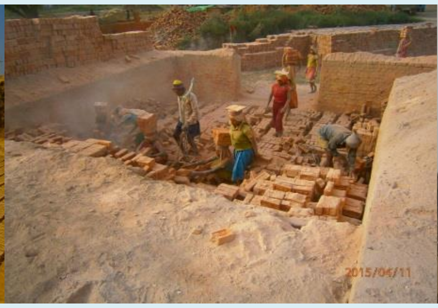
Cluster Profile
Lucknow brick kilns



Promoting Energy Efficiency in SMEs
SAMEEKSHA

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Darbari Seth Block
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India

For more information

Project Monitoring Cell
T E R I
Darbari Seth Block
IHC Complex, Lodhi Road
New Delhi – 110 003
India

Tel. 2468 2100 or 2468 2111
E-mail pmc@teri.res.in
Fax 2468 2144 or 2468 2145
Web www.teriin.org
India +91 • Delhi (0)11

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TERI team is thankful to Mr Charanjeet Talwar (President) and Mr Gyan Prakash (Secretary), Lucknow Brick Kiln Association, Lucknow for providing support and information related to local brick kiln units in the cluster.

Lucknow brick kilns

Overview of cluster

Lucknow is the capital of the state of Uttar Pradesh and a second largest city after Kanpur in Uttar Pradesh. It is also known as 'City of Nawabs'. For centuries, Lucknow has been famous for its various handicraft works. The Nawabs of Awadh were great patrons of fine arts of which the most well-known is the exquisite Chikan work. Chikan is a unique craft involving delicate and artistic hand embroidery in a variety of textile fabric like muslin, silk, chiffon, organza, doriya and organdi. Brick is the major construction material used in the region and there is a large concentration of brick kilns around Lucknow.

Product types and production capacities

There are about 230 brick kiln units around Lucknow. Almost all the brick kiln units use fixed chimney type Bull's Trench Kilns (BTK). There are about 10 brick kiln units in the cluster that are using zig-zag technology for firing of green bricks. All the brick kilns are engaged in production of clay fired solid bricks through a manual production process.

Solid bricks production from a brick kiln

The average production capacity of a typical BTK in Lucknow cluster is about 27,000 bricks per day. Brick kilns are engaged in production of bricks for about 6 months in a year - January to June. The average size of a brick is 9 X 4 X 3 inch weighing about 3.0 kg. The colour of a good quality brick produced is dark brown. Five to six qualities of bricks are generally sold in the market – Class-1, Class-2, Class-3, Tamda, Kali Peti and Tukda. The typical production of different classes of bricks in the cluster is shown in the table.

Production from a brick kiln

Brick class	Average share (%)	Selling price (Rs/brick)
Class-1	45	5.0
Class-2	10	4.0
Class-3	10	2.5
Tamda	20	3.5
Kali Peti	5	3.0
Tukda	10	1.3

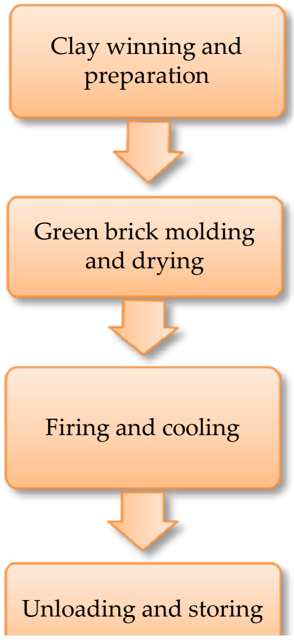
Energy scenario in the cluster

Coal is the main fuel used in the cluster. The average price of coal in the cluster is provided in the table.

Average cost of coal in the cluster

Energy type	Price (Rs)
Coal	12000 per tonne

Production process



Brick production process

Brick making in the cluster follows traditional, labour-intensive processes and practices, with minimal use of mechanization. The major steps involved in brick production process include clay excavation & preparation, moulding, drying of green bricks and firing inside the kiln. The basic raw materials used for making bricks are clay and water. Different steps involved are briefed below.

