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Towards CLEANER Brick Kilns in India

A win–win approach based on Zigzag firing technology





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EXECUTIVE SUMMARY

- With estimated annual production of 250 billion bricks a year, India is the second largest brick producer globally.
- There are more than 100,000 brick kilns in the country producing bricks. Fixed Chimney Bull's Trench Kiln (FCBTK) is the main brick kiln technology accounting for 70% of the production.
- Brick kilns consume about 35 million tonnes (MT) of coal a year, making them the second largest industrial consumer of coal after the steel industry.
- Inefficient combustion and heat loss in brick kilns result in a waste of energy and large emissions of suspended particulate matter (SPM) and black carbon (BC).
- FCBTKs can be retrofitted into efficient and cleaner Zigzag firing. Detailed scientific measurements on brick kilns show that conversion from FCBTK to Zigzag firing results in:
  - 20% savings in coal consumption and CO_2 emissions;
  - 75% reduction in SPM and BC emissions; and
  - doubling of profits for brick producers due to fuel savings and quality improvements.
- A national initiative to retrofit/convert all 30,000–35,000 FCBTKs into Zigzag firing over the next five years can result in:
  - annual coal savings of more than 6 MT of coal a year and
  - reduction of 14 MT of CO_2 and 0.45 MT of SPM per year.
- Among other measures, retrofitting can be greatly facilitated by amending the emission standards for brick kilns by the Ministry of Environment Forests (MoEF). The proposed amendments may include:
  - lowering the emission standards for SPM to 250 mg/Nm^3 and
  - a ban on establishing new FCBTKs and replacing all existing FCBTKs with Zigzag or other cleaner brick kiln technologies within five years.


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1. Brick Industry in India

Fired clay bricks are one of the most important building materials in India. India is the second largest producer of bricks, accounting for over 10% of the global production. It is estimated that India has more than 100,000 brick kilns producing about 250 billion bricks annually. The Gangetic plains of North India comprising the states of Assam, Bihar, Haryana, Punjab, Uttar Pradesh (UP), and West Bengal account for about 65% of the total brick production of India, whereas peninsular and coastal India contribute the remaining 35%. The fringe areas of cities in this region are dotted with large clusters of brick kilns. Figure 1 shows the process of clay-fired brick manufacturing.

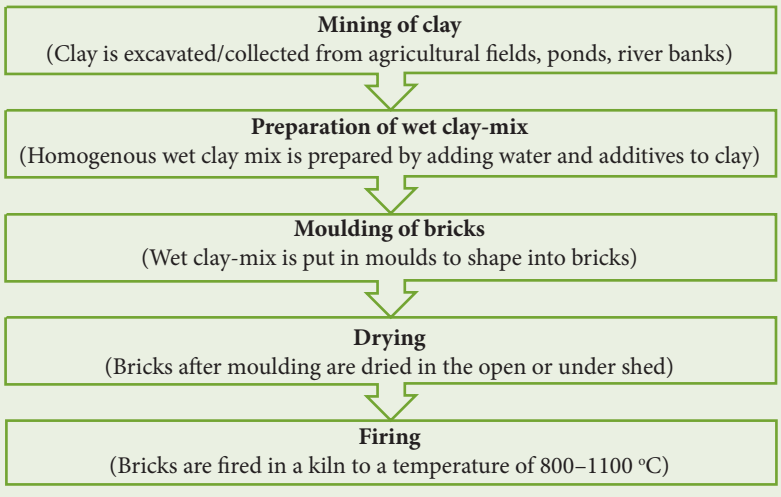

Figure 1 *Brick-making process*

The brick industry in India is highly labour-intensive employing about 15 million workers, and is characterized by the use of manual labour, and primitive and age-old technology.

For firing, Fixed Chimney Bull's Trench Kiln (FCBTK), a type of continuous kiln, is the main technology in use, accounting for about 70% of the total brick production in India (Figure 2). FCBTKs are mostly used in the Gangetic plains and in pockets all around the country (Figure 3).

Intermittent kilns such as clamp kilns, which produce bricks in batches in small quantities, are widely used in the peninsular region, contributing to about 25% of the total brick production. Other firing technologies, such as Vertical Shaft Brick Kiln (VSBK), Hoffmann Kiln, and Zigzag kiln, account for less than five per cent of the total brick production.

Solid fuels such as coal, petcoke and biomass (firewood, sawdust, mustard stalk, rice husk, etc.) are used for firing bricks. Brick kilns are estimated to consume

