Rate of Return
DSCR	Debt Service Coverage Ratio
ROI	Rate on Investment
SIDBI	Small Industries Development Bank of India

Executive Summary

Bureau of Energy Efficiency (BEE) appointed Feedback Ventures Private Limited as the executing agency for brick cluster of Varanasi under BEE's SME programme. Under this project, the executing agency carried out studies in the brick cluster of Varanasi. Out of a total of 229 brick kilns, study was conducted in 67 units. Preliminary audits were undertaken in all the 67 units whereas detailed energy audits were conducted in 22 of these units.

Based on the energy audits, the executing agency submitted their report to BEE in form of a cluster manual with recommendations for energy conservation & savings potentials in the brick sector. Semi mechanized machine is one of the recommended technology which can be installed in the unit and its installation will help in achieving the energy saving in brick industry.

Semi-Mechanized brick kilns utilize a number of machines along the brick manufacturing process to reduce the overall energy consumption, raw materials and labour used in the manufacturing process. Unit having production capacity more than 45 lakh brick per season are ideal for implementing the semi mechanized technique however, a semi mechanized machine of 62 lakh brick production capacity will save about 124 tonne of coal per season.

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	Rs. (in lakh)	10.90
2	Coal saving	tonne/year	124
3	Monetary benefit	Rs. (in lakh)	6.2
4	Debit equity ratio	ratio	3:1
5	Simple payback period	Years	1.76
6	NPV	Rs. (in lakh)	12.93
7	IRR	%age	41.34
8	ROI	%age	23.62
9	DSCR	ratio	2.16
10	Procurement and implementation schedule	week	20

The projected profitability and financial indicators shows that the project will be able to earn profit from inception and project is financially viable and technically feasible.

About BEE's SME Program

Bureau of Energy Efficiency (BEE) is implementing a BEE-SME Programme to improve the energy performance in 25 selected SMEs clusters. The brick cluster of Varanasi 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*:**

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.

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

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.

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 about the SME Cluster

About SME cluster

The Brick cluster selected under BEE's SME programme is located in Varanasi district. In Varanasi brick cluster, there are approximately 226 (Two hundred and twenty six) registered brick kilns operation within the greater Varanasi district. Out of these around 40% units are either closed or not in operation. These brick kilns have been classified into following clusters within the district:

- Haruhua
- Sarnath
- Sindhora Road
- Rohania
- Munari
- Rameshwar
- Badagaon

Existing production process and technology

Although there are many brick production technologies existent but almost all the brick kilns in entire Varanasi cluster are of the traditional coal fired fixed chimney Bull's Trench Kilns (BTK) type, with fixed natural draft chimneys except a few kilns which are operating using induced draft fans for better airflow in the firing/ cooling zone.

Brick Production Process

While the principles of brick manufacture in BTK's is fairly consistent, individual units may and sometimes do depart from these basics to fit their particular requirements, raw materials and mode of operations. The essential steps in brick making are shown in the diagram below.



Figure 1.1: Process flow chart of typical brick kiln process

The first three steps of the brick making process usually start around about 20-40 days before the actual firing of the kiln. This is done to build up a decent stockpile of dried green bricks for continuous operation of the brick kiln. The firing up process of the brick kiln takes 10-20 days to make the kiln reach its appropriate temperature for the bricks to solidify and acquire its pre requisite fired brick attributes. The entire process is continual

and once the firing is initiated, very rarely is the kiln operation course halted.

Clay Winning and Soil preparation

Clay is usually dug from the local vicinity of the brick kiln. The clay is then processed as to be free from gravel, lime and other bio wastes/ matter. This soil once excavated is then watered and left over a period of 8 – 12 hours for weathering and processing. After aging the moistened soil is kneaded/ pugged as required.

Moulding / Brick formation

The Plastic clay after been through the previous process is then moulded into the required brick shape and size with its makers mark using a metal/ wooden / PVC mould.

Brick Drying

Once the clay has been formed into the pre required green brick shape, it is then left out in the sun to dry and reduce its moisture content. Fast drying on extremely hot days may lead to creation of cracks in the green brick which is undesirable. Therefore to minimize crack creation and quick moisture loss, the drying process takes place over a period of 8 - 12 days with the bricks left out in the Sun. The bricks are usually laid out in stacks with a horizontal vertical alignment as to maximize usage of space and Sun light.

Firing and cooling

The firing and cooling is done in the Bull's Trench Kiln (BTK). Relative to combustion zone within the kiln, the trench can be divided into cooling, firing and pre heating zones. The cooling zone is the upstream region in which the fired brick extraction takes place. This area is also vital in the mechanics of the brick kiln functionality as it allows cool air to flow into the combustion zone. The cool air while flowing through the fired brick arrangement cools the brick arrangement while at the same time gaining heat from the previous lines of fired bricks.

The combustion zone is the area where the firing of bricks takes place. To achieve the desired/ required properties of fired bricks the green bricks in this zone are subjected to temperatures of 800 – 1080 degree Celsius. Holes are made in lines on the top layer of the brick arrangement through which coal is fed in regular intervals into the combustion zone. To minimize heat losses during feeding, these holes are covered with metallic lids. Coal feeding of a line within the combustion zone may take anywhere from 3 to 6 hours depending on the draft and temperature of the Pre heating line.

The pre-heating zone is located downstream to the combustion zone. Sufficiently dried green bricks are brought over from the *Pathai* (brick moulding area) and systematically stacked within this zone. This stacking arrangement is then covered with a top layer of fly ash (3 – 6 inches) to offer insulation and minimize heat losses. The hot air/gases coming

from the combustion zone flow through these lines of bricks further reducing their moisture and heating these bricks. A hole connected to the chimney is opened at a suitable location downstream to allow for maximum heating of bricks in the pre heat zone before it is discharged through the chimney. The difference in temperature between the hot air in the chimney and the cold ambient air creates a draft which sucks in air from the cooling zone.

Brick Extraction

The extraction of bricks takes place in the beyond the cooling zone of the brick kiln. As the brick firing and cooling is a continuous process the brick discharge takes place daily in tandem with the position of the firing/cooling of the lines.

Energy usage pattern

Bull's Trench Kiln is the only technology existent in the Varanasi brick cluster and coal is the main source of energy in this kind of technology. Majority of these kilns are using only coal as fuel however a few kilns are also using sawdust/ wood along with coal for firing of bricks. The consumption of other fuels is negligible as compared to the overall consumption of coal in the operation and energy usage of kilns in this cluster. Most of these units use a combination of coal types depending upon its availability and market price.

1.2 Energy performance in existing situation

1.2.1 Fuel and electricity consumption

The main fuel used for energy in brick industry is Coal. A few units within the cluster also use sawdust/ wood along with coal for the firing of bricks. However the energy usage of these fuel sources is negligible as compared to the overall consumption of coal in the operation and energy usage in brick kilns. Electricity is not used in the brick making process, although it is used for lighting purpose in the night in a few units. A typical unit in this cluster consumes approximately 558 tonne of Coal annually.

1.2.2 Average production

The brick production in a typical kiln depends upon firstly the size of the brick kiln and secondly the number of rounds completed within the season. The brick industry operates for around 7-8 months in a year (November to May) but it is highly dependent on the weather conditions. Cloudy or rainy conditions interrupt the process of brick making. On an average a typical unit in this Varanasi brick cluster produces 31 lakh bricks per annum.

1.2.3 Specific fuel consumption

Typically the energy consumption of brick manufacturing units is presented in terms of tonnes of fuel consumed for firing one lakh bricks. This method of representation however

is inaccurate in comparing the performance of brick kilns as:

- It does not account for the varying range of fired brick weight between units in the cluster
- Does not account for the difference in weight/dimensions of half bricks and full bricks
- It does not account for the quality/source of coal being used for the firing of bricks.

Therefore by calculating the specific energy consumption required for firing of one kilogram of fired brick, the performance and energy consumption of the brick kilns within the cluster can be accurately documented using this approach. The Specific Energy Consumption in this cluster is 1.1 to 1.5 MJ per kg of fired brick.