(1) *Clay/soil excavation and preparation*. Generally, top soil from nearby agricultural fields is excavated, which is mixed with other soil types based on requirements. Wet mixing of soil is generally done manually.

(2) *Green brick moulding*. Only solid bricks are produced in the cluster and manual moulding is practiced across the cluster. Wooden/ plastic moulds are used for making solid green bricks.

(3) *Brick drying*. The moisture present in green bricks is removed through drying process. Generally sun drying is practiced in the cluster. Green bricks are stacked under open field, and upon drying they are taken for loading in the kiln.

(4) *Brick firing*. Leather hard dried bricks are loaded and stacked manually inside the kiln. The fired bricks, after cooling are taken out, classified through visual inspection and stacked for dispatch.

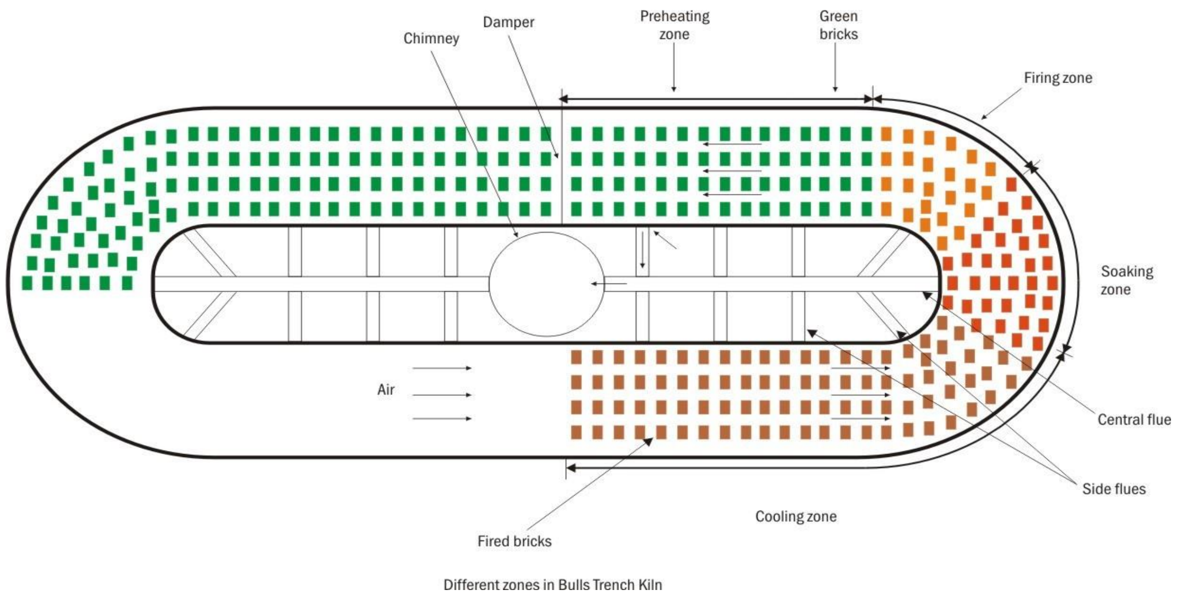
Technologies employed

The cluster predominantly uses fixed chimney Bull's Trench Kilns (BTK) for firing of kilns. BTKs are continuous type of kilns in which bricks are stacked inside the kiln and fire is made to move. The combustion air is preheated while passing through fired bricks thereby cooling them. A firing temperature of 1000-1100 oC is maintained inside the kiln. The flue gases are allowed to pass through stacks of dried bricks to preheat them before allowed to join a central flue duct and exited through chimney. Typically, the temperature of flue gases leaving the chimney is about 80-120°°C.

Fixed chimney kiln

Energy consumption

Coal is the major energy source in brick kilns in the cluster. Diesel is used only to provide water requirements in moulding section in the brick kiln units.