Figure 2 *Fixed Chimney Bull's Trench Kiln*

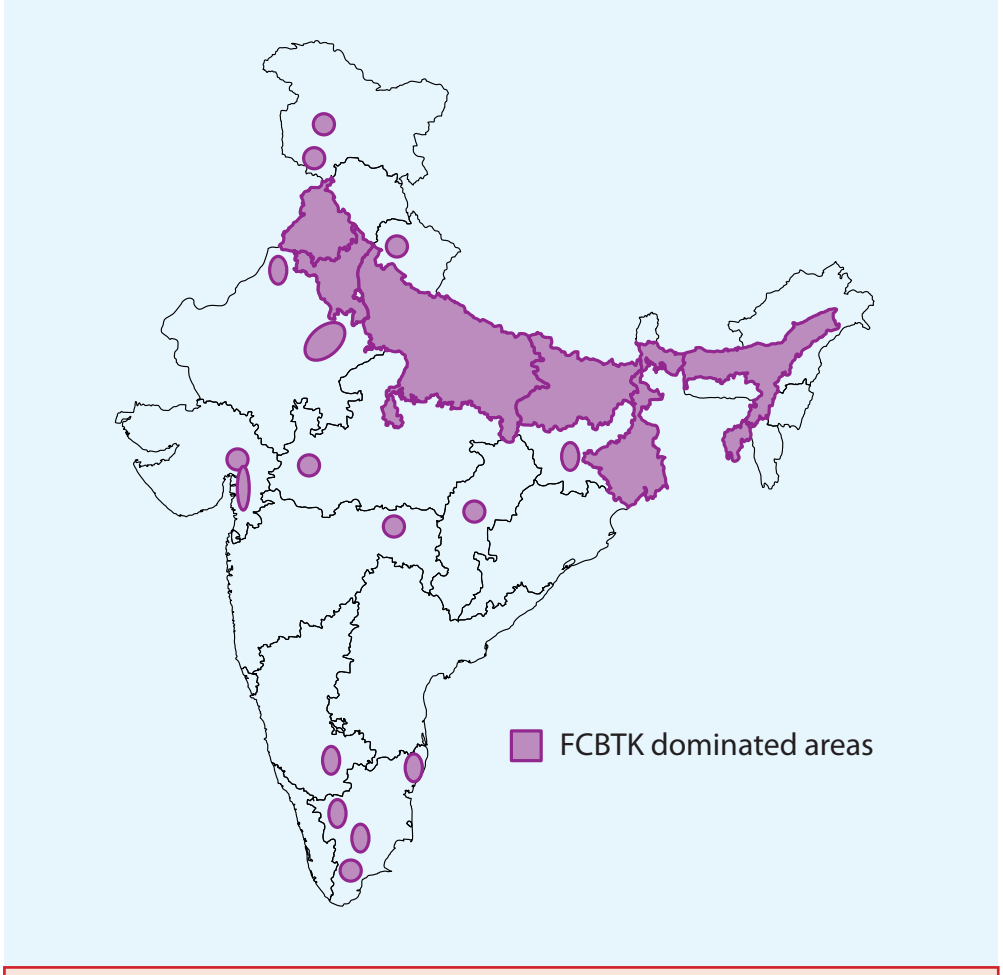

Figure 3 *FCBTK-dominated regions in India*

roughly 35 million tonnes (MT) of coal annually, which make them one of the largest industrial consumers of coal in the country (Figure 4).

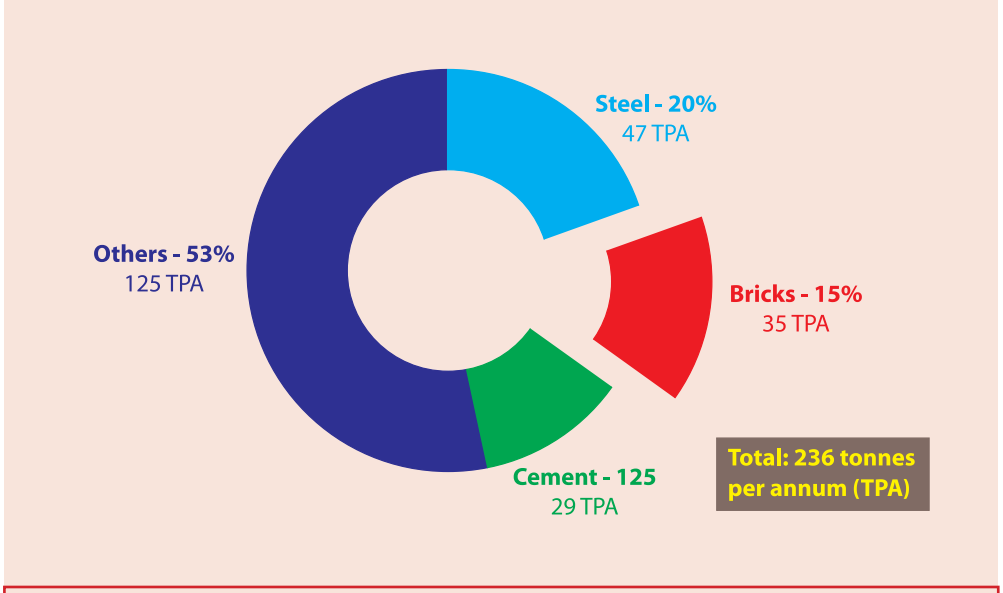

Figure 4 *Share of coal consumption by brick kilns among industrial consumers of coal*

Source *Gautam Dhar, Chief General Manager, Corporate Planning, Coal India Ltd, Presentation on "Demand & Supply Gap and Coal Security", The Associated Chambers of Commerce and Industry, 3 February 2011 and GKSPL estimates.*

The use of large quantities of coal in brick kilns contributes significantly to emissions of carbon dioxide (CO_2), particulate matter (PM), including black carbon (BC), sulphur dioxide (SO_2), oxides of nitrogen (NO_x), and carbon monoxide (CO). The pollutants not only have an adverse effect on the health of workers, local population, and vegetation, but also contribute to global warming.