1.3 Identification of technology/equipment

The existing technology being used in this cluster is mainly the traditional coal fired fixed chimney Bull's Trench Kilns (BTK), with fixed natural draft chimneys. This main reason for the need of technology up gradation is that the existing technology a high coal consuming process. As per the results of the energy audits done in the cluster, a typical BTK consumes around 18 Tonne of coal for producing one lakh of bricks, which is very high compared to the other technology available.

1.3.1 Description of technology/equipment

A BTK is an oval or circular shaped brick kiln with its chimney usually in the centre. The trench is connected to the chimney by means of evenly spaced chambers along the trench. The outer wall has exit points for loading & Unloading of bricks. The firing & cooling process in a BTK comprises of three zones:

- Pre-heating zone
- Firing/ combustion zone
- Cooling zone.

Pre-heating zone is the area which is stacked with green bricks and utilizes the hot air coming from the firing zone for drying the green bricks by absorbing the moisture present in it.

Firing zone is the actual area where the firing takes place. In a straight line firing process, bricks are fired one line at a time at a temperature of around 900^0C - 1000^0C. The temperature is maintained by continuous feeding of coal at regular intervals until the bricks get ready. Once one line of brick is ready, its holes are closed and the firing is moved forward to the next line towards the pre-heating zone.

Cooling zone is the area where the firing has already taken place and the bricks are kept

for cooling before they are unloaded from the kiln. Since bricks are fired at a very high temperature, they take few days to cool down. Cooling time is lesser in the winter season compared to the summers due to the difference in the ambient temperature.

1.3.2 Role in process

The Combustion zone is the area where firing of bricks takes place. To achieve the desired properties of fired bricks the green bricks in this zone are heated at a temperature between 800 to1000 ^{0}C. Holes are made in lines on the top layer of the brick arrangement through which coal is fed in regular intervals into the combustion zone. To minimize heat losses during feeding, these holes are covered with metallic lids. Coal feeding of a line within the combustion zone may take anywhere from 3 to 6 hours depending on the draft and temperature of the Pre heating line.

1.4 Benchmarking for existing specific energy consumption

The baseline data has been established based in the energy audits conducted in a total number of 69 brick kilns out of which 47 were preliminary audits and 32 were detailed audits. These units were identified after conducting a meeting in November 2009 with the brick kilns owners with the cooperation of Int. Nirmata Parishad, the local brick makers association in Varanasi.

1.4.1 Design and operating parameters /specification

BTK has a circular or oval kiln circuit. The bricks to be fired are arranged in column setting. The fire is progressively moved round the kiln through the brick setting. Before entering the brick-firing zone, the air is preheated by exchanging heat with hot-fired bricks in the brick-cooling zone. Brick firing takes place in a narrow brick-firing zone; in which, coal is added manually from the holes provided in the roof of the kiln. The combustion products (hot flue gases) pass over the green bricks resulting in drying and preheating of bricks in the brick-preheating zone. The fire travel takes place in the direction of the airflow. Cooled fired bricks are removed from the brick cooling zone, while fresh green bricks are added in front of the brick preheating zone. A chimney stack provides the necessary draft. The below figure depicts the structure of a BTK.

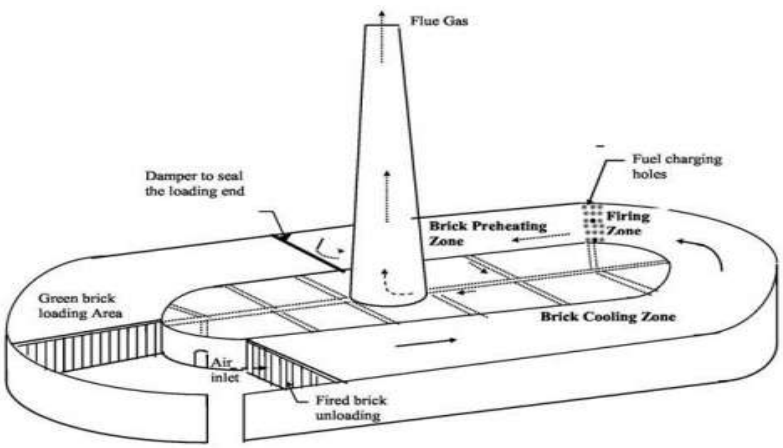


Figure 1.2: Typical structure of BTK

1.4.2 Operating efficiency analysis

To determine the Energy use and technical study, individual units were identified within different clusters in Varanasi district. It is integral to target different clusters as it accounts for deviations in soil properties, sourcing of raw materials, fuel, and variations in manufacturing and housekeeping operations. The overall step by step methodology followed for Energy use and technical study is shown in Figure 3 below:



Figure 1.3: Energy auditing methodology

Preliminary energy study

The preliminary study is the first stage in conducting an energy and technology assessment of the brick manufacturing units in the cluster. The aim of the preliminary study is collecting information relating to kiln operating and energy use to get an overview of energy sources, raw materials, processes involved, etc of the units within the cluster. Preliminary energy studies were conducted at 47 brick manufacturing units in the Varanasi cluster and the time taken for each study was 45 - 90 minutes.

Detailed energy study

Detailed energy studies are conducted to get an in depth breaks up of energy usage of each of the associated processes in the operation of brick kilns. It covers the quintessential steps in preliminary study and provides a thorough analysis of the kiln functioning. Since coal is the main source of fuel used, there are some guidelines which

need to be maintained while analyzing and measuring the coal consumption of the unit.

Location of Combustion zone

The combustion/ firing zone should be in/along the straight position. If the fire is in the curved portion of the kiln the rate of fire travel is higher and therefore it adversely affects the accuracy of the results.

Regular loading of kiln during the study period

Ensure that the kiln has sufficient quantity of dry bricks (either already loaded or available for loading) and labour for loading of the kiln during the course of the trials.

Weekly off-day should not fall during the Study duration

The kiln firing operation is a continuous process, taking place 24 hours, 7 days a week. The associated loading / unloading, moulding process workers are given a weekly day off. It is necessary to ensure the weekly off day does not fall during the study duration as it may affect the firing of the kiln.

Bad Weather

As the brick manufacturing operation in BTKs is open to weather, the precision of detailed study is affected by adverse weather conditions (rain, wind, storms, etc).

1.4.3 Specific fuel and electricity consumption

Based on the data collected from 69 units where the energy audits were conducted, the average specific fuel consumption in a typical brick kiln is being calculated to be 558 tonne of Coal for producing 31 lakh of bricks annually.

Electricity is not being consumed in operational process in a brick kiln, however it is used in some of the units for lighting purpose in the night for the coal feeders.

1.5 Barriers for adoption of proposed technology/equipments

1.5.1 Technological Barrier

There is a definitive void in development and existing facilities for Research and Development in this sector. Institutes in the past have been integral in facilitating technology transfers and improvement in the brick manufacturing cluster all over India, However there is need for continuous Research and Development associated processes (Green brick moulding) other than the thermal firing/cooling to encounter the problems whenever they may arise. Providing Technical support to this industry is the key to keep them abreast with international best practices in brick making.

Majority of the kiln owners have a closed outlook, choosing to look at only the immediate future rather than long term benefits and improvements. There is a fairly dominant mindset

of working it till it breaks and an unwillingness to look at repercussions of kiln operations in terms of land degradation, energy conservation and pollution control.

1.5.2 Financial Barrier

The greater part of the entrepreneurs in the brick community sites lack of financial support and access to credit from financial institutions. Due to the current technology of the brick manufacturing process; i.e. its dependence on weather conditions, constant relocations and its modulus operandi, financial institutions are hesitant to offer a line of credit to interested and progressive kiln owners. Such is the disposition of the brick manufacturing process in this cluster, any major technology upheavals are almost always at a high cost measure, making it inaccessible to be owners without suitable financial interventions.