Schematic diagram of BTK

(i) Unit level consumption

Thermal energy accounts for almost 100% of energy consumption in a brick kiln. The reported coal consumption in a brick kiln is about 16 tonne per lakh brick produced. Apart from coal, the brick kiln units consume diesel for operation of DG sets which is required to supply water for moulding process. Considering 180 days of operation of brick kiln in a year, the total energy consumption of a brick kiln is estimated to be 479 toe per year. The average specific energy consumption (SEC) of solid brick manufacturing is estimated to be about 1.38 MJ per kg fired brick.

Typical energy consumption in fixed chimney BTKs

Production capacity	Production (lakh bricks/year)	Coal (tpy)	Total energy (toe/yr)	Annual energy bill (million INR)
27000 bricks per day	48.6	826	479	10

(ii) Cluster level consumption

The total energy consumption of Lucknow brick kiln cluster is estimated to be 108,254 toe. The energy consumption and estimated GHG emissions are given in the table.

Energy consumption of the Lucknow brick kiln cluster

Energy type	Annual consumption	Equivalent energy (toe)	GHG emissions (tonne CO_2)	Annual energy bill (million INR)
Coal	186,676 tonnes	108,254	196,620	2240
	Total	**108,254**	**196,620**	**2240**

Energy saving opportunities and potential

The average "Specific Energy Consumption" (SEC) of fixed chimney BTKs in the cluster was estimated to be 1.38 MJ per kg fired brick which is quite higher compared to an optimal level of 1.1–1.2 MJ/kg-fired brick. This clearly indicates a significant potential exists in the Lucknow brick kiln cluster for improving the energy efficiency. Some of the major energy-saving opportunities in the brick kiln units in the cluster are discussed in the following section.

(i) Improved kiln operating practices

Improved coal feeding/charging practices would help in improving the combustion of coal thereby reducing formation of various unburnts such as carbon monoxide (CO) and soot thereby improving overall energy efficiency of the kiln. About 10% fuel saving potential exists by adopting feeding practices (equivalent to 18,678 tonne of coal or 10,825 toe at cluster level). The kiln operation must take into account the following:

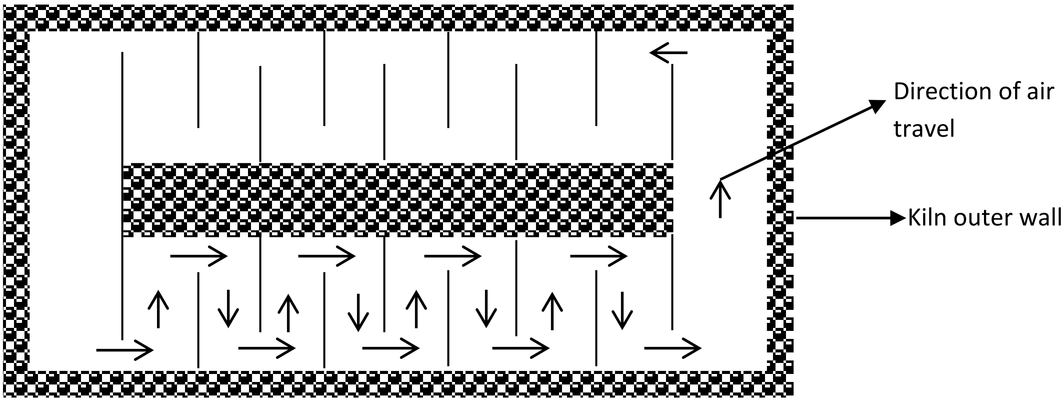
- Coal lumps are generally fed during firing cycle. The size of coal must be reduced to about 10 mm in using a coal crusher before feeding.
- Coal feeding is done intermittently (generally after 45–60 minutes) that leads to formation of black smoke for a substantial period of time after completing coal feeding. Instead, small quantities of coal must be fed in firing lines more frequently (say after every 20 minutes) that would help in reducing unburnt or black smoke formation.
- The quantity of coal fed during each time by the firemen was observed to be high which leads to increased unburnts during fuel feeding. It is suggested to use smaller capacity spoons (750–1000 gram) for feeding coal
- In a majority of the kilns, coal feeding is done in two lines at a time which can be increased to more than three lines in order to lengthen firing zone and ensure complete combustion of fuel.
- Present practices show that fuel feeding is done by two firemen at a time resulting in feeding of large quantity of coal. It is suggested to adopt "single man feeding practices" which would help in improved feeding and reduced unburnt formation.
- Length of cooling zone should not be more than 150–170 feet above which the fuel may not be able to obtain sufficient quantity of combustion air leading to formation of more unburnts
- Iron rod should be used to prevent formation of coal bed at the bottom of firing zone.
- Forward row should be taken on coal feeding only when red bottom is visible through brick setting which corresponds to about 650 ^{O}C.
- The major heat losses from kiln components (wickets, dampers and feedhole covers) can be controlled by the following:
    - Air leakage through kiln structure can be reduced to a large extent by sealing of wickets (i.e. openings in the kiln outer wall which are used to carry green and fired bricks inside/outside the kiln) with at least two-brick thick walls and mud plastering on both sides.
    - Closing side flues with brick wall (1½ brick thick) plastered with a mix of clay, sand and cow dung.
    - A minimum ash layer (rabbish) thickness of about 7 inch may be provided above the brick setting.
- Keeping the floor level of the kiln at least one foot above ground level which would help in natural drainage