The Ministry of Environment and Forests (MoEF), Government of India, has issued standards for suspended particulate matter (SPM) emissions and chimney height for different types and categories of brick kilns (Table 1).

Table 1 Emission standards for brick kilns by MoEF

Technology and size	***SPM emission standard***
Fixed Chimney Bull's Trench Kiln (FCBTK)	
Large and medium size (production >15,000 bricks/day)	<750 mg/Nm^3
Small size (production <15,000 bricks/day)	<1000 mg/Nm^3
Vertical Shaft Brick Kiln (VSBK)	<250 mg/Nm^3
Down-draft kiln	<1200 mg/Nm^3
Source: Ministry of Environment and Forests, The Gazette of India, Part II, Section 3, Sub-section (i), 22 July 2009	

2. Fixed Chimney Bull's Trench Kiln: inefficient and polluting

As mentioned earlier, FCBTK is a continuous, moving fire kiln operated under a natural-draught provided by a fixed chimney. Initially, BTKs had movable metallic chimneys. Movable metallic chimneys were banned through an MoEF notification in 1996. Since then, most BTKs have changed over to fixed chimneys. Box 1 provides the details of the transition process of moving chimney kilns to FCBTK.

The conversion to FCBTK technology reduced the SPM emissions as well as fuel use compared to the moving chimney BTK. However, FCBTK also suffers from incomplete combustion of fuel, indicated by high CO concentration in flue gas (PPM range), black smoke, and unburnt coal deposition at the floor of the kiln. The incomplete combustion of fuel results in high SPM and BC emissions in flue gases. The measured SPM emissions from FCBTK[1] lie in the range of 150–1250 mg/Nm^3.

Box 1: Transition from Moving Chimney BTK to Fixed Chimney BTK (1996–2002)

In the early 1990s, about 30,000 moving chimney BTKs were operational in India. In 1996, based on the recommendations of COINDS (Comprehensive Industry Document Series) study, the MoEF issued a notification banning all types of moving chimney BTKs and ordering all the moving chimney kilns to convert to fixed chimney by June 2002. The Central Building Research Institute (CBRI), the Aligarh Muslim University (AMU), and the Punjab State Council for Science and Technology (PSCST) developed designs for chimneys equipped with gravity settling chambers. By 2002, about 75% of the moving chimney BTKs shifted to fixed chimney BTKs. The conversion not only helped in the reduction in SPM emissions but also resulted in fuel savings (about 10%–15%) and increased production and better quality.

Moving Chimney BTK

Fixed Chimney BTK

[1] Brick Kiln Performance Assessment – 2011. Report prepared by Greentech Knowledge Solutions, Enzen Global Solutions, University of Illinois and Clean Air Task Force and submitted to Shakti Sustainable Energy Foundation. New Delhi: Available at http://www.unep.org/ccac/Portals/24183/docs/Brick_Kilns_Performance_Assessment.pdf

An FCBTK not only suffers from high energy consumption and emissions but also produces a low percentage of class-I bricks. Typically, in an FCBTK operating in UP or Bihar, out of the total production, about 60% is class I (perfectly fired), 25% is class II (a little under-fired), and 15% is class III (under-fired). Non-uniform temperature across the cross-section of FCBTK results in differences in the product quality. At places where there is a large price differentiation among the brick categories, the low percentage of class-I bricks from FCBTK results in significant revenue loss to the brick-kiln owners.

3. Zigzag Firing Technology: a win–win option to replace Fixed Chimney Bull's Trench Kiln

The Zigzag kiln is an improved version of the FCBTK. The main innovation is in the arrangement of bricks. In a Zigzag kiln, the bricks are arranged in such a way that the air is forced to follow a zigzag path. The main differences between an FCBTK and a Zigzag kiln are listed below.

1. In a Zigzag kiln, the air moves in a zigzag path whereas in an FCBTK, the movement of air is in a straight path (Figure 5). The length of the zigzag air path is about three times longer than the straight-line air path. The increased air velocities in the kiln, the turbulence created due to the zigzag air movement, and the longer air path result in improved heat transfer between air/flue gases and bricks.

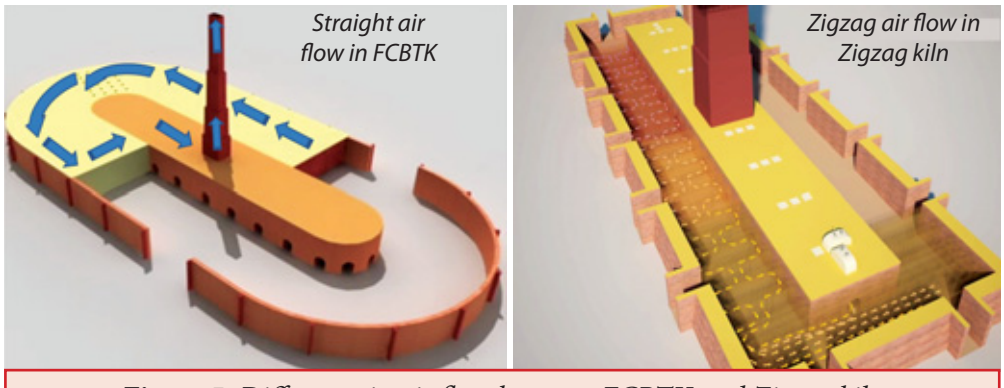

Figure 5 *Difference in air flow between FCBTK and Zigzag kiln*

2. In a Zigzag kiln, powdered coal is fed in small quantities and the fuel feeding zone is six times longer than that of FCBTK. The longer fuel feeding zone, the smaller size of coal particles, and the turbulence created by the zigzag air movement all help to better mix the coal volatiles with air, thereby resulting in more complete and cleaner combustion of coal.
3. An FCBTK is oval or circular in shape, while a Zigzag kiln is rectangular in shape.

