Promoting Resource Efficient Brick Making in Bangladesh

Key Messages

Bangladesh brick industry is the fifth largest in the world, contributes 1% of the country’s GDP and employs more than a million people.

The sector is characterised by use of low efficiency technologies, high emissions and dominance of single raw material (clay) and product (solid clay brick) contributing to adverse impact on environmental pollution and health.

The Policy makers in Bangladesh are concerned with finding a solution to the adverse impacts of brick sector and have recently imposed a ban on most widely used Fixed Chimney Kilns (FCKs).

Bangladesh government is also commissioning large coal based super thermal power plants to deal with its energy crisis that is expected to generate large quantities of hazardous fly ash as by product.

Innovative technological options and policy measures are available that can help in dealing with the issues faced by brick sector and the looming problem of fly ash management. The FaL-G Brick (Fly ash- Lime- Gypsum) is one such technology that has been invented and patented in India. It is a climate-friendly technology that produces high strength fly ash bricks without using top soil & coal and completely eliminates carbon emissions.

This policy brief highlights the technical aspect of FaL-G, the benefits as well as challenges in introducing FaL-G technology in Bangladesh, the guiding principles for framing meaningful policies for promoting adoption of FaL-G technology based on Indian experience and policy measures.

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1. **Background**

   The brick industry in Bangladesh contributes to 1% of the country’s GDP and employs more than a million people. With 17 billion bricks being produced per year, Bangladesh stands as the fifth largest brick producer in the world. The Bangladesh brick industry has been growing at the rate of 2–3 percent annually with the rising demand for construction materials to cater to the infrastructure growth. The growth in the brick industry is also driven by a rapidly rising population, with high rate of migration to the urban areas. Bangladesh has a population of about 153 million and at current growth rate, Bangladesh will need to construct approximately four million new houses annually to meet the demand of the growing population.

   Bangladesh’s brick sector is dominated by small scale brick entrepreneurs with limited financial capacity and characterized by outdated technologies with low energy efficiency, high emissions and dominance of single raw material (clay) and product (solid clay brick). Brick production is threatening food security, environment and forests, consuming around 45 million tonnes of fertile agricultural soil in the process. Currently, the total farmland in Bangladesh is about 14 million hectares and brick making is depleting it by about 80,000 hectares every year. Given this trend, the competing use of already declining fertile agriculture land for brick manufacture will push the country towards the brink of severe food shortages in near future. The brick industry is also heavily reliant on coal and fuel wood with an estimated 3.5 million tons of coal and 1.9 million tons of wood being consumed annually. As price and availability of coal is an issue, many entrepreneurs set up their units close to forest areas to have easy access to wood, which is increasingly leading to large scale de-forestation. Bangladesh Department of Environment has recently established regulations that ban the use of Fixed Chimney Kiln technology and fuel wood and the industry is on the lookout for better technologies. This is on account of lack of reliable alternative technologies that although use relatively less energy, do not completely eliminate its requirement and they are still faced with the problem of agricultural land degradation.

   The current brick making technique also has adverse impact on environmental pollution and health. The analysis from various reports indicate that almost 38 percent of the particulate matter (PM) pollution in and around Dhaka is caused due to brick kilns in addition to being a major source of GHG emission. The brick workers are also exposed to high concentrations of PM posing health hazard. Due to the use of crude techniques it involves considerable drudgery at workplace, exposure to sun for long hours, high concentration of dust and open fire during manual feeding of coal. As brick kilns only provide seasonal employment for six months, majority of the workforce are migrants, with poor remuneration.

2. **Policy Priorities for Brick Sector in Bangladesh**

   The Policy makers in Bangladesh are concerned with finding a solution to the adverse impacts of brick sector to environment, forests, land and health. Movable Chimney Bulls Trench Kilns (BTK) was the predominant technology prior to 2004. But due to poor environmental performance, government imposed a ban on this technology in 2004. After this Fixed Chimney Kilns (FCKs) became the most adopted technology. The FCKs constitutes more than 90 percent of kilns, but they are also highly polluting and relatively inefficient. The government therefore issued a notification in September, 2013 imposing a ban on FCK and its gradual phasing out to other technologies. So the FCKs are now gradually converting to coal-based Zig zag kilns and gas-based Hoffman kilns.
The current status of brick industry in Bangladesh is highly unsustainable and needs to upgrade in order to save valuable natural resources, reduce air pollution, and increase energy efficiency. Innovative technological options and policy measures are available that can help ensure resource conservation and manage these issues in a manner that can address the problems currently being faced by the brick industry and the policy makers. The FaL-G Brick (Fly ash- Lime- Gypsum) is one such technology that has been invented and patented in India. It is a climate-friendly technology that produces high strength fly ash bricks without using top soil and coal and completely eliminates carbon emissions.