(ii) Adopting zig-zag firing in place of conventional firing process

Conventional firing process followed in brick kilns generally leads to poor combustion and higher surface heat losses resulting in higher fuel consumption of the kiln. In place of conventional firing, zig-zag firing process can be adopted. In zig-zag firing, the kiln has long firing zone and the travel path of fire is increased with modified pattern of brick stacking. The stacking pattern results in creating turbulent conditions which help in optimal air-fuel mixing. Some of the benefits of adopting zig-zag technology include:

- Better combustion of fuel due to enhance circulation of air and improved mixing of fuel and air leading to reduced coal consumption
- Reduced surface heat losses
- Reduced CO and particulate emissions

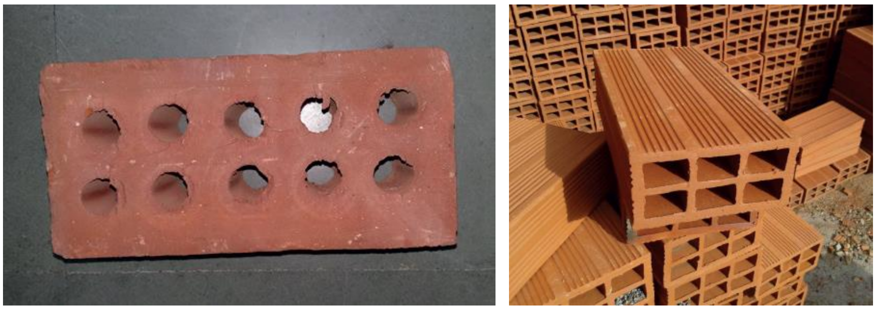
About 10% of fuel saving can be achieved with adoption of zig-zag firing equivalent to 18,678 tonne of coal (~ 10,825 toe) at cluster level.



Air flow in single zig-zag kiln

(iii) Mechanisation/ semi-mechanisation in moulding process

Brick kilns in Lucknow, like many other brick making clusters are involved in production of conventional solid bricks through manual green brick molding process. With less availability of space due to increasing population and demand, a majority of the construction in cities and towns is taking place in the form of multi-storey buildings using RCC (Reinforced Concrete Cement) columns. In RCC column based buildings, bricks are increasingly being used as filler material rather than load bearing walls. The shift towards Resource Efficient Bricks (REBs) like perforated brick and hollow blocks would help in saving fuel and reducing pollution in brick production process. There is also a significant reduction in the consumption of top (agricultural) soil which is the main raw material in brick making. Increased use of REBs in building construction would also help in reducing the energy consumption of buildings due to their improved insulation properties.