The zigzag firing concept was introduced in India by the Central Building Research Institute (CBRI), Roorkee, in the early 1970s in the form of a high-draught kiln, in which a draught is created with a help of a fan. The high-draught kiln gained popularity only in eastern India, especially West Bengal. At present, about 1000 high-draught kilns are operating in the country. The lack of reliable electricity

supply at brick kiln sites has been a major barrier to the adoption of high-draught kiln technology.

In recent years, innovations by two enterprising brick kiln owners have resulted in the operation of Zigzag kilns on natural-draught created by a chimney. This technology is known as natural-draught Zigzag kiln. Presently, there are about 50[2] natural-draught Zigzag kilns operational in eastern UP, Bihar, and West Bengal. Box 2 lists the main differences between natural- and high-draught Zigzag kilns.

Box 2: Main differences between natural- and high-draught Zigzag kilns

Natural-draught Zigzag kiln	*High-draught Zigzag kiln*
➢ Operates under a draught created naturally with the help of a chimney.	➢ Operates under a draught created with the help of a fan.
➢ No electricity/diesel is required for its operation.	➢ Electricity or diesel is required for its operation.
➢ Brick setting is less dense.	➢ Brick setting is very dense.
➢ The height of the chimney is 36–40 m (120–130 ft).	➢ The height of the chimney is 15–24 m (50–80 ft).

3.1. Advantages of Zigzag firing technology over FCBTK

A detailed performance monitoring study was undertaken by a team from Greentech Knowledge Solutions, Enzen Global Solutions, University of Illinois, and Clean Air Task Force to measure the performance of FCBTK and Zigzag firing brick kilns. The monitoring was carried out during 2011 and 2012. The results of the 2011 study are available in the form of a detailed report on the website of the United Nations Environment Programme (UNEP).[3] As per the assessment, the main advantages of Zigzag firing technology over FCBTK are listed below.

1. Lower energy consumption and savings on energy cost

One of the main advantages of a Zigzag kiln is its lower specific energy consumption (SEC) as compared to that of FCBTK. The Zigzag kilns have SECs in the range of 0.95–1.20 MJ/kg fired brick. On an average, in comparison to conventional FCBTK, Zigzag kilns require about 20% less energy (Figure 6).

2. Better environment performance

The concentration of SPM emissions in Zigzag kilns during monitoring ranged from 30 to 260 mg/Nm^3 (Figure 7). Apart from SPM emissions, a Zigzag kiln

[2] Personal communication with Mr O P Badlani, Technology provide for Natural Draught Zigzag kiln, Prayag Clay Products Pvt Ltd, Varanasi

[3] http://www.unep.org/ccac/Portals/24183/docs/Brick_Kilns_Performance_Assessment.pdf