1.5.3 Manpower Skill

Varanasi brick cluster faces shortage of trained manpower at every level. There is a void of competent consultants and qualified masons for planning & supervision of kiln improvements and kiln construction/renovations respectively. The current state of process technology is such that there are no formal training options available to the managers and coal feeders.

1.5.4 Other losses (if any)

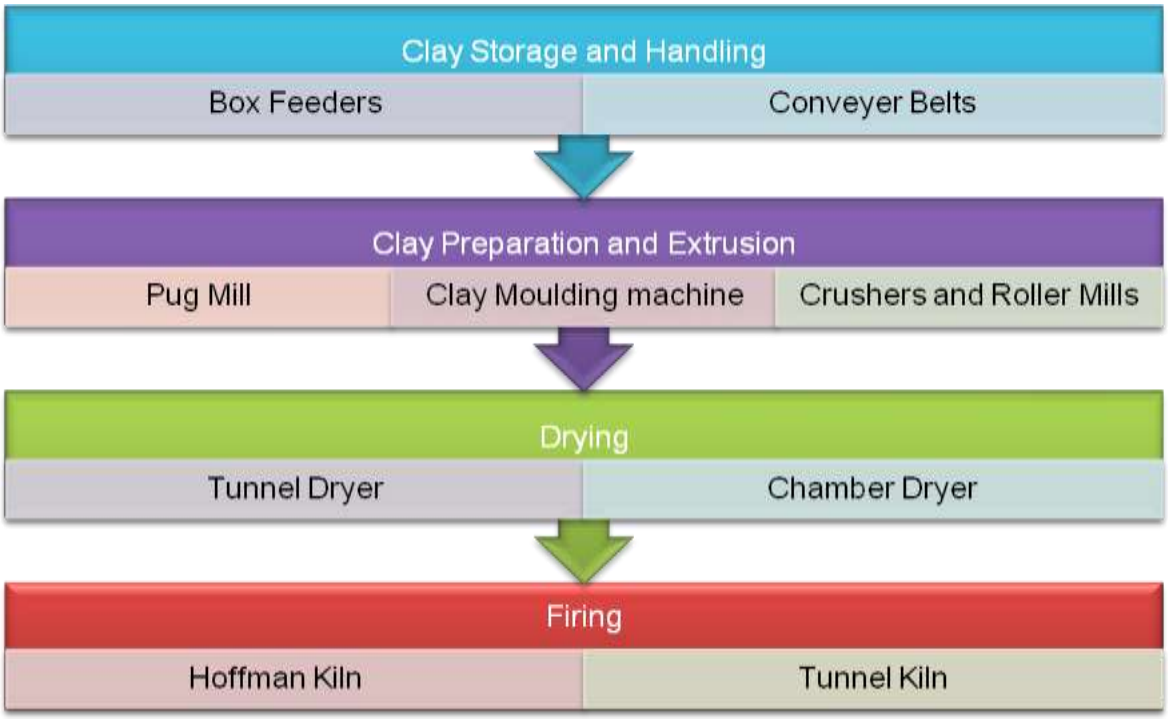
Brick industry is a labour intensive industry and major labour force working in Varanasi brick sector come from the neighbourhood states of Bihar, Jharkhand. The labour force goes back to their native places at the end of the season and their return to these brick kilns in the next season depends upon the financial deals given to them. Since there is no certainty about the labour coming back to the same kilns next season, labour remains a huge problem in the brick sector.

2 TECHNOLOGY OPTIONS FOR ENERGY EFFICIENCY IMPROVEMENTS

2.1 Detailed description of technology selected

2.1.1 Description of technology

Mechanized brick kilns utilize a number of machines along the brick manufacturing process to reduce the overall energy consumption, raw materials and labour used in the manufacturing process. The schematic diagram below illustrates the assortment of machines which may be used along the process value chain;



Integration of one or more of these machines in the brick manufacturing process yields visible benefits in the following areas:

- Significant energy consumption of the brick kiln
- Improved quality and quantity of the final product
- Reduction in raw materials and land degradation
- Greatly reduces the dependence on manual labour
- Significant increase in plant overall capacity
- Better working environment in the workplace and surrounding areas
- Significant reduction in pollution

Brief descriptions of machines to be used along the process chain are given below:

Pug-Mill

A pug-mill consists of a box or trough having a feed hole at one end and a delivery hole or nose at the other end, and provided with a central shaft which carries knives and cutters so arranged that when the shaft revolves they cut and knead the clay, and at the same time force it towards and through the delivery nose. The cross section of this nose of the pug-mill is approximately the same as that of the required brick (9 in. X 41 in. plus contraction, for ordinary bricks), so that the pug delivers a solid or continuous mass of clay from which bricks may be made by merely making a series of square cuts at the proper distances apart. In practice, the clay is pushed from the pug along a smooth iron plate, which is provided with a wire cutting frame having a number of tightly stretched wires placed at certain distances apart, arranged so that they can be brought down upon, and through, the clay, and so many bricks cut off at intervals.



The frame is sometimes in the form of a skeletonne cylinder, the wires being arranged radially (or the wires may be replaced by metal disks); but in all cases bricks thus made are known as "wire-cuts." In order to obtain a better shaped and more compact brick, these wire-cuts may be placed under a brick press and there squeezed into iron moulds under great pressure. These two processes are now generally performed by one machine, consisting of pug-mill and brick press combined. The pug delivers the clay, downwards, into the mould; the proper amount of clay is cut off; and the mould is made to travel into position under the ram of the press, which squeezes the clay into a solid mass.

Moulding Machine

In moulding, soft, wet clay is shaped in a mould, usually a wooden box. The interior of the box is often coated with sand, which provides the desired texture and facilitates removing the formed brick from the mould. Water can also be used to assist release. Pressing, the third type of brick forming, requires a material with low water content. The material is placed in a die and then compacted with a steel plunger set at a desired pressure. More regular in shape and sharper in outline than those made manually.



With the use of these machines the production capacity increases in range of 700 - 4500 bricks per hr.

2.1.2 Technology/equipment specification including fuel & electricity consumption

Details of fuel and electricity saving after adoption of proposed technology in a typical unit of cluster having production capacity 31 lakh brick is shown in Table 2.1 below:

Table 2.1 Fuel & electricity saving

S.No.	Parameter	Unit	value
1	Coal consumption Per Lac Bricks in existing scenario	Tonne	18
2	Coal consumption Per Lac Bricks after adoption of semi mechanised technique	Tonne	16
3	Total brick production per year	Lakh	31
4	Annual Coal Consumption	Tonne	558
5	Coal saved in a year	Tonne	62
6	Cost saving Savings	Rs.	3,10,000
	Operational Costs		
1	On Electricity	Rs.	36,000
2	Using diesel Generators	Rs.	96,000

2.1.3 Suitability or integration with existing process

Manual methods adopted for some processes in brick making can be easily replaced by semi mechanised techniques as the machines used are simple in operation and do not require any special training. The integration of these machines does not require any downtime in production and can be easily installed and set up during the months of in operation between July – November.

2.1.4 Superiority over existing technology/equipment

A semi mechanized technique is superior to the existing technique in multiple aspects from reduction in time and labour, to better homogeneity, standardization and quality of moulded bricks. A better quality green brick utilizes less energy to be fired into a manufactured brick and reduces losses and wastages. Semi – mechanised brick processes reduce the dependency on hired manual labour which are not always

available and can be operated in the monsoon / winter season for stock-piling green bricks for the initial period leading to plant operation. Detail specific energy consumption is shown in Table 2.2 below:

Table 2.2 Specific energy consumption

S.No.	Kiln	Specific Energy Consumption (MJ/kg) fired product
1	Clamp (Biomass)	1.9
2	Clamp (Cole)	1.2 - 1.75
3	Moving chimney BTK	1.2 - 1.75
4	Fixed chimney	1.1 - 1.4
5	Zigzag	0.8-1.1
6	VSBK	0.7-1.0
7	Semi - Mechanised	1.1 – 1.25

2.1.5 Availability of technology/equipment

The technology and equipment for a semi - mechanized brick manufacturing process is available across India through vendor dealerships and stand alone manufacturers. Currently there is only one brick manufacturer in the Varanasi cluster employing this technology / equipment.