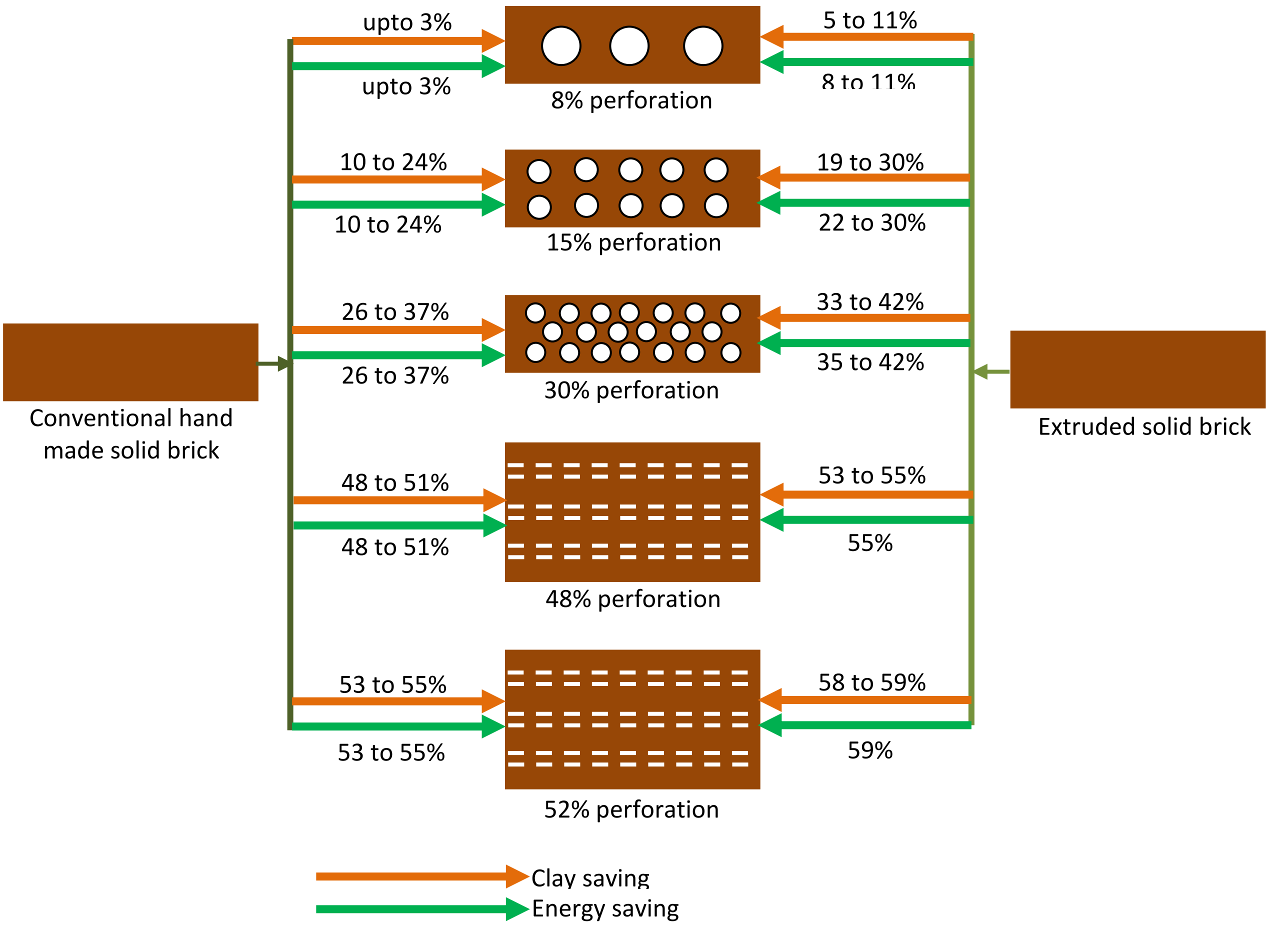


Resource efficient Bricks (REBs)

Some of the benefits of producing REBs include the following:

Resource savings

Clay and fuel (coal) are the main resources used for manufacturing REBs. The production of REBs results in substantial resource savings as compared to production of conventional/extruded solid bricks.