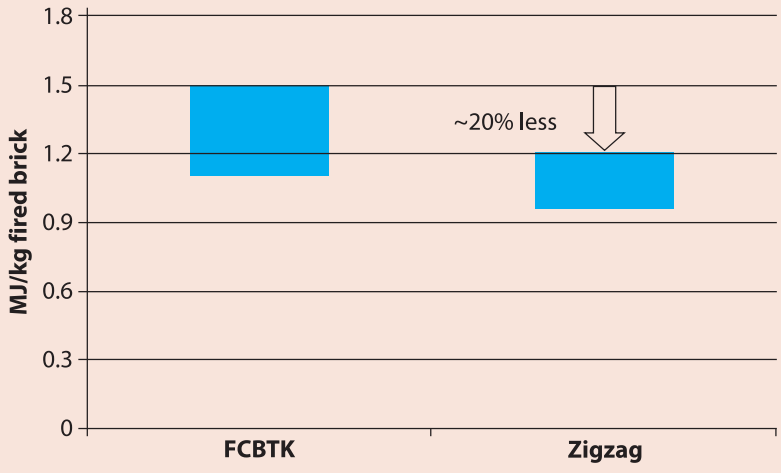

Figure 6 *Range of specific energy consumption of FCBTK and Zigzag kiln*

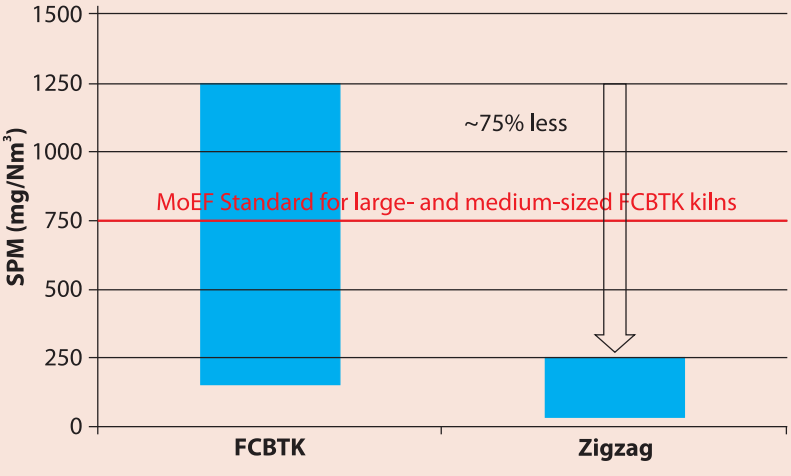

Figure 7 *Range of SPM emissions in FCBTK and Zigzag kiln*

emits 20% less CO_2 emissions and 75% less BC emissions as compared to those of an FCBTK (Figure 8).

3. Higher percentage of class-I bricks

A significant advantage of using a Zigzag kiln is the production of a higher percentage (80%–90%) of class-I bricks as compared to that of FCBTK (50%–60%) (Figure 9). An increase in the proportion of higher quality product results in an increase in the revenue for the brick-kiln owner and acts as a major incentive.

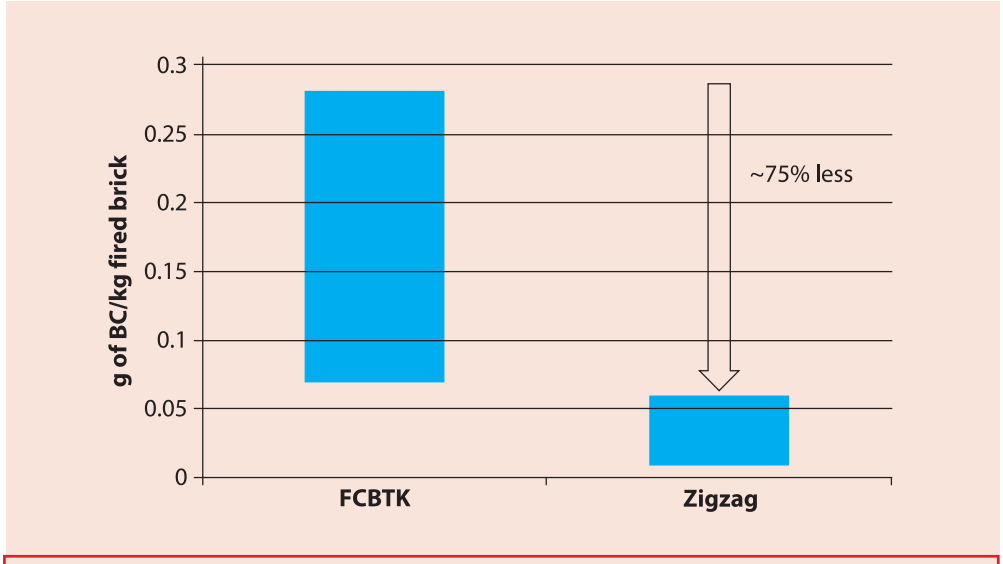

Figure 8 *Range of black carbon emissions in FCBTK and Zigzag kiln*

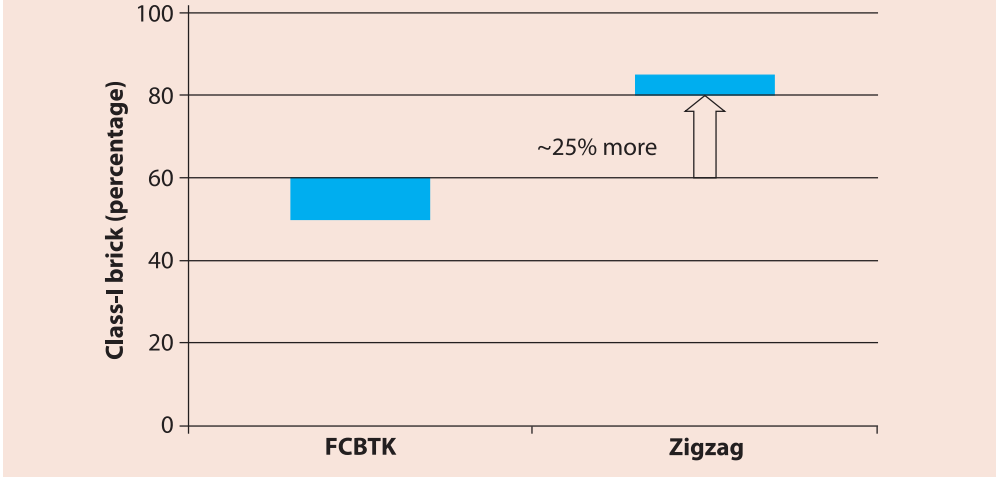

Figure 9 *Class-I brick production percentage in FCBTK and Zigzag kiln*

3.2. Retrofitting of FCBTKs into Zigzag kilns: a win–win proposition

Most of the FCBTKs can be retrofitted into natural or high-draught Zigzag kiln. The cost of retrofitting varies from Rs 10 lakh to Rs 25 lakh (Rs 1 million to Rs 2.5 million) depending upon the condition of the existing kiln and the extent of retrofitting required. Retrofitting involves:

- partial reconstruction of the chimney and reconstruction of the flue-ducts and the outer wall of the kiln (Figure 10a) and
- change from column-blade brick setting in FCBTK to chamber-wise brick setting for Zigzag (Figure 10b).