This policy brief highlights the technical aspect of FaL-G, the benefits as well as challenges in introducing FaL-G technology in Bangladesh, the guiding principles for framing of meaningful policies, learning’s drawing upon the Indian experience and policy measures for promoting adoption of FaL-G technology in the brick making sector. A possible approach that Bangladesh can follow for adoption of the FaL-G brick in construction and building sector is also highlighted.

3. Technical aspect of FaL-G and its applicability in Bangladesh

Clay brick manufacturing involves two key processes: i) producing green bricks (clay bricks before firing are called ‘green bricks’), and ii) sintering/firing the dried up green bricks in a kiln. The sintering process requires thermal energy. Production of FaL-G bricks and blocks in contrast, does not involve any thermal energy, because the product sets and hardens through hydration chemistry, similar to cement.

The FaL-G technology works with the strength of combined hydration chemistry of fly ash, lime and gypsum. As a first step the 3 main ingredients viz. fly ash, lime/cement and gypsum plus water are mixed. This is followed by manual/mechanical casting and lining up the bricks on the platform or casting yard for drying for one or two days. The dried up bricks are stacked and cured with water for one to two weeks, depending on the ambient temperature upon which the product is ready for despatching to the market. FaL-G does not require energy intensive equipment such as heavy duty-press and/or autoclave, which otherwise are required in case of only fly ash and lime brick production. The key ingredients of the FaL-G are available in the form of wastes and by-products from industrial activities. FaL-G technology is developed in two approaches, viz. “FaL-G in lime route” and “FaL-G in Cement route”. The patent specifications on FaL-G cover both the approaches. Though FaL-G technology was primarily developed using lime, ordinary Portland cement (OPC) was identified as a source of lime to facilitate pozzolanic reactions in FaL-G system. These two approaches have significant bearing on technical point of view in the context of LT (low temperature) fly ash and HT (high temperature) fly ash. Research has established that LT fly ash goes well with lime whereas HT fly ash goes well with OPC as per 28-day strength. However, for both the fly ashes either of the routes is interchangeable depending on the logistics of raw material availability and economics, resulting in moderate deviations in strength development pattern. This aspect will allows flexibility in adoption of the technology. By-product lime is available at almost 1/3rd of the mineral lime cost. Otherwise, it is economical to use Ordinary Portland cement (OPC) over mineral lime and, hence, OPC is preferred in areas where by-product lime is not available. Therefore depending on the availability of lime in Bangladesh, either route can be taken up. The following table 1 gives the raw material inputs per cubic meter, for typical recipes, where the density of FaL-G brick/block is 2,000 kg / m3. If sand and/or stone dust is replaced by fly ash as filler, the density of the product comes down to 1700-1800 kg/m3.
### Table 1: raw material inputs per cubic meter in FaL-G bricks

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<thead>
<tr>
<th>Ingredients</th>
<th>Lime route</th>
<th>Cement route</th>
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<tr>
<td></td>
<td>Weight ratio (%)</td>
<td>Kg</td>
</tr>
<tr>
<td>Fly ash</td>
<td>15</td>
<td>300</td>
</tr>
<tr>
<td>Lime [as Ca(OH)2]</td>
<td>7.5</td>
<td>150</td>
</tr>
<tr>
<td>Cement</td>
<td>--</td>
<td>--</td>
</tr>
<tr>
<td>Gypsum</td>
<td>2.5</td>
<td>50</td>
</tr>
<tr>
<td>Filler (aggregate)</td>
<td>75</td>
<td>1500</td>
</tr>
<tr>
<td><strong>TOTAL</strong></td>
<td>100</td>
<td>2000</td>
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But FAL-G option makes sense only if flyash is available—which is the main raw material for this brick. In order to address the energy security problem and keeping in mind the declining gas reserves, The Government of Bangladesh has embarked on an ambitious plan to set up large coal based super thermal power plants. It is estimated that 1.3 million cubic feet of fly ash will be generated from these power plants alone, and is estimated to reach an alarming level of 9.5 million cubic feet by 2018. The flyash management and its possible use, therefore, is a subject that is of great value to Bangladesh and makes FAL-G option worth an assessment in that context.