2.1.6 Source of technology/equipment for the project

The pugging machine was invented by Skipper, Edward M. in United States and moulding machine was invented by Gilbert, Barrie W. (Stonnenall, GB2) also in United States. This technique is widely popular in England since ages and other developed countries .It is being used in India sparsely usually in higher capacity kilns and in Plants manufacturing assortment of brick products using utilizing tunnel kilns and electric furnaces.

2.1.7 Service/technology providers

BTECON and Neptune Industries are the local service providers in Varanasi and the neighbouring areas for implementation of this technology / process. They have a considerable experience in brick making utilizing mechanized equipment for brick manufacturing. Neptune industries have been forerunners in mechanization of brick manufacturing industry within India, they constantly review and research global technologies / equipments and their applicability in the Indian brick manufacturing scenario.

2.1.8 Terms of sales

Mr. Anil Kumar and Neptune industries would provide the necessary support required for sustainable implementation of technology and equipment in the existing brick kilns. They would also help the kiln owners and manufacturers in sourcing of equipment and details of

transactions on case per case basis.

2.1.9 Process down time during implementation

The brick industry in Varanasi is not operational during the rainy season. In the months June to October, the operations related to manufacturing of bricks remain closed. This off season time can be utilized for retro-fitting works related to the installation of machinery and training of workers to minimize the process downtime

2.2 Life cycle assessment and risks analysis

In case of a changeover from manually operated tasks to a semi - mechanized; there would be a singular change in operations and technology, thereafter the components may be replaced when required till the kiln is in operation. The risks associated as with any technological / equipment upgrade require training of machine operators, due diligence to equipment integration and after sale service from vendors.

2.3 Suitable unit/plant size in terms of capacity/production

Manually operated kilns having a capacity of 7 to 10 lakh bricks per round and production of more than 45 lakh brick per season are ideal for implementing the semi mechanized technique. Semi – Mechanised processes are also ideal for lower capacity kilns wanting to increase their capacity with minimum investment and structural changes in their plant.

3 ECONOMIC BENEFITS DUE TO USAGE OF NEW EQUIPMENT

3.1 Technical benefits

3.1.1 Fuel savings per year

On the basis of field studies conducted in the Varanasi cluster and the technology gap assessment of available technology/ process up-gradations, the entrepreneurs can be convinced to adopt semi mechanized technology based on the information provided. Savings in a typical unit having production capacity about 62 lakh after adopting semi mechanized technique are tabulated in Table 3.1 below:

Table 3.1 Fuel saving per year

Energy Efficient Technology/ Measure	*Annual Coal Savings (tonne)*	*Annual Energy Savings (Tera joules)*
Technology change from manual to semi mechanised	124	2.60

3.1.2 Improvement in product quality

A semi mechanized technique uses a pugging mill and a moulding mill for the processes which are performed manually. Pugging mill provides better mixing and kneading of the clay which can be easily cut down into pieces. A moulding machine provides brick of a sharper outline and more regular in shape. Overall using mechanized processes for brick preparation leads to better quality of brick output and less coal requirement for brick manufacture.

3.1.3 Increase in production

In a semi mechanized technique the production automatically improves since the work which was being done manually is replaced by machines. There is an increase in the quantity of bricks being manufactured and the quality of the end product.

3.1.4 Reduction in raw material consumption

The capacity of any machine is fixed at the time of its manufacturing and the quantity of the end product produced depends upon its capacity. So beyond the capacity it is not possible for a machine to work therefore the raw material required for manufacturing a specific product cannot exceed the capacity specification of the machine which reduces material loss.

3.1.5 Reduction in other losses

The major loss which is incurred in any manual process is the loss of energy of the

workforce and the time that is consumed in the making process. These two losses are reduced to a great extent by the use of a semi mechanized technique. Another loss which occurs in a manual process is the loss of a manufactured product due to the rejections, this type of loss is also mitigated in a semi mechanized operation since the processes done by a machine are subjected to least rejections.

3.2 Monetary benefits

Monetary savings in a typical unit after adoption of semi mechanized process has been estimated around Rs. 6, 20,000. This figure has been arrived based on the annual coal savings in a typical unit multiplied by average rate of coal per Tonne. It is also envisioned that the production capacity in terms of number of better quality bricks and reduction in waste material would lead to further monetary benefits reducing the specific energy consumption further.

3.3 Social benefits

3.3.1 Improvement in working environment in the plant

With the adoption of a semi mechanized technique the rate of coal consumption decreases which in turn reduces the amount of pollution caused. It also leads to a smooth working condition in the plant since the excess workforce which is involved in the manual process reduces. The machines employed are user as well as environment friendly. This technique offers a healthy environment to its workforce.

3.3.2 Improvement in skill set of workers

In a semi mechanized plant the machinery that is used requires specially trained people for its operation, especially for the purpose of feeding the raw material. Thus adoption of this technique involves capacity building of the workforce and thereby improving their skills.

3.4 Environmental benefits

3.4.1 Reduction in effluent generation

Since the process is mechanized therefore the use of fossil fuel that is coal is reduced. The less consumption of coal solves a number of problems related to the environment. Since the coal usage reduces therefore the particulate emission is also decreased to a great extent. The generation of the harmful gases like CO_2, NOx and SOx also reduces.

3.4.2 Reduction in GHG emission such as CO_2, NOx, etc

The GHG emission also comes down by the use of a semi mechanized technique which provides a healthy environment to its workforce. Reduction in coal consumption translates into GHG reductions roughly to the order of 1.4 tonnes of GHG per tonne of coal which is

175 tonne CO_2 reductions per year. On a large scale if it is seen then the reduction in emissions helps in saving the nature.

3.4.3 Reduction in other emissions like SOx

SOx are a major pollutant which can even lead to the deadly acid rain, it causes a number of health problems and like every pollutant does it also has a negative impact on the environment. With the adoption of a semi mechanized technology the emission of SOx reduces.

4 INSTALLATION OF NEW ENERGY EFFICIENT EQUIPMENT

4.1 Cost of equipment implementation

4.1.1 Cost of equipments

The costs of equipments that will be required after adoption of semi mechanized technique are provided in table 4.1 below:

Table 4.1: Cost of and equipments (Molding and Pugmill of 15,000 bricks per day)

S. No.	Particulars	Cost (In Rs.)
1	Clay Moulding and Pressing) Automatic Brick Machine 10 Hp electric Motor with water circulating System and four wheels (1500 bricks / Hour) Provision For Diesel Engine Attachment	6,50,000
2	Brick Moulds: 9" x 4" x 3"(Shrinkage allowance not included, depends on customer clay)	1,20,000
3	Brick Moulds Shifting Trolleys (Twelve 3 in 1 Moulds Carrying Capacity)	24,000
4	Conveyor Set 15' Feet X 2' Feet (Melded Moveable On Wheels System)	1,20,000
5	Cost of Consultancy	1,40,000
5	Misc. Cost	36,000
5	Total Cost	10,90,000

4.1.2 Other costs

Cost of civil work and consultancy

There is no such cost of civil work involved in this particular technique. It just involves a change in the technology used; installation of machines, no special structure is required to be constructed for this technique. The consultancy cost associated is almost negligible, there is only the cost incurred in procurement of the machinery from the vendor.

Arrangements of funds

Proposed financing for the Semi Mechanised capacity- 62 lakh bricks is made considering a debt equity ratio of 3:1, which is normally allowed by financial institutions for financing energy efficiency projects. On the basis of debt equity ratio of 3:1 the promoter's contribution works out to 25% of the project cost and the balance would be term loan from the Bank / FIs.

4.2 Financial indicators

4.2.1 Cash flow analysis

Detail cash flow analysis is shown in Annexure 4.

4.2.2 Simple payback period

Payback Period is 1.76 years.