As mentioned earlier, at present there are more than 30,000 FCBTKs operational in India, producing roughly 500 billion kilograms of fired clay products annually.

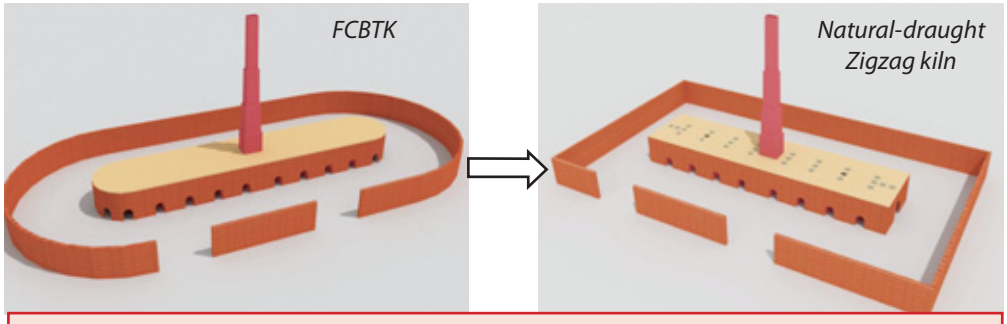

Figure 10a *Reconstruction of the kiln for switching from FCBTK to natural-draught Zigzag kiln*

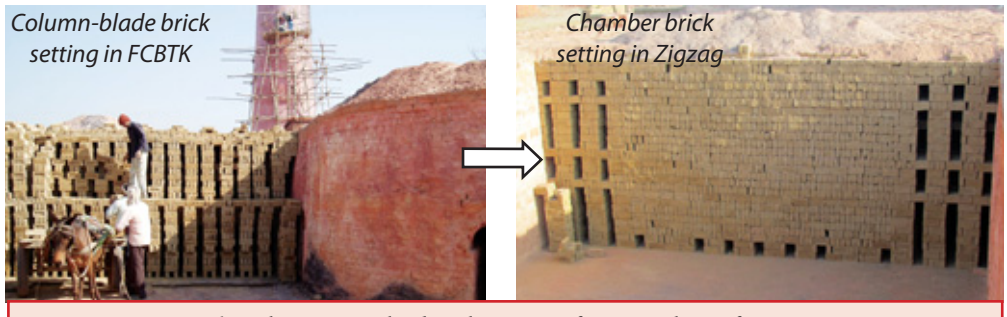

Figure 10b *Change in the brick setting for switching from FCBTK to natural-draught Zigzag kiln*

A 20% reduction in energy consumption through retrofitting of all FCBTKs into Zigzag kilns would result in an annual saving of approximately 6 MT of coal having a monetary value of Rs 3000–5000 crore.[4] Apart from coal savings, it will avoid release of about 455,000 tonnes (T) of SPM, 14 MT of CO_2, and 55,000 T of BC annually into the atmosphere. In order to convert all the FCBTKs to Zigzag kilns, the capital expenditure is estimated to be of the order of Rs 3000–7500 crore (Rs 30,000–75,000 million).

The conversion from FCBTK to Zigzag kilns benefits brick-kiln owners the most. The two-fold financial benefits – firstly through savings from reduced fuel consumption and secondly by increase in revenue due to the higher percentage of the highest quality product – make it a financially attractive proposition. Clay-fired bricks are locally produced and locally consumed. Therefore, the price of bricks and the price differentiation between the quality grades of bricks vary across the regions. Hence the techno-economics of conversion will vary from one region to the other. The conversion of a typical FCBTK located in eastern UP, Bihar, or West Bengal to Zigzag kiln would result in doubling the operating profit margin of the kiln. For a new construction, the capital cost of constructing a Zigzag kiln is equivalent to or in some cases marginally higher than an FCBTK; however Zigzag kiln yields higher profit margins. Box 3 provides the success story of a retrofitted FCBTK into a natural-draught Zigzag kiln.

[4] Considering the retail market price of coal to brick-makers as Rs 5000–8000/tonne.

Box 3: Success story of retrofitting of FCBTK to natural-draught Zigzag kiln

In 2011, Payal Bricks of Varanasi retrofitted its circular-shaped FCBTK into rectangular shaped natural-draught Zigzag kiln. The capital cost involved in retrofitting was about Rs 25 lakh (Rs 2.5 million). The owner is happy with the performance of the retrofitted natural-draught Zigzag kiln. According to the owner, in FCBTK, the coal consumption was 18 tonnes per lakh of bricks. After retrofitting, the coal consumption has come down to 13 tonnes per lakh of bricks. (This figure has been verified through an energy audit of the kiln.) There has been a significant increase in the share of class-I bricks, from 55% in FCBTK to 80% in natural-draught Zigzag kiln.

Today, Payal Bricks saves about 250 tonnes of coal annually, resulting in monetary savings of Rs 20 lakh (Rs 2 million). The increase in revenue due to higher percentage of class-I bricks results in additional revenue of about Rs 30 lakh (Rs 3 million). Overall the capital cost of conversion (Rs 25 lakh or Rs 2.5 million) was recovered in 6 months time.