Resource savings by REB production

Improvement in product quality

Adoption of mechanization for preparation of raw-mix and molding process helps in proper homogenization of clay particles. The process also helps in manufacturing bricks with proper size and shape. This leads to production of better quality of green (freshly molded brick with moisture) as well as fired bricks and increased output of better quality (Class-I) bricks from the kiln.

Reduction in green brick wastage

During the brick-making season, about 20% of total green brick production of a kiln is wasted due to rain. However, with adoption of mechanization and installation of shed, the wastage of green bricks is avoided.

Flexibility in production

A mechanized brick production unit can adapt to variation in product type as per market demand which is not possible with hand-molding operation.

Reduction in plaster and mortar requirement

REBs have a uniform size and shape and can be used as such without any plaster on the surface. Hollow blocks (400 X 200 X 200 mm) are equivalent to 9 solid bricks (230x110x70 mm) and their use as walling material can help in 40%–70% savings in mortar requirements.

Reduction in steel requirements

The weight of REBs is less than the equivalent size of solid bricks. For same volume of walling unit, the weight of hollow block is about 60% less than solid bricks. Therefore, use of REBs results in reduced dead load of the building and a substantial reduction in requirement of steel as reinforcement.

Reduction in energy bills of buildings

The REBs have lower heat transfer coefficient as compared to conventional solid bricks; therefore, their use as walling material in buildings improves the insulating property and, depending upon the climatic zone, can reduce the energy bill by 1.5–6.4%.

Improved skill set of workers

The operation/maintenance of machinery/equipment will help in upgrading the skills of workers and reduce the drudgery involved in manual clay preparation and the green brick molding process.

Major stakeholders

The major stakeholder is Lucknow Brick Kiln Association. Other stakeholders include MSME-Development Institute (MSME-DI), Kanpur.

Cluster development activities

There were no specific cluster level activities specific to Lucknow brick cluster.

About TERI

A dynamic and flexible not-for-profit organization with a global vision and a local focus, TERI (The Energy and Resources Institute) is deeply committed to every aspect of sustainable development. From providing environment-friendly solutions to rural energy problems to tackling issues of global climate change across many continents and advancing solutions to growing urban transport and air pollution problems, TERI's activities range from formulating local and national level strategies to suggesting global solutions to critical energy and environmental issues. The Industrial Energy Efficiency Division of TERI works closely with both large industries and energy intensive Micro Small and Medium Enterprises (MSMEs) to improve their energy and environmental performance.

About SDC

SDC (Swiss Agency for Development and Cooperation) has been working in India since 1961. In 1991, SDC established a Global Environment Programme to support developing countries in implementing measures aimed at protecting the global environment. In pursuance of this goal, SDC India, in collaboration with Indian institutions such as TERI, conducted a study of the small-scale industry sector in India to identify areas in which to introduce technologies that would yield greater energy savings and reduce greenhouse gas emissions. SDC strives to find ways by which the MSME sector can meet the challenges of the new era by means of improved technology, increased productivity and competitiveness, and measures aimed at improving the socio-economic conditions of the workforce.

About SAMEEEKSHA

SAMEEEKSHA (Small and Medium Enterprises: Energy Efficiency Knowledge Sharing) is a collaborative platform set up with the aim of pooling knowledge and synergizing the efforts of various organizations and institutions - Indian and international, public and private - that are working towards the development of the MSME sector in India through the promotion and adoption of clean, energy-efficient technologies and practices. The key partners are of SAMEEEKSHA platform are (1) SDC (2) Bureau of Energy Efficiency (BEE) (3) Ministry of MSME, Government of India and (4) TERI.

As part of its activities, SAMEEEKSHA collates energy consumption and related information from various energy intensive MSME sub-sectors in India. For further details about SAMEEEKSHA, visit http://www.sameeeksha.org