4.2.3 Net Present Value (NPV)

Net Present Value of new project would work out Rs. 12.93 lakh.

4.2.4 Internal rate of return (IRR)

Internal Rate of Return (IRR) would be 41.34%.

4.2.5 Return on investment (ROI)

The average return on investment of the project activity works out at 23.62%.

4.3 Sensitivity analysis

In different situation fuel saving may increase or decrease due to market fluctuations, external and internal mechanisms, weather dependency etc. To correctly estimate savings potential relevance to changing market scenarios for financial feasibility of projects it is necessary to conduct sensitivity analysis in realistic, pessimistic and optimistic scenarios as illustrated on the parameters below.

- Fuel saving increase by 5%
- Fuel saving decrease by 5%

Particulars	*IRR*	*NPV*	*ROI*	*DSCR*
In normal Condition	41.34	12.93	23.62	2.16
Fuel saving increase by 5%	44.01	14.11	23.71	2.27
Fuel saving decrease by 5%	38.66	11.74	23.53	2.05

4.4 Procurement and implementation schedule

Procurement and implementation required for implementation of this technology is about 20 weeks and their detail brake up are shown in Annexure 5.

Annexure – 1: Energy audit reports used for establishing Baseline Parameters

The results of 22 kilns detailed energy audit with heat balance is given below

Audit No. 1

Heat Balance			
Particulars	***Unit***	***Value***	***%age***
Sensible heat in Brick	MJ/1000 brick	192	0.8
Energy in water vapour leaving the system	MJ/1000 brick	751	3.3
Heat required for chemical reactions	MJ/1000 brick	6494	28.2
Dry flue gas loss	MJ/1000 brick	2027	8.8
Unaccounted (mainly structure + surface)	MJ/1000 brick	13547.6	58.9
Total heat input	MJ/1000 brick	23011	100
Total heat input	MJ/1000 brick	23010.9	-
Kiln Efficiency	%age	%age -	31.5
Coal CV	MJ/kg	20.9	-
Specific Energy consumption	MJ/kg Brick	1.20133	-

Audit No. 2

Heat Balance			
Particulars	***Unit***	***Value***	***%age***
Sensible heat in Brick	MJ/1000 brick	411	2.0
Energy in water vapour leaving the system	MJ/1000 brick	1022	5.0
Heat required for chemical reactions	MJ/1000 brick	6125	29.9
Dry flue gas loss	MJ/1000 brick	1603	7.8
Unaccounted (mainly structure + surface)	MJ/1000 brick	11318.3	55.3
Total heat input	MJ/1000 brick	20480	100
Kiln Efficiency	%age	-	34.9
Coal CV	MJ/kg	19.3	-
Specific Energy consumption	MJ/kg Brick	1.13476	-

Audit No. 3

Heat Balance			
Particulars	***Unit***	***Value***	***%age***
Sensible heat in Brick	MJ/1000 brick	223	1.7
Energy in water vapour leaving the system	MJ/1000 brick	952	7.4
Heat required for chemical reactions	MJ/1000 brick	3119	24.4
Dry flue gas loss	MJ/1000 brick	620	4.8
Unaccounted (mainly structure + surface)	MJ/1000 brick	7888.2	61.6
Total heat input	MJ/1000 brick	12802	100
Kiln Efficiency	%age	31.8	%
Coal CV	MJ/kg	25.3	-
Specific Energy consumption	MJ/kg Brick	1.39302	-

Audit No. 4

Heat Balance			
Particulars	***Unit***	***Value***	***%age***
Sensible heat in Brick	MJ/1000 brick	265	2.1
Energy in water vapour leaving the system	MJ/1000 brick	1239	10.0
Heat required for chemical reactions	MJ/1000 brick	3438	27.8
Dry flue gas loss	MJ/1000 brick	987	8.0
Unaccounted (mainly structure + surface)	MJ/1000 brick	6452.1	52.1
Total heat input	MJ/1000 brick	12382	100
Kiln Efficiency	%age	-	37.8
Coal CV	MJ/kg	23.1	-
Specific Energy consumption	MJ/kg Brick	1.17193	-

Audit No. 5

Heat Balance			
Particulars	***Unit***	***Value***	***%age***
Sensible heat in Brick	MJ/1000 brick	270	2.6
Energy in water vapour leaving the system	MJ/1000 brick	748	7.3
Heat required for chemical reactions	MJ/1000 brick	2966	29.0
Dry flue gas loss	MJ/1000 brick	583	5.7
Unaccounted (mainly structure + surface)	MJ/1000 brick	5647.3	55.3
Total heat input	MJ/1000 brick	10214	100
Kiln Efficiency	%age	-	36.4
Coal CV	MJ/kg	23.1	-
Specific Energy consumption	MJ/kg Brick	1.12068	-

Audit No. 6

Heat Balance			
Particulars	***Unit***	***Value***	***%age***
Sensible heat in Brick	MJ/1000 brick	232	2.4
Energy in water vapour leaving the system	MJ/1000 brick	991	10.1
Heat required for chemical reactions	MJ/1000 brick	2378	24.2
Dry flue gas loss	MJ/1000 brick	2314	23.6
Unaccounted (mainly structure + surface)	MJ/1000 brick	3908.6	39.8
Total heat input	MJ/1000 brick	9824	100
Kiln Efficiency	%age	-	34.3
Coal CV	MJ/kg	26.1	-
Specific Energy consumption	MJ/kg Brick	1.37874	-

Audit No. 7

Heat Balance			
Particulars	**Unit**	**Value**	**%age**
Sensible heat in Brick	MJ/1000 brick	146	1.3
Energy in water vapour leaving the system	MJ/1000 brick	1432	12.8
Heat required for chemical reactions	MJ/1000 brick	2973	26.6
Dry flue gas loss	MJ/1000 brick	1943	17.4
Unaccounted (mainly structure + surface)	MJ/1000 brick	4693.0	41.9
Total heat input	MJ/1000 brick	11188	100
Kiln Efficiency	%age	-	39.4
Coal CV	MJ/kg	21.2	-
Specific Energy consumption	MJ/kg Brick	1.25599	-

Audit No. 8

Heat Balance			
Particulars	**Unit**	**Value**	**%age**
Sensible heat in Brick	MJ/1000 brick	225	2.0
Energy in water vapour leaving the system	MJ/1000 brick	971	8.8
Heat required for chemical reactions	MJ/1000 brick	2945	26.7
Dry flue gas loss	MJ/1000 brick	448	4.1
Unaccounted (mainly structure + surface)	MJ/1000 brick	6429.8	58.4
Total heat input	MJ/1000 brick	11018	100
Kiln Efficiency	%age	-	35.5
Coal CV	MJ/kg	21.1	-
Specific Energy consumption	MJ/kg Brick	1.26851	-

Audit No. 9

Heat Balance			
Particulars	***Unit***	***Value***	***%age***
Sensible heat in Brick	MJ/1000 brick	809	3.3
Energy in water vapour leaving the system	MJ/1000 brick	1105	4.5
Heat required for chemical reactions	MJ/1000 brick	7545	30.8
Dry flue gas loss	MJ/1000 brick	899	3.7
Unaccounted (mainly structure + surface)	MJ/1000 brick	14176.0	57.8
Total heat input	MJ/1000 brick	24534	100
Kiln Efficiency	%age	-	35.3
Coal CV	MJ/kg	25.3	-
Specific Energy consumption	MJ/kg Brick	1.10234	-

Audit No. 10

Heat Balance			
Particulars	***Unit***	***Value***	***%age***
Sensible heat in Brick	MJ/1000 brick	2123	9.0
Energy in water vapour leaving the system	MJ/1000 brick	1323	5.6
Heat required for chemical reactions	MJ/1000 brick	6216	26.3
Dry flue gas loss	MJ/1000 brick	2305	9.8
Unaccounted (mainly structure + surface)	MJ/1000 brick	11675.3	49.4
Total heat input	MJ/1000 brick	23643	100
Kiln Efficiency	%age	-	31.9
Coal CV	MJ/kg	21.1	-
Specific Energy consumption	MJ/kg Brick	1.28942	-