4. The Way Forward

Transtion to cleaner brick production offers immense potential for energy savings. In addition, there are reductions in SPM, BC and CO_2 emissions, improvements in the incomes and working conditions of workers, and production of better quality building material. Wide-scale adoption of clean and efficient brick-firing technologies such as Zigzag firing technology, production of hollow clay-fired bricks and non-fired non-clay bricks are the main technological solutions for cleaner brick production.

Transformation of the brick industry requires a national-level policy framework aiming at cleaner brick production in India. China and Vietnam are excellent examples where transformation of the brick industry is driven through comprehensive national-level policy on building materials including bricks. Box 4 describes the Vietnamese building material policy.

Retrofitting of FCBTKs into Zigzag kilns offers a win–win approach for brick makers, Government, and society and could be the first step towards cleaner brick production in India. Transition of the existing FCBTKs to Zigzag firing technology would require: (1) introduction of regulation and policies at both central and state levels that encourage adoption of cleaner brick-firing technologies, (2) an effective technology delivery system, and (3) financial instruments specifically for upgradation of the brick industry.

The section below discusses the possible roles of various stakeholders including central and state governments, brick industry, technology providers and training

Box 4: Building materials (Brick) policy of Vietnam

In Vietnam, the production of bricks was estimated at 25 billion standard bricks in 2010. This is likely to increase to 42 billion standard bricks by 2020.

The main concerns addressed by the national policy on building materials are (1) the loss of agricultural top soil due to brick making, (2) excessive coal use and CO_2 emissions, and (3) the need for better insulation of the buildings for better thermal comfort and energy savings.

The main goals of the policy are:

a. Promotion of hollow clay-fired bricks through clean technologies such as tunnel kiln.
b. Promotion of non-fired bricks (with emphasis on light-weight bricks autoclaved aerated concrete blocks, foam concrete, etc.). The aim is to provide 30%–40% non-fired type bricks by 2020.

institutions, development agencies, and financial institutions that may have to work in close coordination for the smooth transition to Zigzag-firing technology.

4.1. Central Government - Ministry of Environment and Forests (MoEF)

At the central government level, the MoEF can take a lead role. The Ministry can amend the emissions standards for brick kilns, as suggested below.

1. No new FCBTK shall be allowed to come up after 30 June 2013.
2. The standards for SPM emissions shall be lowered to 250 mg/Nm^3 from the present standards of 750 and 1000 mg/Nm^3 for FCBTKs.
3. The existing FCBTKs need to be replaced by 30 June 2018 with kilns that meet the revised standards for SPM emissions.

The Ministry can also provide a list of accredited brick-kiln designs/technology suppliers. The list can be amended from time to time to accommodate new technologies and technology suppliers.

It should be noted that our neighbouring country, Bangladesh, has already announced a ban on operational FCBTKs in July 2010 and has instructed the brick industry to change over to cleaner brick-firing technologies within a period of three years.

Apart from MoEF, other central government agencies that can play a role in the dissemination of Zigzag and other efficient firing technologies are the Ministry of Power through the Bureau of Energy Efficiency (BEE) and the Ministry of Micro, Small and Medium Industries. While the BEE runs a programme for improving energy efficiency in micro, small, and medium enterprises (MSMEs), the Ministry

of Micro, Small and Medium Industries is overall responsible for the development of the MSME sector in India.

4.2. State governments

Active involvement of state governments in the development of the brick industry is highly desirable. In several states of the Gangetic region, the brick industry is not only the provider of one of the most basic building materials, but also a major industry in itself in terms of providing entrepreneurship and employment opportunities to the local population.

The state governments can play an important role in:

- ensuring the implementation of the MoEF emissions standards through state pollution control boards,
- creating awareness amongst brick makers about the new technologies, and
- providing incentives to the industry to facilitate technology upgradation.

It is important to note that the Government of Bihar (Box 5) has taken a step in this direction with the formation of a high-level task force (being led by Bihar State Pollution Control Board) for the development of cleaner brick production in the state.

Box 5: Inter-departmental task force for cleaner brick production in Bihar

The Government of Bihar under an initiative towards low-carbon economy formed an inter-departmental task force involving various stakeholders for improving the brick sector in terms of pollution reduction, coal consumption, and use of top soil for brick production. A workshop was organized on 6 December 2012 by the Bihar State Pollution Control Board on cleaner brick production in Patna. The workshop was inaugurated by the Hon'ble Deputy Chief Minister of the state and was attended by more than 170 brick-kiln entrepreneurs, service providers, and various government officials. The formation of the task force was facilitated by Development Alternatives, an NGO, under an initiative of Shakti Sustainable Energy Foundation. The task force has proposed several actions to promote cleaner brick production.