### Bangladesh’s Energy Shortage

Bangladesh faces up to 1,800 MW of load shedding. According to the latest data from the Power Division of the Ministry of Power, Energy, and Mineral Resources, the country’s generation capacity is about 3,800–4,300 MW, with a peak demand of about 5,500–5,800 MW. In addition, more than 88 percent of electricity is generated from natural gas–based power plants. The reserve of natural gas is limited and fast depleting, and domestic production is expected to peak soon if new reserves are not found. Under these circumstances, the GOB has decided not to provide natural gas to brick kilns, and existing gas-fired ones face closure due to supply shortage. The country expects an enormous increase in electricity demand as economic growth continues (at a rate of 5–6 percent per year). As supply shortages of natural gas are likely to grow in the future, more coal might be demanded for power generation and industrial sectors. - Source: Government of Bangladesh (2010)

### 4. Benefits of promoting Fal-G Technology

Fal-G production process contributes to a host of environmental and social benefits. On the environmental aspect, FaL-G brick units do contribute in many ways such as:

- **Conservation of top soil**
- **Utilisation of industrial by-products**, otherwise would have caused pollution. This includes an effective way of managing flyash generated from coal based power plants
- **Conservation of Fossil fuel**
- **Avoidance of local pollution** on account of elimination of the sintering process
- **Abatement of GHG emissions**
In addition, adoption of Fal-G technology would also impact different stakeholder groups as highlighted below:

- **Local communities**: reduced negative environmental and health impacts on account of better workplace environment. Round the year livelihood and reduced drudgery.
- **The global community**: Reduction in GHG emissions and contribution for our fight against climate change.
- **Local Government**: better waste management and overcoming pressing local environmental issues by promoting the concept of circular economy
- **Industrial sector**: production of better quality bricks with reduced resource input as well as reduced cost of waste disposal

3. **Indian policy experience and learning’s from fly ash management**

Out of approximately 2,00,000 MW total power generated in India, about 70% in produced by thermal power plants (TPPs). With 80 billion tonnes coal reserve, majority of TPPs (84%) are run on coal and rest on gas (13%) and oil (3%). About 260 million tonnes (MT) of coal (65% of annual coal produced in India) is being used by TPPs. Presently over 112 Million Tonnes of fly ash is being generated by TPPs as a byproduct, which poses a serious environmental and health hazard and has a high disposal cost (Rs. 50-100/Metric Tonne) and also requires large area of land for disposal through conventional methods.

In order to protect the environment, conserve top soil and prevent the dumping and disposal of fly ash generated from coal or lignite based thermal power plants, Government of India has two inter-related strategies (i) limiting fly ash generation by reducing the ash content of coal in power plant; and (ii) enhancing fly ash utilization by policy intervention. While ash generation and its disposal is a massive problem in India, it was only in late 1990s that policies to counter this was first framed at the national level. The earlier notifications of 1997 and subsequent amendments in 1998 focused on reducing ash generation primarily focussing on using low ash coal. However, the 1999 notification and subsequent other notifications shifted its focus for enhancing fly ash utilization. While the mandate under the 1999 notification was to provide free fly ash to its potential users, MoEF, GOI notification dated 3 November 2009 made it a saleable commodity. Fly ash was also shifted from the category of "Hazardous Industrial waste" to the category of "Waste material" in the year 2000. However, it became a saleable commodity subject to certain conditions, since November 2009 with the comprehensive MoEF, GOI notification dated 3 November 2009 in which fly ash was redefined which included ash collected from ESP, dry fly ash, bottom ash, pond ash from coal/ lignite based TPP including captive power plants (CPPs). Also fly ash was made a saleable product subject to condition that (a) pond ash should be made available free of any charge on "as is where is basis" to manufacturers of bricks/tiles, farmers, Central and State road construction agencies, PWD, agencies engaged in backfilling of abandoned mines and (b) at least 20% of dry fly ash shall be made available free of charge to fly ash brick/tiles manufacturers on priority basis over other users.

The key features of MOEF 2009 notification are:

“(1A) Every construction agency engaged in the construction of buildings within a radius of hundred kilometers (by road) from a coal or lignite based thermal power plant shall use only fly ash based products”;
“(1B) All construction agencies of Central or State or Local Government and private or public sector shall submit annual returns to the concerned State Pollution Control Board or Pollution Control Committee”;

“(1C) Minimum fly ash content for building materials or products to qualify as “fly ash based products