Audit No. 11

Heat Balance			
Particulars	***Unit***	***Value***	***%age***
Sensible heat in Brick	MJ/1000 brick	476	1.8
Energy in water vapour leaving the system	MJ/1000 brick	1889	7.0
Heat required for chemical reactions	MJ/1000 brick	6440	24.0
Dry flue gas loss	MJ/1000 brick	921	3.4
Unaccounted (mainly structure + surface)	MJ/1000 brick	17158.8	63.8
Total heat input	MJ/1000 brick	26884	100
Kiln Efficiency	%age	-	31.0
Coal CV	MJ/kg	25.1	-
Specific Energy consumption	MJ/kg Brick	1.41533	-

Audit No. 12

Heat Balance			
Particulars	***Unit***	***Value***	***%age***
Sensible heat in Brick	MJ/1000 brick	532	1.7
Energy in water vapour leaving the system	MJ/1000 brick	2223	7.2
Heat required for chemical reactions	MJ/1000 brick	6623	21.5
Dry flue gas loss	MJ/1000 brick	1731	5.6
Unaccounted (mainly structure + surface)	MJ/1000 brick	19653.9	63.9
Total heat input	MJ/1000 brick	30764	100
Kiln Efficiency	%age	-	28.8
Coal CV	MJ/kg	25.6	-
Specific Energy consumption	MJ/kg Brick	1.48124	-

Audit No. 13

Heat Balance			
Particulars	***Unit***	***Value***	***%age***
Sensible heat in Brick	MJ/1000 brick	344	1.3
Energy in water vapour leaving the system	MJ/1000 brick	1723	6.5
Heat required for chemical reactions	MJ/1000 brick	5857	22.1
Dry flue gas loss	MJ/1000 brick	928	3.5
Unaccounted (mainly structure + surface)	MJ/1000 brick	17698.3	66.7
Total heat input	MJ/1000 brick	26550	100
Kiln Efficiency	%age	-	28.5
Coal CV	MJ/kg	21.2	-
Specific Energy consumption	MJ/kg Brick	1.50578	-

Audit No. 14

Heat Balance			
Particulars	***Unit***	***Value***	***%age***
Sensible heat in Brick	MJ/1000 brick	269	2.2
Energy in water vapour leaving the system	MJ/1000 brick	714	5.9
Heat required for chemical reactions	MJ/1000 brick	2935	24.2
Dry flue gas loss	MJ/1000 brick	419	3.4
Unaccounted (mainly structure + surface)	MJ/1000 brick	7816.5	64.3
Total heat input	MJ/1000 brick	12155	100
Kiln Efficiency	%age	-	30.0
Coal CV	MJ/kg	18.8	-
Specific Energy consumption	MJ/kg Brick	1.32041	-

Audit No. 15

Heat Balance			
Particulars	***Unit***	***Value***	***%age***
Sensible heat in Brick	MJ/1000 brick	189	1.6
Energy in water vapour leaving the system	MJ/1000 brick	811	6.7
Heat required for chemical reactions	MJ/1000 brick	3372	27.9
Dry flue gas loss	MJ/1000 brick	997	8.3
Unaccounted (mainly structure + surface)	MJ/1000 brick	6703.2	55.5
Total heat input	MJ/1000 brick	12071	100
Kiln Efficiency	%age	-	34.7
Coal CV	MJ/kg	21.4	-
Specific Energy consumption	MJ/kg Brick	1.15079	-

Audit No. 16

Heat Balance			
Particulars	***Unit***	***Value***	***%age***
Sensible heat in Brick	MJ/1000 brick	185	1.5
Energy in water vapour leaving the system	MJ/1000 brick	1081	8.7
Heat required for chemical reactions	MJ/1000 brick	2671	21.4
Dry flue gas loss	MJ/1000 brick	2016	16.2
Unaccounted (mainly structure + surface)	MJ/1000 brick	6516.5	52.3
Total heat input	MJ/1000 brick	12470	100
Kiln Efficiency	%age	-	30.1
Coal CV	MJ/kg	20.7	-
Specific Energy consumption	MJ/kg Brick	1.50059	-

Audit No. 17

Heat Balance			
Particulars	***Unit***	***Value***	***%age***
Sensible heat in Brick	MJ/1000 brick	177	1.7
Energy in water vapour leaving the system	MJ/1000 brick	770	7.5
Heat required for chemical reactions	MJ/1000 brick	2520	24.4
Dry flue gas loss	MJ/1000 brick	277	2.7
Unaccounted (mainly structure + surface)	MJ/1000 brick	6578.8	63.7
Total heat input	MJ/1000 brick	10322	100
Kiln Efficiency	%age	-	31.9
Coal CV	MJ/kg	25.2	-
Specific Energy consumption	MJ/kg Brick	1.31676	-

Audit No. 18

Heat Balance			
Particulars	***Unit***	***Value***	***%age***
Sensible heat in Brick	MJ/1000 brick	427	1.9
Energy in water vapour leaving the system	MJ/1000 brick	2270	9.9
Heat required for chemical reactions	MJ/1000 brick	6200	27.0
Dry flue gas loss	MJ/1000 brick	3044	13.3
Unaccounted (mainly structure + surface)	MJ/1000 brick	11018.7	48.0
Total heat input	MJ/1000 brick	22960	100
Kiln Efficiency	%age	-	36.9
Coal CV	MJ/kg	25.2	-
Specific Energy consumption	MJ/kg Brick	1.19035	-

Audit No. 19

Heat Balance			
Particulars	***Unit***	***Value***	***%age***
Sensible heat in Brick	MJ/1000 brick	348	1.3
Energy in water vapour leaving the system	MJ/1000 brick	2630	10.0
Heat required for chemical reactions	MJ/1000 brick	6684	25.3
Dry flue gas loss	MJ/1000 brick	4205	15.9
Unaccounted (mainly structure + surface)	MJ/1000 brick	12514.7	47.4
Total heat input	MJ/1000 brick	26382	100
Kiln Efficiency	%age	-	35.3
Coal CV	MJ/kg	20.9	-
Specific Energy consumption	MJ/kg Brick	1.3	-

Audit No. 20

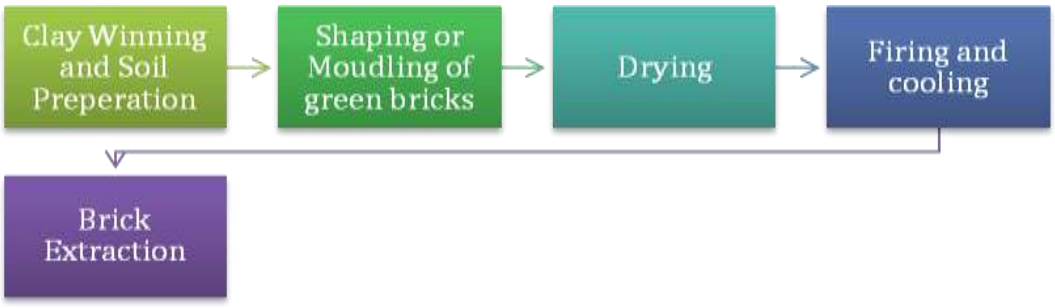
Heat Balance			
Particulars	***Unit***	***Value***	***%age***
Sensible heat in Brick	MJ/1000 brick	485	1.6
Energy in water vapour leaving the system	MJ/1000 brick	2394	7.7
Heat required for chemical reactions	MJ/1000 brick	6213	20.0
Dry flue gas loss	MJ/1000 brick	2324	7.5
Unaccounted (mainly structure + surface)	MJ/1000 brick	19676.3	63.3
Total heat input	MJ/1000 brick	31092	100
Kiln Efficiency	%age	-	27.7
Coal CV	MJ/kg	25.2	-
Specific Energy consumption	MJ/kg Brick	1.60866	-

Audit No. 21

Heat Balance			
Particulars	***Unit***	***Value***	***%age***
Sensible heat in Brick	MJ/1000 brick	545	2.1
Energy in water vapour leaving the system	MJ/1000 brick	1433	5.6
Heat required for chemical reactions	MJ/1000 brick	5953	23.2
Dry flue gas loss	MJ/1000 brick	996	3.9
Unaccounted (mainly structure + surface)	MJ/1000 brick	16759.4	65.2
Total heat input	MJ/1000 brick	25687	100
Kiln Efficiency	%age	-	28.8
Coal CV	MJ/kg	22.9l	-
Specific Energy consumption	MJ/kg Brick	1.37827	-

Annexure– 2: Process Flow Diagram

While the principles of brick manufacture in BTK's is fairly consistent, individual units may and sometimes do depart from these basics to fit their particular requirements, raw materials and mode of operations. The essential steps in brick making are shown in the diagram below.