4.3. Technology providers and training institutions

Conversion of all the 30,000 FCBTKs in an orderly and accelerated manner would require an efficient and reliable technology delivery mechanism coupled with training of the owner, as well as the supervising and operating staff. The local technology suppliers could be technical training institutions, brick industry associations, individual brick makers, engineering consultants, etc. The initial phase would require training programmes aimed at building awareness of the Zigzag technology in the owners of existing FCBTKs, as well as training the supervisors

Box 6: Training module on Zigzag technology

Greentech Knowledge Solutions, in association with Nextgen Brick Training Academy, has developed a technology knowledge package and training module on Zigzag firing technology, with support from the Shakti Sustainable Energy Foundation. The first training programme on Zigzag-firing technology for brick-kiln owners was held on 20–26 June 2012 at Varanasi. Two more training programmes are scheduled in March and April 2013, respectively.

Participants of the first training programme on Zigzag-firing technology in Varanasi

A practical session during the training programme

and the operational workforce of the kilns to be converted. An example of a training programme aiming at capacity building of brick-kiln owners and their supervisors is provided in Box 6.

4.4. Development agencies

During the past 20 years, several development agencies such as the Swiss Agency for Development and Cooperation (SDC), the United Nations Development Programme–Global Environment Facility (UNDP–GEF), the Indo-Canadian Environment Facility (ICEF), and the Shakti Sustainable Energy Foundation (SSEF) have played an important role in introducing new technologies, creating awareness, policy advocacy, building capacities, and providing platforms for discussing developmental issues related to the brick industry. Development agencies can play an important role, particularly in the area of policy advocacy and training and development of the technology providers (or technology supply chain).

4.5. Financial institutions

Some relatively large brick-kiln owners may be in a position to self-finance kiln upgrades (e.g. retrofitting of FCBTKs into Zigzag kilns), but that is not the case universally. Small- and medium-size operators would need access to financial services for kiln retrofits. Further, entrepreneurs interested in setting up large modern brick manufacturing facilities would also need access to finance. At present, there are several constraints that make conventional bank financing inaccessible to the brick-makers. Some of the main constraints are listed below.

1. Most brick-kiln entrepreneurs operate on leased land and hence the land cannot be used for providing collateral security for availing loans.
2. A large part of the brick trade takes place in cash, which means that tax compliance is poor and the profit and loss accounts and balance sheets of brick enterprises do not reflect the true picture of the trade and in establishing credit worthiness.
3. Many brick-kiln entrepreneurs lack financial knowledge and the ability to prepare business plans and the documentation needed to apply for a loan.
4. Commercial banks have limited experience lending to the brick sector and do not currently offer financial instruments tailored to this sector.

Thus these multiple barriers to both lenders and borrowers necessitate a multipronged approach in the form of a Special Technology Upgradation Fund (STUF) for the brick industry (Box 7).

Box 7: Special Technology Upgradation Fund (STUF) for Brick Industry

The characteristics of the proposed STUF for the brick industry should be as follows:

1. Allocation of dedicated funds for lending to brick industry in the form of loans coupled with capital or interest subsidy.
2. Elimination of collateral requirements by operating the scheme under Credit Guarantee Trust Fund Scheme for Micro and Small Enterprises (CGTMSE)

Setting up the proposed STUF would provide a direct line of credit and would address the issues of collateral securities required for availing finance. An awareness-cum-capacity building programme for preparing the brick-kiln owners for availing financial incentives from the lending institutions and orientation programmes for lending institutes providing the overview and characteristics of the brick industry would also be required.

5. Conclusions

India is the second largest producer of clay-fired bricks in the world with an annual production of about 250 billion bricks. Brick kilns consume a large amount of coal and are an important source of air pollution in the country. About 70% of the brick production in the country takes place through the 30,000 brick-making units that are based on FCBTK technology. Retrofitting of the FCBTKs into Zigzag-firing technology offers a win–win opportunity not only for brick-makers (by doubling their profits) but also for the nation leading to annual savings of 6 MT of coal and abatement of 455,000 T of SPM, 14 MT of CO_2, and 55,000 T of BC. Policy and regulatory measures at central and state levels, coupled with an effective technology delivery system linked with access to finance, can play a crucial role in the dissemination of Zigzag-firing technology. The changeover to Zigzag kilns could be the first step towards modernizing the brick industry in India.

About Greentech Knowledge Solutions Pvt. Ltd

Greentech is a niche research and consulting firm providing sustainable energy solutions. Founded in the year 2007 and based in New Delhi, Greentech provides following services:

- **Cleaner brick production**: Greentech carries out energy and environment monitoring of brick kilns and provides consulting and training services for cleaner brick production. Greentech is considered as one of the premier consulting agencies in this sector in the developing world and has been providing consulting and training services in India, Nepal, Vietnam, and South Africa under projects supported by UNDP, UNEP, Swiss Agency for Development and Cooperation, etc.
- **Energy-efficient building design**: Greentech carries out a systematic analysis of the climate, desired comfort conditions, demand for energy, and availability of resources. It uses sophisticated building energy simulation tools to come up with low energy design concepts for buildings and campuses including integration of solar energy. Greentech is also a Project Management and Technical Unit (PMTU) of the prestigious Indo-Swiss Building Energy Efficiency Project being implemented by the Bureau of Energy Efficiency, Ministry of Power, Government of India.
- **Solar energy applications**: Greentech prepares feasibility studies, detailed project reports and solar energy roadmaps covering solar water heating, solar steam generation, and solar electricity production for industries and businesses. Greentech was awarded the 'Best Consultant' award by the Ministry of New and Renewable Energy, Government of India, in August 2012.

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