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<th>S No.</th>
<th>Building Materials or Products</th>
<th>Minimum % of fly ash by weight</th>
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<tbody>
<tr>
<td>1</td>
<td>Fly ash bricks, blocks, tiles, etc. made with fly ash, lime, gypsum, sand, stone dust, cement, etc. (without clay).</td>
<td>50% of total raw material</td>
</tr>
<tr>
<td>2</td>
<td>Paving blocks, paving tiles, checker tiles, mosaic tiles, roofing sheets, pre-cast elements, etc. wherein cement is used as binder</td>
<td>Usage of PPC (fly ash) or 20% of OPC content</td>
</tr>
<tr>
<td>3</td>
<td>Cement</td>
<td>20% of total raw materials</td>
</tr>
<tr>
<td>4</td>
<td>Clay based building materials such as bricks, blocks, tiles, etc</td>
<td>25% of total raw materials</td>
</tr>
<tr>
<td>5</td>
<td>Concrete, mortar and plaster</td>
<td>Usage of PPC (fly ash) or 20% of total raw material</td>
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Further to 2009 modifications, MOEF has recently released the draft fly ash notification, 2015. According to the notification, construction activities happening 500 km around power plants should use only fly ash bricks. This indirectly implies a ban on clay bricks and use of only fly ash based bricks in whole of India except few north eastern states. This notification is yet to be formalised but so far, pro-active policy measures and technology support have led to following encouraging results:

- Over 18,000 FaL-G brick plants are now in operation throughout India
- Fly ash bricks account for about one sixth of India’s annual brick production.
- Fly ash brick plants use over 25 million tons of fly ash, helping the country tackle this environmental menace
- FaL-G technology is providing workers a stable year-round livelihood nearer their homes and allowing their children to attend regular school, giving them reason not to migrate to cities.

Although the adoption of FaL-G technology has had encouraging results, the widespread scale-up of FaL-G brick technology, like any new technology, faces a number of challenges. The clay brick production continues to remain the preferred option for the brick entrepreneurs as there are not much incentives for them to innovate or modernize. This is on account of a number of reasons. Clay brick activity is financially more remunerative as they are positioned in the informal sector in India, where compliance to tax regime is not strictly enforced. At the same time, enterprises based on FaL-G brick production are subjected to tax compliances. As a result, FaL-G technology is not provided a level playing field in comparison to conventional brick kiln technology, in spite of having a host of environmental and social advantages over conventional brick making. Further, the Fly-Ash although is provided free of cost, the brick manufacturers have to bear the cost of
transporting fly ash from thermal power plants to their production sites. In contrast, top soil for making clay bricks is easily available around production sites. To deal with these challenges, FaL-G entrepreneurs in India got together as Fly Ash Brick and Block Manufacturers Federation (FABMAFED) in the hope that collective strength and a strong institutional backing will help tilt the political economy in favour of the environment-friendly brick technology. So far, they have been quite successful in lobbying with the government on policy reforms favouring adoption of FaL-G technology over clay brick technology.

The Bureau of Energy Efficiency (BEE) (under the Ministry of Power) encourages the use of eco-friendly construction materials such as fly ash bricks, but its guidelines are voluntary. Experts feel that if BEE’s green building regulations become mandatory, the annual demand for fly ash bricks would go up to about 370 million units.

4. Factors to be considered for framing policies for promoting FaL-G brick technology
Based on the learning’s from India, this section articulates the possible barriers that Bangladesh may face in the introduction of the FaL-G technology. It is important to consider these possible challenges while framing policies for promoting Fal-G and for its subsequent mainstreaming

4.1 Lack of motivation to change: Burnt clay bricks is the most popular form of walling material in the country. They are cheap and have traditionally been believed to be the most suitable walling material for building construction. Although alternative building materials, such as cement concrete blocks and hollow Bricks/ blocks are available, they only account for a minuscule percentage of the total market for walling material in the country. Further, clay brick production is a simple activity and is practiced even at the tiny and cottage sector level that has been passed on from generation to generation. Small fired clay brick producers may have no incentives to introduce alternate technologies, which require new investments, training to stabilize the operation, and a different business practice with a longer term perspective. Production and use of burnt clay bricks are, therefore, considered to be the most common practice at present and is expected to remain a common practice in the future unless significant policy and regulatory mechanisms are evolved and enforced effectively. During the initial stage of market seeding, any kind of financial assistance would also speed up the uptake of this new technology

4.2 Overcoming user perception: In spite of various superiorities of the FaL-G brick over clay brick, the grey colour (imparted by the colour of fly ash) of FaL-G products may create a barrier in terms of low consumer acceptance. This is the common observation made by consumers during various informal discussions with stakeholders in Bangladesh. In addition to the colour, the presence of ash in the product also creates negative perception on the quality of the product. It is therefore important to educate the users and build their confidence in the new product through structured sensitization campaigns

4.3 Need for skill development: FaL-G is a proven technology in terms of the strength for use in walling material. However, the technology needs to be promoted among the entrepreneurs, and technical skills of artisans need to be developed for large scale implementation of this new technology.