The first three steps of the brick making process usually start around about 20-40 days before the actual firing of the kiln. This is done to build up a decent stockpile of dried green bricks for continuous operation of the brick kiln. The firing up process of the brick kiln takes 10-20 days to make the kiln reach its appropriate temperature for the bricks to solidify and acquire its pre requisite fired brick attributes. The entire process is continual and once the firing is initiated, very rarely is the kiln operation course halted.

Annexure – 3: Detailed Technology Assessment Report

The brick kilns technology in the entire Varanasi cluster are of the traditional coal fired fixed chimney Bull's Trench Kilns (BTK) type, where all the activities are performed manually.

Proposed Technology from manual work to semi mechanized

A semi mechanized process makes use of either a pegging machine or / and moulding machine. The use of these machines significantly reduces the work done in the brick preparation process which is time consuming, labour intensive and weather dependent.

The first step in green brick moulding involves tempering, which is done to produce a homogeneous plastic clay mass, and is carried out in a pegging mill. Additionally water is added to sand/ clay raw material in a pug mill, where a mixing chamber with one or more revolving shafts with blade extensions uniformly mixes the two ingredients. After pegging, the plastic clay mass is ready for formed in the desired final product output shape. The number of bricks produced by this process varies from 700 bricks/hr to 1000 bricks/hr as per the requirement.

Moulding the clay mass into the desired shape and dimensions is carried out using a moulding machine also known as a soft mud process. It is used for clay containing a large amount of water. Once the clay has been tempered it is placed in the mould boxes where a pre decided pressure is applied on it through a plunger, to compact the green brick mould. The final product is almost obtained which after drying and firing processes are ready for shipping. The moulds in the machine are lubricated with either sand or water to produce "sand-struck" or "water-struck" brick. With the use of these machines the production capacity increases in range of 700 - 4500 bricks/hr

.

Annexure – 4: Detailed financial calculations & analysis

Assumptions

Name of the Technology	**Semi Mechanized**		
Rated Capacity	**62 Lakh**		
Details	Unit	Value	Basis
Installed Capacity	Lakh	62	Installed Capacity
No of working days	Days		No of working days
Proposed Investment			
Plant & Machinery	Rs.(in lakh)	9.14	
Cost of consultancy	Rs.(in lakh)	1.40	
Total cost	Rs.(in lakh)	9.14	
Misc. Cost	Rs. (in lakh)	0.36	
Total Investment	Rs. (in lakh)	10.90	
Financing pattern			
Own Funds (Equity)	Rs. (in lakh)	2.73	Feasibility Study
Loan Funds (Term Loan)	Rs. (in lakh)	8.18	Assumed
Loan Tenure	Years	5	Assumed
Moratorium Period	Months	6	Assumed
Repayment Period	Months	66	SIDBI Lending rate
Estimation of Costs			
O & M Costs	% on Plant & Equip	2.00	Feasibility Study
Annual Escalation	%	2.00	Feasibility Study
Estimation of Revenue			
Coal savings	Tons	124	
Cost	Rs./ tone	5000	
St. line Depn.	%	5.28	Indian Companies Act
IT Depreciation	%	80.00	Income Tax Rules
Income Tax	%	33.99	Income Tax

Estimation of Interest on term loan

Rs. (In lakh)

Years	Opening Balance	Repayment	Closing Balance	Interest
1	8.18	0.60	7.58	0.74
2	7.58	1.30	6.28	0.70
3	6.28	1.44	4.84	0.56
4	4.84	1.80	3.04	0.40
5	3.04	1.92	1.12	0.22
6	1.12	1.12	0.00	0.03
		8.18		

WDV Depreciation

Rs. (In lakh)

Particulars / years	1	2	3	4	5	6
Plant and Machinery						
Cost	10.54	2.11	-	-	-	-
Depreciation	8.43	1.69	-	-	-	-
WDV	2.11	0.42	-	-	-	-

Projected Profitability **Rs. (in lakh)**

Particulars / Years	*1*	*2*	*3*	*4*	*5*	*6*	*7*	*8*
Fuel savings	6.20	6.20	6.20	6.20	6.20	6.20	6.20	6.20
Total Revenue (A)	6.20	6.20	6.20	6.20	6.20	6.20	6.20	6.20
Expenses								
O & M Expenses	0.22	0.22	0.23	0.23	0.24	0.24	0.25	0.25
Total Expenses (B)	0.22	0.22	0.23	0.23	0.24	0.24	0.25	0.25
PBDIT (A)-(B)	5.98	5.98	5.97	5.97	5.96	5.96	5.95	5.95
Interest	0.74	0.70	0.56	0.40	0.22	0.03	0.00	0.00
PBDT	5.24	5.28	5.41	5.57	5.75	5.93	5.95	5.95
Depreciation	0.58	0.58	0.58	0.58	0.58	0.58	0.58	0.58
PBT	4.67	4.70	4.84	4.99	5.17	5.35	5.38	5.37
Income tax	-	1.22	1.84	1.89	1.95	2.01	2.02	2.02
Profit after tax (PAT)	4.67	3.48	3.00	3.10	3.22	3.34	3.36	3.35

Computation of Tax **Rs. (in lakh)**

Particulars / Years	*1*	*2*	*3*	*4*	*5*	*6*	*7*	*8*
Profit before tax	4.67	4.70	4.84	4.99	5.17	5.35	5.38	5.37
Add: Book depreciation	0.58	0.58	0.58	0.58	0.58	0.58	0.58	0.58
Less: WDV depreciation	8.43	1.69	-	-	-	-	-	-
Taxable profit	(3.19)	3.59	5.41	5.57	5.75	5.93	5.95	5.95
Income Tax	-	1.22	1.84	1.89	1.95	2.01	2.02	2.02

Projected Balance Sheet

Particulars / Years	*1*	*2*	*3*	*4*	*5*	*6*	*7*	*8*
Liabilities								
Share Capital (D)	2.73	2.73	2.73	2.73	2.73	2.73	2.73	2.73
Reserves & Surplus (E)	4.67	8.15	11.15	14.25	17.46	20.80	24.16	27.51
Term Loans (F)	7.58	6.28	4.84	3.04	1.12	0.00	0.00	0.00
Total Liabilities (D)+(E)+(F)	14.97	17.15	18.71	20.01	21.30	23.52	26.88	30.23

Assets	1	2	3	4	5	6	7	8
Gross Fixed Assets	10.90	10.90	10.90	10.90	10.90	10.90	10.90	10.90
Less Accm. depreciation	0.58	1.15	1.73	2.30	2.88	3.45	4.03	4.60
Net Fixed Assets	10.32	9.75	9.17	8.60	8.02	7.45	6.87	6.30
Cash & Bank Balance	4.64	7.40	9.53	11.41	13.28	16.07	20.00	23.93
TOTAL ASSETS	14.97	17.15	18.71	20.01	21.30	23.52	26.88	30.23
Net Worth	7.39	10.87	13.87	16.97	20.19	23.53	26.88	30.23
Debt Equity Ratio	1.02	0.58	0.35	0.18	0.06	0.00	0.00	0.00