4.4 Sourcing of raw materials: In contrast to the clay brick industry, where the basic raw material is the soil and available in and around the production sites, FaL-G technology and products require fly ash, cement and/or lime and gypsum as key ingredients. These ingredients are required to be sourced from industrial facilities, which will involve transportation cost. Therefore the FaL-G units
will have to be carefully located to ensure that the cost of transportation does not make it financially unviable.

5. **Way Forward for Bangladesh**

The timing for introduction of FaL-G technology in Bangladesh is right as the government has recently banned FCK technology, which have to be completely phased out by next year and at the same time government is commissioning large coal based super thermal power plants to deal with the energy shortage. These thermal power plants will produce large quantities of fly ash, which would pose a huge environmental and health hazard. With this background, technologies like FaL-G is quite relevant as while it would help in greening of the brick industry on one hand, it would also help Bangladesh in partly dealing with the issue of flyash management in years to come. Bangladesh Department of Environment and the Bangladesh Brick Manufacturers and Owners Association (BBMOA) are keen to introduce FaL-G brick technology in Bangladesh, wherein the inventors of the technology have agreed to disseminate it without any technology transfer fee.

However, as seen in India, successful scale up of the technology will need the involvement and support of not just the brick industry but other stakeholders, specifically, the policy makers. This will be particularly important for overcoming the barriers that a new technology like FaL-G will face in replacing conventional and well established and prevailing methods of brick manufacture. Indian experience with the FaL-G technology provides lot of learning that can help in shaping of favourable policies in Bangladesh, particularly in dealing with the implementation challenges that are quite similar in both the countries. Experience shows that scaling up of such technologies will require both ‘supply side’ push through technology assistance, capacity building and government policies that incentivizes adoption of such technologies as well as ‘demand side’ pull through favourable public procurement policy that promotes sourcing of resource efficient brick by construction/Building Companies and through a well-designed awareness campaign for educating public at large. Some of the key recommendations that can be considered while policy formulation are:

i. **Demonstration of FaL-G technology:** As with any new technology, there will be a need for dissemination of information about resource efficient products and technologies like FaL-G, and educating the entrepreneurs and users. Support in extensive applications particularly in government building and construction activity will also help to improve the technologies and make them more commercially relevant. The best way to achieve this will be to establish a demonstration plant to build confidence of the brick maker as well as brick users. It would also help in customizing the technology and optimize the raw material mix as per the local availability and cost. The demonstration site can also be utilized for training, skill up gradation and dissemination of information to the user community.

ii. **Development of testing facilities/ Standards:** As this is a new technology and product there is a need to build confidence in the market with regard to its strength and other properties. An institute like Bangladesh University for Engineering and Technology (BUET) could be requested to review the present Building codes and Standards on building materials and consider incorporating suitable amendments in the existing standards to cover these materials, as the case may be on an on-going basis for acceptance by major government and private builders, housing boards etc. The testing of FaL-G bricks/blocks, can be undertaken based on the national standards or guidelines applicable to bricks. Here the role of BUET as apex technical support agency could be extremely useful.
iii. **Develop local capacity for manufacturing of plant and machinery:** The know-how and expertise in processing fly ash for production of FaL-G Bricks and Blocks, and adequate testing infrastructure are prerequisites for scale up of such technologies. While import of machinery for FaL-G brick production and necessary know-how may be allowed on easy terms in the initial period, the focus should be on developing local manufacturing facilities for its sustenance and mainstreaming in the long-run.

iv. **Support to Entrepreneurs in the market seeding stage:** Technical, infrastructural and financial support needs to be provided to encourage rapid building up of capacity for fly ash bricks and blocks, and markets for the same. The financial incentives to entrepreneurs could be in the form of free fly ash, transport subsidy, tax holiday, preferential purchases by govt. bodies, cheap land near TPPs, etc. Retail outlets and distribution network could be provided, if need be.

v. **Framing of favourable policies:** In India the rapid scale up of FaL-G brick manufacturing technology can be attributed to government policy mandating the use of fly ash products within 100 km radius of thermal power plants. Policies along similar lines that promote use of fly ash bricks and other products in the construction activities and building material, in particular those carried out by government agencies, will help in creating market and demand for such technology. Use of such products in government buildings will also help in in creating awareness and building confidence among private sector builders and consumers and provide a level playing field to this new technology/product.

vi. **Structured sensitization campaign:** The Fal-G technology, although having many advantages will also face the challenge of competing against traditional product which are in use for ages. In order to sensitize the users about the advantages of Fal-G, it is important to launch a structured dissemination campaign that educates the consumers not only about the product quality but also the environment friendly way of manufacturing this new product. It is best if this campaign is spearheaded by Government agency like Bangladesh DoE.