Projected Cash Flow **Rs. (in lakh)**

Particulars / Years	*0*	*1*	*2*	*3*	*4*	*5*	*6*	*7*	*8*
Sources									
Share Capital	2.73	-	-	-	-	-	-	-	-
Term Loan	8.18								
Profit After tax		4.67	3.48	3.00	3.10	3.22	3.34	3.36	3.35
Depreciation		0.58	0.58	0.58	0.58	0.58	0.58	0.58	0.58
Total Sources	10.90	5.24	4.06	3.57	3.67	3.79	3.91	3.93	3.93
Application									
Capital Expenditure	10.90								
Repayment Of Loan	-	0.60	1.30	1.44	1.80	1.92	1.12	0.00	0.00
Total Application	10.90	0.60	1.30	1.44	1.80	1.92	1.12	0.00	0.00
Net Surplus	-	4.64	2.76	2.13	1.87	1.87	2.79	3.93	3.93
Add: Opening Balance	-	-	4.64	7.40	9.53	11.41	13.28	16.07	20.00
Closing Balance	-	4.64	7.40	9.53	11.41	13.28	16.07	20.00	23.93

IRR **Rs. (in lakh)**

Particulars / months	*0*	*1*	*2*	*3*	*4*	*5*	*6*	*7*	*8*
Profit after Tax		4.67	3.48	3.00	3.10	3.22	3.34	3.36	3.35
Depreciation		0.58	0.58	0.58	0.58	0.58	0.58	0.58	0.58
Interest on Term Loan		0.74	0.70	0.56	0.40	0.22	0.03	-	-
Cash outflow	(10.90)	-	-	-	-	-	-	-	-
Net Cash flow	(10.90)	5.98	4.76	4.13	4.08	4.01	3.94	3.93	3.93
IRR	41.34%								
NPV	12.93								

Break Even Point

Particulars / Years	*1*	*2*	*3*	*4*	*5*	*6*	*7*	*8*
Variable Expenses								
Oper. & Maintenance Exp (75%)	0.16	0.17	0.17	0.17	0.18	0.18	0.18	0.19
Sub Total*(G)*	0.16	0.17	0.17	0.17	0.18	0.18	0.18	0.19
Fixed Expenses								
Oper. & Maintenance Exp (25%)	0.05	0.06	0.06	0.06	0.06	0.06	0.06	0.06
Interest on Term Loan	0.74	0.70	0.56	0.40	0.22	0.03	0.00	0.00
Depreciation *(H)*	0.58	0.58	0.58	0.58	0.58	0.58	0.58	0.58
Sub Total (I)	1.37	1.33	1.19	1.03	0.85	0.67	0.64	0.64
Sales (J)	6.20	6.20	6.20	6.20	6.20	6.20	6.20	6.20
Contribution (K)	6.04	6.03	6.03	6.03	6.02	6.02	6.02	6.01
Break Even Point (L= G/I)	22.66%	22.08%	19.80%	17.17%	14.13%	11.09%	10.59%	10.61%
Cash Break Even {(I)-(H)}	13.13%	12.54%	10.26%	7.62%	4.57%	1.53%	1.02%	1.04%
Break Even Sales (J)*(L)	1.40	1.37	1.23	1.06	0.88	0.69	0.66	0.66

Return on Investment **Rs. (in lakh)**

Particulars / Years	*1*	*2*	*3*	*4*	*5*	*6*	*7*	*8*	*Total*
Net Profit Before Taxes	4.67	4.70	4.84	4.99	5.17	5.35	5.38	5.37	31.10
Net Worth	7.39	10.87	13.87	16.97	20.19	23.53	26.88	30.23	131.67
									23.62%

Debt Service Coverage Ratio **Rs. (in lakh)**

Particulars / Years	*1*	*2*	*3*	*4*	*5*	*6*	*7*	*8*	*Total*
Cash Inflow									
Profit after Tax	4.67	3.48	3.00	3.10	3.22	3.34	3.36	3.35	12.65
Depreciation	0.58	0.58	0.58	0.58	0.58	0.58	0.58	0.58	2.30
Interest on Term Loan	0.74	0.70	0.56	0.40	0.22	0.03	0.00	0.00	1.21
Total (M)	5.98	4.76	4.13	4.08	4.01	3.94	3.93	3.93	16.17

DEBT

Interest on Term Loan	0.74	0.70	0.56	0.40	0.22	0.03	0.00	0.00	1.21
Repayment of Term Loan	0.60	1.30	1.44	1.80	1.92	1.12	0.00	0.00	6.28
Total (N)	1.34	2.00	2.00	2.20	2.14	1.15	0.00	0.00	7.49
Average DSCR (M/N)	2.16								

Annexure – 5: Details of Procurement and Implementation Plan

S.No	Activity	Weeks									
		2	4	6	8	10	12	14	16	18	20
1	Service Contract										
2	Civil and infrastructure Modification (as										
3	Installation of Pugmill and Moulding										
4	Process integration and Training										
6	Trail operation										

Annexure – 6: Details of Technology/equipment and service providers

Name	*Organization*	*Contact No.*	*E-mail*
Mr. Shakti Swarup	Neptune Industries	+91 - 9909966776	Shakti@neptune-india.com
Mr.Anil Kumar	BTECON -5, Millinium Business Center, 34 corner Market, Malviya Nagar, New Delhi	+91-9891584175	ak@btecon.com

Annexure– 7: Quotations or Techno-commercial bids for new technology/equipment

We have basically tyree types of pugmill as below. For making simple mud bricks you will require pugmill without vacuum

1) 8" output
H.P 5
output 700 Brikcs/ hour

Rs. 75000/-

2) 10" output
H.P 7.5
output 1000 Brikcs/ hour

Rs. 1,00,000/-

3) 12" output
H.P 15
output 1000 Brikcs/ hour

Rs. 1,35,000/-

CNA Engineering Company

SF NO.561/1,SOMAYAMPALAYAM POST,
KANUVAI, COIMBATORE Tamilnadu India
Phone: 0422-2437208 – 2436129 Fax : 2452104
www.cnaengco.in www.cnaengco.co.in
E-mail: cnaengco@gmail.com

To

QUOTATION

OUR REF:
DATE :

DEAR SIR/S
REFERRING TO VALUED ENQUIRY NO.....DATED .....WE ARE PLEASED TO SUBMIT OUR QUOTATION AS FOLLOWS.

NO	DESCRIPTION	QTY	AMOUNT	
1	Double Shaft Clay Brick Moldings Machine 10 Hp 960 Rpm Electric Motor with water circulating System and four wheels (3,000 to 3600 bricks / Hour) Provision for Diesel engine attachment.	1 No	6,50,000	00
2	Brick Moulds Brick Moulds: 9" x 4" x 3"(Shrinkage allowance not included, depends on customer clay) Brick Moulds of **Two** Or **Three** Bricks "X "X " (Optional)	60 No's	1,20,000	00
3	Brick Moulds Shifting Trolleys	4 No's		00
4	Conveyor Set 15' Feet X 2' Feet with 2 Hp Power (Moveable on wheels System)	1 No	24,000	00
.			1,20,000	
	Total		9,14,000	00
	VAT 4% or (CST 2% Against 'C' Form Otherwise 12.5%)		36,560	00
	Grand Total		9,50,560	00
	(RUPEES NINE LAKHS FIFTY THOUSAND FIVE HUNDRED AND SIXTY ONLY)			
	ERECTION CHARGES: RS: 500 Per day, LOADING: By CNA Eng Co Free of cost UNLOADING: By party, FREIGHT: By Party actual, DELIVERY: 40 DAYS, ADVANCE 40% , BALANCE: 60% AT EX - FACTORY COIMBATORE. VALIDITY: 90 DAYS, WARANTY: 12MONTHS			

For CNA Engineering Company

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

Feedback Ventures Pvt. Ltd
15th Floor, Tower 9B, DLF Cyber city
DLF Phase-III, Gurgaon-122 002
Ph: 0124-416 9100
Fax: 0124-416 9175
www.feedbackventures.com

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